wellcome

Young people's views on science education

Science Education Tracker Research Report February 2017

THE ROYAL SOCIETY

Department for Business, Energy & Industrial Strategy

Science Education Tracker

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Kantar Public

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Foreword

Welcome to the report of the first Science Education Tracker. This new survey will build our understanding of the experiences, aspirations and intentions of young people across England with respect to science and related disciplines.

There are some reassuring findings in this representative study of over 4,000 young people. They express high levels of interest in science, science lessons and science careers. These findings reinforce those of Programme for International Student Assessment (2015) in which the UK was one of just seven countries occupying a sweet spot of above average attainment, engagement and career aspiration in science. This positioning is vital if we want young people to do well in science, apply it in their day-to-day lives and build our science related workforce.

Should we need reminding, this report confirms the central role that teachers play in the lives of young people: determining the nature of the science they are taught; providing career advice and enrichment; and encouraging them to learn. It is crucial that teachers' professionalism and skills are both celebrated and developed.

Science is an inherently practical subject – young people shouldn't just be learning scientific facts they should be learning how to experiment. The Science Education Tracker provides new insights into practical science in schools. It shows how motivating young people find practical work and that most of them want to do more. However, it also reveals alarming variations in frequency and type of practical science. We must address these inequalities.

Many students reported they had taken part in extra-curricular activities that encouraged them to learn science, such as attending talks by STEM Ambassadors, going to science fairs or doing long term projects. Schools also have a role to play in helping young people to organise work experience, especially those without family networks. Twice as many young people told us that they would have liked to do science related work experience than had been able to do so. There is plenty of scope to expand such opportunities.

Overall, the findings convey the complex relationships between various aspects of young people's relationships with science - their interest, desire to learn, confidence, attainment and aspirations - and the educational opportunities they have. These relationships vary with gender, ethnicity, school area and family background. Our learning here is that any interventions must be carefully tailored to their goals and the participants involved.

The Science Education Tracker will help us to plan Wellcome's activities and we hope that it is useful to those with an interest in improving science outcomes for young people. The research data are freely available at the UK Data Archive and we encourage researchers to exploit them further; we have barely scratched the surface.

Dr Hilary Leevers

Head of Education and Learning

Wellcome Trust

Executive summary

Introduction

- This report presents findings from the 2016 Science Education Tracker (SET) survey, a survey of young people conducted by Kantar Public on behalf of Wellcome and supported by the Royal Society, the Department for Business, Energy and Industrial Strategy (BEIS) and the Department for Education (DfE).
- The SET survey is designed to provide evidence on a range of key indicators for science engagement, education and career aspirations among young people in England.
- The survey is based on a nationally representative sample of 4,081 young people in school years 10 to 13 (aged 14-18) attending state-funded schools in England.
- Fieldwork was conducted online between June 29th and August 31st 2016.

Chapter 1: Science outside the classroom

- Having strong family science networks was related to several science outcomes including visiting science-related attractions and future aspirations to study science. Young people from less affluent backgrounds were less likely to hold family science connections. A Family Science Connection Index (FSCI) was constructed to measure the strength of young people's family science networks.[1]
- A fifth of young people (20%) had visited a science museum or planetarium in the previous 12 months. Attendance was higher amongst young people with the following characteristics: high science attainment, strong family science networks, living in more affluent neighbourhoods, and living in London or the North East.
- Mothers were important routes of access to science museums, accompanying young people in 38% of reported visits, while schools supported young people in 36% of cases. Parental support was highest within white families and where parents were university-educated. School-led access on the other hand was higher among Asian young people, those with lower science attainment and when neither parent had attended university.
- Seven in ten young people (68%) had watched, read or listened to science-related content in the last 12 months via TV, print and online channels. Consumption of science content was most common among young people in Year 10 (73%) thereafter declining by age to 64% of Year 13s.
- Half of young people (53%) said that they were very interested (13%) or fairly interested (40%) in hearing more from scientists about the research they are conducting.

[1] See chapter 1, section 1.1 for further details on the Family Science Connection Index (FSCI).

- Three in ten young people (30%) had participated in an extra-curricular school science event, for example a science-related talk (20%). Two-fifths (41%) of those who had participated in extra-curricular science stated that these experiences had motivated them to study science, computer science, engineering or maths. BME males were especially likely to feel encouraged by these types of activities (61%).

Chapter 2: Science at school

- Biology was the most enjoyed science subject, ranked third out of the subjects asked, behind English and maths.
    - There were substantial gender differences in the enjoyment of subjects. For example, males ranked physics third out of seven subjects while females ranked the subject last.
- Young people considered exam success in science, maths and English to be a balance of natural ability and hard work. Success in science was, however, more related to hard work than success in English or maths.
- More than two-thirds of young people (68%) said they found science lessons at school very or fairly interesting.
    - Males were more likely than females to find science lessons interesting. This gender gap was only evident, however, among young people from white backgrounds.
- After ‘finding science interesting’, the most important factors encouraging young people to learn science were ‘having a good teacher’ and ‘enjoying practical work’. In both cases, 35% of young people said this had encouraged them.
    - Conversely, the most common factor cited by young people as putting them off learning science was ‘having a bad teacher’, mentioned by one in three young people (33%).
- Females were more likely to have been put off learning science than males: 22% of males said nothing had discouraged them from learning science, compared with 11% of females.
    - In particular, females were much more likely to say they had been put off by finding science more difficult than other subjects (35%, compared with 22% of males), or because they have difficulty with the maths involved (26%, compared with 13% of males).

Chapter 3: Practical science

- A little under half (45%) of GCSE students reported doing hands-on practical work in science lessons at least once a fortnight, but three in ten (29%) reported doing it less than once a month or never.
- The majority of GCSE students (58%) said they wanted to do more practical work in science lessons. This was higher for single science students, three-quarters of whom said they wanted to do more practical work (76%).[2]
- Young people often do not understand the purposes behind the practical work they do in science lessons: 22% said that they simply follow instructions without understanding the purpose of the work 'a lot of the time'.
- Young people at higher performing schools reported doing practical work more often, although greater frequency of practical work was not associated with higher scores on the science knowledge quiz. However, young people who reported doing more advanced practical work (such as designing and carrying out their own experiment) achieved higher scores on the science quiz than their peers who had not done this kind of work.
- Young people's experience of practical work varied substantially depending on the science GCSE course taken:
    - Single science students were less likely to have done more advanced practical work such as designing and carrying out their own experiment (62%, compared with 83% of triple science students).
    - Triple science students reported doing hands-on practical work more often (52% at least once a fortnight, compared with 37% of single science students) while single science students more frequently watched videos of practicals (44% at least once a fortnight, compared with 37% of triple science students).
    - Single science students were more likely to say they wanted to do more practical work (76%, compared with 49% of triple science students).
- Young people from more deprived areas did less practical work in GCSE science lessons than young people from less deprived areas.
    - 36% of GCSE students from the most deprived areas reported doing hands-on practical work at least once a month, compared with 54% of those from the least deprived areas.
    - 69% of GCSE students from the most deprived areas reported designing and carrying out their own experiment, compared with 84% of those from the least deprived areas.

[2] See the Glossary (Appendix E) for definitions of the different GCSE science courses (single science, double science, triple science).

Chapter 4: Science at GCSE

- Three-quarters of young people (75%) said that they studied either triple science (37%) or double science (39%) at GCSE. While this *overall* rate matches official figures, there is evidence that some young people in the survey misclassified double science as triple science due to confusion in terminology.
- Based on the survey classification, young people living in the most deprived areas were much less likely to study triple science than those living in more affluent areas. Asian males were more likely than other ethnicity/gender groups to study triple science.
- Young people who studied triple science were more likely than those studying other science GCSE courses to study (or intend to study) science subjects at Years 12 and 13.
- Triple science students had more timetabled science hours than students studying other science courses: half of triple science students (54%) cite 6 or more weekly hours compared with 20% of double and 13% of single science students.
- Amongst those who didn't study it, barriers to studying triple science were classified into three types: 58% cited personal barriers such as lack of confidence or interest; 41% cited school selection barriers such as not achieving the grade required; while 23% cited school access barriers (i.e. their school didn't enter any students for the course). While most students who took a non-triple science pathway were content with this, 16% would have liked to study triple science if it had been available to them.
- Among students who didn't study triple science, 30% cited lack of confidence as a reason for not studying it. While females (36%) were more likely than males (24%) to cite this, there was evidence that this was due in part to an under-estimation of ability among female students.
- One in five students (18%) said that they had studied or were studying computer science at GCSE: 25% of males and 9% of females. Analysis by year group indicates a rise in computer science entries between 2014-15 and 2015-16 corresponding with a fall in ICT GCSE entries, a pattern which reflects national trends.
- Key barriers to studying computer science were lack of availability and interest. Females were especially likely to lack interest in the subject. Lack of access declined rapidly through age cohorts such that only 16% of Year 10 students in 2015-16 said that computer science was unavailable at their school. This reflects government policy to widen access to this subject.

Chapter 5: Science at Year 12 and beyond

- Intentions to continue in education are strong:
  - 57% of all young people were thinking of studying for a higher education qualification in any subject, with a further 29% undecided.
  - More than nine in ten young people in Years 10 and 11 (93%) were considering continuing studying in any subject after Year 11. Three-quarters (75%) were 'definitely' planning to continue their studies, with a further 18% undecided.
  - However, only 74% of young people in Years 12 and 13 were actually studying for a Level 3 qualification. This suggests that a sizeable proportion of the young people in Years 10 and 11 considering further study will not go on to study for a Level 3 qualification.
  - The largest gaps between aspirations of young people in Years 10/11 and actual behaviour of young people in Years 12/13 was among those eligible for free school meals in the last six years and those from the most deprived areas. For example, more than nine in ten (93%) young people in Years 10/11 in the most deprived areas said they were intending to study beyond Year 11, but only 60% of young people from similarly deprived areas were studying for Level 3 qualifications in Years 12/13.
- Males were less interested than females in continuing in education. However, males were more likely to be interested in studying maths or science subjects:
  - 69% of males were planning to continue their studies after Year 11 and 50% were thinking of studying for a higher education qualification, compared with 79% and 63% of females respectively.
  - 66% of males studying for a qualification in Year 12 or 13 were taking at least one maths or science subject, compared with 57% of females.
  - 55% of males thinking of studying for a higher education qualification were considering a Maths or Science subject, compared with 49% of females.
- Higher education subject choices were heavily gendered:
  - Males were more likely than females to be interested in studying maths, physics or computer science. Females on the other hand were more likely to be interested in biology, psychology or health related subjects such as medicine / dentistry.

Chapter 6: Science as a career

- A large majority (90%) of young people said they had received careers advice from at least one source, although a third of students (33%) said they had not received advice from their school or college.
- About two in five (43%) of young people were interested in a science-related career with 19% stating that they were 'very interested'.
  - Females (35%) were less interested in a science-related career than males (51%).
  - Young people from white backgrounds (39%) were also less likely to be interested in a science-related career than those from Asian (61%) or black backgrounds (61%). Young white women in particular were less inclined to pursue a science-related career (30%).
- Young people from lower income backgrounds, as defined by free school meal eligibility and area deprivation, were just as likely to aspire to a science-related career as those from higher income backgrounds. They were however less likely to agree that science-related careers are 'suitable for someone like me'.
- Young people with strong family science connections were more likely to be interested in a science-related career (59%) and to have done relevant work experience in this area (22%) than young people with weak family science connections (33% and 8% respectively).
- Perceptions of science-related careers were generally positive: 72% agreed that 'science careers are open to anyone who has the ability, regardless of their background.' One in ten agreed they are 'more suited to men than women.'
- Only 13% of young people have participated in a work experience placement in science, computer science, engineering or maths at some stage (from 8% among those in Year 10 to 15% among those in Year 13). This rises to 30% among those with a firm interest in a science-related career. Over a quarter of young people (27%) reported wanting to secure science-related work experience but being unable to do so.

Introduction

Background and objectives

The Science Education Tracker (SET) is a new survey of young people in Years 10 to 13 attending state-funded schools in England. The survey was conducted by Kantar Public on behalf of Wellcome with support from the Royal Society, the Department for Business, Energy and Industrial Strategy (BEIS) and the Department for Education (DfE). The survey provides evidence on key indicators for science engagement, education and career aspirations among young people in England.

The SET survey has 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 how this influences decision-making around science-based subject 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 is focussed on England, while the Wellcome Monitor covered the whole of the UK; and the sample size was substantially increased to allow more detailed analysis by school year cohorts and population subgroups.

Methodology

Further information about the survey background and methodology can be found in Appendix D while full details can be found in the detailed Technical Report. Key details are as follows:

- The sample is a random sample of young people in school years 10 to 13 (aged 14-18) attending state-funded education in England. It was drawn from a combination of the National Pupil Database (NPD) and the Individualised Learner Record (ILR).
- All sampled individuals were sent a letter inviting them to take part in a survey; for young people aged under 16 correspondence was directed via parents. Respondents then completed the survey online.
- 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 drew on existing surveys such as the Wellcome Monitor, as well as newly developed questions for this survey. The questionnaire wording and content was also informed by focus groups with young people commissioned by Wellcome at the outset of the project. All new questions were cognitively tested with young people prior to administration.

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

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- A field pilot of c. 200 online completions was conducted before the main survey to test and pilot survey procedures.
- Respondents were able to complete the survey on any online device, including PCs, laptops, tablets, and mobile phones.
- 4,081 respondents completed the survey between June 29th and August 31st 2016, representing a response rate of 50%[4]. Questions related to the September 2015-July 2016 school year which respondents had recently completed.
- 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 in order to maximise the representativeness of the sample. The achieved sample closely matched the population on a range of demographic variables.

It is important to note that the sample design and mode of data collection differ from the 2009 and 2012 Wellcome Monitors. Therefore, while the Science Education Tracker has built upon the knowledge collected from the previous waves of the Wellcome Monitor, caution must be exercised in making comparisons with previous waves and drawing conclusions about changes over time.

Achieved sample

The table below gives the number of respondents across a range of demographic groups. See Appendix D (Table D.4) for a more detailed profile of the sample and comparisons to population totals.

Achieved sample			
	No. of respondents		**No. of respondents**
Academic year		***Region***	
Year 10	1,113	East Midlands	371
Year 11	1,086	East of England	492
Year 12	949	London	552
Year 13	933	North East	196
		North West	544
Gender		South East	695
Male	1,931	South West	400
Female	2,115	West Midlands	435
		Yorkshire & the Humber	392

[4] Response rate is calculated as: 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).

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Achieved sample (cont.)			
	No. of respondents		**No. of respondents**
Ethnicity		***Income Deprivation Affecting Children Index (IDACI – quintiles)***	
White	3,167	Most deprived (1)	840
Mixed	179	(2)	797
Asian	444	(3)	787
Black	172	(4)	827
Other	45	Least deprived (5)	826

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: 83% gave permission for their data to be linked. This administrative data include (amongst other data):

- eligibility status for free school meals;
- whether English is the young person's first language;
- academic results from Key Stage 2 and Key Stage 4[5];

The 17% 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

In the Wellcome Monitor, respondents were asked a series of true/false questions relating to knowledge of different areas of science such as genetic modification, DNA, electrons and mass. A very similar knowledge quiz was used in the Science Education Tracker.

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

- Low (23% of respondents) – 0-5 correct answers;
- Medium (57% of respondents) – 6-8 correct answers;
- High (20% 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

[5] 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.

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Key Stage 4 science results. A moderate Pearson's correlation coefficient of 0.5 was observed between quiz score and Key Stage 4 results. Further details about the scoring of the knowledge quiz can be found in Appendix D.

Ethnicity

Where analysis by ethnicity has been conducted we have in general compared findings across five subgroup categories: white, mixed, Asian, black and other. However, in some cases where the analysis is based on a sub-sample which is smaller than the total sample size, the subgroup sizes for individual ethnic groups are too small to permit this. In these cases we have used a broader comparison (white vs. BME).

Structure of report

The report is structured as follows:

- Chapter 1 explores young people's experience of science outside of school, including family connections to science and informal science learning in the local community.
- Chapter 2 examines young people's perceptions of science in relation to other school subjects and looks at the factors which encourage or discourage young people from learning science.
- Chapter 3 considers young people's experience of practical science at school.
- Chapter 4 looks more explicitly at science at GCSE, including an investigation of the barriers to studying triple science.
- Chapter 5 covers science learning at Year 12 and beyond, focusing on subject choices and higher education aspirations.
- Chapter 6 explores science-related career aspirations and the factors which encourage or discourage students from considering a career in a scientific field.

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

Appendices cover bibliography (Appendix A), additional data tables (Appendix B), multivariate analysis (Appendix C) and technical information about the survey (Appendix D). Across the report we will also use a number of acronyms and terms related to education, science and careers. For clarity, a glossary of terms and acronyms is provided in Appendix E.

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Reporting conventions

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

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’. Where a respondent refused an answer, they have not been included in the analysis for that question. “Don’t know” responses are included in all questions reported except where otherwise specified.

For consistency we have used the term ‘young people’ throughout the report to describe the sample of respondents. However, where we refer to young people in a school setting we also use the term ‘students’ for brevity.

1. 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. More specifically it considers the role of family networks, engagement with science learning in informal settings (i.e. outside of school such as in museums or watching television) and the extent to which family and schools facilitate access to these informal science learning opportunities.

Key findings

- Having strong family science networks was related to several science outcomes including visiting science-related attractions and future aspirations to study science. Young people from less affluent backgrounds were less likely to hold family science connections. A Family Science Connection Index (FSCI) was constructed to measure the strength of young people's family science networks.
- A fifth of young people (20%) had visited a science museum or planetarium in the previous 12 months. Attendance was higher amongst young people with the following characteristics: high science attainment, strong family science networks, living in more affluent neighbourhoods, and living in London or the North East.
- Mothers were important routes of access to science museums, accompanying young people in 38% of reported visits, while schools supported young people in 36% of cases. Parental support was highest within white families and where parents were university-educated. School-led access on the other hand was higher among Asian young people, those with lower science attainment and when neither parent had attended university.
- Seven in ten young people (68%) had watched, read or listened to science-related content in the last 12 months via TV, print and online channels. Consumption of science content was most common among young people in Year 10 (73%) thereafter declining by age to 64% of Year 13s.
- Half of young people (53%) said that they were very interested (13%) or fairly interested (40%) in hearing more from scientists about the research they are conducting.
- Three in ten young people (30%) had participated in an extra-curricular school science event, for example a science-related talk (20%). Two-fifths (41%) of those who had participated in extra-curricular science stated that these experiences had motivated them to study science, computer science, engineering or maths. BME males were especially likely to feel encouraged by these types of activities (61%).

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1.1 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 a family and children's future science aspirations, where science capital refers to the science-related networks and influences people can draw on. This includes family science skills, knowledge and qualifications; knowing people in science-related jobs; and opportunities to talk about science in informal settings (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 (see for example De Witt *et al.,* 2013).

In the Science Education Tracker we developed a Family Science Connection Index (FSCI) to help measure and explain the variation in family connections to science. The index was constructed by scoring and combining responses to the three questions displayed in Figure 1.1.

Figure 1.1 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 questions were then summed to create a scale with a minimum value of zero and a maximum value of 6.

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

- Low FSCI score (28% of respondents) – score of 0;
- Medium FSCI score (54% of respondents) – score of 1-3;
- High FSCI score (18% of respondents) – score of 4-6.

Thus, 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 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 or were considered to have an interest in science.

The distributions of scores on the three items and on the FSCI groups are shown in Figure 1.2. This indicates that nearly half (47%) of young people do not know anyone with a relevant job that they can talk to about scientific issues outside of school; 58% do not consider that (or know whether) either of their parents are interested in science; and 61% say that no-one within their immediate or extended family has a job in a science-related field. The proportion of young people who do not hold any of these family science connections (i.e. are assigned the lowest possible FSCI score) is 28%.

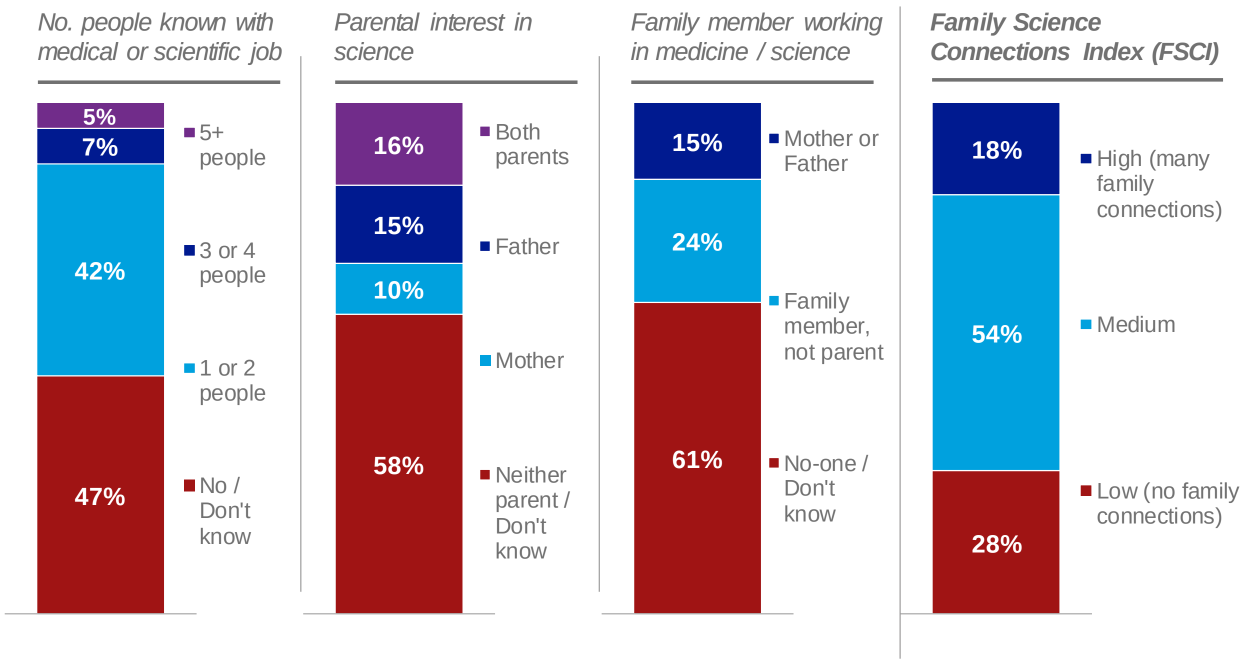
Figure 1.2: Constituents of Family Science Connections Index (FSCI)

Q. 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?

Q. Would you say your parents are interested in science?

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

Family Science Connections Index (FSCI): combining responses to these three questions



Base (All respondents): Number people known with medical or scientific job (4,018); Parental interest in science (3,891); Family member working in medicine/science (4,029); FSCI (3,841).

Note: 'Parental interest in science' excludes those who do not live with either parent.

Consistent with findings form ASPIRES (Archer *et al.*, 2013), family science connections were unevenly distributed across the student population (Figure 1.3).

Those with a low FSCI score were most highly represented among young people living in more deprived areas and eligible for free school meals. A high FSCI score, on the other hand, was more common among young people from families living in less deprived areas, who were not entitled to free school meals, who had a parent with a university degree and those from a black ethnic group.

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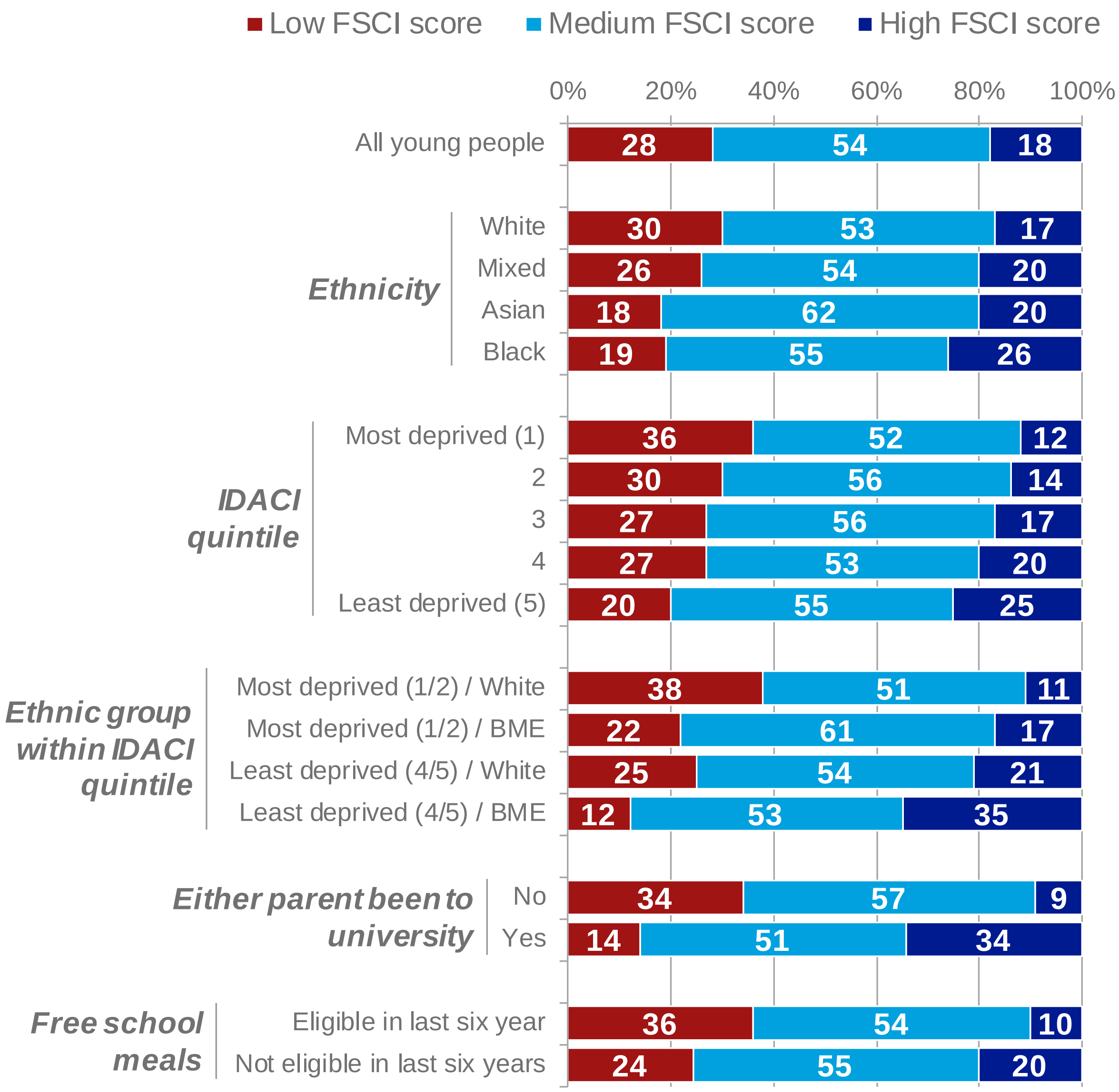
Even wider gradients are observed when ethnic group differences are considered within deprivation quintiles. White young people living in the two most deprived geographic quintiles are three times more likely to lack family science connections than BME young people living in the two least deprived geographic quintiles (38% compared with 12%).[6]

Figure 1.3: FSCI by demographic subgroups

Family Science Connections Index (FSCI) – see Fig. 1.1



Base (All respondents): All young people (3,841), White (3,024), Mixed (167), Asian (403), Black (155), IDACI Quintile 1 (761), Quintile 2 (747), Quintile 3 (739), Quintile 4 (787), Quintile 5 (804), IDACI Quintile 1,2/White (995), IDACI Quintile 1,2/BME (477), IDACI Quintile 4,5/White (1,426), IDACI Quintile 4,5/BME (158), Parent been to university (1,341), Parent not been to university (2,197), FSM eligible (625), FSM not eligible (2,280)

Note: FSCI scores unable to be classified not included

[6] Due to low base sizes, black and minority ethnic groups are combined for the analysis of ethnicity within IDACI quintile.

1.2 Informal science learning

Engaging with science informally outside of school can have a positive impact on student science performance and aspirations (Archer *et al.,* 2015).

However, there is a body of evidence to suggest that access to such activities is inconsistent across demographic subgroups. Findings from previous surveys such as the 2015 Wellcome Monitor (Huskinson *et al.,* 2016) and Public Attitudes to Science study (Castell *et al.,* 2014) indicate that participation is lower among adults and families in the lowest bands of income, educational attainment and socio-economic status. A qualitative study commissioned by Wellcome (Atkinson *et al.,* 2014) identified a particular challenge associated with encouraging white British families from more disadvantaged backgrounds to engage in science learning outside of school.

The findings in this section broadly corroborate this existing literature while providing a more in-depth analysis of behaviour among young people; the findings also show how patterns of access to informal learning vary across science and the arts.

1.2.1 Overall participation

Young people were asked about their attendance in the last 12 months at a number of different science-related activities. Attendance at arts and cultural events was also asked about to allow findings across the arts and science sectors to be compared.

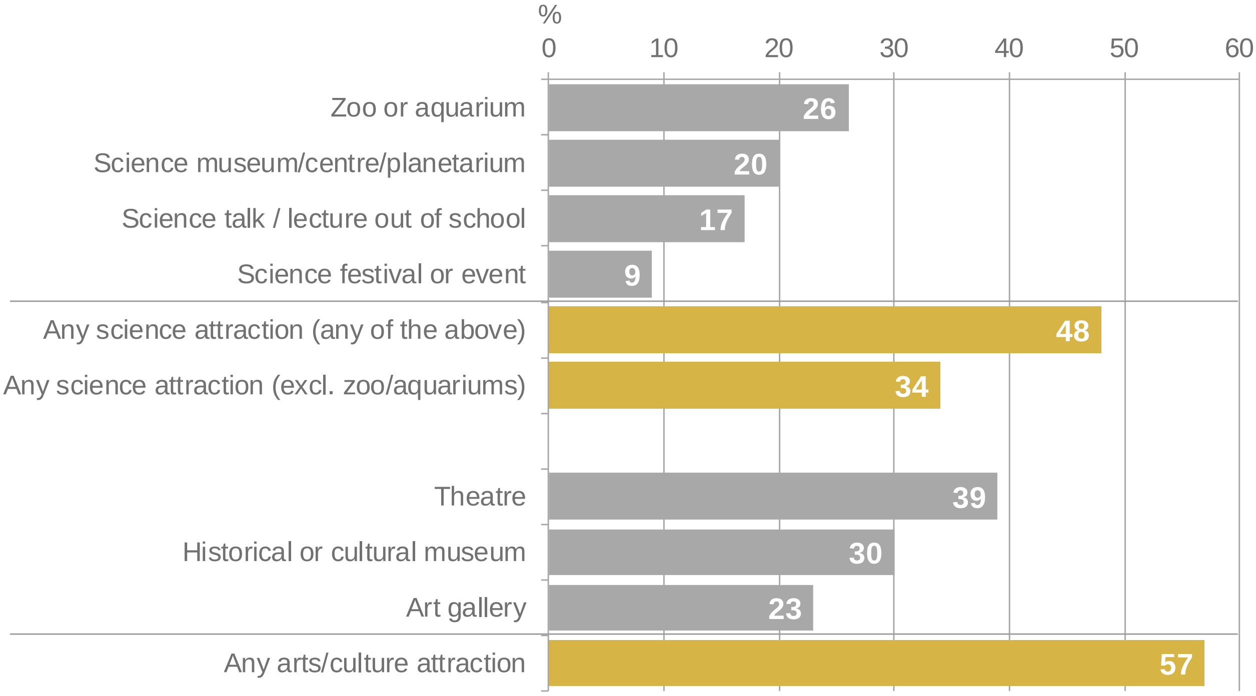
As shown in Figure 1.4, the overall level of participation in the past year is 34% based on attendance at any science attraction excluding zoos and aquariums, or 48% if attendance at zoos and aquariums is included. Although not directly comparable with the findings from the 2012 Wellcome Monitor (Clemence *et al.,* 2013) this latter finding is broadly consistent; the 2012 Monitor cited an attendance rate of 57% among young people, though this measure encompassed a wider range of scientific activities including visits to nature reserves.

Attendance at arts-based activities in the past 12 months was higher in comparison to science-based events. About six in ten (57%) had visited at least one of the following attractions: art gallery, historical or cultural museum or theatre.

Engagement with informal science learning outside of school was infrequent. Of the 20% who reported visiting a science museum/centre/planetarium in the past 12 months, most (72%) said they usually visit these types of attractions no more than once a year.

Figure 1.4: Visits to science and arts attractions in the last 12 months

Q. Which of these have you been to in the last 12 months?



Base (All respondents):4,057

1.2.2 Participation across demographic groups

For the remainder of this chapter we base our measure of informal science participation and informal arts participation (as a comparison) on two summary measures:

- those who have attended a science museum, centre or planetarium in the last 12 months;
- those who have attended a historical or cultural museum in the last 12 months.

Consistent with the Public Attitudes to Science Survey (Castell *et al.*,2014) there is a high correlation between those attending arts/cultural events and those attending science-related events. Of those who have visited a historical or cultural museum in the past 12 months, 40% have also attended a science-related event; this compares with a 12% participation rate among those who have not attended a history or culture based museum. However, while there is a clear overlap, there are some differences in the profile of young people visiting science and arts attractions.

As Figure 1.5 shows, young people attending historical or cultural museums were disproportionately from the following subgroups: female; white or mixed ethnic group; living in more affluent areas; living in the South East and South West; holding strong family science connections; and where at least one parent has a university degree.

In general these patterns are consistent with the existing literature. For example the Taking Part survey of adults aged 16+ (Matthews *et al.,* 2016) identified lower arts and/or heritage participation among adults living in more deprived areas, and adults from BME groups.

However, in the SET survey, there are some differences between the profiles of those who attend science-based museums compared with historical/cultural museums (Figure 1.5).

- There was a gender imbalance for history/cultural museums (females most likely to attend) but no such gender difference among those attending science museums.
- The ethnicity profile was different for the two sectors. Those attending history/cultural museums were more likely to be of white or mixed ethnic origin than Asian. For science museums, on the other hand, Asian young people were as likely to attend as white young people.
- The regional profile is also different across the sectors. Compared with the average, history/culture museum attendance is highest in the South East and South West. However, science museum attendance is more concentrated in London and the North East. Science museum attendance is lowest in the West Midlands and Yorkshire and Humberside.

There are also some common trends across the arts and science sectors:

- There is a strong association between participation in out-of-school activities (both science and arts) and the following attributes: high FSCI score, graduate parents and high science attainment.
- Young people eligible for free school meals in the last six years were less likely to attend both history/culture and science attractions.
- Black young people had the lowest participation rates for both types of attraction.

Therefore, although there are some common themes, the findings highlight variation in the factors associated with engagement in the arts and sciences.

Multivariate analysis

Multivariate analysis was undertaken through logistic regression to investigate how different factors correlate with visits to science museums, science centres and planetariums. Details of this analysis can be found in Appendix C.

The strongest predictor of visits to science attractions was whether or not the young person had also **visited a historical or cultural museum** in the last year. This may indicate that a young person's broad social and cultural background is more relevant to such informal learning opportunities than *science*-specific characteristics. **Parental interest in science** was also associated with visits to science attractions, but it was not as strongly predictive as visits to cultural/historical museums.

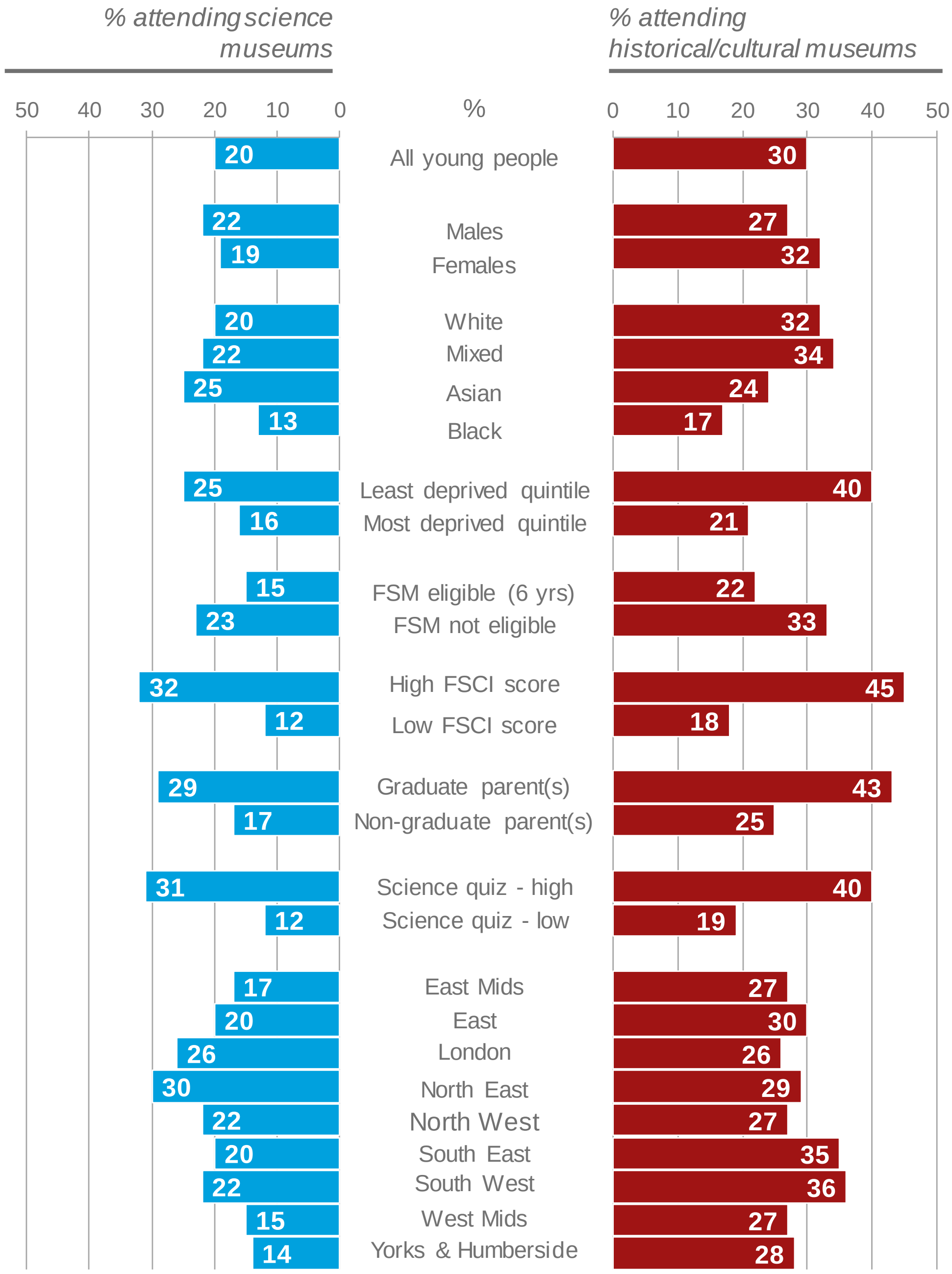
Before controlling for other factors, having a university educated parent and having a family member with a science-related job were both significantly associated with visits to science attractions. Notably, however, after controlling for parental interest in science, these were no longer significant predictors. In this way, parental engagement with science appears to be more important than the parents' educational or employment background.

The differences in participation by ethnicity remained even after controlling for other factors; young people from **white** and **Asian** backgrounds more likely to make visits than those from black backgrounds. After controlling for visits to historical/cultural museums, **males** were more likely to make visits than females. Although the overall difference in participation between males and females was relatively small (see Figure 1.5), among young people who had visited historical/cultural museums, males were much more likely to have also visited science attractions.

Finally, there was substantial regional variation in visits to science attractions; after controlling for other factors, visits were more common for young people in London and the North East and less common for young people in Yorkshire and The Humber.

Figure 1.5: Visits to science and historical / cultural museums in the last 12 months by demographic subgroups

Q. Which of these have you been to in the last 12 months? - a science museum, science centre or planetarium; a historical or cultural museum



Base (All respondents): All young people (4,057), Males (1,913), Females (2,112), White (3,156), Mixed (177), Asian (438), Black (171),IDACI Quintile 1 most deprived (834), IDACI Quintile 5 least deprived (823), FSM eligible in last 6 years (681), FSM not eligible (2,348), High FSCI score (714), Low FSCI score (1,023), Graduate parent(s) (1,350), Non-graduate parent(s) (2,367), Science quiz score high (860), Science quiz score low (834), E Mids (369), East (490), London (549), N East (196), N West (539), S East (691), S West (399), W Mids (431), Yorks & Humberside (389)

1.2.3 Families and schools supporting science and arts engagement activities

As in the previous section, this section also focuses on two specific types of activities:

- young people visiting science museums, science centres or planetariums in the last 12 months;
- young people visiting historical or cultural museums in the last 12 months.

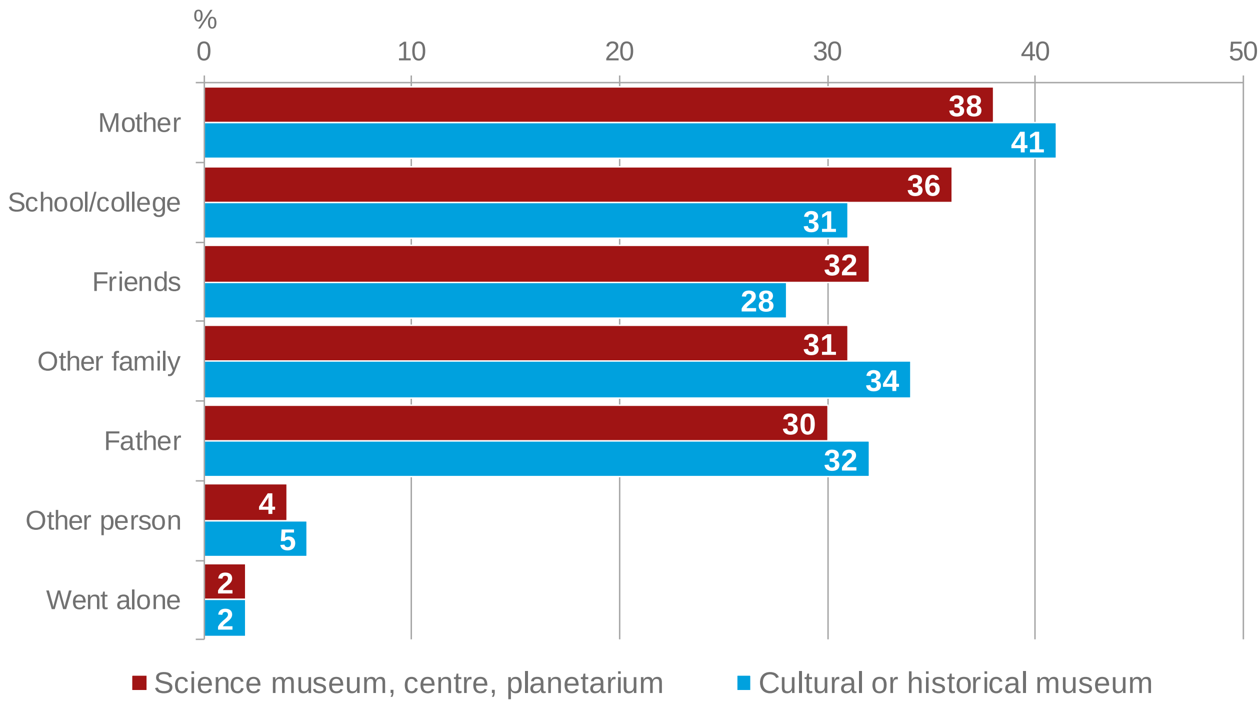
Young people were asked who accompanied them the last time they visited one of these attractions. The distributions are similar for both science-based and history/cultural museums. For both types of activity, mothers were an important point of access, accompanying young people to 38% of science museum visits and 41% of other cultural events. This finding corroborates the findings from the Public Attitudes to Science survey (Castell *et al.,* 2014) which also highlighted the key role of women in facilitating access to informal science learning.

Schools were also an important route of access to science museums, with 36% of young people who visited a science museum in the past year attending with their school. Fathers, other family members and friends played an important supporting role, around 30% of each accompanying young people to science events.

Figure 1.6: Who accompanied young person on last visit to museums in the last 12 months

Q. Who was with you the last time you visited a science museum, science centre of planetarium?

Q. Who was with you the last time you visited a historical or cultural museum?



Base (All respondents who have visited a science museum/science centre/planetarium or cultural/historical museum): All respondents who have visited a science museum/science centre/planetarium (860), All respondents who have visited a historical or cultural museum (1,278)

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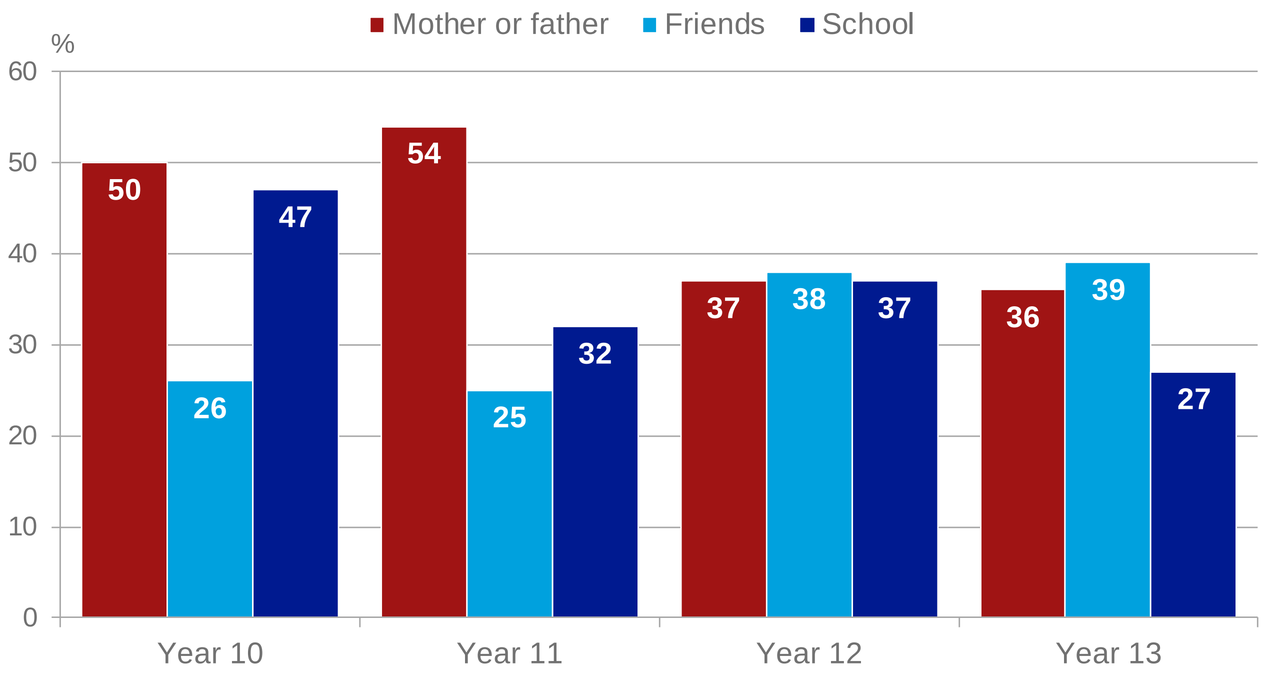
As young people progress through school, patterns of attendance begin to change: the influence of parents begins to diminish while peer group becomes more important. There are noticeable dips in school-led access to science museums in the exam years (Years 11 and 13, Figure 1.7).

Figure 1.7: Who accompanied young person on last visit to science museum in the last 12 months by school year

Q. Who was with you the last time you visited a science museum, science centre of planetarium?



Base (All respondents who have visited a science museum/science centre/planetarium): Year 10 (273), Year 11 (205), Year 12 (194), Year 13 (188)

There are some notable differences between demographic groups in terms of who is supporting access to science events (Figure 1.8).

Parents are the key points of access for young people from white backgrounds (49% compared with 29% of Asian young people) and with a graduate parent (54% compared with 38% with non-graduate parents).

Schools, on the other hand, play a more important role in supporting informal science learning for other subgroups: school-led access is higher for young people who are Asian (49% compared with 32% white); who do not have a parent who has been to university (41% compared with 29% who have); and with lower scores on the science quiz (44% compared with 32% with a high score). These findings suggest that schools play an important role in supporting access to informal science learning among groups with lower rates of participation.

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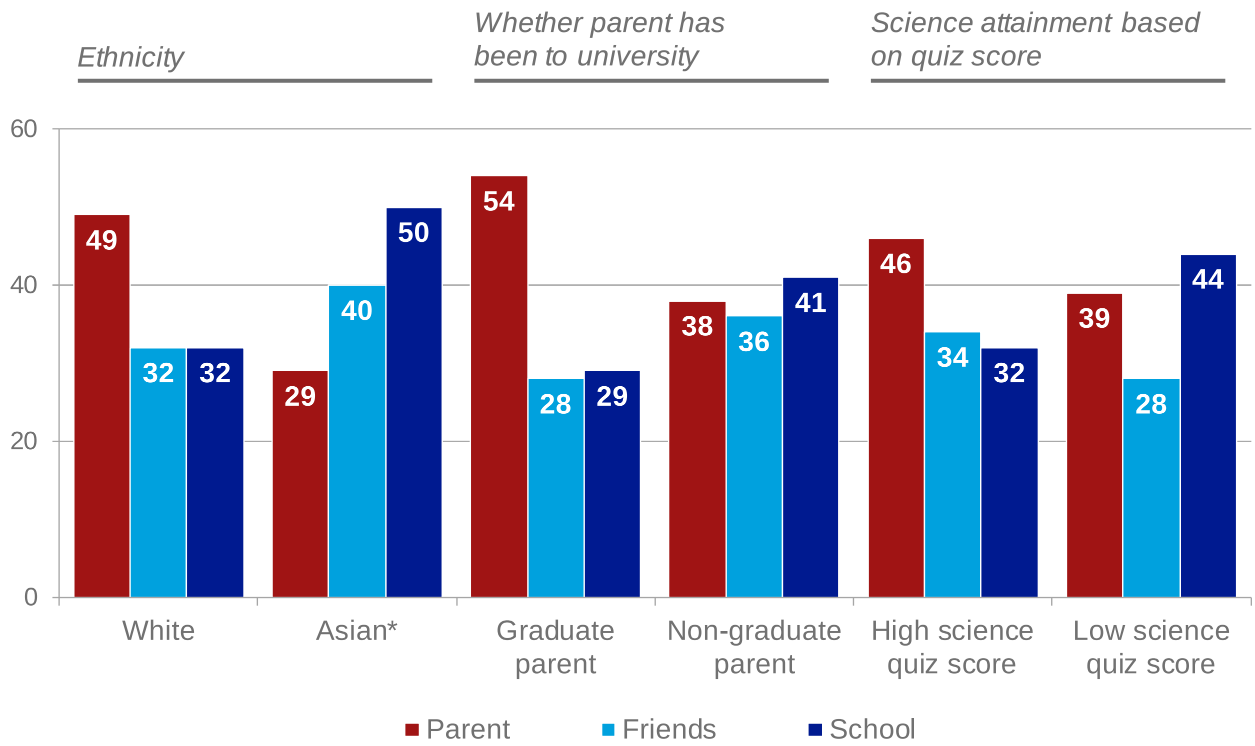
Figure 1.8: Who accompanied young person on last visit to science museum in the last 12 months by demographic subgroups

Q. Who was with you the last time you visited a science museum, science centre or planetarium?*



Base (All respondents who have visited a science museum/science centre/planetarium): White (670), Asian (113), Graduate parent (397), Non-graduate parent (419), High science quiz score (271), Low science quiz score (98)

* *Note that sample sizes are too small to allow findings based on other ethnic groups to be presented*

1.2.4 Consumption of science through other channels

Young people can also engage with science content outside of school through less structured channels than science centres, museums, and so on (Figure 1.9). Seven in ten (68%) engaged with science in the last 12 months via print media, TV, radio, or online. Science was most commonly engaged with via visual media including TV and online video content (57%) and printed media such as books, newspaper or online written content (43%).

There is a positive association between consumption of science-related content and structured informal science learning: of those who have attended science museums outside of school in the last 12 months, 85% have engaged with science-related content, while the rate is 64% among those who have not attended science-related events. However, the higher rate of media-based informal science learning compared with structured forms of informal science learning (such as science museums) demonstrates the importance of media and other channels in widening access to engagement with science.

The 2012 Wellcome Monitor (Clemence *et al.,* 2013) found that 46% of 14-19 year olds had never read factual books about science outside of school. The equivalent proportion of young people who have not read about science in the last 12 months (through books, magazines or online) was 57%

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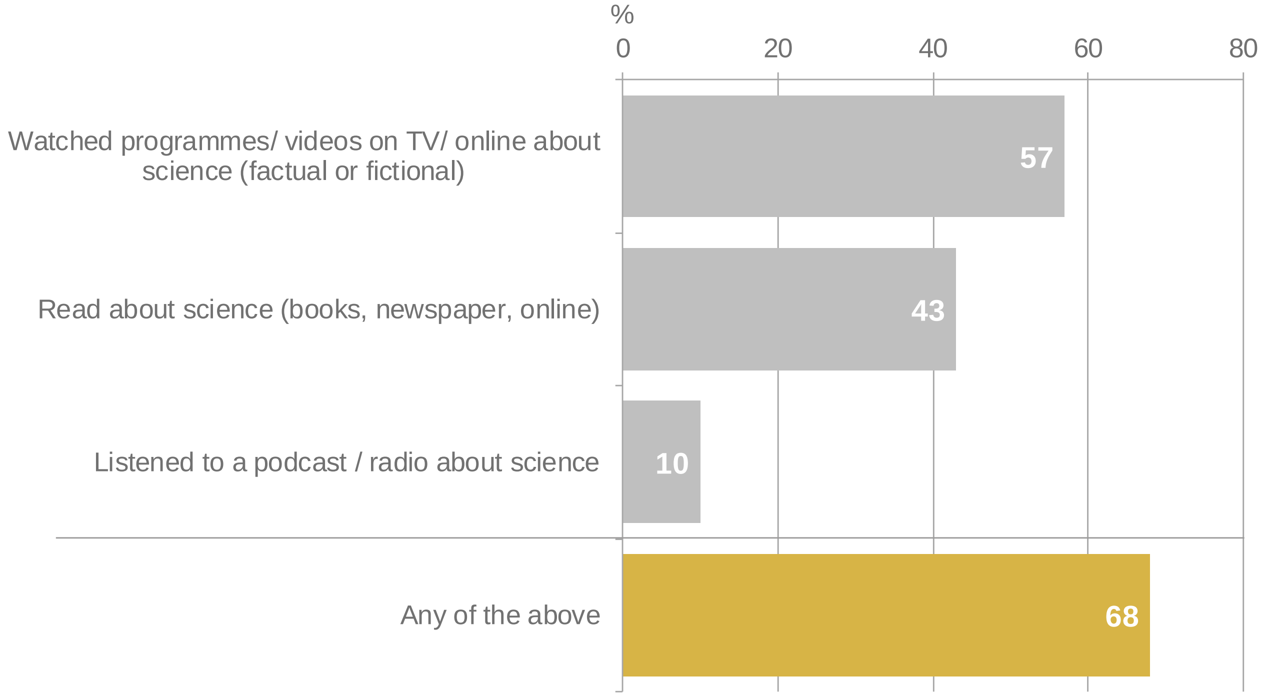
in the SET survey. However, differences in question wording and reference periods[7] mean that these figures are not directly comparable.

The importance of online resources for science learning is also picked up in the 2014 Public Attitudes to Science survey (Castell *et al.,* 2014) which showed that online sources for science information, including news websites and social networks, are becoming more widely used among young adults aged 16-24.

Figure 1.9: Consumption of science content though other channels

Q. Which of these have you done in the last 12 months outside of school?



Base (All respondents): 4,057

Engagement in science via media declines by age, with young people in Year 10 the most active in this area (73%), falling to 64% among those in Year 13. Males were more likely than females to engage with science via media (72% compared with 64%); as were those from Asian or black backgrounds compared with white (both 75% compared with 67% of those from white backgrounds). The gender disparity however was only evident within the white subgroup: compared with all other groups white females had the lowest propensity to engage with science via these more informal channels (62% compared with 68% overall).

Consistent with other relationships considered in this chapter, propensity to engage with science in this way was linked to high scores on the science quiz (86% of high science quiz scores declining to 48% of low quiz scorers); more family science connections (83% of those with high FSCI scores compared with 52% of those with low FSCI scores); and living in more affluent areas (74% in the

[7] 'Last 12 months' in the Science Education Tracker and 'ever' in the Wellcome Monitor.

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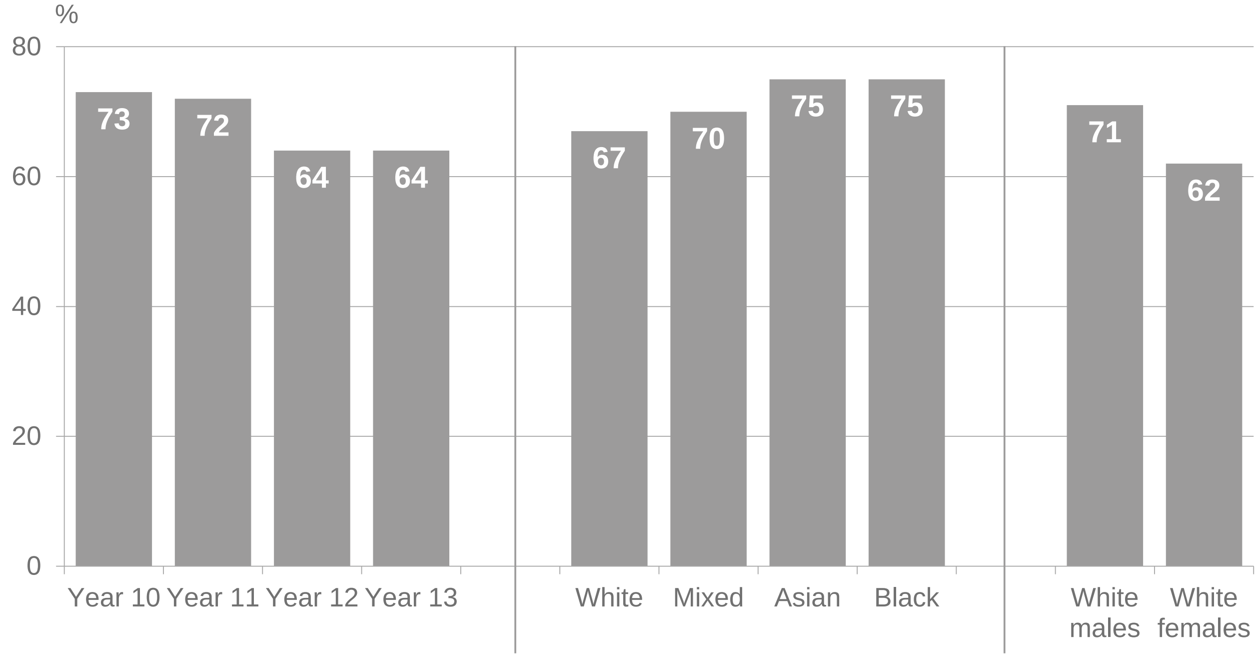
least deprived compared with 63% in the most deprived quintile). Figure 1.10 illustrates a selection of these findings.

Figure 1.10: Consumption of science through other channels by year group and gender / ethnicity

Q. Which of these have you done in the last 12 months outside of school?

% who have read, watched or listened to material about science (via books, magazines, TV, radio, online etc.)



Base (All respondents): Year 10 (1,110), Year 11 (1,081), Year 12 (942), Year 13 (924), White (3,157), Mixed (178), Asian (437), Black (171), White males (1,511), White females (1,627)

1.2.5 Interest in hearing from scientists

As shown in Figure 1.11, a little over half (53%) of young people say that they are interested in hearing more from scientists about the research they are conducting, a figure which does not vary by age, gender or ethnicity. While not directly comparable (due to differences in question wording) this is somewhat lower than the proportion of adults (63%) in the 2015 Wellcome Monitor who said they were interested in learning more from scientists.

A recent survey conducted by Kantar Public on behalf of Wellcome and other funders (Hamlyn *et al.,* 2015) indicates that scientists working in higher education are engaging with families and young people via schools and other partners: for example 33% of STEM researchers in 2015 engaged with the public via a schools-based event in the previous 12 months, 30% at a science festival and 16% at a science museum or centre.

While the SET survey findings indicate that there is an appetite among young people to engage with scientists directly, it is also clear that this interest is concentrated within some groups more than others. For example, interest in hearing more from scientists is associated with attendance at science-based attractions: 68% of those who have attended science museums outside of school in

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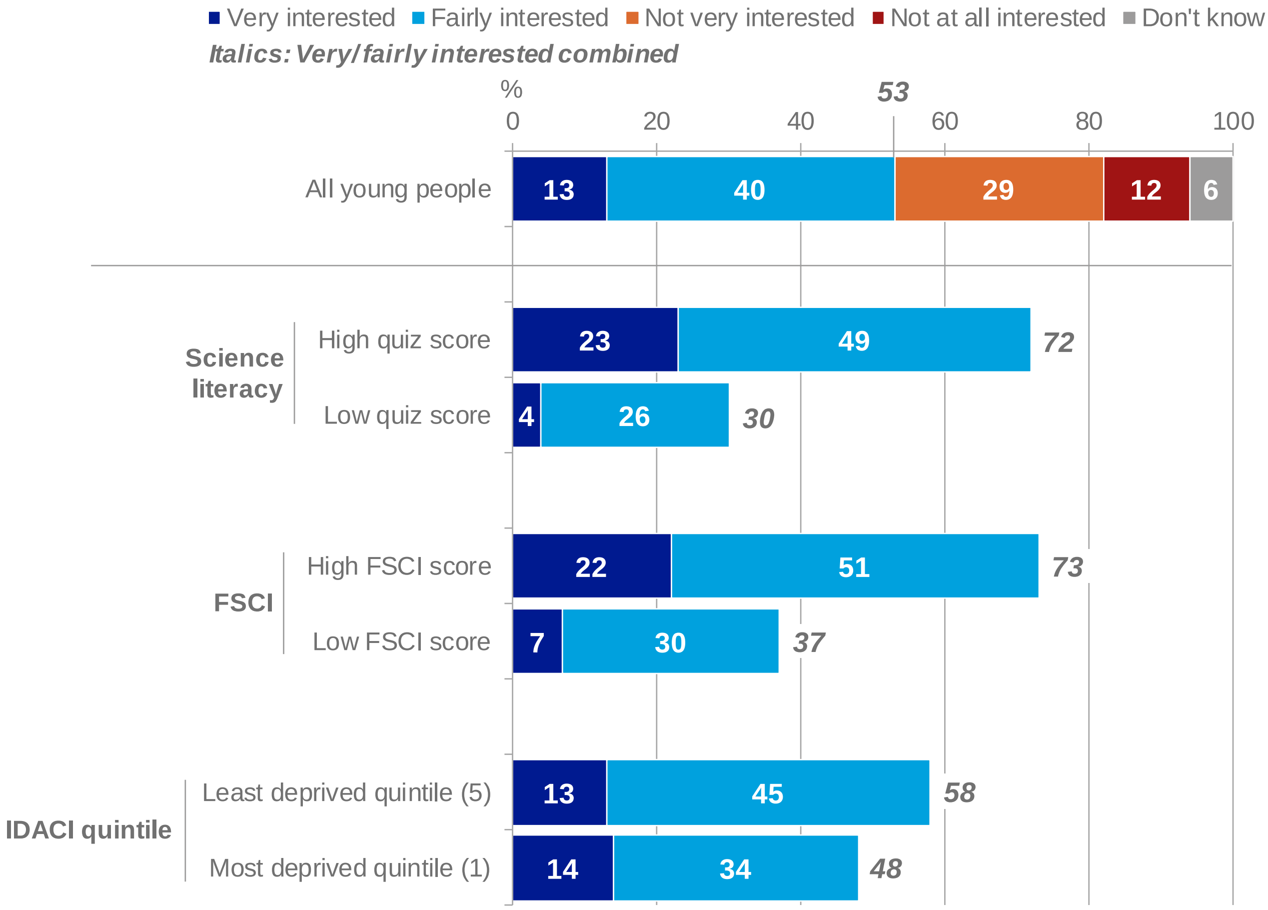
the last 12 months are interested in hearing more from scientists compared with 49% who have not. This interest is also associated with consumption of science via books and media: 64% of those who have read, watched or listened to something related to science are interested in hearing more from scientists compared with 30% who have not.

As with these other forms of engagement, being very or fairly interested in hearing more from scientists is linked to: higher science quiz scores (72% of those with a high quiz score compared with 30% of those with a low score); more family science connections (73% with a high FSCI score compared with 37% with a low score); and living in more affluent areas (58% in the least deprived quintile compared with 48% in the most deprived quintile).

Figure 1.11: Interest in hearing more from scientists

Q. How interested are you in finding out more from scientists about the research they are conducting?



Base (All respondents): All young people (2,015), Science quiz score high (421), Science quiz score low (391), High FSCI score (365), Low FSCI score (508), Least deprived quintile (420), Most deprived quintile (426)

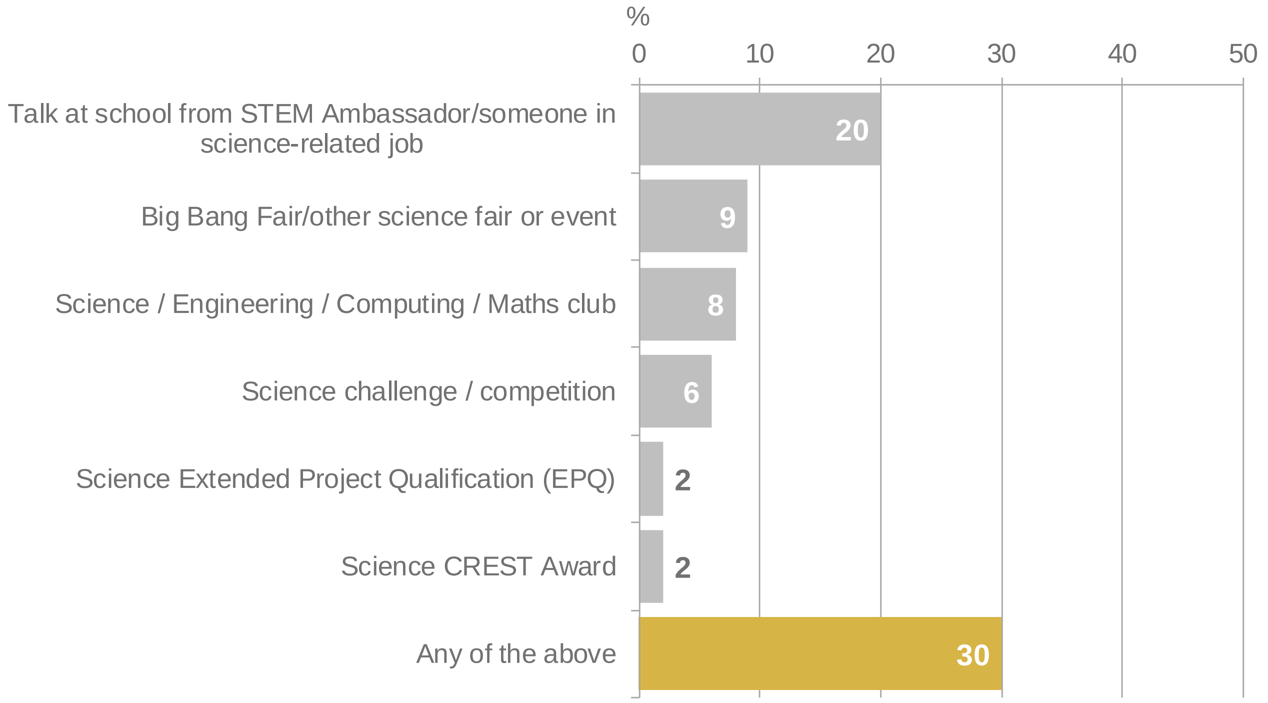
1.3 Extra-curricular science activities at school

Young people were asked about a range of science-related activities facilitated by the school which are outside of the core curriculum.

Overall three in ten (30%) had participated in at least one of the activities shown in Figure 1.12 in the last three years. Receiving a talk from a STEM ambassador or someone else in a science-related job was the most commonly mentioned activity (20%). Participation in Extended Project Qualifications (EPQs) and Science Crest Awards were less common (two per cent participation rate).

Figure 1.12: School-based extra-curricular science learning

Q. In the last three years, have you taken part in any of the following activities related to science, computer science, engineering or maths?



Base (All respondents): 4,032

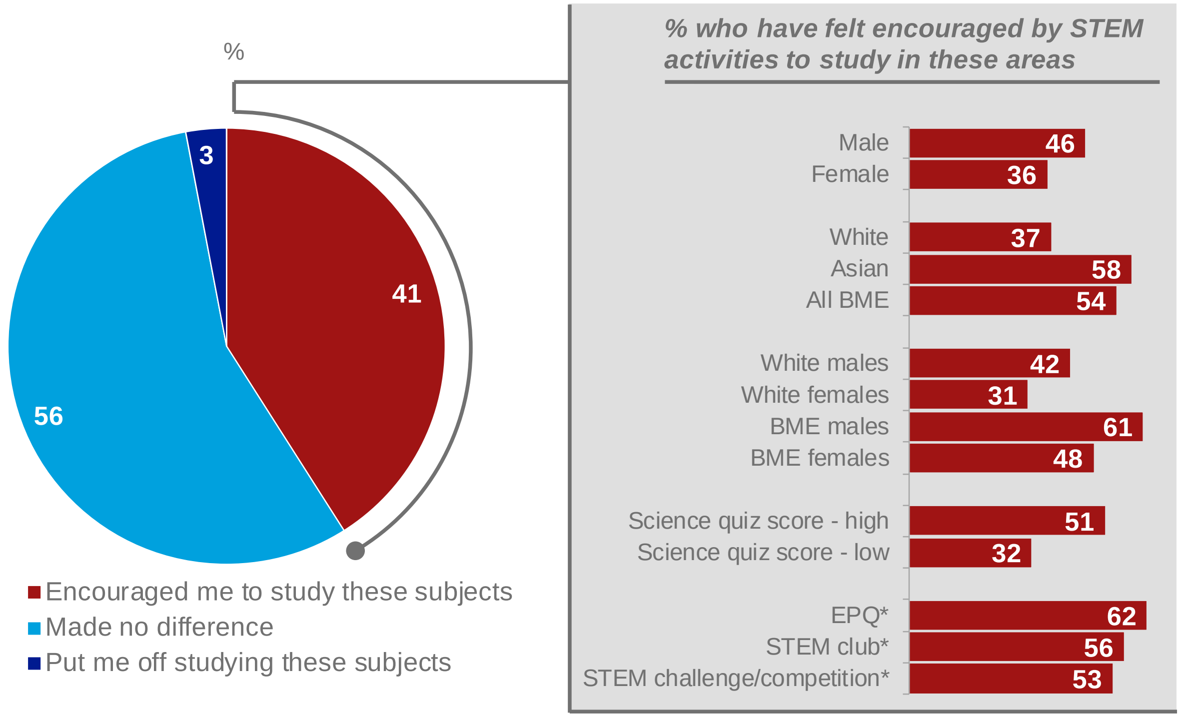
Compared with the average (30%), participation in any of the above activities was higher among the following subgroups: Asian (37%); high quiz score (46%); and high FSCI score (49%). It is worth noting that there are no significant differences in participation rates by gender, free school meal eligibility or level of deprivation.

Young people who reported having undertaken at least one of the above activities were asked whether such participation had encouraged them to study science, computer science, engineering or maths.

Overall, two in five (41%) felt that such activities had motivated them to study these subjects, although 56% considered that it had made no difference. Some groups were more likely to report having been encouraged than others. As shown in Figure 1.13, the groups most likely to say they were influenced by extra-curricular activities were: males (46% compared with 36% of females); young people with Asian ethnicity (58% compared with 37% white); and those with a high score on the science quiz (51% compared with 32% of those with a low score). Particularly striking however is the high percentage of BME males feeling encouraged, with 61% of this group feeling that these activities had motivated them to study science, computer science, engineering or maths.[8]

Figure 1.13: Whether taking part in extra-curricular activities has encouraged student to study science, computer science, engineering or maths

Q. Taking part in these activities has …?



These are not mutually exclusive; students who have done these activities may have done other activities in the list too.

Base (All respondents who have taken part in extra-curricular activities): All young people (1,249), Male (585), Female (658), White (941), Asian (157), BME (294), White males (452), White females (486), BME males (127), BME females (165), High quiz score (397), low quiz score (145), EPQ (86), STEM clubs (303), STEM challenge/competition (252)

Note: 'Don't know' not included

[8] Due to low base sizes, black and minority ethnic groups are combined for the analysis of ethnicity within gender.

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2. Science at school

This chapter focuses on young people's experience of studying science at school. It starts with perceptions of science in relation to other subjects and then looks at young people's interest in studying science and the factors that have encouraged or discouraged them from learning science.

Key findings

- Biology was the most enjoyed science subject, ranked third out of the subjects asked, behind English and maths.
    - There were substantial gender differences in the enjoyment of subjects. For example, males ranked physics third out of seven subjects while females ranked the subject last.
- Young people considered exam success in science, maths and English to be a balance of natural ability and hard work. Success in science was, however, more related to hard work than success in English or maths.
- More than two-thirds of young people (68%) said they found science lessons at school very or fairly interesting.
    - Males were more likely than females to find science lessons interesting. This gender gap was only evident, however, among young people from white backgrounds.
- After 'finding science interesting', the most important factors encouraging young people to learn science were 'having a good teacher' and 'enjoying practical work'. In both cases, 35% of young people said this had encouraged them.
    - Conversely, the most common factor cited by young people as putting them off learning science was 'having a bad teacher', mentioned by one in three young people (33%).
- Females were more likely to have been put off learning science than males:22% of males said nothing had discouraged them from learning science, compared with 11% of females.
    - In particular, females were much more likely to say they had been put off by finding science more difficult than other subjects (35%, compared with 22% of males), or because they have difficulty with the maths involved (26%, compared with 13% of males).

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2.1 Science in relation to other subjects at school

Respondents were asked to rank school subjects based on two characteristics:

- **Enjoyment**, ranking subjects from the one they enjoyed the most to the one they enjoyed the least.
- **Employability**, ranking subjects from the one they consider most useful to the one they consider least useful to get a job.

The subjects included the three sciences (biology, chemistry, physics), English, maths, foreign languages and history. The list of subjects was chosen to be relevant for all young people and to cover a range of experiences and preferences.[9] Young people in Years 12 and 13 who had stopped studying these subjects were asked to think back to when they had studied these subjects in earlier years.

Figure 2.1 shows the mean rankings for each subject. Biology was the most enjoyed science subject, and just over a quarter of young people (26%) chose one of biology, chemistry or physics as the subject they enjoyed most. Maths and English were ranked as the most enjoyable subjects overall. Maths and English were also perceived as being more useful for employability; 86% of young people ranked either maths or English as the most useful subject to help someone get a job. Foreign languages were the least enjoyed subject by some distance. Despite this, languages were still seen as more useful compared to the sciences in terms of employment opportunities.

There were, however, notable differences in subject enjoyment by gender (Figure 2.2). Males ranked maths and especially physics higher than females, while females ranked English higher. Physics was the third most enjoyed subject among males, but the least enjoyed among females. This demonstrates the strong, persistent differences in science subjects as experienced by males and females. Research has consistently shown certain subject choices to be heavily gendered and, in particular, physics to be much more positively perceived by males than by females (for example, Mujtaba and Reiss, 2013). This topic is explored in further detail throughout this report.

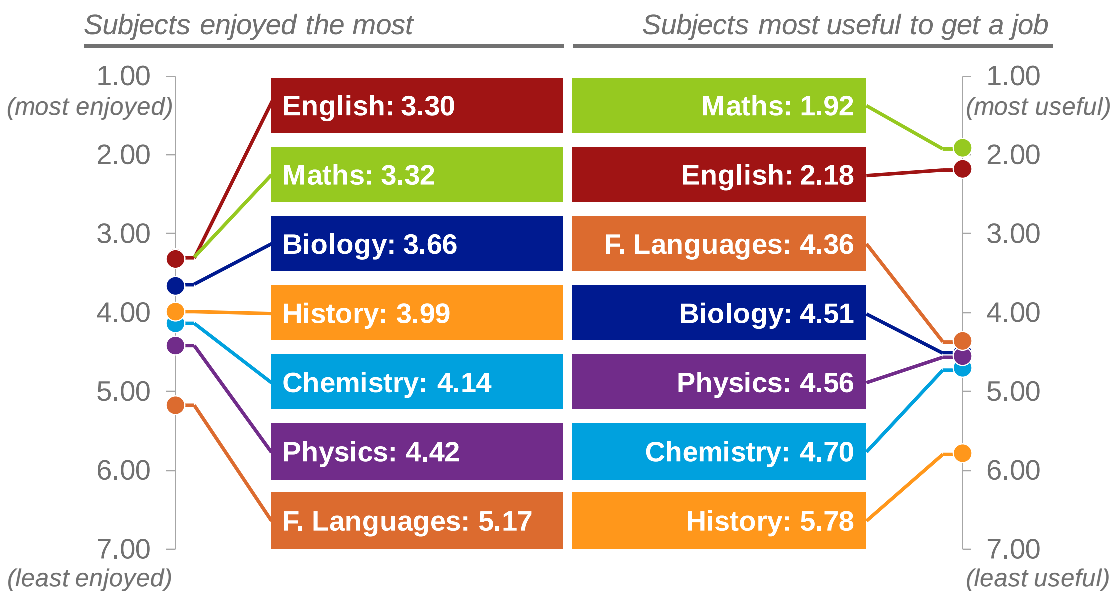
Despite the differences in enjoyment, there was broad agreement between males and females about the relative importance of subjects for improving employability (Figure 2.3). The main difference was that males ranked physics higher for employability than females.

[9] The list of subjects was limited to seven so as to ensure the task was manageable for respondents and not too time consuming.

Figure 2.1: Mean ranking of subjects by enjoyment and employability

Q. At school, which of these subjects [do / did] you enjoy the most?

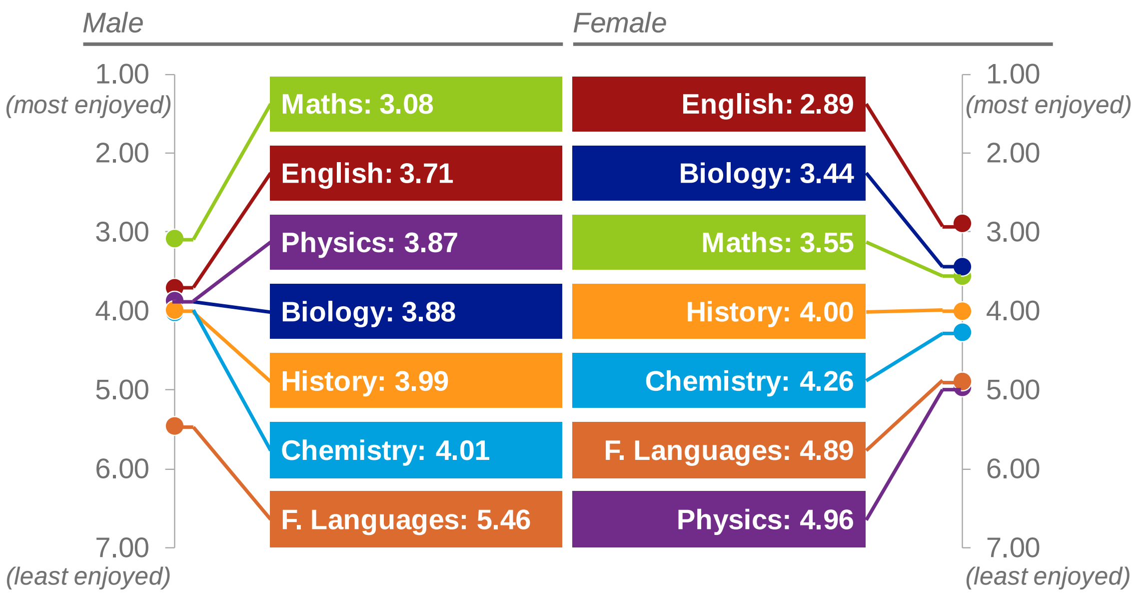
Q. Thinking about young people in general, which of these subjects is most useful to help someone get a job?



Base (Randomly selected half of respondents): Subjects enjoyed the most (1,989); Subjects most useful to get a job (1,970)

Figure 2.2: Mean ranking of enjoyment of subjects by gender

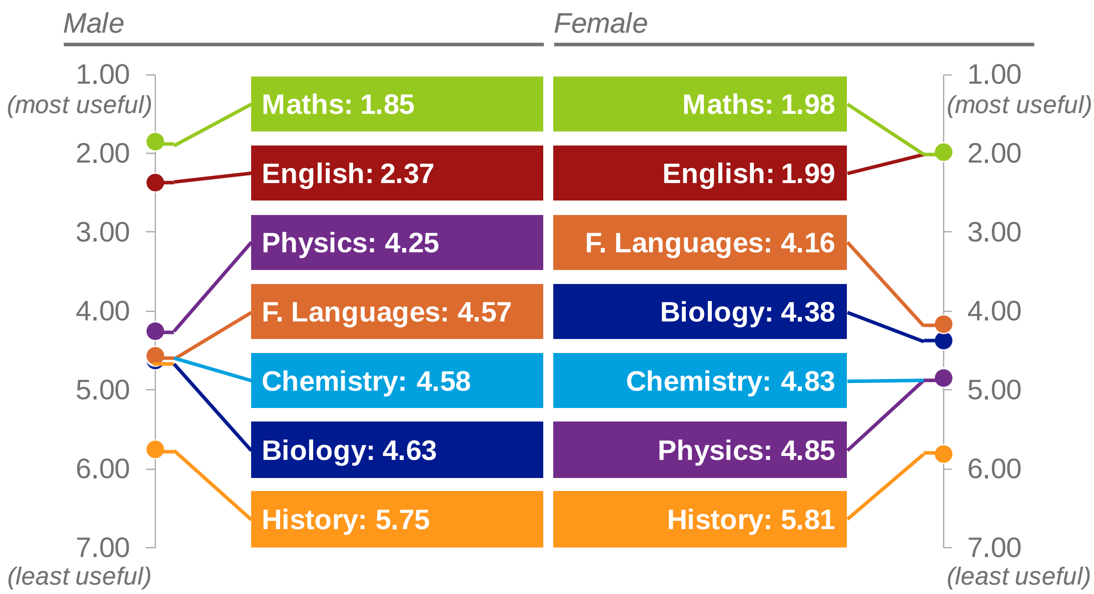
Q. At school, which of these subjects [do / did] you enjoy the most?



Base (Randomly selected half of respondents): Male (927), Female (1,046)

Figure 2.3: Mean ranking of employability of subjects by gender

Q. Thinking about young people in general, which of these subjects is most useful to help someone get a job?



Base (Randomly selected half of respondents): Male (909), Female (1,044)

Respondents were also asked whether they thought how well someone does in exams for English, maths and science is to do with natural ability or hard work. Respondents placed each of these subjects on an 11-point scale from 'Natural ability' to 'How hard you work'.[10]

The means for each subject were around the middle of the scale indicating that, on average, young people think exam success is related to a balance of natural ability and hard work (Figure 2.4). Success in science exams, however, was perceived as more related to hard work than English or maths.

Based on findings from the cognitive testing undertaken during the development of the questionnaire, this finding might best be understood as the perception that results in science are more within a student's own control than results in a subject such as English. In addition, science was often seen as a 'difficult' subject (see, for example, section 2.3) and so hard work was considered especially important for achieving good results.

[10] For a random half of respondents, the scale was reversed so that it ran from 'How hard you work' to 'Natural ability'.

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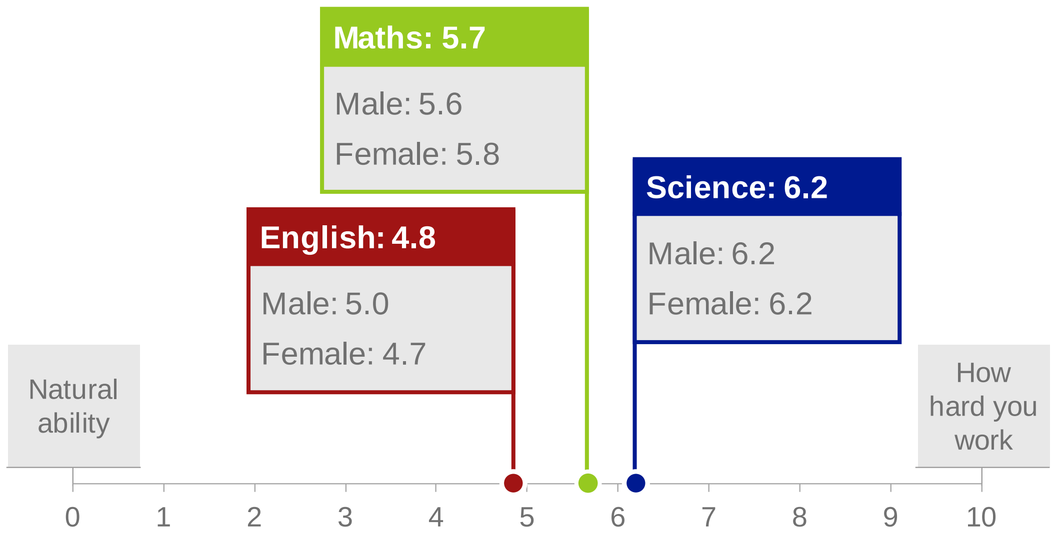
Figure 2.4: Mean score of exam performance based on natural ability / hard work

Q. 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.



Base (Randomly selected half of respondents): All young people (1,991), Male (947), Female (1,030)

2.2 Interest in science at school

Turning to perceptions of science lessons, the majority (68%) said they found science lessons at school very interesting or fairly interesting (Figure 2.5). This is similar to findings from the ASPIRES project where 70% of Year 6 and Year 8 students agreed they learn interesting things in science lessons (Archer *et al.*, 2013).[11]

Young people from black and Asian backgrounds were more likely to say they found science lessons interesting (82% and 77% respectively, compared with 67% from white backgrounds, Figure 2.6). Males were also more likely to say they found science lessons interesting (72%, compared with 65% of females), although this gender difference was only evident for white males / white females. Even then, the difference was only between the proportions finding lessons 'fairly interesting' (Figure 2.7). There was no significant difference in the proportion saying they found lessons 'very interesting'. Among other ethnic groups, there were no gender differences in finding science lessons interesting.

There was also no difference in interest by measures of deprivation. Young people in more deprived areas or eligible for free school meals in the last six years were just as likely to say they found science lessons interesting as their peers in less deprived areas or not eligible for free school meals.

Family science connections were, however, strongly related to interest in science at school; only 54% of those with a low FSCI score said they found lessons very or fairly interesting, compared

[11] This was lower, however, than was observed for young people in the 2012 Wellcome Monitor, in which 82% of young people said they found science lessons very or fairly interesting. Rather than attributing this to a decline in interest since 2012, we note that the changes in sampling method and the move to online self-completion data collection mean the figures cannot be directly compared. One possible explanation is that online data collection reduced social desirability bias and that respondents may have been more positive in the Wellcome Monitor in front of an interviewer than they would be in private.

http://dx.doi.org/10.6084/m9.figshare.4524551

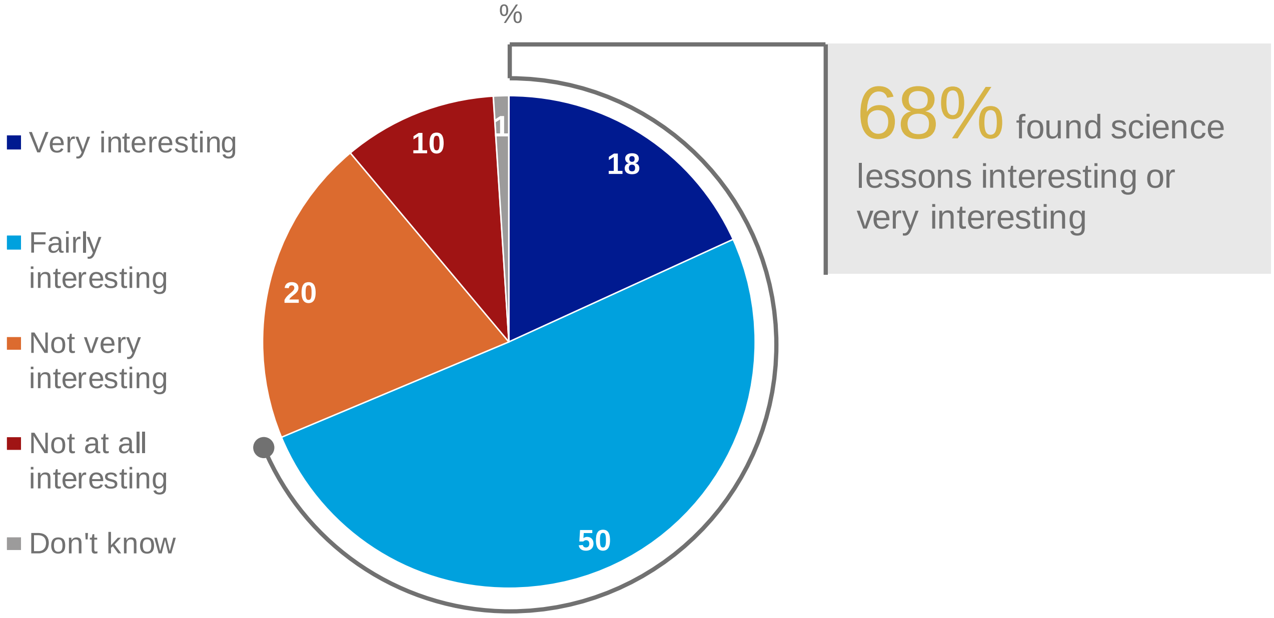
with 80% of those with a high FSCI score. Engagement with science at school should therefore be understood as not merely a factor of experiences *within* school but as heavily influenced by a young person's experiences of science *outside* school. There is a particular challenge for schools to engage young people who do not have the advantage of strong science networks outside school.

It is also notable that for all these groups mentioned above – including young people with a low FSCI score – a majority said they found science lessons interesting.

We also note that the gender differences shown in Figure 2.6 are already seen in the youngest SET age group (Year 10). This would suggest that the persistent gender differences in perceptions of science are present from a younger age.

Figure 2.5: Interest in science lessons at school

Q. How interesting do you find science lessons at school? If you no longer study science, think back to when you were studying it.

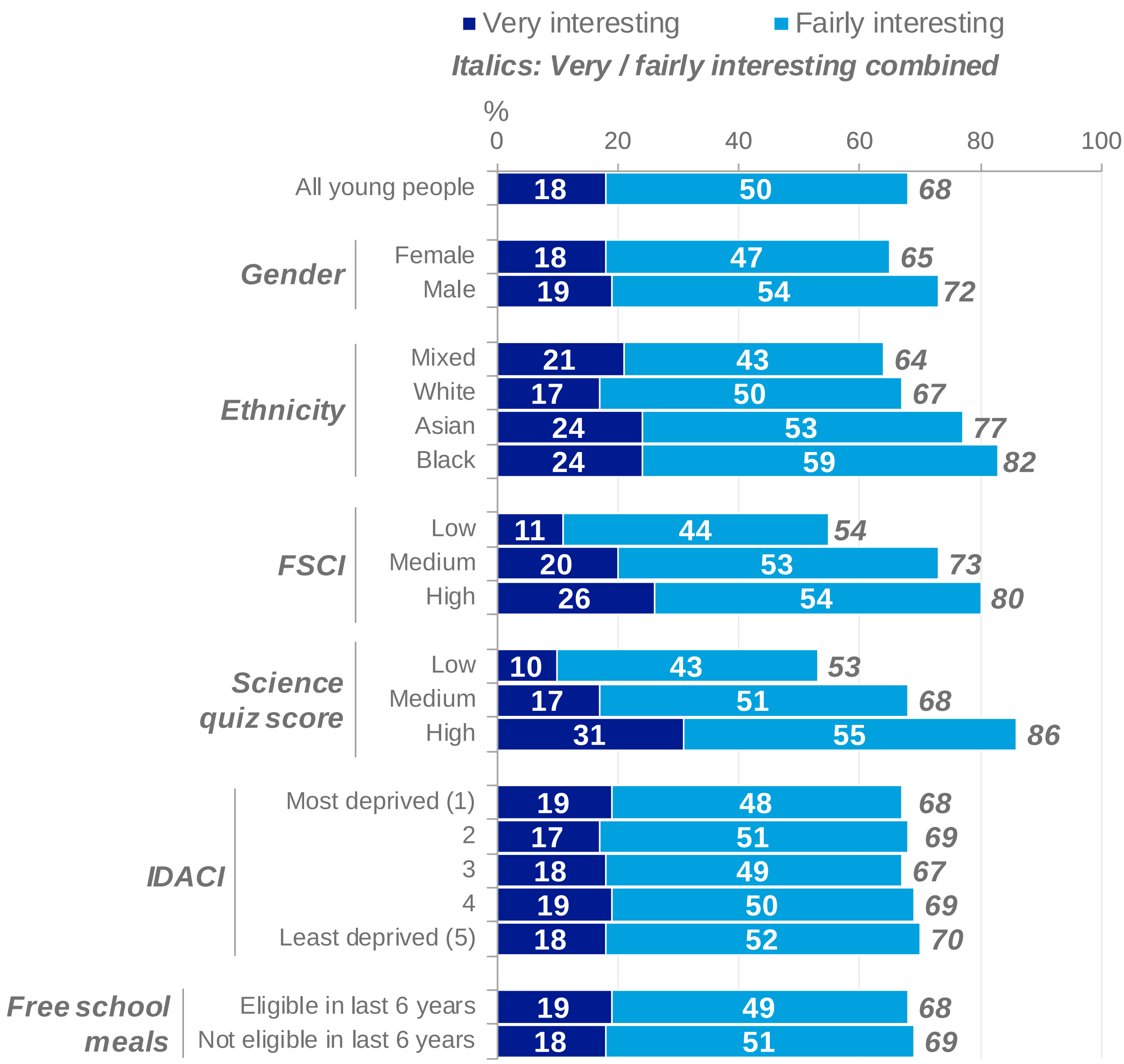


Base (All respondents): 4,069

http://dx.doi.org/10.6084/m9.figshare.4524551

Figure 2.6: Interest in science lessons at school

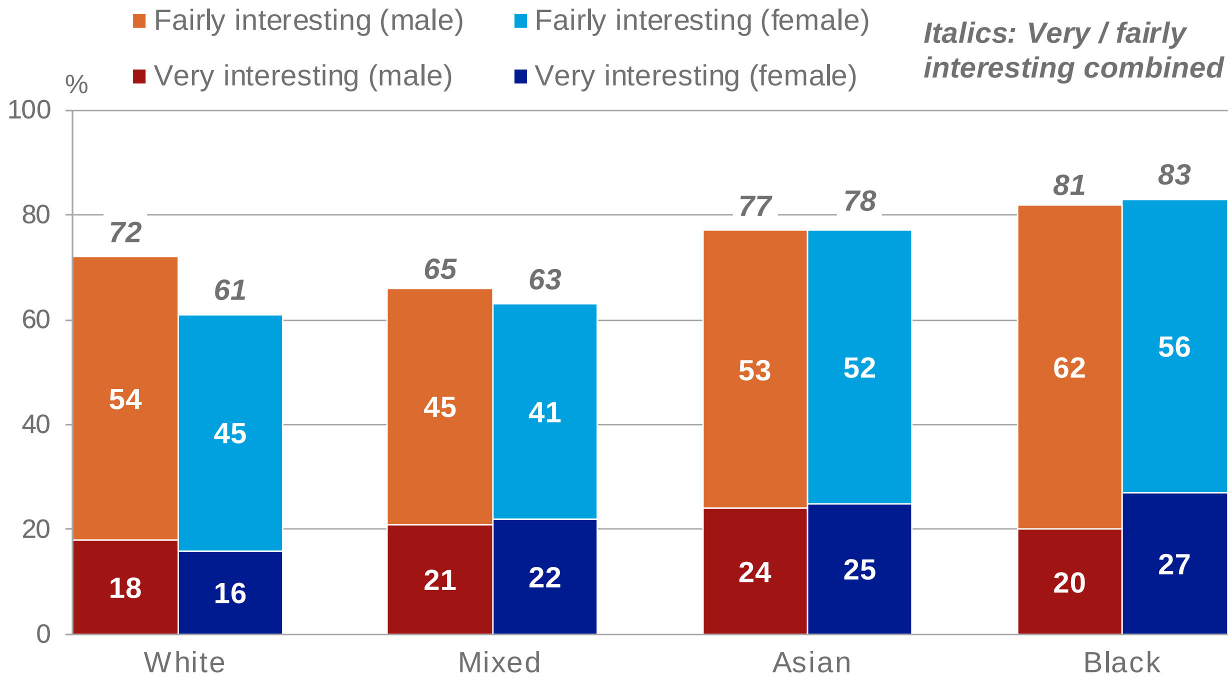
Q. How interesting do you find science lessons at school? If you no longer study science, think back to when you were studying it.



Base (All respondents):All young people (4,069), Female (2,113), Male (1,924), Mixed (178), White (3,162), Asian (441), Black (172), Low FSCI (1,023), Medium FSCI (2,100), High FSCI 714), Low quiz score (844), Medium quiz score (2,364), High quiz score (861), IDACI quintiles from most deprived to least deprive (837 / 793 / 784 / 826 / 825), Eligible for free school meals in the last six years (685), Not eligible for free school meals in the last six years (2,347)

Figure 2.7: Interest in Science lessons at school by gender and ethnicity

Q. How interesting do you find science lessons at school? If you no longer study science, think back to when you were studying it.



Base (All respondents): White Male (1,515), White Female (1,628), Mixed Male (79), Mixed Female (98), Asian Male (212), Asian Female (226), Black Male (71), Black Female (101)

2.3 Factors encouraging and discouraging young people from learning science

Based on a list presented to them, respondents were asked what had encouraged them to learn science and what had put them off learning science.[12]

'Finding the subject interesting' was the most frequently cited encouraging factor, mentioned by 41% of young people. After this, young people most commonly cited 'having a good teacher' and 'enjoying practical work' as encouraging influences (both 35%). These are broadly consistent with the most common encouraging factors for young people found in the 2012 Wellcome Monitor[13] which were:

- Having a good teacher;
- Being interested in the subject;
- The chance to learn about things relevant to real life;
- The chance to carry out experiments.

[12] Respondents were asked to choose from a list of answers, developed from a similar question used on the Wellcome Montior and refined through cognitive testing with young people.

[13] There were slight differences in the wording of the SET question and answer options compared with the Wellcome Monitor.

The influence of teachers, in particular, is widely recognised as a key component of engaging young people in science. The Department for Children, Schools and Families (DSCF, 2009), for example, reported that in schools with high levels of science participation after Key Stage 4 'knowledgeable specialists in biology, physics and chemistry teach their subjects enthusiastically and well'.

The relative importance of different encouraging factors was broadly similar for males and females (Figure 2.8), although males were more likely to say they had been encouraged by 'finding the subject interesting' and 'enjoying the maths' involved in studying science, while females were more likely to say they were encouraged by 'having a good teacher' and by the relevance of science for future study / career plans. Young people from more deprived areas were less likely to say that they had been encouraged by 'having a good teacher' (28% in the most deprived areas, compared with 40% in the least deprived areas).

One in five young people did not report any encouraging factors for learning science. This rises to one in three of those with a low FSCI score (33%, compared with 11% of those with a high FSCI score). Similarly, only three per cent of young people with a low FSCI score had felt encouraged by their friends or family, compared with almost a quarter of young people with a high FSCI score (24%). These findings underline the advantage of young people with good science networks outside of school. It is particularly important for schools to engage and encourage those young people who will not get such motivation outside of school (see also chapter 1 section 1.2.3 which highlights the important role of schools in widening opportunities for young people).

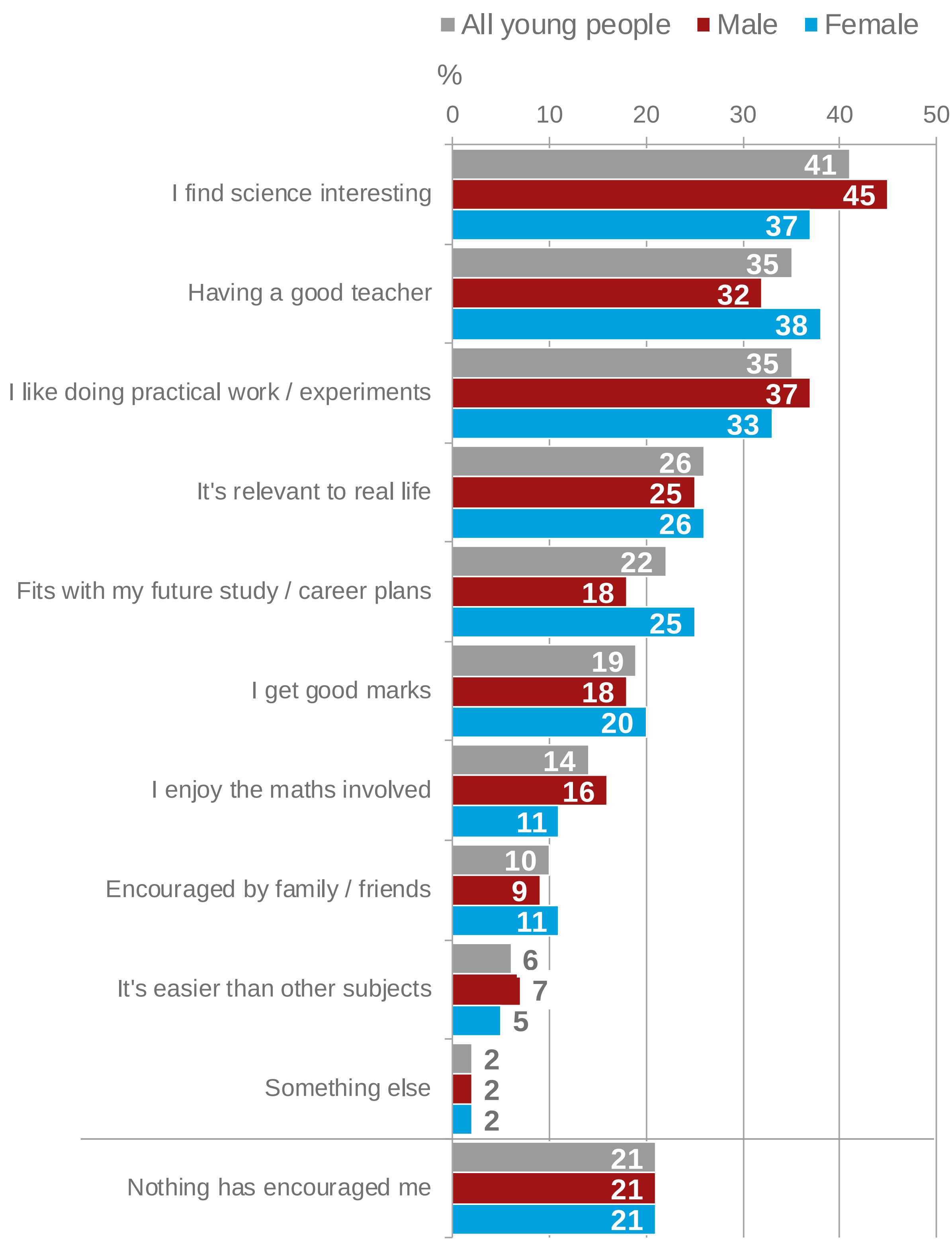
The influence of teachers was again emphasised when looking at the factors which put young people off learning science (Figure 2.9); a third of young people felt that they had been discouraged from learning science by 'having a bad teacher'. Likewise, this was the most commonly cited discouraging factor among young people identified in the 2012 Wellcome Monitor.

The perception of science as being 'difficult' stands out as an important negative factor: this was cited by 29% of young people and 'finding the maths difficult' by 20%. These perceptions were higher among females; more than one in three females said they were put off by finding science more difficult than other subjects and more than a quarter were put off by finding the maths involved in science difficult.

This difference in perceptions of difficulty points to a lack of confidence among some females compared to their male peers, a well-established barrier in the take up of science subjects and careers in science among young women (for example, Kyriacou and Goulding, 2006; Brown *et al.*, 2008). It is important to note that the increased propensity to cite a lack of confidence among females is just as relevant among those with high science knowledge quiz scores and those with low scores. That is, even females with high quiz scores were more likely than males with similar quiz scores to have been put off science by its perceived difficulty (Figure 2.10). The apparent under-estimation of ability among females is also noted in chapter 4 section 4.2.2 which demonstrates that this can also act as a barrier to the take up of triple science.

Figure 2.8: Factors young people said had encouraged them to learn science

Q. What has encouraged you to learn science?

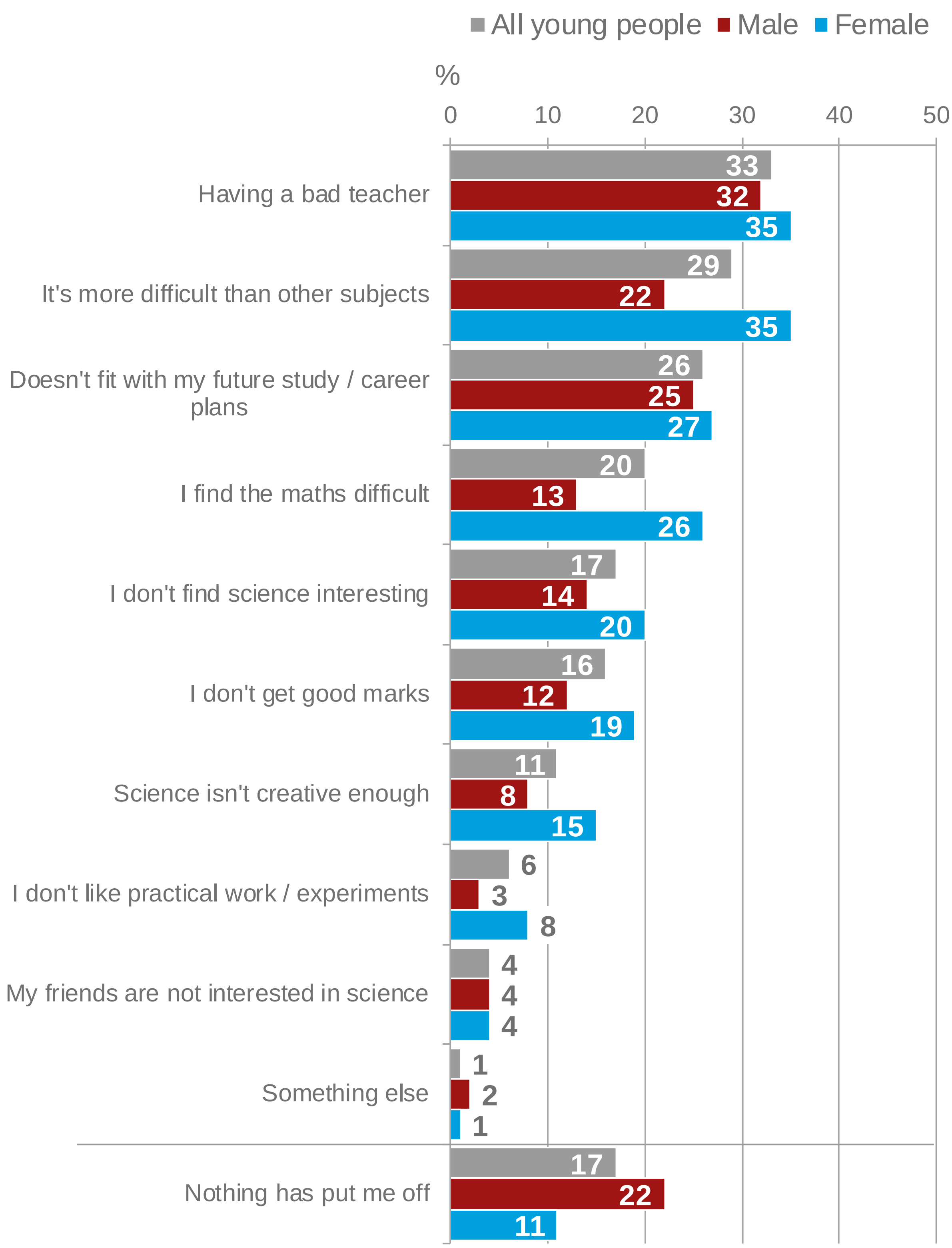


Base (All respondents): All young people (4,056), Male (1,916), Female (2,108)

http://dx.doi.org/10.6084/m9.figshare.4524551

Figure 2.9: Factors discouraging young people from learning science by gender

Q. And what has put you off learning science?

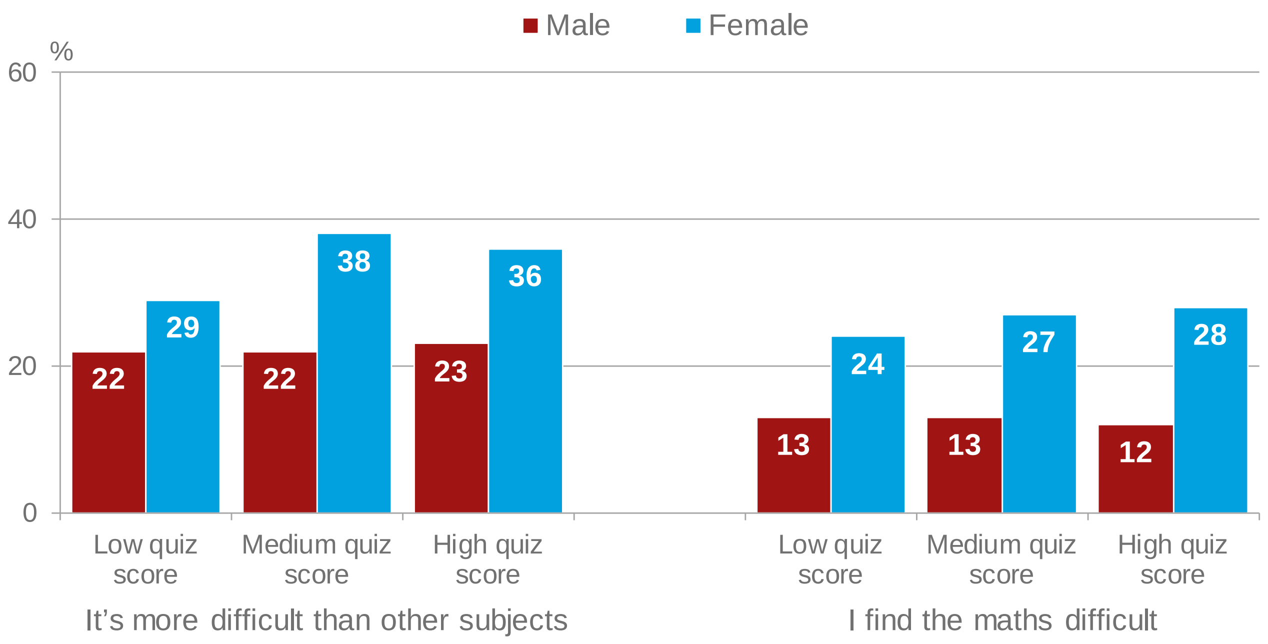


Base (All respondents): All young people (4,060), Male (1,914), Female (2,113)

http://dx.doi.org/10.6084/m9.figshare.4524551
This project was carried out in compliance with our certification to ISO 9001 and ISO 20252 (International Service Standard for Market Opinion and Social Research)

Figure 2.10: Factors discouraging young people from learning science by gender and attainment

Q. And what has put you off learning science?



Base (All respondents): Male with low quiz score (367), Female with low quiz score (465), Male with medium quiz score (1,032), Female with medium quiz score(1,309),Male with high quiz score (515), Female with high quiz score (339)

3. Practical science

This chapter examines young people's experience of practical work in GCSE science lessons. It considers the kinds of practical work experienced at school, the frequency of practical work and young people's own perceptions of learning through practical work.

Key findings

- A little under half (45%) of GCSE students reported doing hands-on practical work in science lessons at least once a fortnight, but three in ten (29%) reported doing it less than once a month or never.
- The majority of GCSE students (58%) said they wanted to do more practical work in science lessons. This was higher for single science students, three-quarters of whom said they wanted to do more practical work (76%).
- Young people often do not understand the purposes behind the practical work they do in science lessons; 22% said that they simply follow instructions without understanding the purpose of the work 'a lot of the time'.
- Young people at higher performing schools reported doing practical work more often, although greater frequency of practical work was not associated with higher scores on the science knowledge quiz. However, young people who reported doing more advanced practical work (such as designing and carrying out their own experiment) achieved higher scores on the science quiz than their peers who had not done this kind of work.
- Young people's experience of practical work varied substantially depending on the science GCSE course taken:
  - Single science students were less likely to have done more advanced practical work such as designing and carrying out their own experiment (62%, compared with 83% of triple science students).
  - Triple science students reported doing hands-on practical work more often (52% at least once a fortnight, compared with 37% of single science students) while single science students more frequently watched videos of practicals (44% at least once a fortnight, compared with 37% of triple science students).
  - Single science students were more likely to say they wanted to do more practical work (76%, compared with 49% of triple science students).
- Young people from more deprived areas did less practical work in GCSE science lessons than young people from less deprived areas.
  - 36% of GCSE students from the most deprived areas reported doing hands-on practical work at least once a month, compared with 54% of those from the least deprived areas.
  - 69% of GCSE students from the most deprived areas reported designing and carrying out their own experiment, compared with 84% of those from the least deprived areas.

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Introduction

Practical work is considered a central part of learning science at school. Ofsted (2011) found that '[i]n schools that showed clear improvement in science subjects, more practical science lessons and the development of the skills of scientific enquiry were key factors in promoting pupils' engagement, learning and progress'. Similarly, the House of Commons Science and Technology Committee (2002) concluded that:

'In our view, practical work, including fieldwork, is a vital part of science education. It helps students to develop their understanding of science, appreciate that science is based on evidence and acquire hands-on skills that are essential if students are to progress in science. Students should be given the opportunity to do exciting and varied experimental and investigative work.'

There is a concern, however, that practical work conducted in many lessons is often ineffective. Abrahams and Millar (2008), for example, found in observations of practical work in secondary school science lessons that:

'The overwhelming sense, from the lessons observed, was that a high priority for teachers is ensuring that the majority of students can produce the intended phenomenon, and collect the intended data…If, however, this ceases to be merely a priority and becomes the sole aim, the learning value of practical work is very significantly limited.'

Additionally: '[t]here was almost no discussion…of specific points about scientific enquiry in general, or any examples of use by the teacher of students' data to draw out general points about the collection, analysis, and interpretation of empirical data'.

In this way, the concern is not just that young people conduct a sufficient amount of practical work, but that the work is of sufficient quality to engage young people, develop their scientific skills and help them to understand important concepts.

3.1 Experience of practical work at school

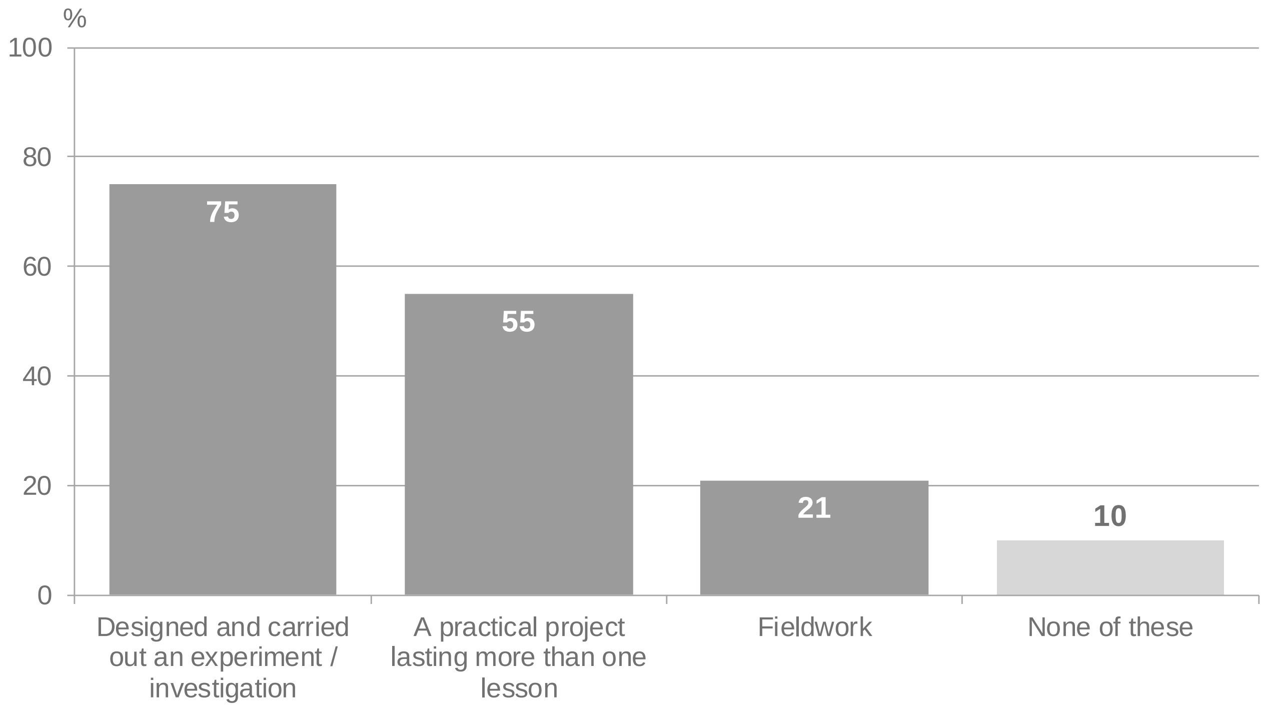
Respondents were asked about the kinds of practical work they do and how often they take part in different activities as part of science lessons.

In terms of the *types* of practical work being undertaken, three-quarters (75%) reported designing and carrying out an experiment in the last year, while a majority (55%) reported taking part in a practical project lasting more than one lesson (Figure 3.1). Fieldwork, on the other hand, appears to be less commonly undertaken in schools; only one in five young people (21%) reported doing this as part of science lessons in the last year.[14]

[14] We note, however, that in the cognitive testing stage of questionnaire development, it was common for young people to be vague about what constitutes 'fieldwork', associating it fairly generally with science work 'outside'. In part, this difficulty for cognitive testing respondents was because relatively few of them had experienced fieldwork.

Figure 3.1: Types of practical work undertaken

Q. Have you done any of these kinds of work in science lessons in the last year?



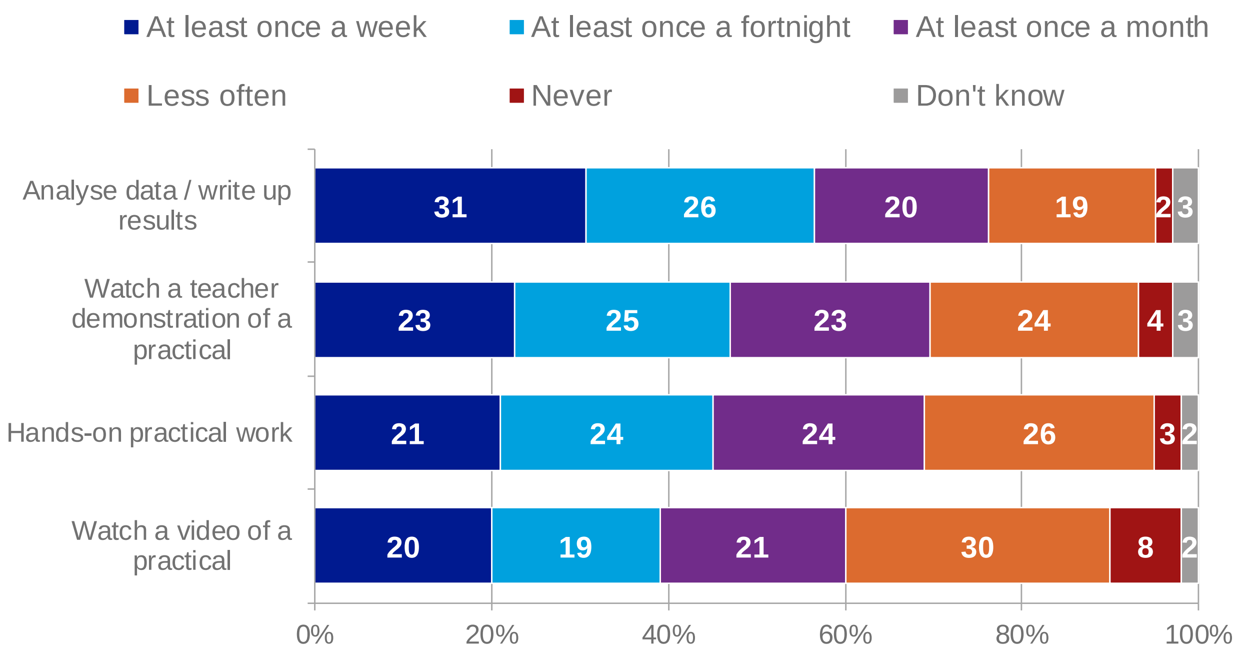
Base (Years 10/11): 2,185

In terms of the *amount* of practical work being done, one in five young people (21%) reported doing hands-on practical work every week, and 45% at least once a fortnight (Figure 3.2). However, there was still a large proportion of young people who reported doing little or no practical work; 29% of young people reported doing hands-on practical work less than once a month or not at all.

http://dx.doi.org/10.6084/m9.figshare.4524551

Figure 3.2: Frequency of practical work

Q. Apart from when you were preparing for exams, about how often did you do the following in science lessons?



Base (Years 10/11): 2,199

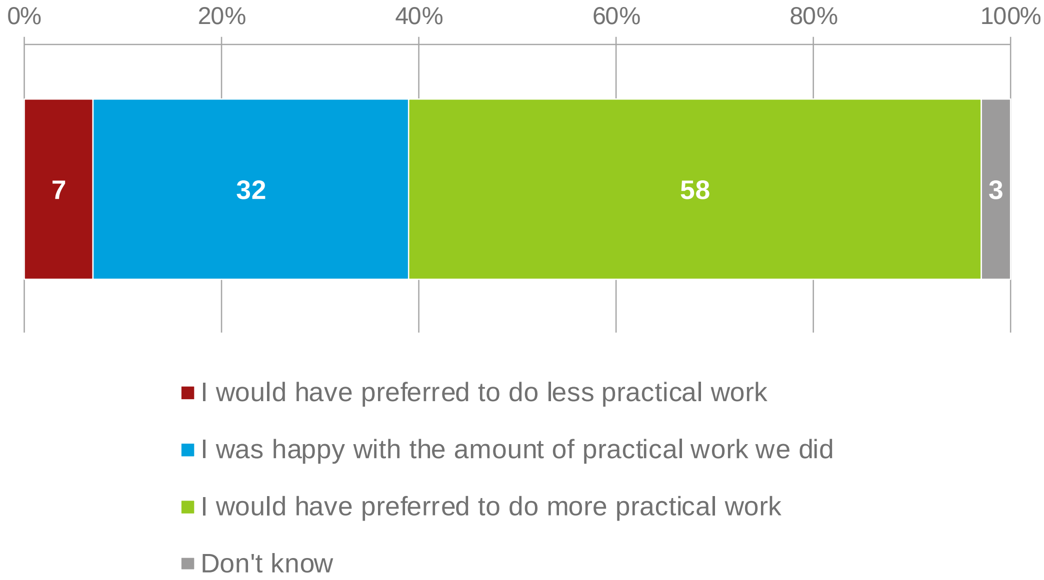
The majority of young people themselves said that they would have preferred to do more practical work (58%, Figure 3.3). Very few (7%) said they would have preferred to do less.

A preference to do more practical work is related to the frequency of hands-on practical work reported (Figure 3.4). Around half of young people doing hands-on practical work at least once a fortnight said they would still have preferred to do more, rising to two-thirds of those doing hands-on practical work less often than once a month.

Practical work seems to be particularly important for engaging certain groups of young people (Figure 3.5). Males were more likely to say they would have preferred more practical work than females (64%, compared with 51%). Those with a low FSCI score and especially those with a low science quiz score were also more likely to say they would have preferred to do more practical work.

Figure 3.3: Preferences for amount of practical work

Q. Which of these best applies to you?

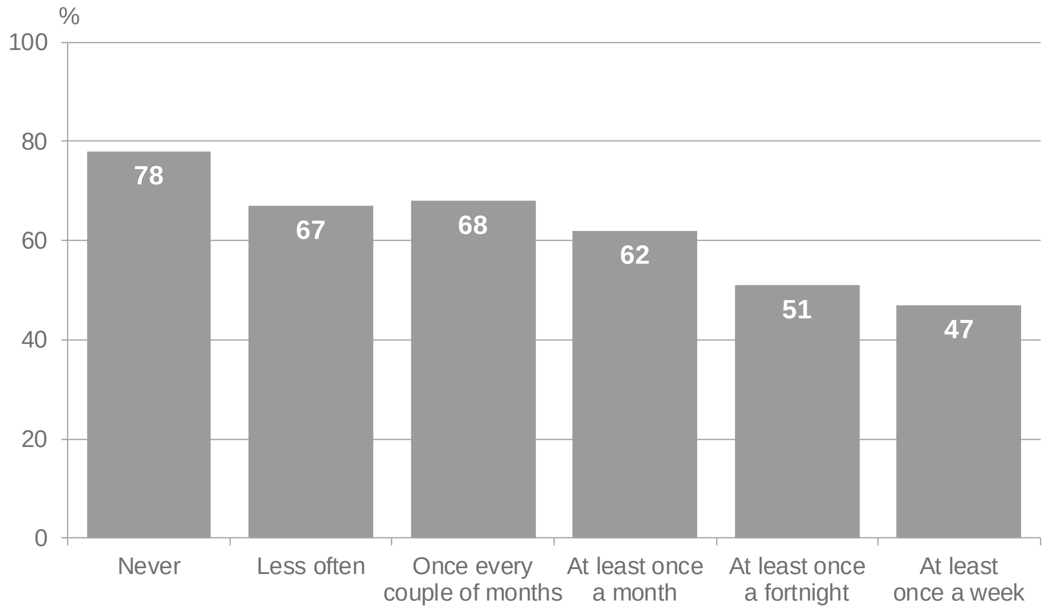


Base (Randomly selected half of respondents in Years 10 / 11): 1,061

Figure 3.4: % Preferred to do more practical work by frequency of hands-on practical work

Q. Which of these best applies to you?

I would have preferred to do more practical work



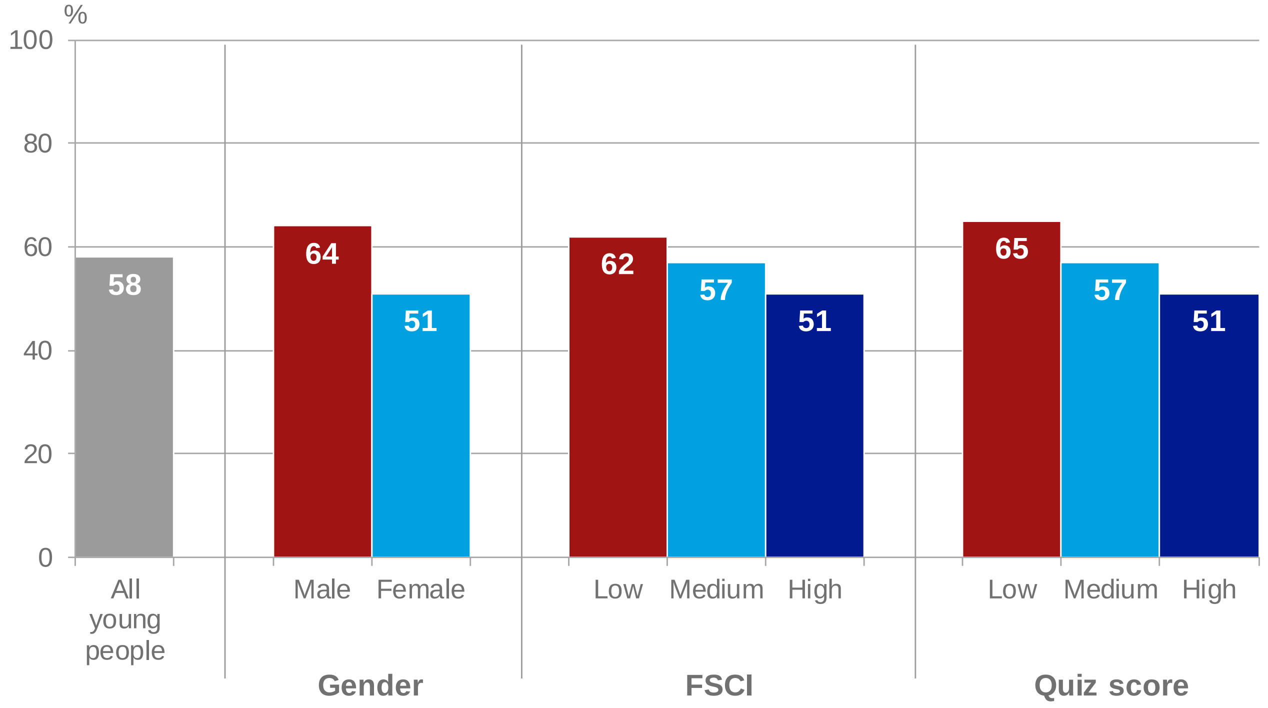
Base (Randomly selected half of respondents in Years 10 / 11): Never (30), Less often (96), Once every couple of months (163), At least once a month (266), At least once a fortnight (268), At least once a week (215)*

**Caution, low base*

Figure 3.5: Preferences for amount of practical work by gender, FSCI and science quiz

Q. Which of these best applies to you?

I would have preferred to do more practical work



Base (Randomly selected half of respondents in Years 10 / 11): Total (1,061), Male (499), Female (554), Low FSCI score (260), Medium FSCI score (569), High FSCI score (184), Low quiz score (202), Medium quiz score (641), High quiz score (218)

Nonetheless, as noted above, the importance of practical work lies not only in how much is done but also in how useful it is for developing a young person's understanding of science. There appears to be a clear shortcoming in the effectiveness of practical work, with 22% of young people saying that when doing practical work, they 'just followed the instructions without understanding the purpose of the work' a lot of the time (Figure 3.6). Nearly half of young people (46%) reported following the instructions without understanding the purpose of the work a lot of the time or sometimes. This was more common among females than males (51%, compared with 42%, Figure 3.7). It was also more common among those with low FSCI scores than those with high FSCI scores (52%, compared with 39%)

Although there was some difference on this measure by respondents' science quiz score (those with low quiz scores were more likely than those with high quiz scores to say that they frequently followed instructions without understanding the purpose of the work), 17% of young people with high quiz scores still said that a lot of the time they followed instructions without understanding the purpose of the work. Therefore, even for more able students, practical work is often failing to enable young people to develop lasting skills and understanding.

http://dx.doi.org/10.6084/m9.figshare.4524551
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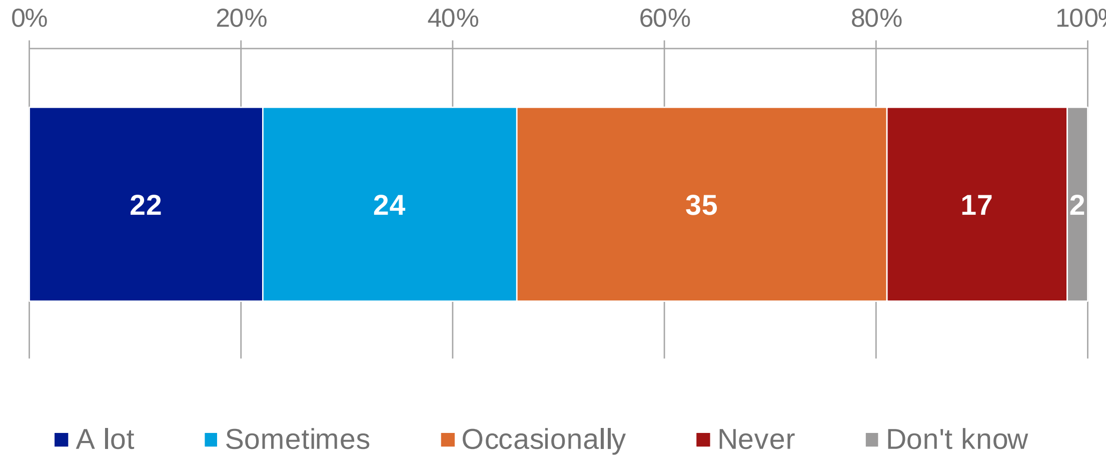
Figure 3.6: Understanding of practical work

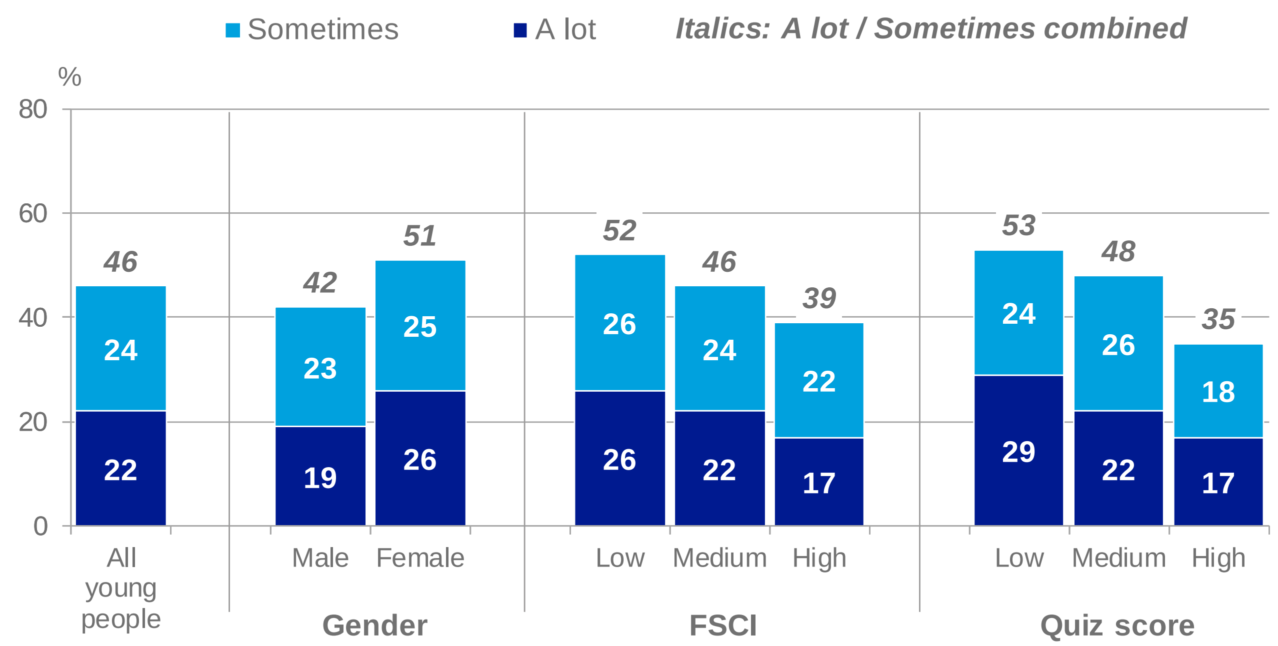
Q. When doing practical work, how often would you say that you just followed the instructions without understanding the purpose of the work?



Base (Randomly selected half of respondents in Years 10 / 11): 1,058

Figure 3.7: Understanding of practical work by science course and quiz score

Q. When doing practical work, how often would you say that you just followed the instructions without understanding the purpose of the work?



Base (Years 10 / 11): All young people (1,058), Male (498), Female (553), Low FSCI score (258), Medium FSCI score (568), High FSCI score (184), Low quiz score (200), Medium quiz score (640), High quiz score (218)

http://dx.doi.org/10.6084/m9.figshare.4524551

3.2 Practical work and academic performance

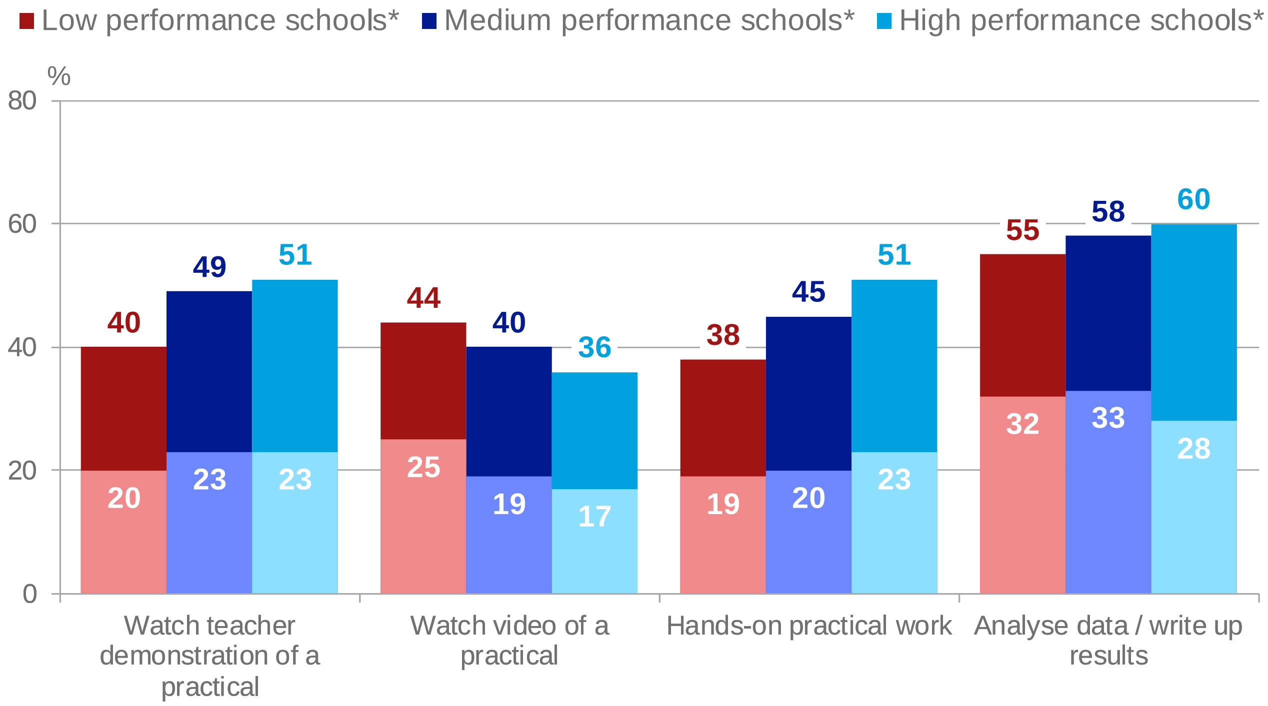
Young people at higher performing schools[15] reported doing practical work more frequently (Figure 3.8). For example, half of young people in high performing schools (51%) said they did hands on practical work at least once a fortnight, compared with 38% of those in low performing schools. Young people in high performing schools were also more likely to have done more advanced practical work such as designing and carrying out their own experiment (85%, compared with 71% in low performing schools, Figure 3.9).

There is some evidence that videos of practicals are being used as an alternative to hands-on practical work in lower performing schools; 44% of young people in lower performing schools reported watching videos of practicals in science lessons at least once a fortnight, compared with 36% of those in high performing schools.

Figure 3.8: Frequency of practical work by school performance

Q. Apart from when you were preparing for exams, about how often did you do the following in science lessons?

% done activity at least once a fortnight. The lighter shade bar shows % done activity at least once a week



**Low performance: under 50% of pupils achieving five GCSEs at A*-C*

Medium performance: 50-69% of pupils achieving five GCSEs at A-C*

High performance: At least 70% of pupils achieving five GCSEs at A-C*

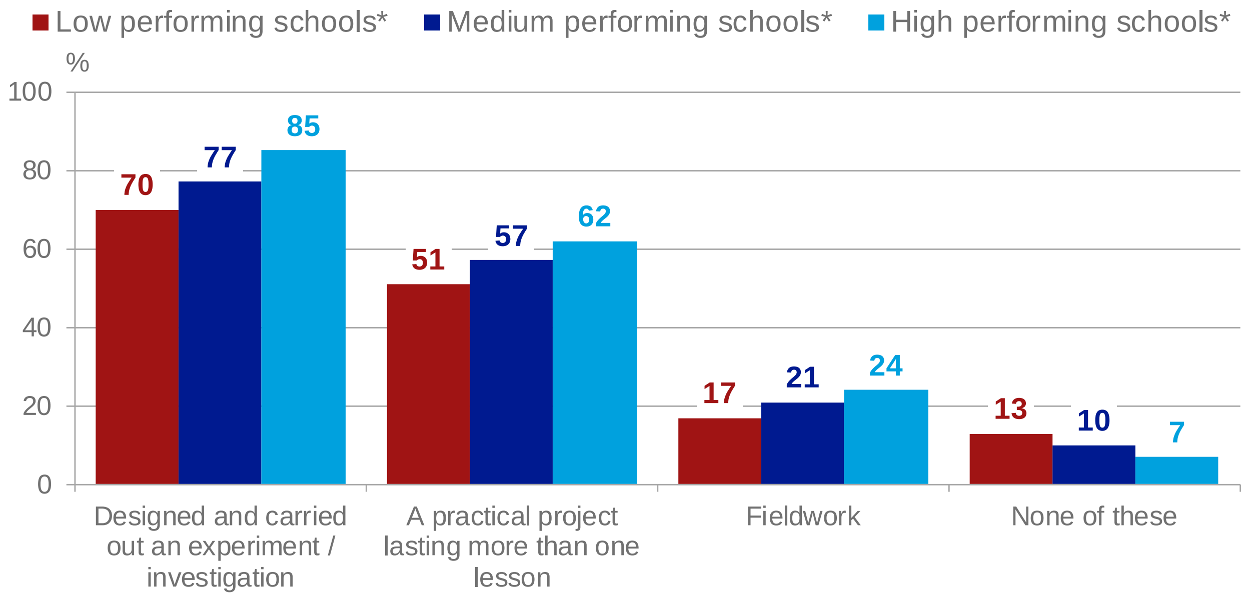
Base (Years 10 / 11): Low performance schools (451), Medium performance schools (841), High performance schools (528)

[15] See Figure 3.8 for definitions of high, medium and low performing schools in this analysis.

http://dx.doi.org/10.6084/m9.figshare.4524551
This project was carried out in compliance with our certification to ISO 9001 and ISO 20252 (International Service Standard for Market Opinion and Social Research)

Figure 3.9: Types of practical work by school performance

Q. Have you done any of these kinds of work in science lessons in the last year?



**Low performance: under 50% of pupils achieving five GCSEs at A*-C*

Medium performance: 50-69% of pupils achieving five GCSEs at A-C*

High performance: At least 70% of pupils achieving five GCSEs at A-C*

Base (Years 10 / 11): Low performance schools (448), Medium performance schools (841), High performance schools (526)

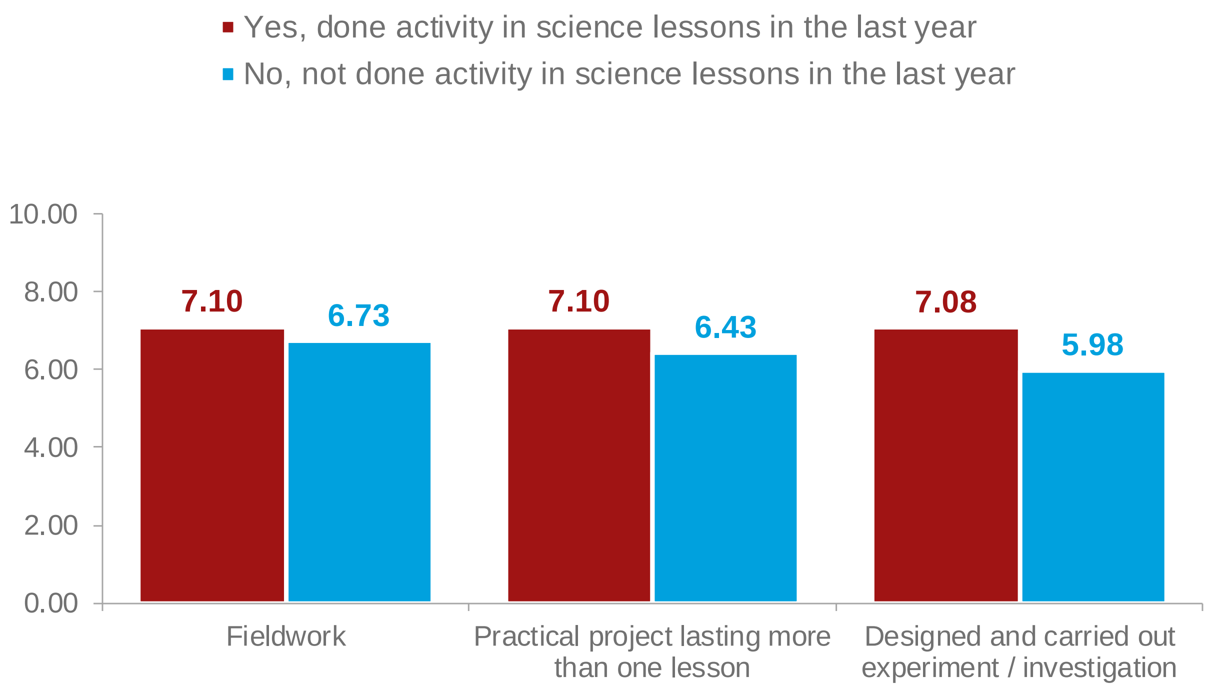
Despite the greater frequency of practical work in higher performing schools, more frequent practical work was not associated with higher scores in the science quiz (Figure 3.10). Quiz scores were no higher for young people who reported doing hands-on practical work at least once a fortnight than those who reported doing so only once a month or once every couple of months. The same was also true for watching teacher demonstrations and analysing data / writing up results. This is consistent with evidence from the 2015 PISA study in which greater frequency of enquiry-based instruction (experiments and hands-on activities) was not associated with higher scores in science and, in many countries including the UK, was associated with *lower* science scores (OECD, 2016c).

In SET, higher quiz scores were however observed for young people who reported doing more advanced forms of practical work such as designing and carrying out their own experiment (Figure 3.11). Quiz scores were, on average, 1.1 points higher for those who had done this kind of practical work, compared with those who had not done this kind of work – and this difference was evident between young people in more deprived areas as well as in less deprived areas. This supports the idea that effectiveness of practical work should be considered alongside its frequency.

Figure 3.10: Mean science quiz score by frequency of practical work

Base: Years 10 / 11	At least once a fortnight	At least once a month	Once every couple of months	Less often	Never
Watch a teacher demonstration of a practical	6.93	7.07	6.77	6.67	4.93
(Unweighted base)	*(1,046)*	*(512)*	*(317)*	*(191)*	*(70)*
Watch a video of a practical	6.81	7.07	6.85	6.91	6.20
(Unweighted base)	*(856)*	*(470)*	*(307)*	*(350)*	*(164)*
Hands-on practical work	6.96	6.96	6.92	6.35	5.65
(Unweighted base)	*(997)*	*(538)*	*(331)*	*(215)*	*(68)*
Analyse data / write up results of practical work	6.88	6.96	6.95	6.59	5.26
(Unweighted base)	*(1,260)*	*(439)*	*(257)*	*(151)*	*(35)*

Figure 3.11: Mean science quiz score by types of practical work



Base (Years 10 / 11 – Done activity / Not done activity): Fieldwork (464 / 1,735), Practical project lasting more than one lesson (1,235 / 964)

Designed and carried out experiment / investigation (1,673 / 526), Most deprived IDACI quintile (306 / 135), Second quintile (318 / 111), Third quintile (304 / 128), Fourth quintile 358 / 81), Least deprived quintile (384 / 71)

3.3 Practical work in GCSE science courses

Triple science students reported doing hands on practical work, analysing data / writing up results and watching teacher demonstrations more frequently than young people studying other courses (Figure 3.12). This is not surprising as triple science students will typically spend more time in science lessons than other pupils and so are likely to have more opportunities to take part in practical work.

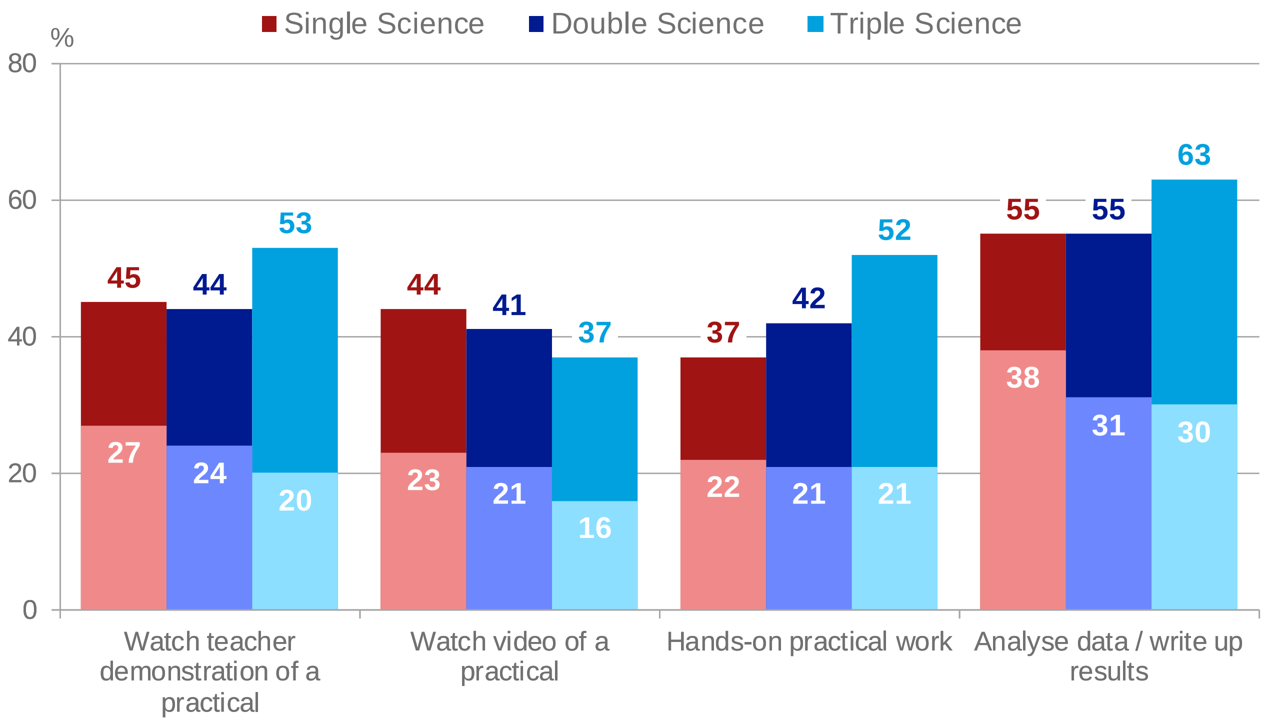
Nonetheless, a sizeable minority of single science students reported doing little or no practical work. Almost a third (31%) of young people studying single science reported doing hands-on practical work less often than once a month (compared with 19% of triple science students) and five per-cent reported never doing any hands-on practical work (compared with 1% of triple science students).

Again, there is some evidence that videos are being used as a replacement for practical work in single science classrooms. Almost half of single science students (44%) reported watching practical videos at least once a fortnight (compared with 37% of triple science students) and almost a quarter (23%) reported watching videos at least once a week (compared with 16% of triple science students).

Figure 3.12: Frequency of practical work by science GCSE course

Q. Apart from when you were preparing for exams, about how often did you do the following in science lessons?

% done activity at least once a fortnight. The lighter shade bar shows % done activity at least once a week



Base (Years 10 / 11): Single Science (245), Double Science (862), Triple Science (883)

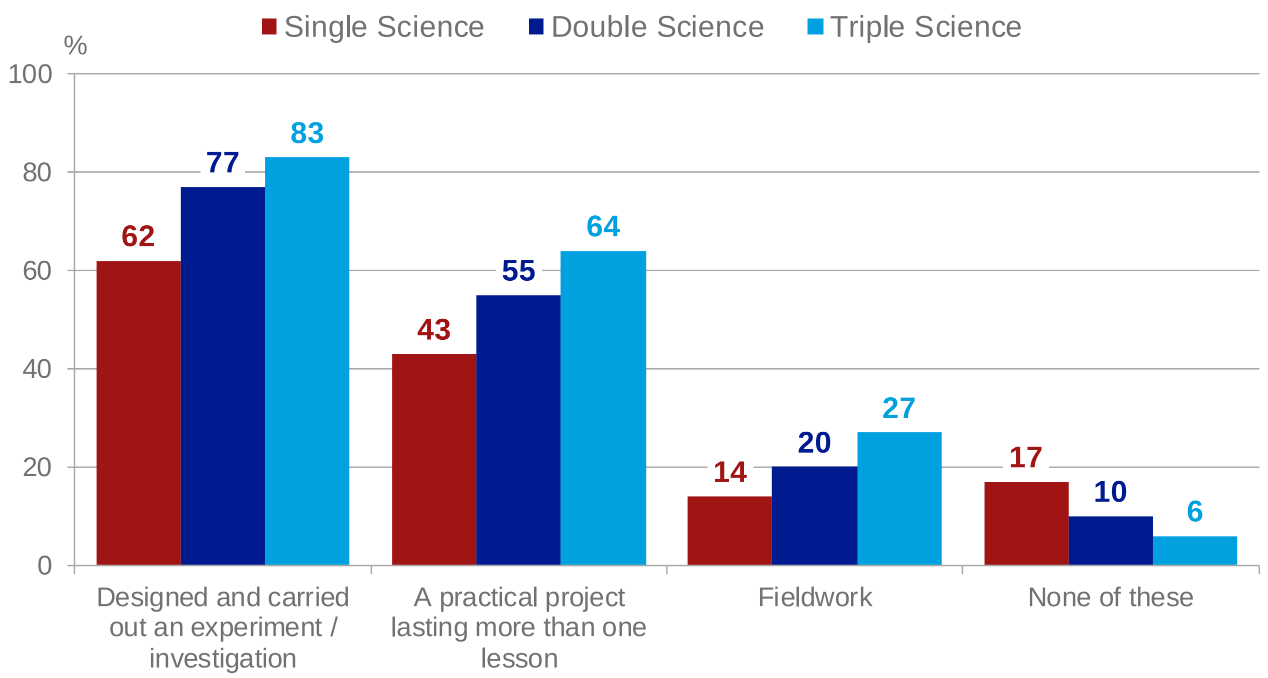
http://dx.doi.org/10.6084/m9.figshare.4524551

Single science students were also less likely to have undertaken more advanced forms of practical work (Figure 3.13). A lower proportion of single science students reported having designed and carried out their own experiment or investigation (62%, compared with 83% of triple science students and 77% of double science students) or conducting an experiment lasting more than one lesson (43%, compared with 64% of triple science students and 55% of double science students).

Furthermore, single science students were much more likely to say they would have preferred to do more practical work (Figure 3.14). More than three quarters (76%) of single science students said they wanted to do more practical work, compared with half of triple science students (49%). There appears, therefore, to be a particular demand from single science students to be given more opportunities to do practical work.

Figure 3.13: Types of practical work undertaken by science GCSE course

Q. Have you done any of these kinds of work in science lessons in the last year?

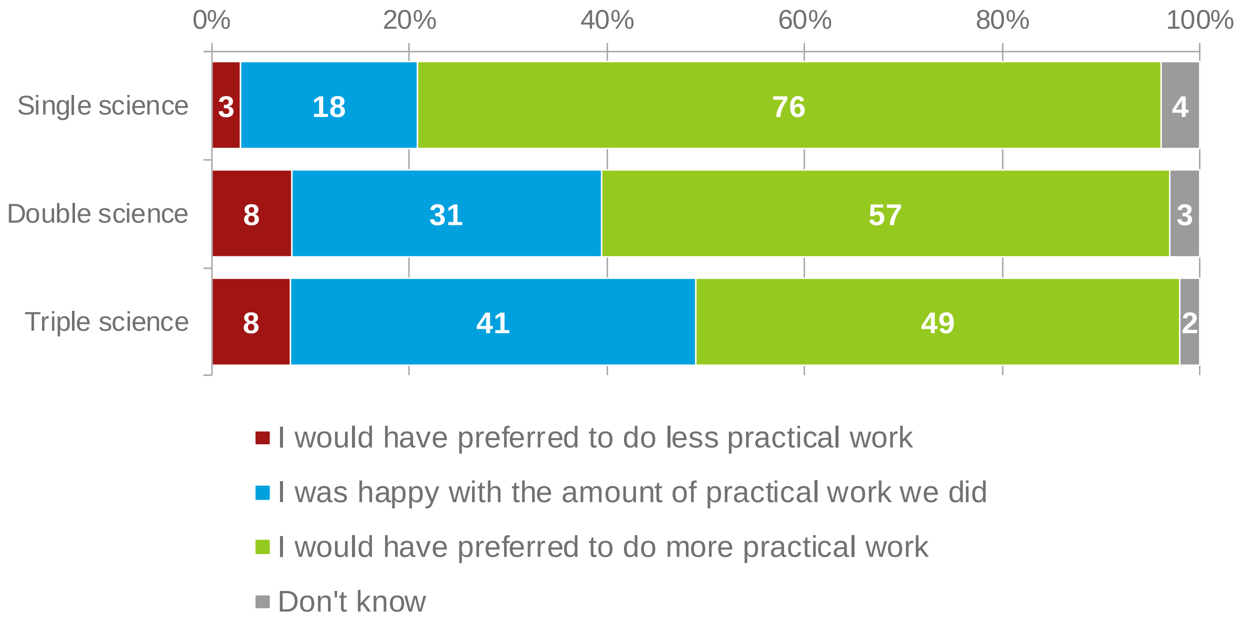


Base (Years 10 / 11): Single Science (242), Double Science (859), Triple Science (883)

http://dx.doi.org/10.6084/m9.figshare.4524551

Figure 3.14: Preferences for amount of practical work by science GCSE course

Q. Which of these best applies to you?



Base (Years 10 / 11): Single science (112), Double science (398), Triple science (454)

One limiting factor for schools in doing practical work is the amount of time spent in science lessons. Ofsted (2013) have recognised this, saying that 'time in the laboratory was the most pressing concern' for teachers trying to conduct practical work and that this can be a particular problem for triple science students:

'Those attempting to squeeze triple science GCSEs into less than 20% of a week's timetable, starting in Year 10, faced this problem most acutely. In these situations, any practical work that students did was the necessary minimum for controlled assessments. As a result, opportunities for illustrative and investigative scientific enquiry were limited, and so was the achievement of students.'

The results of the Science Education Tracker are consistent with this observation, with levels of practical participation for triple science students increasing with the amount of time they spend in science lessons (Figure 3.15); 42% of triple science students with four hours or less time per week in science lessons reported doing hands-on practical work at least once a fortnight, rising to 61% of those with at least 7.5 hours of science lessons a week.

Although this pattern is not as clear for single and double science students, there is still substantial variation in the likelihood of doing more advanced forms of practical work (Figure 3.16). More than three-quarters (77%) of single or double science students with at least 6.5 hours of science lessons a week had designed and carried out an experiment in the last year, compared with just 58% of those with up to three hours of lessons a week. Similarly, 60% of those with at least 6.5 hours of lesson time a week reported conducting a practical project lasting more than one lesson, compared with 42% of those with up to three hours a week.

The time pressures in lessons are therefore relevant for pupils across science courses, underlining the importance of ensuring that adequate time is dedicated to science lessons in the curriculum.

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Figure 3.15: Experience of practical work for Triple science students by no. of hours science lessons per week

Base: Triple science students in Years 10 / 11

	Up to 4 hours	4.5-5 hours	5.5-6 hours	6.5-7 hours	7.5 hours or more
	(%)	(%)	(%)	(%)	(%)
Have you done any of these kinds of work in science lessons in the last year?					
Designed and carried out an experiment / investigation	76	82	84	86	89
A practical project lasting more than one lesson	57	64	62	67	70
Fieldwork	21	23	29	25	36
Apart from when you were preparing for exams, about how often did you do the following in science lessons? (% done activity at least once a fortnight)					
Analyse data / write up results of practical work	54	61	67	69	64
Watch a teacher demonstration of a practical	46	52	52	59	63
Hands-on practical work	42	49	55	56	61
Watch a video of a practical	37	35	35	41	39
Unweighted base	*135*	*229*	*236*	*115*	*142*

Figure 3.16: Experience of practical work for Single / Double science students by no. of hours science lessons per week

Base: Single / Double science students in Years 10 / 11

	Up to 3 hours	3.5-4 hours	4.5-5 hours	5.5-6 hours	6.5 hours or more
	(%)	(%)	(%)	(%)	(%)
Have you done any of these kinds of work in science lessons in the last year?					
Designed and carried out an experiment / investigation	58	74	78	78	77
A practical project lasting more than one lesson	42	50	58	56	60
Fieldwork	14	17	20	22	21
Apart from when you were preparing for exams, about how often did you do the following in science lessons? (% done activity at least once a fortnight)					
Analyse data / write up results of practical work	53	51	56	59	62
Watch a teacher demonstration of a practical	54	39	46	46	46
Hands-on practical work	45	41	39	45	43
Watch a video of a practical	46	40	39	44	44
Unweighted base	*115*	*311*	*400*	*143*	*75*

3.4 The relationship between practical work and perceptions of teaching quality

Experience of practical work was also related to whether or not a young person reported being encouraged to learn science by a good teacher. It should be noted that respondents were not necessarily referring to any of their current teachers when saying they had been encouraged or put off learning science by a teacher. Moreover, many young people will have had more than one science teacher and so their perceptions of teaching quality could vary from one lesson to another. Nonetheless, there is an association between experience of practical work and whether a young person felt they had been encouraged by what they consider good teaching.

Young people who reported designing and carrying out their own experiment in science lessons in the last year were much more likely to say that they had been encouraged to learn science by ‘having a good teacher’ (34%, compared with 29% of those who had not designed and carried out their own experiment, Figure 3.17). Young people were also more likely to say they had been encouraged to learn science by having a good teacher if they had taken part in a practical project lasting more than one lesson (45%, compared with 33%) or fieldwork (46%, compared with 38%) in the last year.

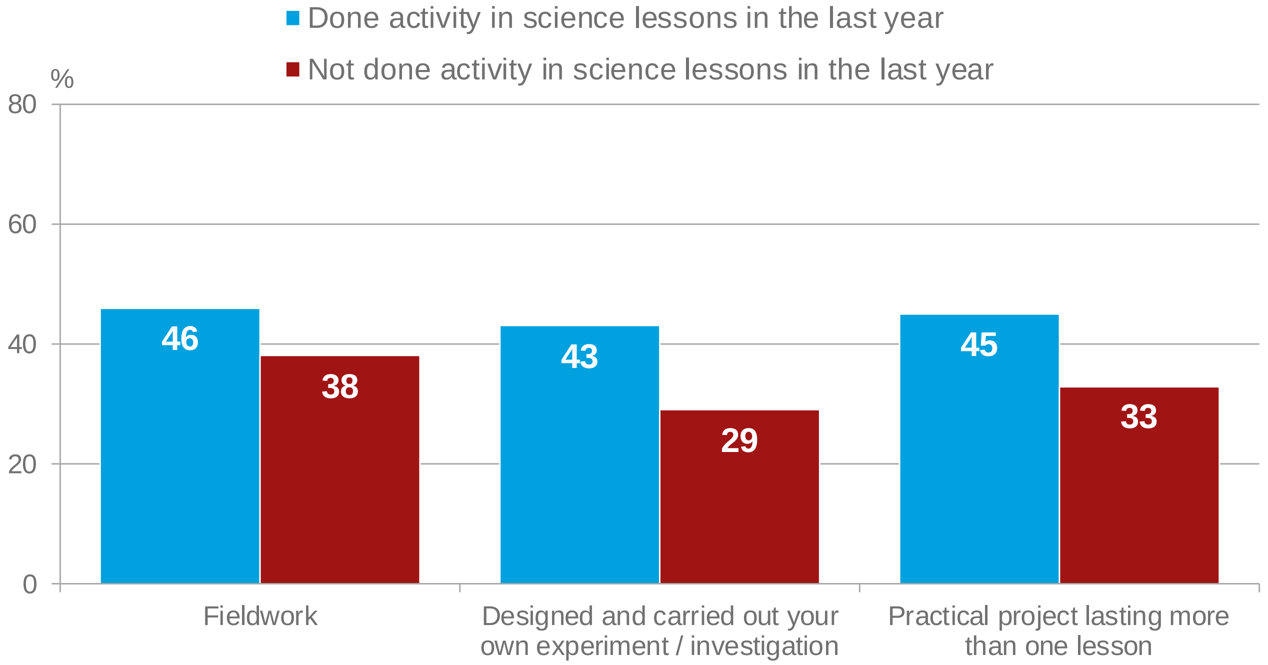
Similarly, those who did practical work more frequently were more likely to say they had been encouraged to learn science by ‘having a good teacher’ (Figure 3.18). Of those who reported doing hands-on practical work at least once a fortnight, 44% said they had been encouraged to learn science by ‘having a good teacher’, compared with 39% of those doing hands-on practical work once a month or once every couple of months and only 24% of those doing such practical work less often. Similar results were found for young people watching teacher demonstrations of practicals and analysing data / writing up results.

Additionally, young people were ***less likely*** to say they had been encouraged to learn science by ‘having a good teacher’ if they didn’t understand the purpose of the practical work they did (Figure 3.19). Of those who said that a lot of the time they just followed instructions without understanding the purpose of practical work, 29% said they had been encouraged to learn science by having a good teacher, compared with more than half of those who said they never had this problem (56%). More than half of young people who said they were happy with the amount of practical work they did (51%) said they had been encouraged to learn science by ‘having a good teacher’, compared with 37% of those who said they would have preferred to do more practical work.

Figure 3.17: Teacher encouragement to learn science by types of practical work

Q. What has encouraged you to learn science?

% ‘Having a good teacher’



Base (Years 10 / 11 – Done activity in science lessons in the last year / not done activity in science lessons in the last year): Fieldwork (464 / 1,721), Designed and carried out own experiment / investigation (1,673 / 512), Practical project lasting more than one lesson (1,235 / 950)

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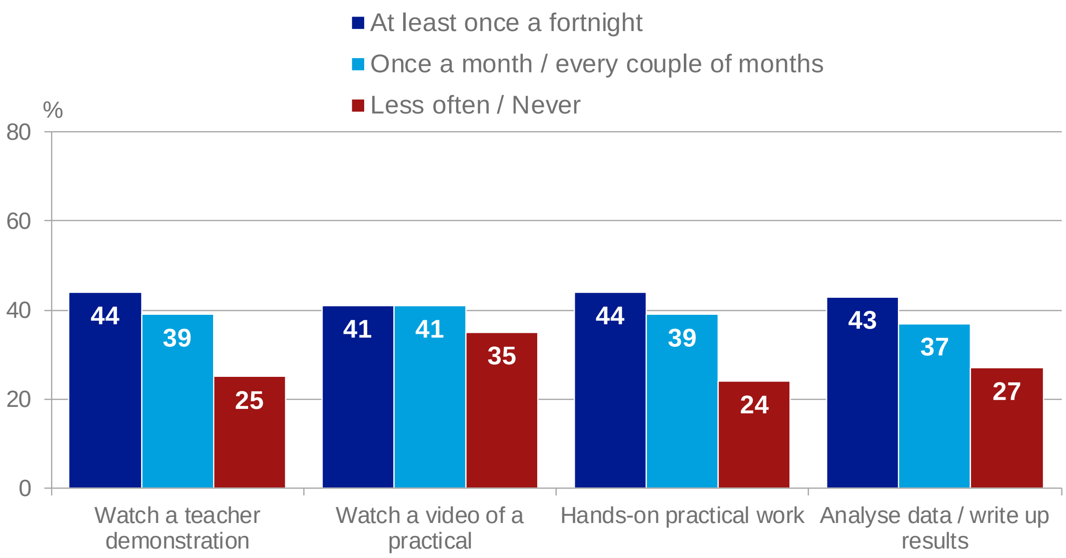
Figure 3.18: Teacher encouragement to learn science by frequency of practical work

Q. What has encouraged you to learn science?

% 'Having a good teacher'

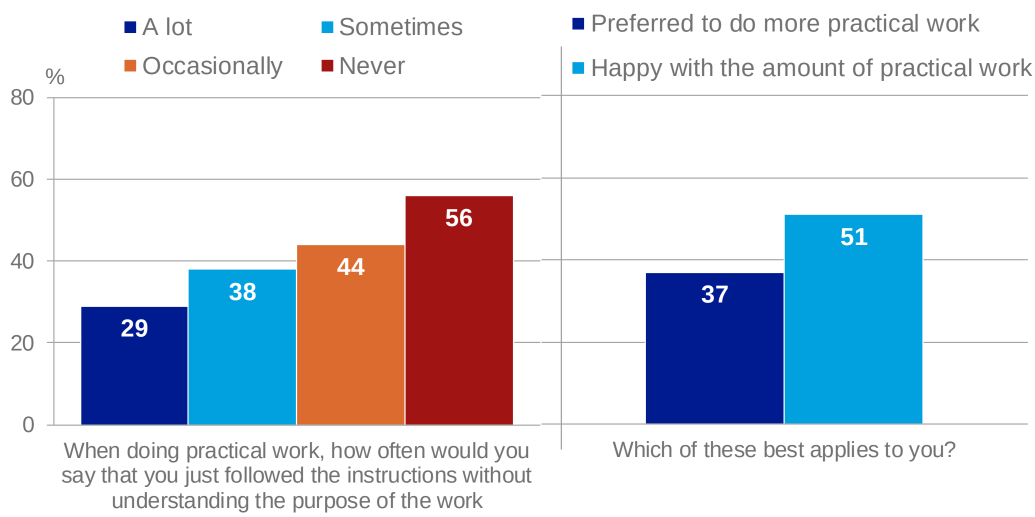


Base (Years 10 / 11 – At least once a fortnight / once a month, every couple of months / Less often, Never): Watch a teacher demonstration (1,046 / 829 / 261), Watch a video of a practical (856 / 777 / 514), Hands-on practical work (997 / 869 / 283), Analyse data / write up results (1,260 / 696 / 186)

Figure 3.19: Teacher encouragement to learn science by experience of practical work

Q. What has encouraged you to learn science?

% 'Having a good teacher'



Base (Years 10 / 11): A lot (234), Sometimes (256), Occasionally (368), Never (178), Preferred to do more practical work (597), Happy with the amount of practical work we did (356)

http://dx.doi.org/10.6084/m9.figshare.4524551
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3.5 Practical work and deprivation

One final consideration is the variability of young people's experiences of practical work based on the area in which they live; young people from more deprived areas had reduced opportunities to conduct practical work compared with young people from more affluent areas.

A little more than two-thirds (69%) of those in the most deprived quintile had designed and carried out an experiment in the last year, compared with 84% of those in the least deprived quintile. Similarly, half (51%) of young people in the most deprived areas reported conducting a practical project lasting more than one lesson, compared with 61% in the least deprived areas (Figure 3.20).

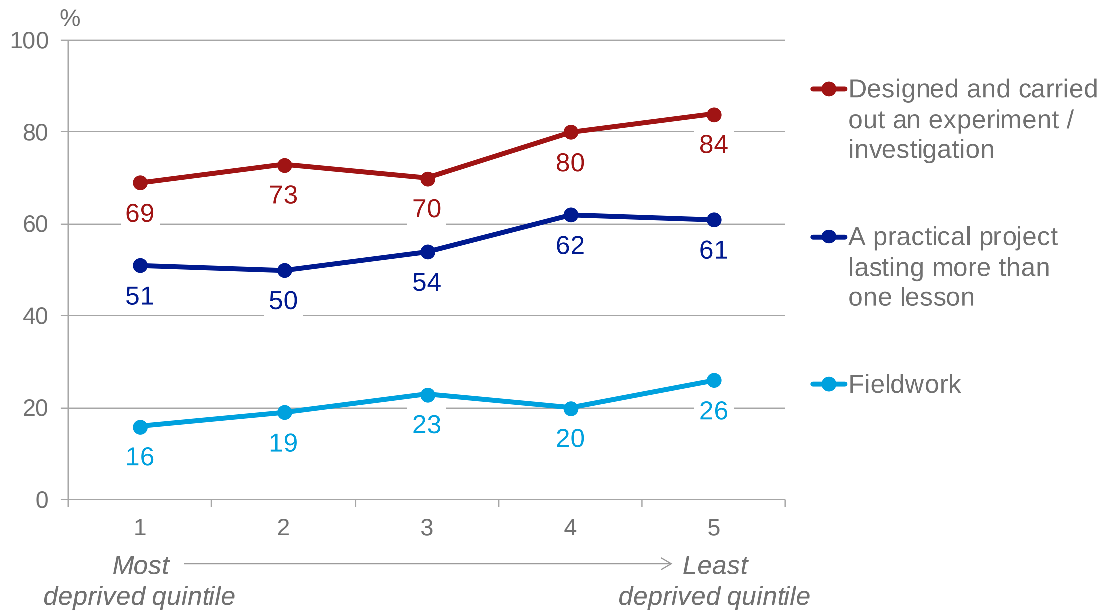
In addition, young people from the least deprived areas were much more likely to do hands-on practical work at least once a fortnight, to watch teacher demonstrations and to analyse data / write up practical results (Figure 3.21). The varied experience of practical work was evident for both double and triple science students (Figure 3.22).

Additionally, young people eligible for free school meals in the last six years were less likely to have designed and carried out an experiment (69%, compared with 79% of those not eligible for free school meals) or a practical project lasting more than one lesson (58%, compared with 52%). They also had less frequent experience of hands-on practical work (41% at least once a fortnight, compared with 46%), teacher practical demonstrations (42%, compared with 48%) and analysing data / writing up results (53%, compared with 59%).

Chapter 5 describes the lower participation rates of young people from more disadvantaged backgrounds in further and higher science education. Addressing disparities in the experience of practical work may be one way in which these young people can be further engaged with science subjects as well as enabling them to feel fully confident and prepared to continue their studies at higher levels.

Figure 3.20: Types of practical work undertaken by IDACI

Q. Have you done any of these kinds of work in science lessons in the last year?



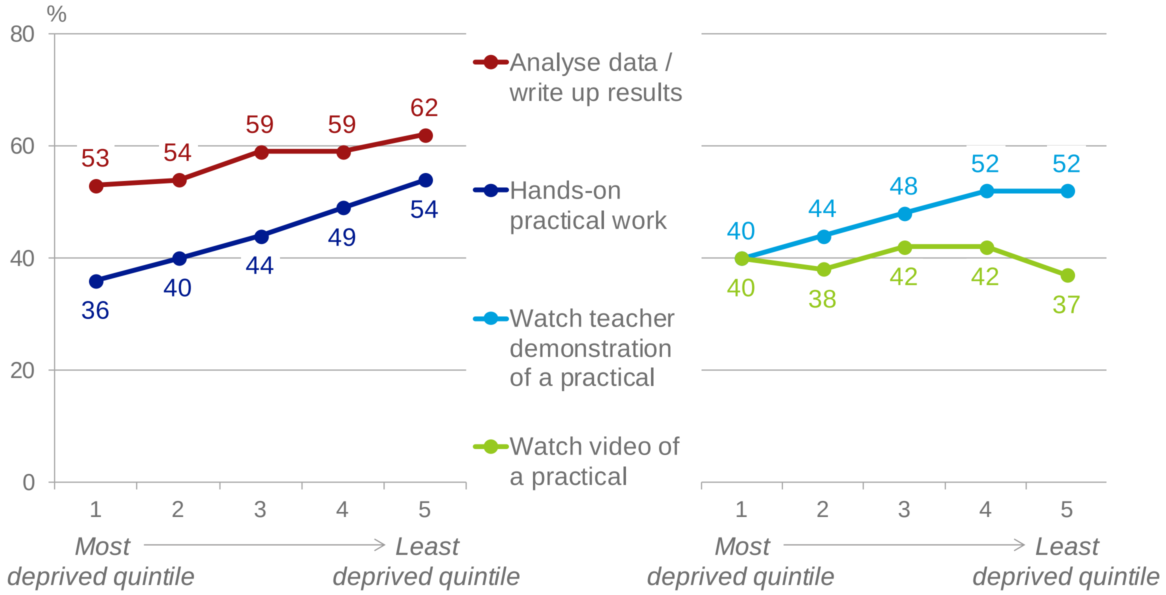
Base (Years 10 / 11): IDACI quintiles from most deprived to least deprived (433 / 427 / 439 / 439 / 454)

http://dx.doi.org/10.6084/m9.figshare.4524551

Figure 3.21: Frequency of practical work by IDACI

Q. Apart from when you were preparing for exams, about how often did you do the following in science lessons?

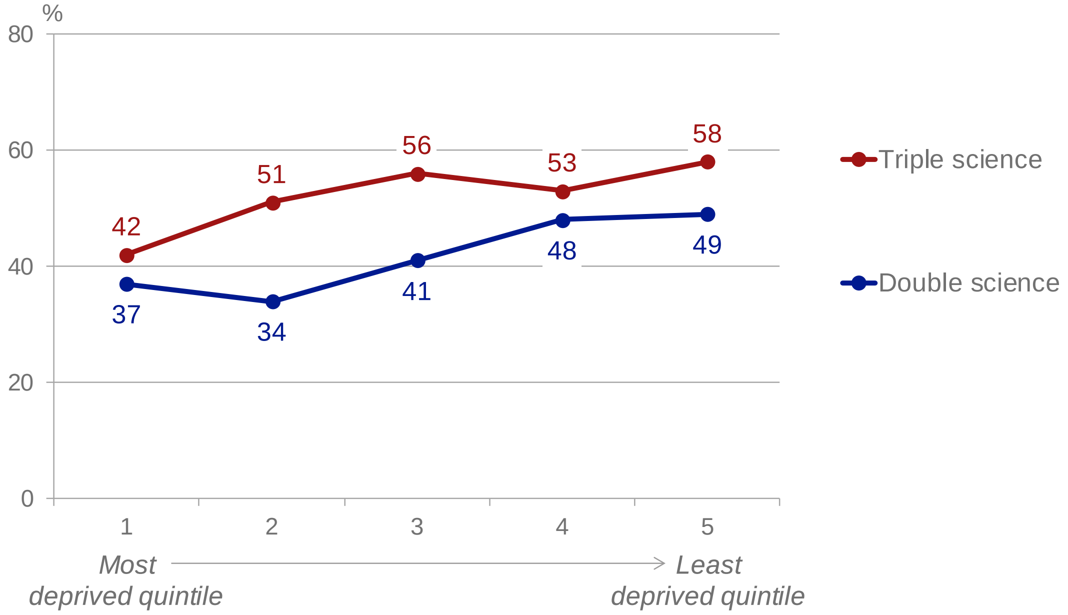
% done activity at least once a fortnight



Base (Years 10 / 11): IDACI quintiles from most deprived to least deprived (441 / 429 / 432 / 439 / 455)

Figure 3.22: Frequency of hands-on practical work by IDACI and GCSE course

Q. Apart from when you were preparing for exams, about how often did you do [hands-on practical work] in science lessons?



Base (Years 10 / 11 – IDACI quintiles from most deprived to least deprived): Triple science (155 / 135 / 165 / 204 / 223), Double science (160 / 180 / 176 / 171 / 173)

4. Science at GCSE

This chapter investigates the pathways taken by students during their GCSE years, including the uptake of triple science versus other science options, and the relationship between science course and future aspirations. The chapter also examines the barriers to studying triple science, including the relative importance of school-based barriers (such as lack of access or not meeting grade requirements) and personal barriers (such as lack of confidence). Finally we look at the profile of students taking computer science GCSE and the barriers associated with uptake.

Key findings

- Three-quarters of young people (75%) said that they studied either triple science (37%) or double science (39%) at GCSE. While this *overall* rate matches official figures, there is evidence that some young people in the survey misclassified double science as triple science due to confusion in terminology.
- Based on the survey classification, young people living in the most deprived areas were much less likely to study triple science than those living in more affluent areas. Asian males were more likely than other ethnicity/gender groups to study triple science.
- Young people who studied triple science were more likely than those studying other science GCSE courses to study (or intend to study) science subjects at Years 12 and 13.
- Triple science students had more timetabled science hours than students studying other science courses: half of triple science students (54%) cite 6 or more weekly hours compared with 20% of double and 13% of single science students.
- Amongst those who didn't study it, barriers to studying triple science were classified into three types: 58% cited personal barriers such as lack of confidence or interest; 41% cited school selection barriers such as not achieving the grade required; while 23% cited school access barriers (i.e. their school didn't enter any students for the course). While most students who took a non-triple science pathway were content with this, 16% would have liked to study triple science if it had been available to them.
- Among students who didn't study triple science, 30% cited lack of confidence as a reason for not studying it. While females (36%) were more likely than males (24%) to cite this, there was evidence that this was due in part to an under-estimation of ability among female students.
- One in five students (18%) said that they had studied or were studying computer science at GCSE: 25% of males and 9% of females. Analysis by year group indicates a rise in computer science entries between 2014-15 and 2015-16 corresponding with a fall in ICT GCSE entries, a pattern which reflects national trends.
- Key barriers to studying computer science were lack of availability and interest. Females were especially likely to lack interest in the subject. Lack of access declined rapidly through age cohorts such that only 16% of Year 10 students in 2015-16 said that computer science was unavailable at their school. This reflects government policy to widen access to this subject.

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4.1 Science at GCSE

4.1.1 Policy context

Over the last decade there have been a number of changes to the way that science has been taught at GCSE level in schools. The default position has been that students take either a single science GCSE, a double science GCSE (made up of core and additional science) or three separate sciences (triple science). 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 higher rates of post-16 science uptake and raised aspirations to study STEM subjects (Archer *et al.,* 2016c, NAO, 2010).

Before 2006, only a limited number of schools entered students for triple science GCSE; for example in 2003-4 only 30% of state secondary schools entered students for triple science (NAO, 2010). However in 2006 the Government of the time set out a commitment (HM Treasury, 2006) to ensure that all students had an entitlement to study triple science. Since that time, the rise in the number of schools entering students for triple science has been dramatic. Recent data suggests that the majority of state schools now offer this option (OPSN, 2015). Moreover, entries to triple science increased threefold in the decade to 2013 (Gatsby 2016) while other sources cite substantive increases over more recent time periods (Allen & Thompson, 2016, Greevy *et al.,* 2012). However there have been several recent publications citing regional, demographic and attainment imbalance in the entitlement to triple science (see section 4.2.1).

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 include modifications to course content, a move from modular to linear assessment, and the removal of practical assessments leaving only written exams.

In this sub-section we cover the profile of students in terms of the science course they have taken (section 4.1.2); variation across demographic subgroups (section 4.1.3); how this relates to future aspirations (section 4.1.4); and the relationship between science course and volume of teaching hours (section 4.1.5). Section 4.2 then explores the barriers to uptake of triple science including a detailed analysis of both school-based and personal barriers.

4.1.2 Science pathway taken in Years 10 and 11

The Science Education Tracker asks students to report their current (if Year 10/11) or previous (if Year 12/13) GCSE science course. According to this, the proportion of students who have taken triple science over this four year period is 37%; double science accounts for 39% of courses; while single science and other non-GCSE courses such as BTEC were taken by 18% of students.

However, it is important to note that these figures are based on student self-reports and we consider it very likely that the rate of triple science uptake was over-estimated due to student confusion around what counts as 'triple' and 'double' science.[16]

[16] We attempted to get around this in question wording by providing the clarification 'Triple Science GCSE is biology. chemistry and physics, or core, additional and further additional science' but we recognise that many students may still have been confused or misunderstood the question.

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In fact official Department for Education statistics (DfE, 2016a and DfE, 2016b) quote an average rate of 23% for triple science[17] and 51% for double (or core and additional) science, based on all state-funded schools in England 2016.[18]

Figure 4.1 shows the official rate of triple and double science entries compared with the results from the SET survey for the equivalent years. This shows that:

- Although this comparison with official statistics strongly implies that SET survey data over-estimates the proportion of students studying triple science, the survey estimate of all students taking either one of the core science options that form part of the EBacc, i.e. double or triple science, closely matches official figures (75% in the SET survey vs. an official rate of 74% averaged across the equivalent four years). This suggests that some GCSE science students may be misclassifying ‘double science’ as ‘triple science’, which is plausible as double science still involves the study of all three sciences (biology, chemistry, physics).
- Consistent with official statistics on triple sciences entries between 2012-2013 and 2014-2015, the rate of reported triple science in the SET survey across equivalent school years has remained relatively constant, while the reported rate of double science has increased. In Year 10 (2015-16 cohort), the SET survey figures suggest an increase in triple science and a decrease in double science. However, this could be a consequence of Year 10 figures being an ‘interim’ measure as it is known that some students studying triple science in Year 10 switch to double science in Year 11.
- The reduction over time in the rate of SET survey students taking other courses such as BTEC is in line with official statistics where DfE (DfE, 2016b) state *‘The increase in pupils entering the core and additional pathway is driven by a move from science BTECs to core and additional science, by pupils with lower prior attainment.’*
- In the SET survey the rate of young people stating that they did not know which science course they took is six per cent. For young people in the survey who have recently completed their first year of GCSE (Year 10) the rate of ‘don’t know’ is higher than average (10%) which could suggest that, in the light of changes over recent years, the terminology around science course pathway has become increasingly confusing for students.

[17] Note that this figure is based on ‘three sciences’ which means three out of biology, chemistry, physics, and computer science. However the majority of triple science entries will be the three core sciences.

[18] Other survey-based studies have reported rates similar to the SET survey (for example a school-based survey Greevy *et al*., 2012 documents the rate at 34%).

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Figure 4.1 a): DfE statistics (DfE, 2016a & DfE, 2016b) Percentage of pupils entered for triple and double science pathways

Base: England, state-funded schools, 2012-2016

	2012-13 %	2013-14 %	2014-15 %	2015-16 %	Average (four years) %
Triple science	24.7	22.2	21.7	23.9	23.1
Core and additional science/Double science	41.5	46.5	52.4	62.3	50.7
Total	**66.2**	**68.7**	**74.1**	**86.2**	**73.8**

Figure 4.1 b): SET survey results for science pathway by corresponding year

	Year 13 %	Year 12 %	Year 11 %	Year 10 %	All students Y10-Y13 %
Triple science	37	35	35	42	37
Core and additional science/Double science	34	41	45	34	39
Single science	15	13	12	13	13
Other science course (e.g. BTEC)	9	7	2	1	5
Don't know	6	4	6	10	6
Triple or Double science	**71**	**75**	**80**	**76**	**75**
Base: All respondents	*923*	*943*	*1,079*	*1,107*	*4,052*

For young people in Years 12/13 in the SET survey who agreed to link to NPD data, we can compare survey responses with their recorded GCSE results. According to NPD, 29% of young people in SET had taken triple science and 52% had taken double science (81% overall). These figures are a little higher than DfE statistics for the equivalent years but once again this provides evidence of a misclassification by students with some students recorded on the NPD file as studying double science but stating that they took triple science in the survey.

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4.1.3 Variation in GCSE science pathway by demographic subgroups

The discussion in section 4.1.2 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 (Figure 4.2). Based on this survey classification, and compared with the overall survey rate (37%), triple science take-up was higher in the following groups:

- Asian males (46%) (there were no differences by gender or ethnic group at an overall level);
- Students living in the least deprived areas (48%);
- BME[19] students living in the least deprived areas (56%);
- Students with strong family science connections (54% of those with a high FSCI score).

On the other hand the rate of triple science, when compared with the overall rate of 37%, was lower in the following groups:

- Students living in the most deprived areas (32%);
- White students living in the most deprived areas (34%);
- Students eligible for free school meals (28%);
- Students with no family science connections (26% of those with a low FSCI score).

Focusing on the proportion of students who take either double or triple science, there are again gradients across subgroups. Compared with the overall rate (75%) the following groups were less likely to take either of these options:

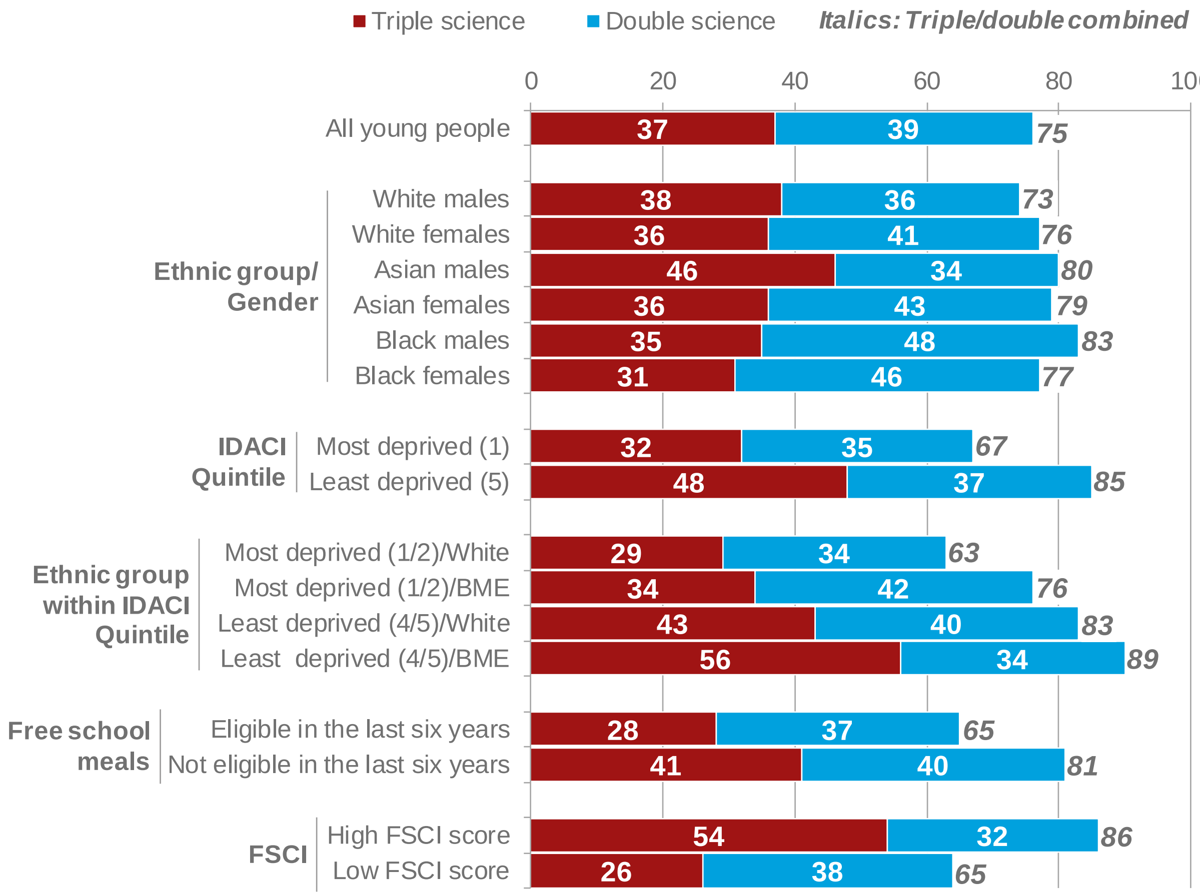
- Students in the most deprived areas (67%);
- Students with free school meal eligibility (65%);
- White students living in the most deprived areas (63%).

These relationships are consistent with findings reported on the ASPIRES study (Archer *et al.,* 2016b) and the Longitudinal Study of Young People in England (Jin *et al.*, 2011) and underline the importance of income and family science connections in explaining science outcomes for young people.

[19] Due to low base sizes, black and minority ethnic groups are combined for the analysis of ethnicity within IDACI quintile.

Figure 4.2: Science course (self-reported*) by demographic subgroups

Q. Which science course [did you take/are you taking] in Year 10 and 11?



Base (All respondents):All young people (4,052), White males (1,507), White females (1,625), Asian males (212), Asian females (223), Black males (70), Black females (101), IDACI Quintile 1 (824), Quintile 5 (823), IDACI Quintile 1,2/white (1,053), IDACI Quintile 1,2/BME (519), IDACI Quintile 4,5/white (1,466), IDACI Quintile 4,5/BME (170), FSM eligible last 6 years (678), FSM not eligible (2,347), High FSCI score (712), Low FSCI score (1,016)

** Refer to notes in section 4.1.2 on the interpretation of these figures.*

4.1.4 Links between triple science and science-related aspirations

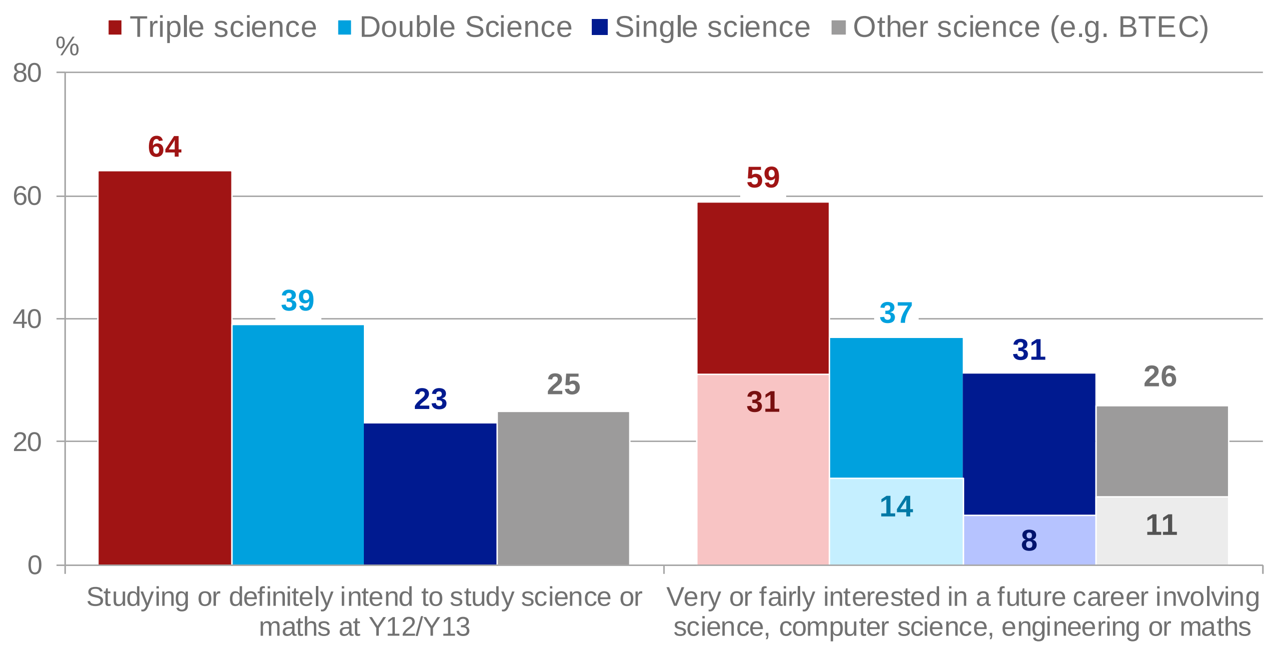
As noted in section 4.1.1, a number of studies have identified a link between triple science and post-16 science uptake as well as aspirations to study STEM subjects in the future.

The SET also demonstrated that triple science was strongly linked to likelihood and aspirations to study science at Year 12 and beyond (Figure 4.3). Two-thirds (64%) of those who had taken triple science (either currently or in the past) were on a pathway to study science at Year 12 and 13; this figure compares with 39% for double science, 23% for single science and 25% of those studying another science course such as BTEC. Students studying triple science (31%) were twice as likely as those studying double science (14%) to say that they were 'very interested' in a science-related career.

Figure 4.3: Likelihood to study science or take up a science-related career by science course taken

Left hand bars: **Studying / intending to study science or maths at Year 12/13**
Year 10/11:
Q.(If already chosen Y12 options) Are you intending to study any of the following [science] subjects in Year 12?
Q. (If not yet chosen Year 12 options) How likely are you to study A levels, NVQ level 3 or a similar qualification in [science subjects]?
Year 12/13:
Q: Have you been studying any of these [science] subjects in Year 12 or 13?

Right hand bars: **Interest in science-related careers**
Q. Are you interested in a future career that involves science, computer science, engineering or maths?



Base (All respondents)

Studying or definitely intend to study science or maths at Y12 /Y13: Triple science (1,596), Double science (1,555), Single science (476), Other science (135)

Interest in science-related careers: Triple science (1,600), Double science (1,560). Single science (485), Other science (142)

4.1.5 Number of hours of science education by type of course

Students in Years 10 and 11 were asked about the number of hours spent learning science, where science was defined as lessons in biology, chemistry, and physics. The number of hours spent learning science is a key measure of how science is experienced at school. For example, chapter 3 section 3.3 shows how a reduced science timetable is related to more limited opportunities to undertake practical work.

As shown in Figure 4.4, triple science students reported more timetabled science hours than those studying other courses: around half of triple science students (54%) cite 6 or more weekly science

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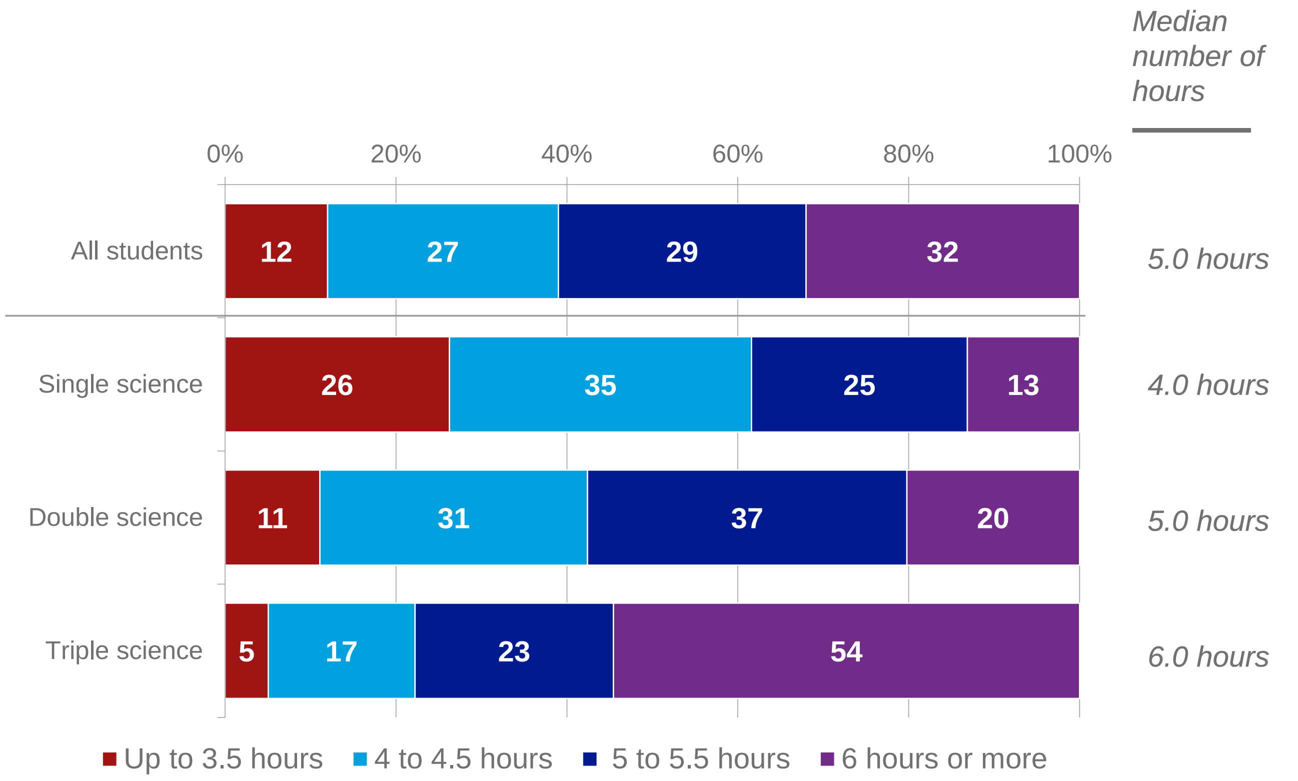
hours compared with 20% of double and 13% of single science students. At the other end of the scale, 26% of single science students say they receive less than 4 hours per week. The median number of hours increases incrementally from 4 hours (single science) to 6 hours (triple science). The overall median of 5 hours is consistent with findings from the 2015 PISA survey (OECD, 2016c) which quotes an average figure of 4.7 hours in science lessons per week.

Based on the content of the teaching curriculum, it might be expected that double science students spend twice as many hours in science lessons as single science students; and that triple science students receive three times as many science hours as single science students and 1.5 times as many as double science students. The survey findings do not support this and suggest that, although the number of hours increases with the level of course, the gradient is much shallower than this. However, in the light of the discussion in 4.1.2 which suggests some misclassification by survey respondents of double science as triple science, it is possible that the number of hours reported by triple science students is an under-estimate. Therefore any conclusions about differences in timetabled hours by science pathway must be treated by a degree of caution.

Figure 4.4: Number of hours spent studying science at GCSE by type of course

Q. Which science course [did you take/are you taking] in Year 10 and 11?



Base (All respondents in Year 10 or 11):All students (2,072), Single science (222), Double science (818), Triple science (857)

Note: 'Don't know' not included

http://dx.doi.org/10.6084/m9.figshare.4524551

4.2 Barriers to taking triple science

We have placed the reasons for not taking up triple science 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.

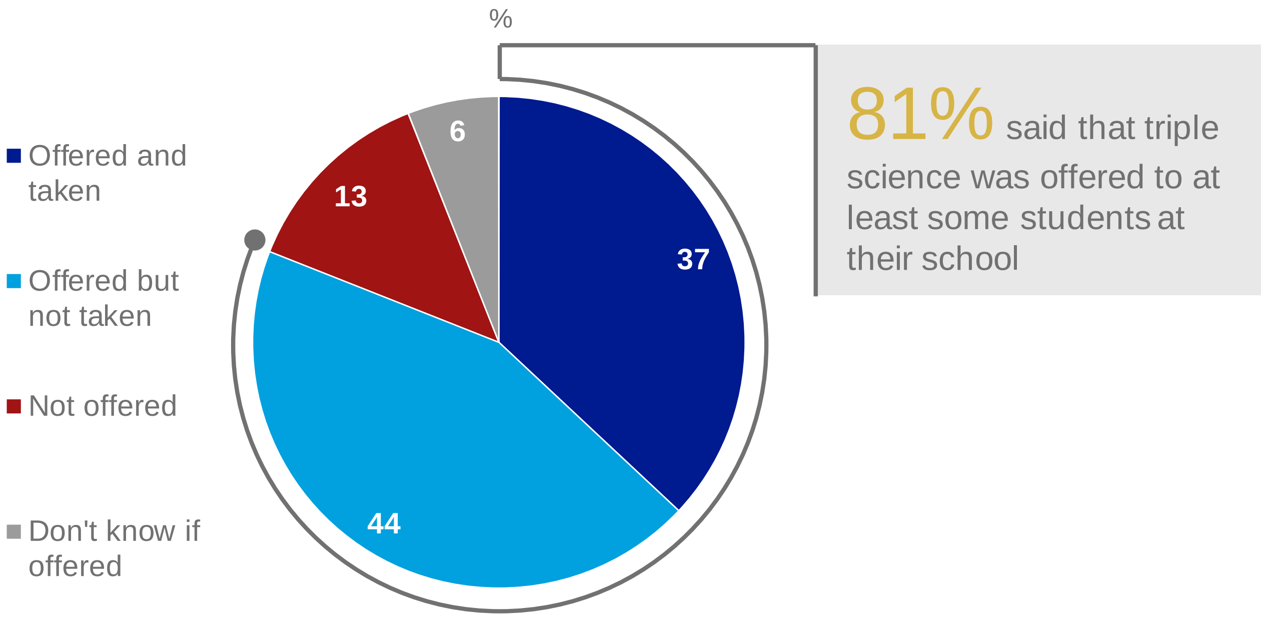
4.2.1 School access barriers

Figure 4.5 shows the proportion of students in the SET who believed that their school entered at least some students for triple science. Overall, 81% said that their school offered triple science, of which slightly less than half (37% overall) took up this pathway. One in eight (13%) said that triple science had not been available at their school. This figure is broadly consistent with data presented by the Open Public Services Network (OPSN, 2015) which shows that in 10% of state secondary schools no pupils were entered for GCSE triple science. However, a 2012 school-based survey (Greevy *et al.*, 2012) found the rate of state schools not entering students for triple science to be slightly lower, at seven percent.

Figure 4.5: Whether triple science was offered to at least some students at their school

Q. Which science course [did you take/are you taking] in Year 10 and 11?

Q. (If not triple) When you were choosing your GCSE options, did your school offer triple science?



Base (All respondents): 4,070

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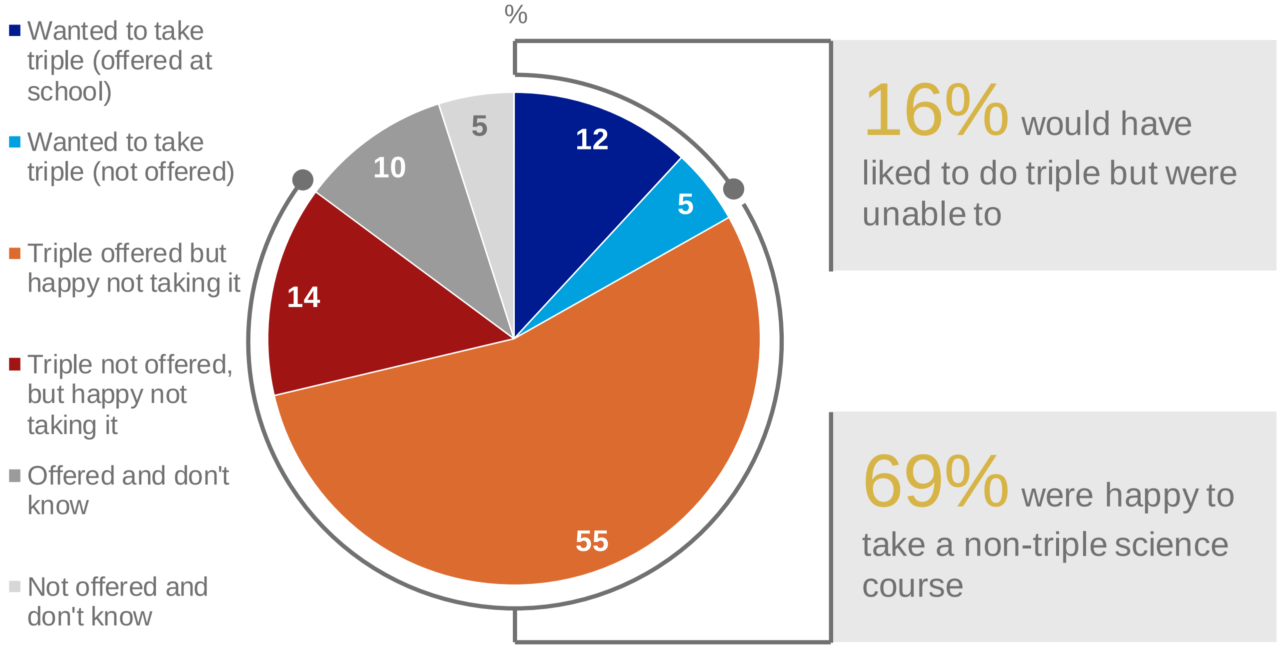
Consistent with other published reports (OPSN, 2015; NAO, 2010; Morgan, 2012) which highlight the more limited availability of triple science within more socially disadvantaged areas, the SET also found a link between access to triple science and socio-economic status. Compared with the average (13%), the non-access rate was higher for students living in more deprived quintiles (17% in quintile 1 and 18% in quintile 2) and students who were eligible for free school meals within the previous six years (19%).

Students who did not take triple science were asked whether this was their preference. Figure 4.6 shows that a large majority of students (69%) were happy with the science route they took, while 16% felt that they had been denied access to triple science by their school, either because it was not offered (5%), or because it was selectively not offered to them (12%).

Figure 4.6: If did not take triple science, was this the preferred route?

Q. (If triple science not offered by school) Would you have wanted to study triple science if your school had offered it?

Q. (If triple science offered by school) Did you want to study [science course] or would you have preferred to take triple science?



Base (All respondents not taking triple science): 2,202

Note: Responses of 'Don't know whether triple science was offered' have been excluded from this analysis

Asian students were considerably more likely than average to feel that they had been denied access to triple science. Over a quarter (28%) of Asian students said that they would have liked to have studied triple science but this was not available to them, either because the school did not offer it at all (10%) or because the school turned them down (18%).

4.2.2 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 4.7 displays the key reported barriers to participation. The results are compared for two different subgroups:

a) All students not taking triple science;

b) All students not taking triple science *but who would have preferred to.*

The proportion of students who were not able to study triple science because their school didn't offer it is shown in Figure 4.7 for completeness although school access is discussed in more detail in section 4.2.1.

At an overall level, personal barriers are more important than school-selection barriers in explaining why students do not take up triple science: 58% cited at least one personal barrier and 41% at least one school-selection barrier. Under personal barriers, lack of confidence (30%), lack of interest (27%) and not needing triple science for future career plans (22%) are the key barriers. School-based barriers are mainly focused on not being in the right set (19%), not achieving the right level (18%) and being dissuaded by teachers (12%).

Among the smaller group who considered that they would have liked to study triple science if it had been available, the barriers are predominantly school-based. A little over half (55%) felt that the school had blocked them in some way on the basis of their ability, science set or due to teacher discouragement. Personal barriers such as lack of confidence or interest were not as pronounced among this smaller subgroup.

Variation in barriers by demographic subgroups

There was some variation in the types of barriers cited by different groups of the student population. In order to summarise the key differences, we have focused subgroup comparison on three barriers which represent the main themes displayed in Figure 4.7:

- **Confidence barrier** (*Thought it would be too difficult/lacked confidence*);
- **Academic barrier** (*I didn't achieve the grade I needed*);
- **Personal choice** (*I prioritised other subjects*).

Results are shown in Figure 4.8. The following patterns can be observed:

Confidence was more of a barrier for female students and students living in the least deprived areas. Students attending a higher performing school were also more likely to lack confidence which could be a reflection of higher expectations set within these schools.

Interestingly there was no difference by science quiz score in the proportion of all young people citing a lack of confidence. Students who obtained high scores were as likely to lack confidence as those with low scores. This suggests that confidence may be more of a matter of perception than reality.

In order to unpick this further we explored the 'mismatch' between attainment and confidence in more depth. Overall a third (33%) of students achieving a high quiz score lacked confidence in their ability to study triple science and this mismatch rate was higher for female students (44%) than male students (25%). This under-estimation of ability among females is likely to explain the higher rate of females compared with males who say that they do not have the confidence to take triple science. The findings are also consistent with wider literature on self-efficacy. For example, the 2015 PISA study (OECD, 2016c) found that boys show significantly greater self-efficacy than girls in 41 countries, and that gender differences in science self-efficacy are larger in the United Kingdom than on average across OECD countries.

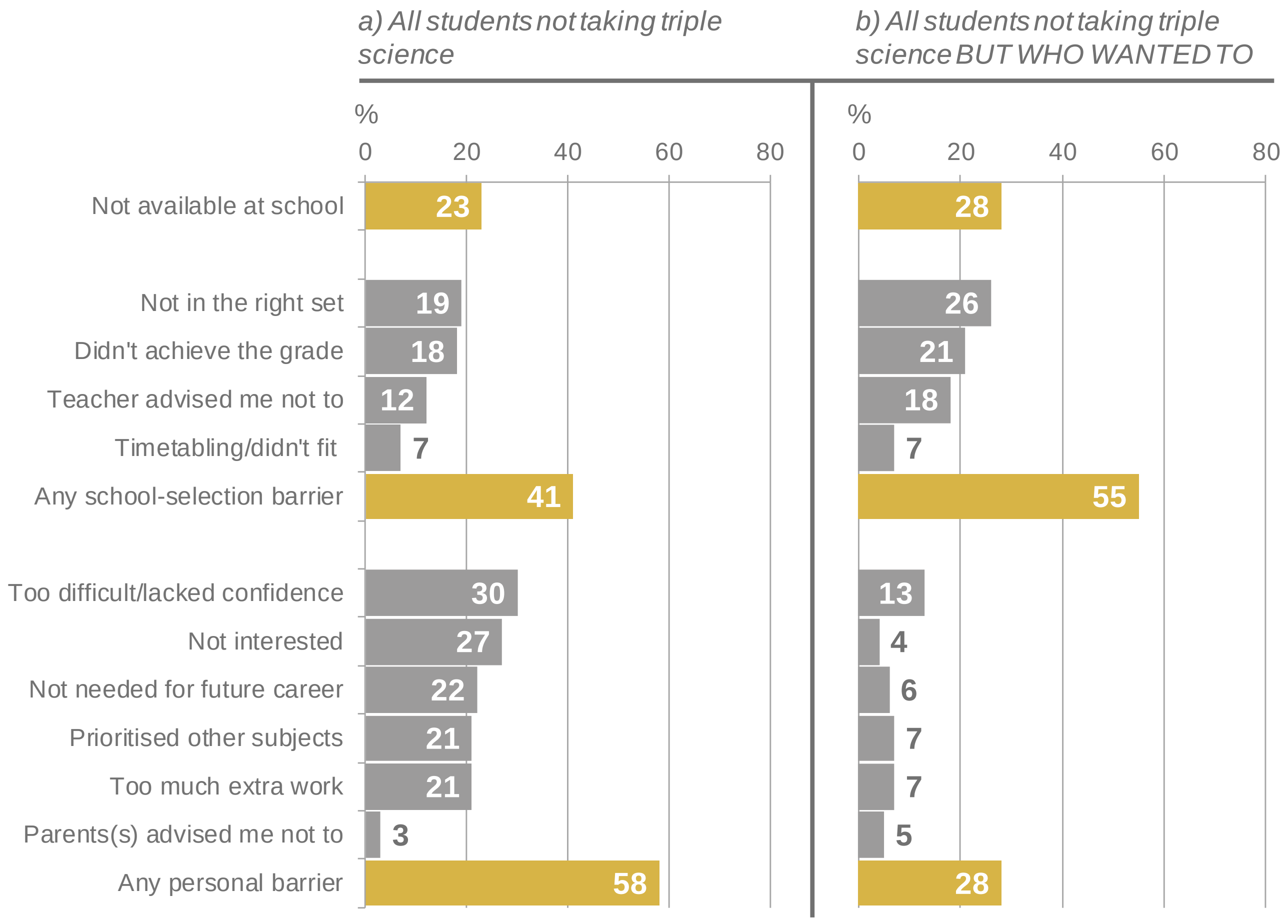
Academic barriers were particularly heightened among black students and students living in the least deprived areas.

Personal choice: There was evidence that higher ability science students were more likely than lower ability science students to actively choose a non-triple science route. Given the likely correlation between attainment in science and attainment in other subjects, more able students are likely to have greater freedom to choose the science pathway which they feel is right for them. Personal preference to opt out of triple science was also greater among students attending a higher performing school, which could also reflect a greater degree of freedom of choice.

Figure 4.7: Barriers to uptake of triple science among those not studying it

a) Q. Why didn't you study triple science?/Why didn't you want to study triple science?

b) Q. (If wanted to study triple science) Why didn't you study triple science?



Base (All respondents not taking triple science): All respondents not taking triple science (2,197), All respondents not taking triple science but who wanted to (349)

http://dx.doi.org/10.6084/m9.figshare.4524551
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Figure 4.8 Barriers to studying triple science among those not taking it by demographic subgroups

Base: All respondents not taking triple science

Note: Percentages which relate to subgroups which have a higher propensity to cite a barrier compared with the overall average are cited in bold

		Confidence	Academic	Personal choice	
		Thought it would be too difficult/lacked confidence	*Didn't achieve the grade I needed*	*Prioritised other subjects*	*(Base)*
		(%)	(%)	(%)	
All students		30	18	21	*2,197*
Gender	Males	24	17	19	*989*
	Females	**36**	**20**	23	*1,188*
Ethnic group	White	31	19	**23**	*1,731*
	Asian	28	15	14	*217*
	Black	31	**28**	17	*97*
Deprivation	IDACI Quintile 5 (least deprived)	**40**	**23**	28	*380*
	IDACI Quintile 1 (most deprived)	21	15	17	*470*
Attainment	High attainment (high quiz score)	27	18	**31**	*284*
	Low attainment (low quiz score)	28	15	14	*591*
School performance (from NPD data)[20]	High performing school (70%+ of pupils with 5 'good' GCSEs)	**45**	22	**31**	*407*
	Low performing schools (Less than 50% with 5 'good' GCSEs)	27	17	17	*536*

[20] A 'good' GCSE is defined as achieving a grade of A* to C.

4.3 Access to Computer science

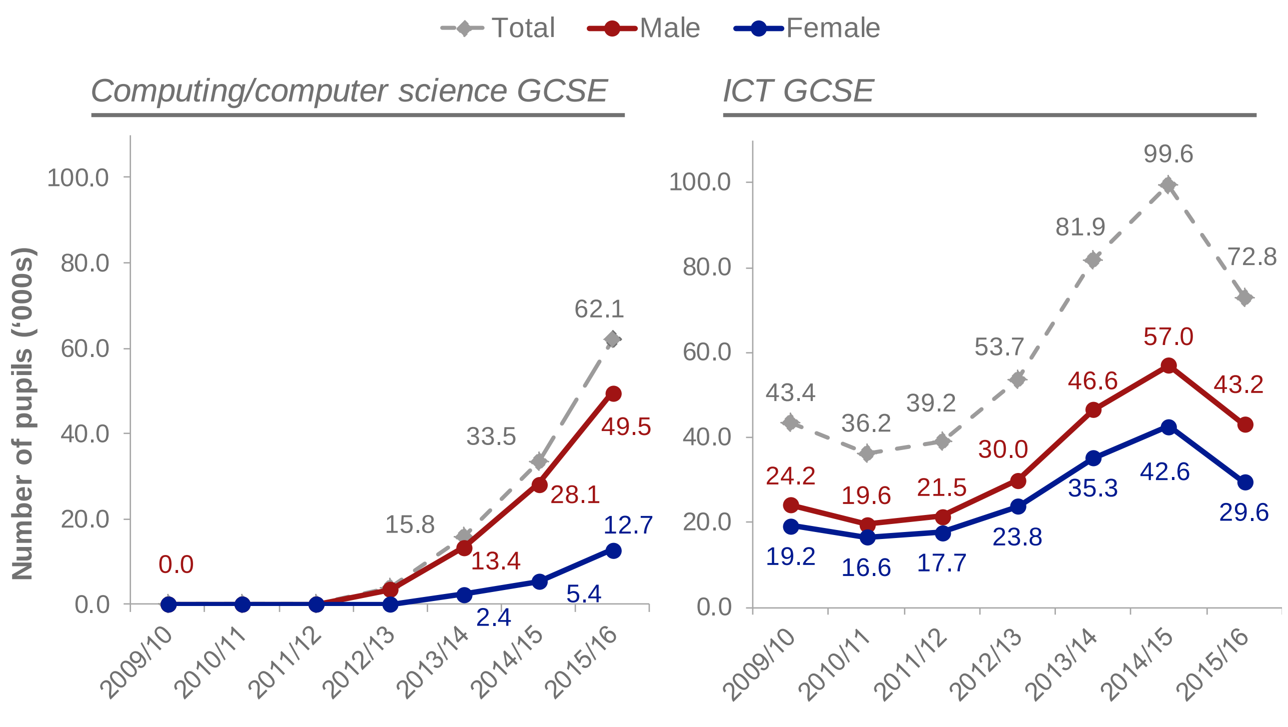
Unlike the physical sciences, computer science is not a compulsory subject at GCSE. However, since 2014, computer science has been included in the EBacc as one of the eligible core science subjects such that a three science pathway can now include any three out of biology, chemistry, physics, and computer science.

Figure 4.9 replicates data published by the DfE (DfE, 2016c). This shows that, although starting from a low base, entries to this subject have risen dramatically between 2014/15 and 2015/2016. This increase will be linked to the replacement of the ICT GCSE in favour of computer science GCSE which began in 2013/14. As can be seen from the official data, entries to ICT GCSE dropped between 2014/15 and 2015/16, corresponding with the rise in computer science GCSE during this period. By 2017, it is planned that the ICT GCSE will be phased out entirely.

According to the 2016 DfE statistics, males were four times more likely to be entered for a computer science GCSE than females, a wide gender gap which has persisted since the GCSE's introduction. This is a wider relative gender gap than that observed within the ICT GCSE, although male/female differences are evident here too.

Figure 4.9: Time trends of students entered for computer science and ICT GCSE by gender

Total number of pupils entered for GCSE computing/computer Science and GCSE ICT ('000s) in England (DfE, 2016)

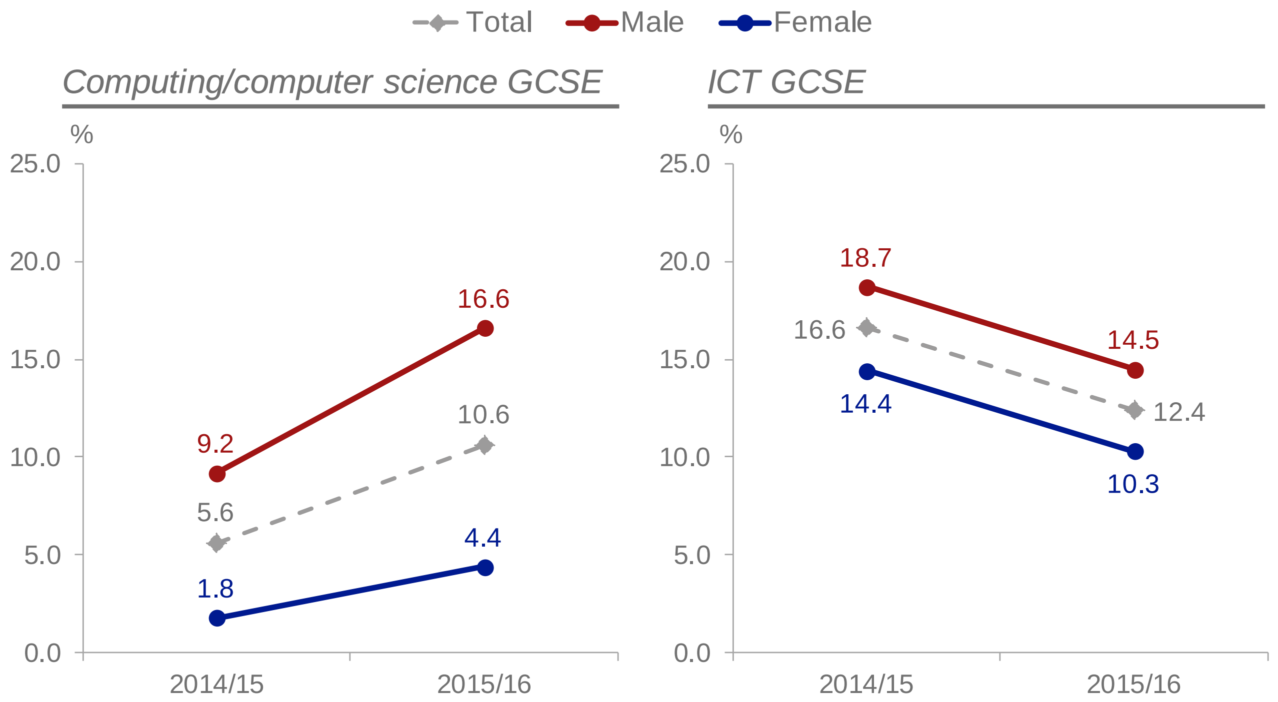


http://dx.doi.org/10.6084/m9.figshare.4524551

More recent official data for 2014/15 and 2015/16 on the proportion of students who took computer science and ICT GCSE are also available (DfE, 2016c & DfE, 2016d) and these are shown in Figure 4.10.The data again reflect the recent replacement of ICT with computer science in the school curriculum and allows us to compare SET survey findings with official statistics.

Figure 4.10: Proportion of students in England entered for computer science and ICT GCSE by gender and year

Percentage of pupils entered for GCSE Computing/Computer Science and GCSE ICT in England (DfE, 2016c/2016d)



In the Science Education Tracker, a little under one in five young people (18%) reported having taken computing or computer science at GCSE, a figure which stands at 19% for the 2015/16 cohort of Year 10s. This is higher than official statistics for the equivalent year (11%) which suggests that the SET survey figure may be an over-estimate[21]. By survey year, the SET survey findings also reflect the rise in computer science entries and fall in ICT entries between 2014/15 and 2015/16.

Also consistent with DfE trends, there is a wide gender gap: across all four cohort years 25% of male students and 9% of female students report taking computer science GCSE in SET.

Unlike uptake of triple science, there is very little additional demographic variability in the proportions taking computer science, with uptake rates remaining constant across ethnicity and socio-economic groupings. However, uptake is slightly higher among students with high science

[21] In cognitive piloting we found that some students confused computer science with ICT and other IT-based courses

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quiz scores: 22% of high scoring students took computer science compared with 15% of low scoring students.

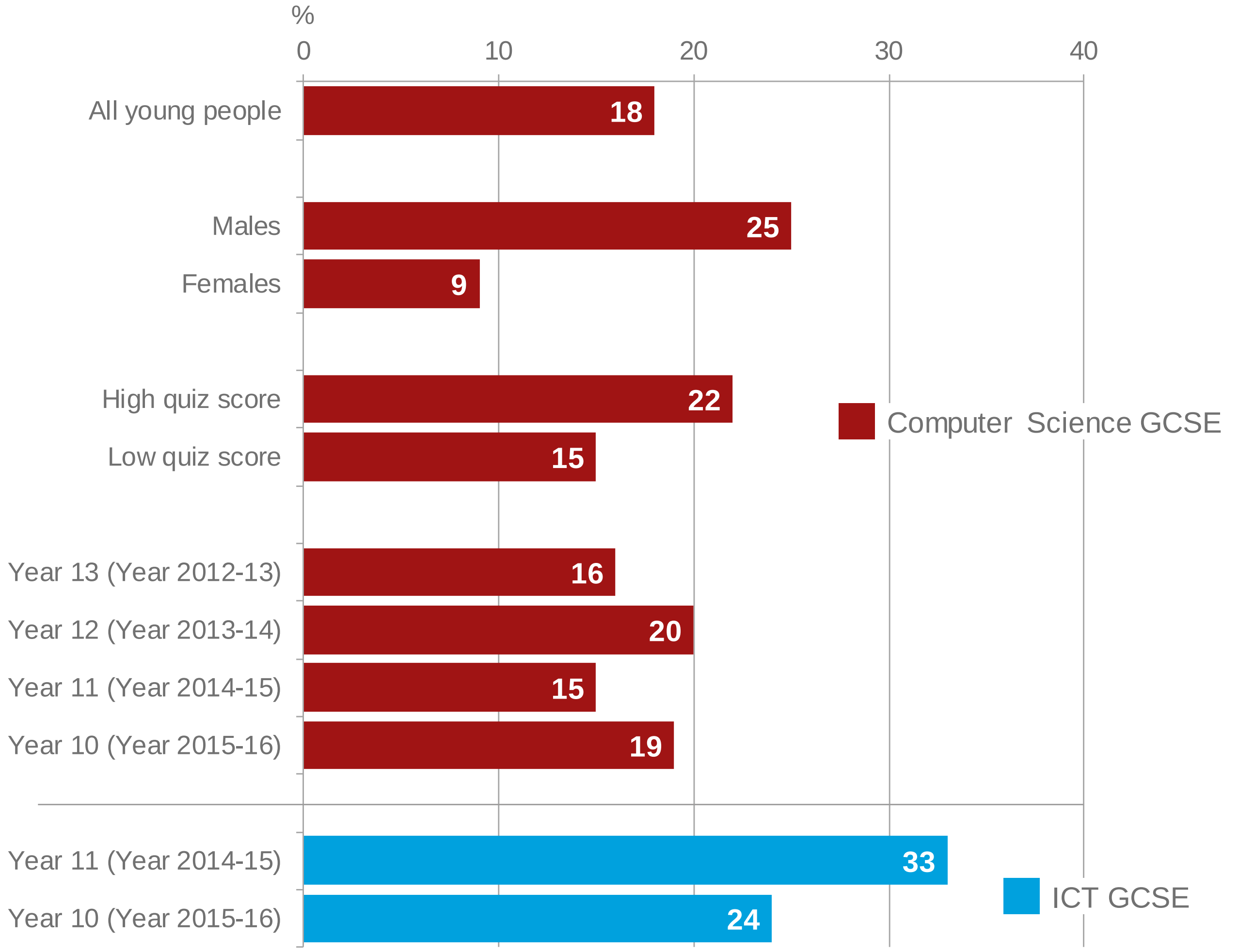
Access to computer science does not appear to be related to type of science course undertaken: triple science students (19%) were no more likely than double science students (17%) or single science students (16%) to study computer science.

See Figure 4.11 for differences in computer science uptake by subgroup.

Figure 4.11: Uptake of computer science GCSE by gender and school year

Q. (If Year 10 or 11) Which of the following subjects have you been studying at GCSE?: Computer science / computing; ICT*

Q. (If Year 12 or 13) Did you study computer science or computing at GCSE?



Base (All respondents): All young people (3,994), Male (1,899), Female (2,064), Year 10 (1,113). Year 11 (1,086). Year 12 (900), Year 13 (895)

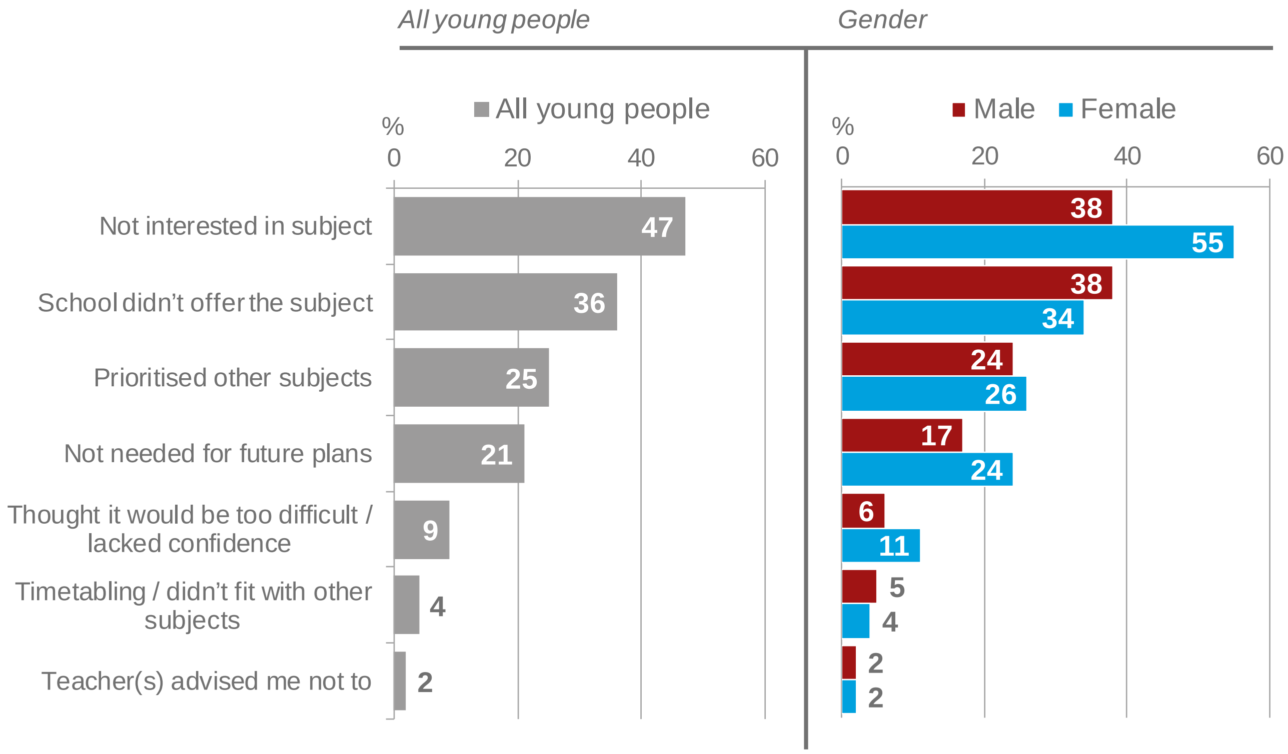
** ICT was only asked of those who were currently in Year 10 or 11*

Barriers to studying computer science are shown in Figures 4.12 and 4.13. The key barriers were lack of interest (47% overall), lack of availability because the school didn't offer it (36% overall) and a desire to prioritise other subjects (25% overall). However, there are some noteworthy gender differences. Females were considerably more likely than males to cite lack of interest as a barrier (55% compared with 38%) and this was by far the dominant barrier for females.

There is also variation by age cohort. Reflecting the change in government policy whereby computer science became an established part of the curriculum from 2014/15, the barriers have changed over time. In 2012/13 lack of availability was the dominant barrier (56%), a barrier which has rapidly diminished over time, such that only 16% of Year 10 students (the most recent 2015/16 cohort) said that this had prevented them from studying computer science. In contrast, other barriers have increased over time, with the most recent cohort of Year 10 students more likely than in earlier years (Year 12/13 cohorts) to cite a lack of interest, a preference for other subjects and a lack of confidence.

Figure 4.12: Barriers to studying computing/computer science among those not taking it: overall and by gender

Q. Why didn't you study computer science or computing?

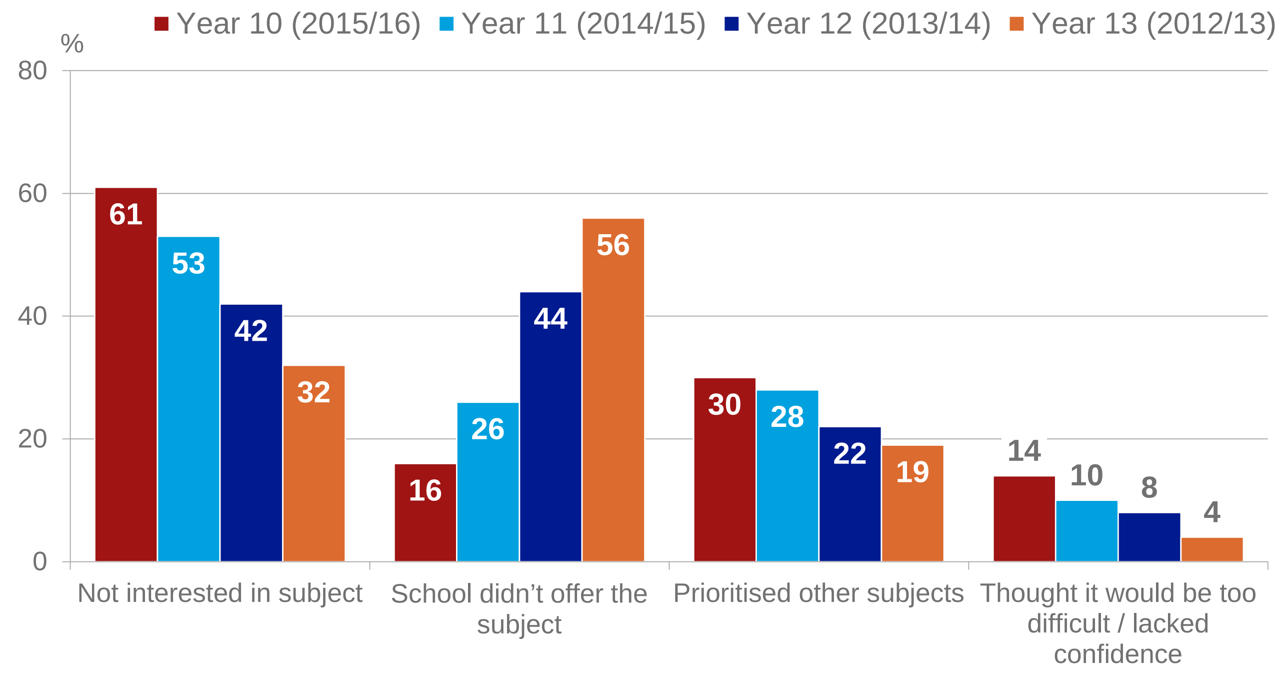


Base (All respondents who did not take computing/computer science): All young people (3,289), Males (1,392), Females (1,874)

http://dx.doi.org/10.6084/m9.figshare.4524551

Figure 4.13: Barriers to studying computing/computer science among those not taking it by year group

Q. Why didn't you study computer science or computing?



Base (All respondents who did not take computing/computer science): Year 10 (899), Year 11 (916). Year 12 (721), Year 13 (753)

5. Science at Year 12 and beyond

This chapter considers young people's educational plans at Year 12 and beyond. It looks at patterns of interest in studying for science qualifications at A-level or equivalent, followed by intentions to study science at a higher education level.

Key findings

- Intentions to continue in education are strong:
  - 57% of all young people were thinking of studying for a higher education qualification in any subject, with a further 29% undecided.
  - More than nine in ten young people in Years 10 and 11 (93%) were considering continuing studying in any subject after Year 11. Three-quarters (75%) were 'definitely' planning to continue their studies, with a further 18% undecided.
  - However, only 74% of young people in Years 12 and 13 were actually studying for a Level 3 qualification. This suggests that a sizeable proportion of the young people in Years 10 and 11 considering further study will not go on to study for a Level 3 qualification.
  - The largest gaps between aspirations of young people in Years 10/11 and actual behaviour of young people in Years 12/13 was among those eligible for free school meals in the last six years and those from the most deprived areas. For example, more than nine in ten (93%) young people in Years 10/11 in the most deprived areas said they were intending to study beyond Year 11, but only 60% of young people from similarly deprived areas were studying for Level 3 qualifications in Years 12/13.
- Males were less interested than females in continuing in education. However, males were more likely to be interested in studying maths or science subjects:
  - 69% of males were planning to continue their studies after Year 11 and 50% were thinking of studying for a higher education qualification, compared with 79% and 63% of females respectively.
  - 66% of males studying for a qualification in Year 12 or 13 were taking at least one maths or science subject, compared with 57% of females.
  - 55% of males thinking of studying for a higher education qualification were considering a Maths or Science subject, compared with 49% of females.
- Higher education subject choices were heavily gendered:
  - Males were more likely than females to be interested in studying maths, physics or computer science. Females on the other hand were more likely to be interested in biology, psychology or health related subjects such as medicine / dentistry.

http://dx.doi.org/10.6084/m9.figshare.4524551
This project was carried out in compliance with our certification to ISO 9001 and ISO 20252 (International Service Standard for Market Opinion and Social Research)

5.1 Trends in science and maths qualifications at Level 3

Figures 5.1 and 5.2 shows the percentage of A level students studying maths and science subjects at A level since 2009/10 based on national data (DfE, 2016e). There has been a notable increase in the last six years in the proportion of students studying maths, from 24.7% in 2009/10 to 28.6% in 2014/15. The Department for Education (2016e) has identified maths as the most popular A level subject, accounting for 11% of all A level entries in 2016. The increase in take-up of maths A level has been driven primarily by an increase in male students studying the subject; in 2015/16 almost two in five male A level students studied maths.

There are substantial gender differences in the take-up of subjects. Male students have been much more likely than female students to take A levels in maths, physics, and computing. Female students, on the other hand, were more likely to study biology. The gender gap in biology has increased in recent years from 1.7 points in 2009/10 and 2011/12 to 4.2 points in 2014/15.

Uptake of computing A level is relatively low, with 1.8% of A level students taking the subject in 2014/15. Again there was a substantial gender difference; 3.6% of male students were entered for A level computing in 2014/15, compared with just 0.3% of female students.

Reasons for the gender disparity in science and maths are much discussed in the wider science education literature. For maths, there is evidence that female students are not as confident in their abilities as male students are (for example, Kyriacou and Goulding, 2006; Brown *et al.*, 2008). Ceci *et al.,* (2009) note that women with strong maths skills are more likely to pursue non-maths careers than men with similarly strong maths skills. Meanwhile, Mujtaba and Reiss (2013) found that girls were less likely to have been encouraged by their teachers, family and friends to continue studying physics after Years 10 and 11. All of these findings are supported to some extent by the Science Education Tracker as discussed throughout this report.

5.2 Uptake of Level 3 qualifications after Year 11

For the SET, young people in Years 12 and 13 were asked which Level 3 qualifications[22] they were studying towards (if any), and whether they were studying towards qualifications in any science subjects.

Just over half of young people in Years 12 and 13 were studying A levels or AS levels. Almost a third were studying for Level 3 vocational qualifications such as a BTEC National Certificate (Figure 5.3). These are broadly in line with national figures. Figures from DfE (2016e) show the number of 16-18 year olds entered for A levels in 2016 as a proportion of the 'potential number of students' was 54% and the proportion entered for at least one Level 3 qualification was 73%.[23] The proportions entered for vocational Level 3 qualifications were divided into Applied general qualifications (21%) and tech qualifications (11%).

Figure 5.4 shows the uptake of Level 3 qualifications in SET by key demographic groups. Males were less likely to be studying for Level 3 qualifications (69%, compared with 79% of females) as were young people from white backgrounds (72%, compared with 85% of young people from Asian backgrounds).

Uptake of Level 3 qualifications was considerably lower among those eligible for free school meals in the last six years; 55% of this group were studying for a Level 3 qualification compared with 77% of those who had not been eligible. Similarly, participation was much lower in the most deprived areas: 60% in the most deprived quintile, compared with 85% in the least deprived quintile. In other

[22] See the glossary in Appendix E for a definition of Level 3 qualifications.

[23] The 'potential number of students' is defined as those 16-18 year olds who completed Key Stage 4 two years previously.

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words, young people eligible for free school meals or living in more deprived areas were much less likely to study at Level 3.

Figure 5.1: National trends of students entered for mathematics and science A levels by gender

% of total A level students aged 16, 17 or 18 at start of academic year entered for A levels in each subject (DfE, 2016e)

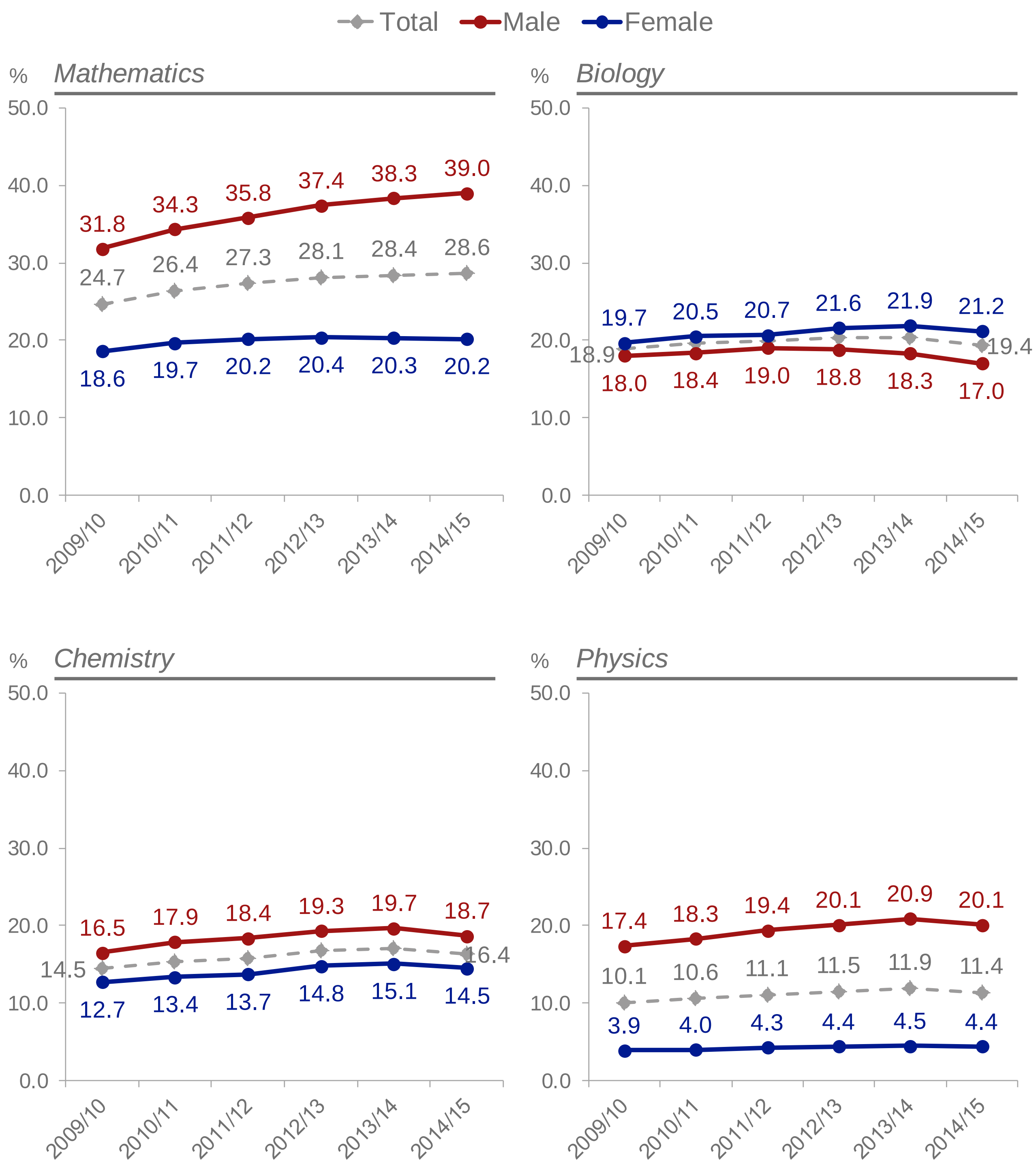

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Figure 5.2: Trends of students entered for computing A levels by gender

% of total A level students aged 16, 17 or 18 at start of academic year entered for computing A level (DfE, 2016e)

	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
	(%)	(%)	(%)	(%)	(%)	(%)
Total	**1.3**	**1.3**	**1.3**	**1.2**	**1.4**	**1.8**
Male	*2.7*	*2.6*	*2.6*	*2.6*	*2.9*	*3.6*
Female	*0.2*	*0.2*	*0.2*	*0.1*	*0.2*	*0.3*

Figure 5.3: Uptake of Level 3 qualifications[24]

Base: Years 12 / 13

	(%)
Academic route (A level / AS level / IB)	**52**
A levels / AS levels	*51*
International Baccalaureate	*1*
Vocational route	**30**
BTEC National Certificate / ONC / OND	*25*
NVQ Level 3 / GNVQ Advanced	*5*
City and Guilds Advanced Craft or Part III / RSA Advanced Diploma	*2*
Not studying for Level 3 qualification	**20**
Don't know	**7**
Unweighted base	*1,843*

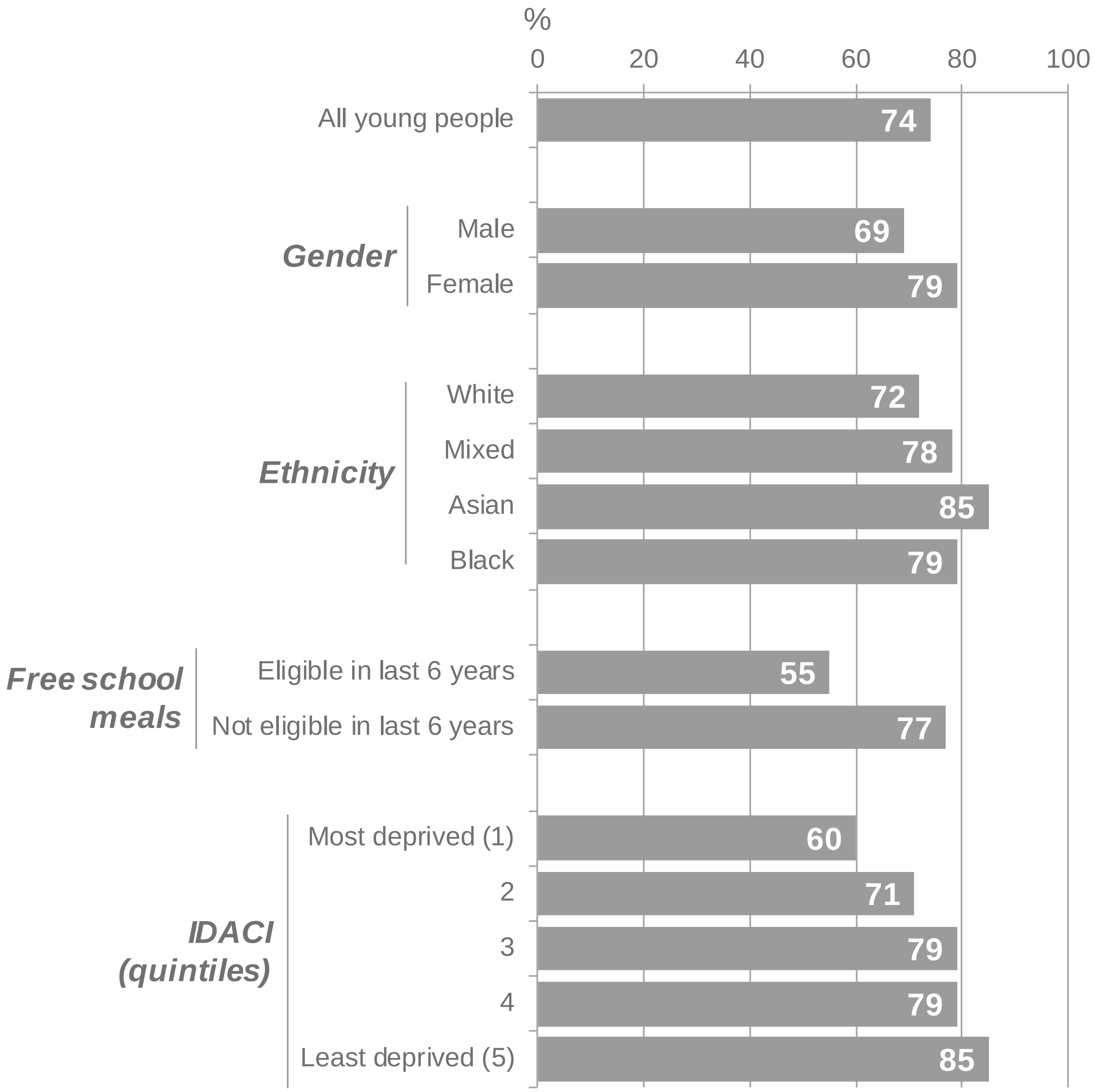
[24] Note: Young people can be studying for more than one type of qualification.

http://dx.doi.org/10.6084/m9.figshare.4524551

Figure 5.4: Uptake of Level 3 qualifications by gender, ethnicity, eligibility for free school meals and IDACI

Q. Have you been studying towards any of these qualifications in Year 12 or 13?

% studying for any Level 3 qualification



Base (Years 12 / 13): All young people (1,843), Male (864), Female (963),White (1,460), Mixed (80), Asian (199), Black (63), Eligible for free school meals in the last six years (277), Not eligible for free school meals in last six years (894), IDACI quintiles from most deprived to least deprived (390 / 352 / 351 / 383 / 366)

Of those studying for a Level 3 qualification, almost two-thirds were studying maths or at least one science subject. The most popular science subjects were maths (32%), biology (20%), chemistry (17%) and psychology (17%).

Subject choice was heavily patterned by gender (Figure 5.5). Of those studying for a Level 3 qualification, males were more likely than females to be studying a maths or science subject. In particular, males were much more likely to be taking maths, physics, computer science, and electronics / engineering. Females were more likely to be studying biology and psychology.

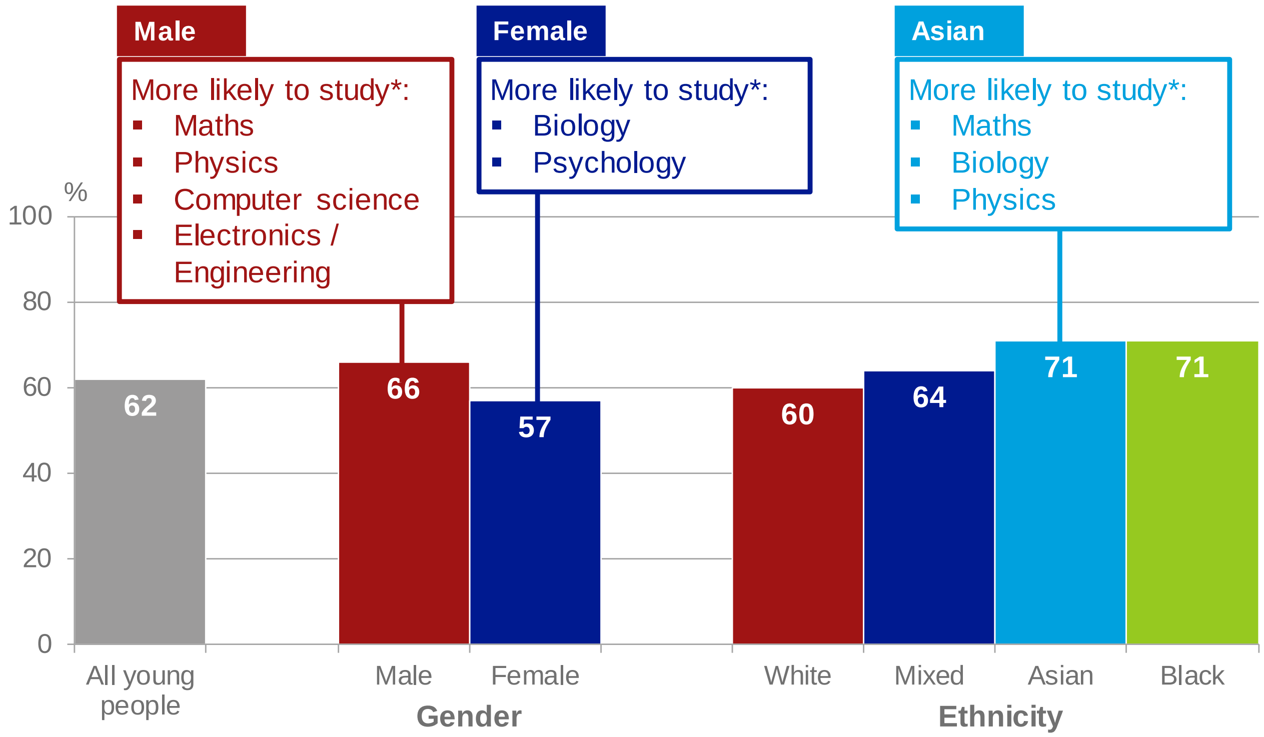
Uptake of maths and science subjects among Asian young people was especially high. In particular, young people with an Asian background were more likely than those with a white background to be studying maths, biology or chemistry. This is consistent with the findings of Tripney *et al.* (2010) noting that Asian students were more likely than others to continue with maths and science subjects.

A full breakdown of subjects taken by gender and ethnicity can be found in Appendix B.

Figure 5.5: Subject choices for Level 3 qualifications by gender and ethnicity

Q. Have you been studying any of these subjects in Year 12 or 13?

% studying for any maths / science subject



**Comparing Male against Female; Mixed, Asian, black against white*

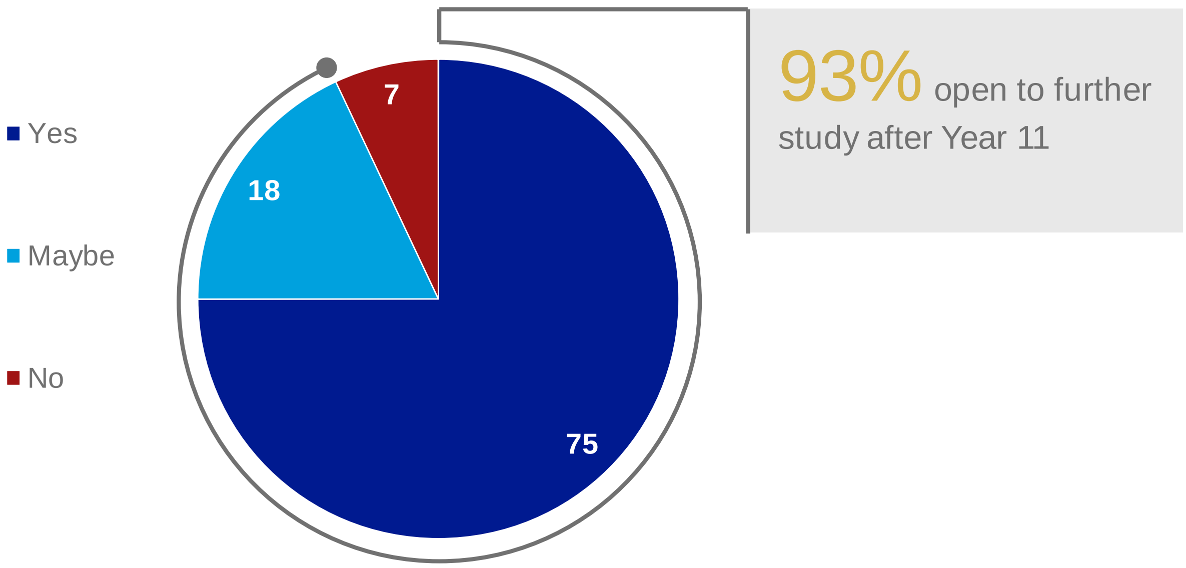
Base (Years 12 / 13 studying for any Level 3 qualification): All young people (1,424), Male (625), Female (785), White (1,102), Mixed (66), Asian (173), Black (52)

5.3 Intentions to study after Year 11

Young people in Years 10 and 11 were asked about their intentions for further study beyond Key Stage 4. The vast majority of young people in Years 10 and 11 said they were open to studying for further qualifications; three-quarters said they were planning to study for further qualifications in any subject after Year 11, and a further 18% were still considering this as an option (Figure 5.6).

Figure 5.6: Intentions for further study after Year 11

Q: After Year 11, are you planning to study for further qualifications in any subject, for example A levels or an NVQ level 3?



Base (Years 10 / 11): 2,178

Demographic differences were consistent with those outlined in section 5.2 for young people in Years 12 and 13 who had already made the decision whether or not to continue to further study. Females were more likely to be planning to continue their studies, as were young people from Asian or black backgrounds, those from less deprived areas and those not eligible for free school meals in the last six years.

Nonetheless, interest was high among all of these groups; at least nine in ten young people in each of these groups were either planning to undertake or considering further study.

There is, however, a sizeable gap between the 93% of young people in Years 10 and 11 considering further study and the 74% of young people in Years 12 and 13 who were actually studying for a Level 3 qualification (section 5.2). This suggests that a large proportion of young people do not follow through with their initial aspirations.

Comparing Figure 5.4 and Figure 5.7, the largest gaps between aspirations of young people in Years 10/11 and actual behaviour of young people in Years 12/13 are among those eligible for free school meals in the last six years and those from the most deprived areas. Nine in ten (91%) young people in Years 10/11 and eligible for free school meals in the last six years were considering further education, while only 55% of them went on to study for a Level 3 qualification in Year 12/13. Similarly, 93% of young people in Years 10/11 from the most deprived areas were

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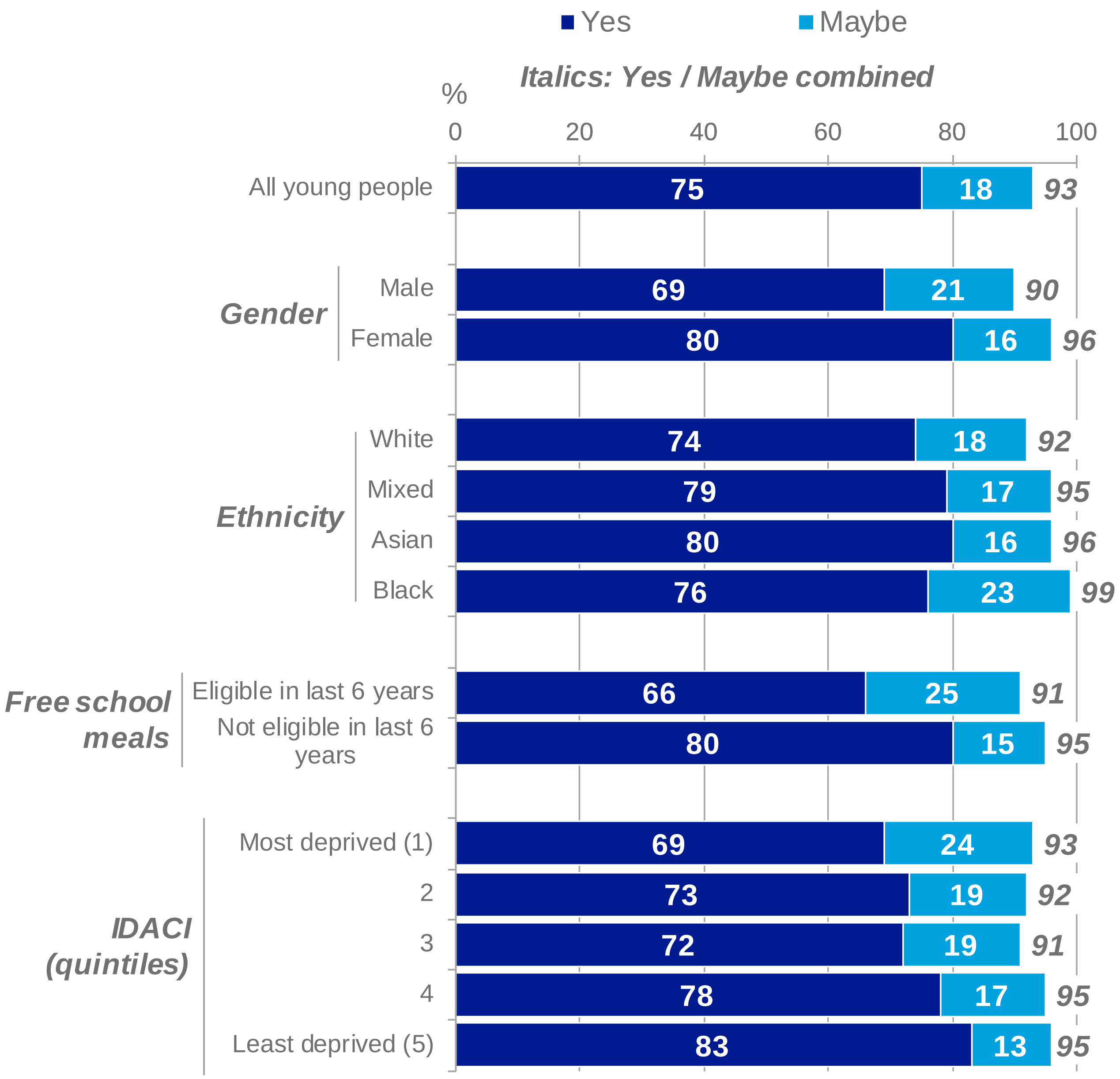
considering further education after Year 11 while only 60% of young people in Years 12/13 in these areas progressed to Level 3.

Figure 5.7: Intentions for further study after Year 11

Q: After Year 11, are you planning to study for further qualifications in any subject, for example A levels or an NVQ level 3?



Base (Years 10 / 11): All young people (2,178), Male (1,032), Female (1,134),White (1,664), Mixed (96), Asian (239), Black (106), Eligible for free school meals in the last six years (400), Not eligible for free school meals in last six years (1,441), IDACI quintiles from most deprived to least deprived (433 / 426 / 427 / 434 / 455)

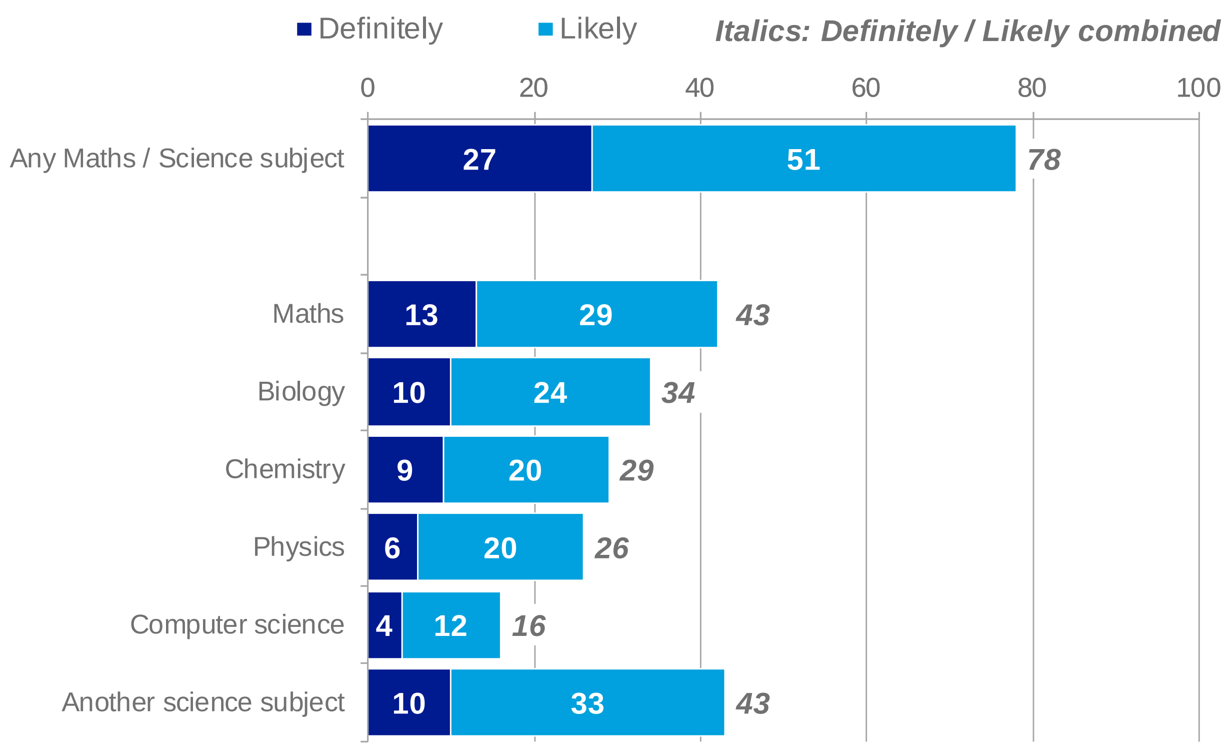
It is notable from Figure 5.7 that these groups were also less firm about their interest in further education. Although there was no significant difference in the *rejection* of further education for the most deprived quintile and the least deprived, those from the most deprived areas or who have been eligible for free school meals were more likely to answer ‘Maybe’ rather than ‘Yes’ when asked about further study. It could be that these young people who are less certain about their future aspirations are in need of greater support to encourage them to follow through with their early stage aspirations.

Young people who were considering further study were then asked how likely they were to study for Level 3 qualifications in certain maths and science subjects.[25] Levels of interest were high, with more than a quarter (27%) saying they would ‘definitely’ study at least one maths or science subject in Year 12 and a further 51% saying they were ‘likely’ to study one of these subjects (Figure 5.8).

Subject preferences were again strongly patterned by gender and ethnicity (Figure 5.9). Males were more likely than females to be planning to study maths, physics, and computer science. Females on the other hand were more likely to be planning to study biology. Young people with an Asian background were particularly likely to study biology; almost half planning to continue to further study said they would definitely or likely study biology (48%, compared with 34% overall).

Figure 5.8: Planned subject choices for Level 3 qualifications

Q: How likely are you to study A levels, NVQ level 3 or a similar qualification in…?

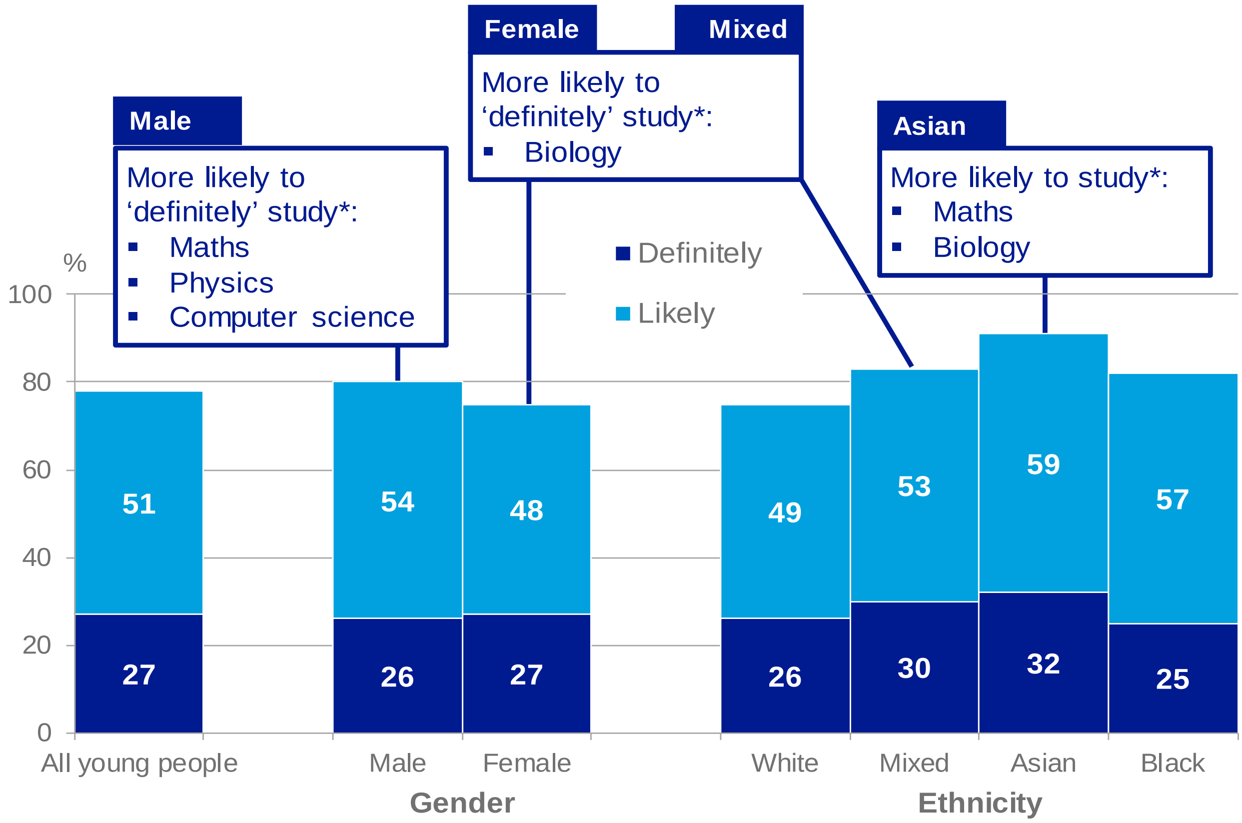


Base (Years 10 / 11, if not made final subject choices for Year 12):1,206

[25] Note: Young people in Year 11 were only asked this question if they had not yet made their final subject choices for Year 12.

Figure 5.9: Likely subject choices by gender and ethnicity

Q. How likely are you to study A levels, NVQ level 3 or a similar qualification in…[any maths / science subject]?



**Comparing Male against Female; Mixed, Asian, black against white*

Base (Years 10 / 11, if not made final subject choices for Year 12): All (1,206), Male (579), Female (621), White (899), Mixed (59), Asian (143), Black (61)

5.4 Transitions from Key Stage 4 to Level 3 qualifications

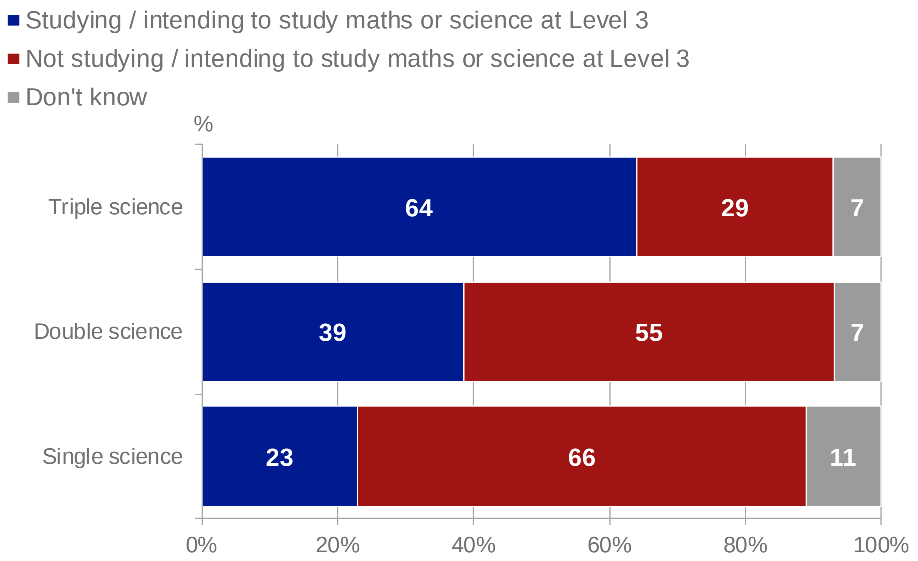
Two thirds (64%) of young people who studied triple science at Key Stage 4 either went on to study a maths or science subject at Level 3 or were intending to do so (Figure 5.10). In comparison, around two in five double science students (39%) and one in four single science students (23%) progressed to Level 3 in a maths or science subject, or were planning to do so.

There was also a difference in the specific science subjects young people went on to study at Level 3, with single and double science students relatively unlikely to go on to study maths or one of the three core sciences. More than three-quarters of those taking physics or chemistry and two-thirds of those taking biology or maths had previously studied triple science (Figure 5.11). Instead, single or double science students were more likely to go into other science subjects. Around half of computer science and psychology students had previously studied a course other than triple science at Key Stage 4. In other words, if young people do not study triple science they are less likely to continue with chemistry, physics and (to a lesser extent) biology. This is consistent with the findings of Archer *et al.* (2016a) from the ASPIRES survey which found that those taking double science or alternative qualifications tended to question their ability in science and few aspired to work in STEM.

Figure 5.10: Progression to Level 3 maths / science qualifications from GCSE science courses

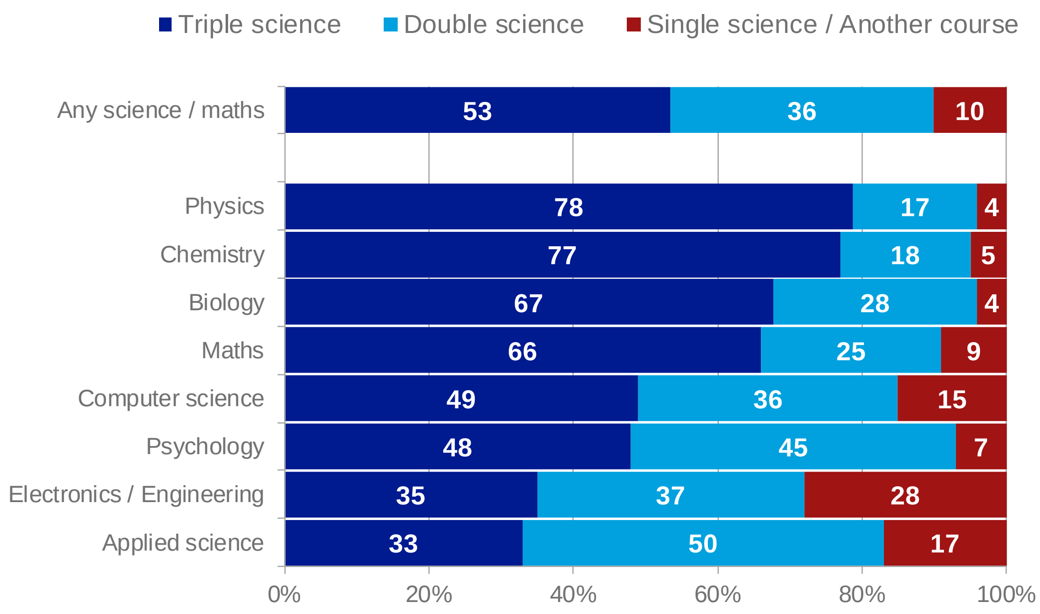
Q. Have you been studying any of these subjects in Year 12 or 13?

Q: After Year 11, are you planning to study for further qualifications in any subject, for example A levels or an NVQ level 3?



Base (All respondents): Triple science (1,596), Double science (1,555), Single science (476)

Figure 5.11: GCSE Science courses studied by those studying for Level 3 qualifications in maths / science subjects



Base (Years 12 / 13 studying for Level 3 qualification, or Year 11 and made final subject choices for Level 3 qualification): Physics (321), Chemistry (416), Biology (508), Maths (721), Computer science (152), Psychology (455), Electronics / Engineering (85), Applied science (141)

Note: Answers of 'Don't know' not included

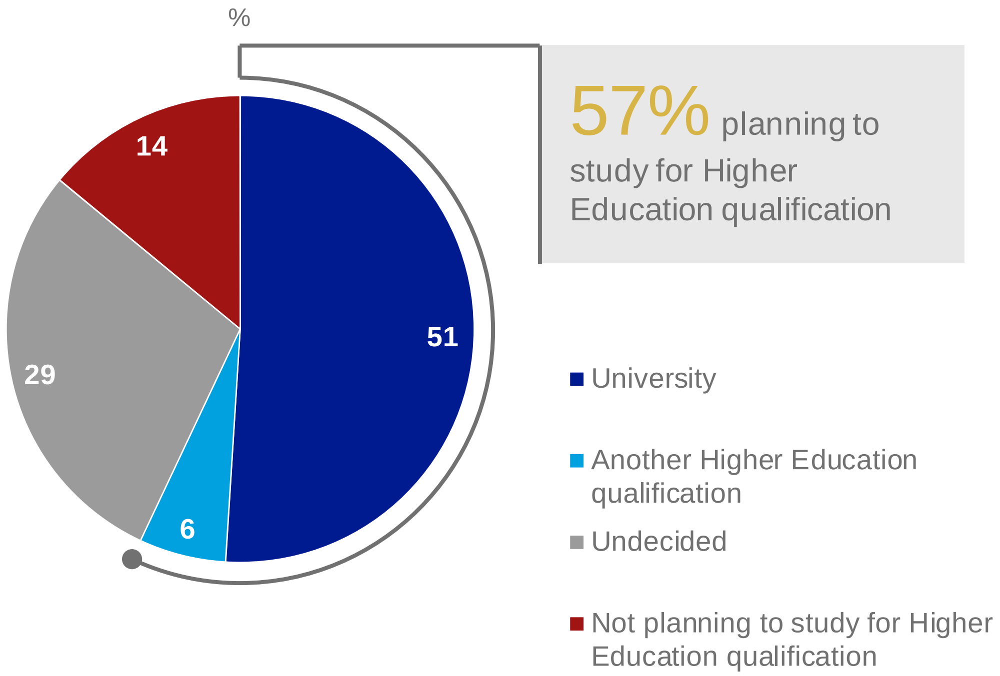
5.5 Intentions to study for higher education qualifications

All respondents were asked about their intentions to study for higher education qualifications. Just over half (51%) said they were thinking about studying for a university degree and a further six per cent said they were considering studying for another higher education qualification (Figure 5.12).

A relatively high proportion was undecided (29%). The rate of indecision was higher among younger school years (Figure 5.13) who understandably have less clearly defined plans for their future. Young people in Years 12 /13 were more likely to say they were not thinking of studying for any higher education qualification; in many cases these young people had already started down non-academic paths, for example, moving into paid work or an apprenticeship. Nevertheless, one in five young people in Year 13 was still undecided about pursuing higher education.

Figure 5.12: Intentions to study for a higher education qualification

Q: Are you thinking about going on to study for a higher education qualification in any subject?



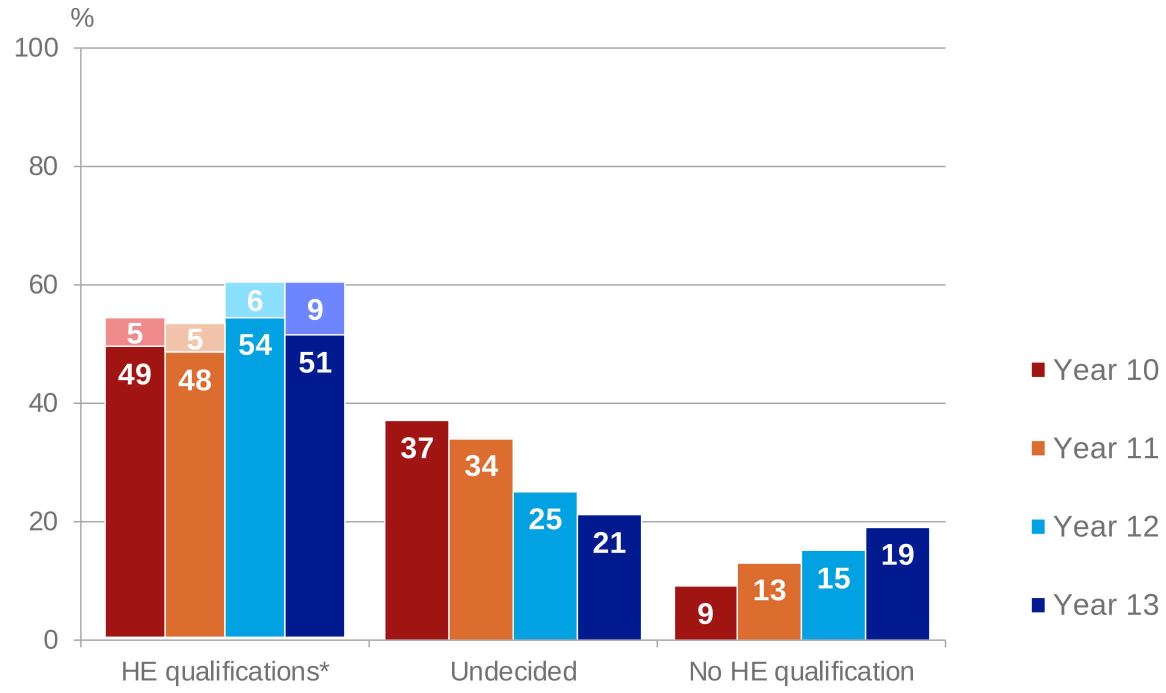
Base (All respondents): 4,032

Note: Answers of 'Don't know' not included

http://dx.doi.org/10.6084/m9.figshare.4524551
This project was carried out in compliance with our certification to ISO 9001 and ISO 20252 (International Service Standard for Market Opinion and Social Research)

Figure 5.13: Intentions to study for a higher education qualification by academic year

Q: Are you thinking about going on to study for a higher education qualification in any subject?



**For HE qualification, darker shade = University degree, lighter shade = other higher education qualification*

Base (All respondents): Year 10 (1,105), Year 11 (1,069), Year 12 (938), Year 13 (920)

Females were more likely to want to pursue a higher education qualification and, specifically, to want to gain a university degree. The gender gap in higher education aspirations was evident across ethnic groups. Young people with a white background were, however, considerably less likely to aspire to attaining a higher education qualification (Figure 5.14). Furthermore, white males had the lowest levels of university aspiration, with one in five having already decided not to pursue higher education (Figure 5.15). White males were the only group where a majority were not planning to go into higher education.

In general, aspirations for higher education were no lower in the most deprived areas than in other areas. Those eligible for free school meals in the last six years, however, were less likely to say they were thinking of going to university than those who had not been eligible.

These demographic differences are broadly consistent with research from the Sutton Trust which showed that aspirations to go to university were higher among girls, BME groups, families with higher salaries and young people who lived in a neighbourhood with lower levels of unemployment (Sammons *et al.*, 2016).

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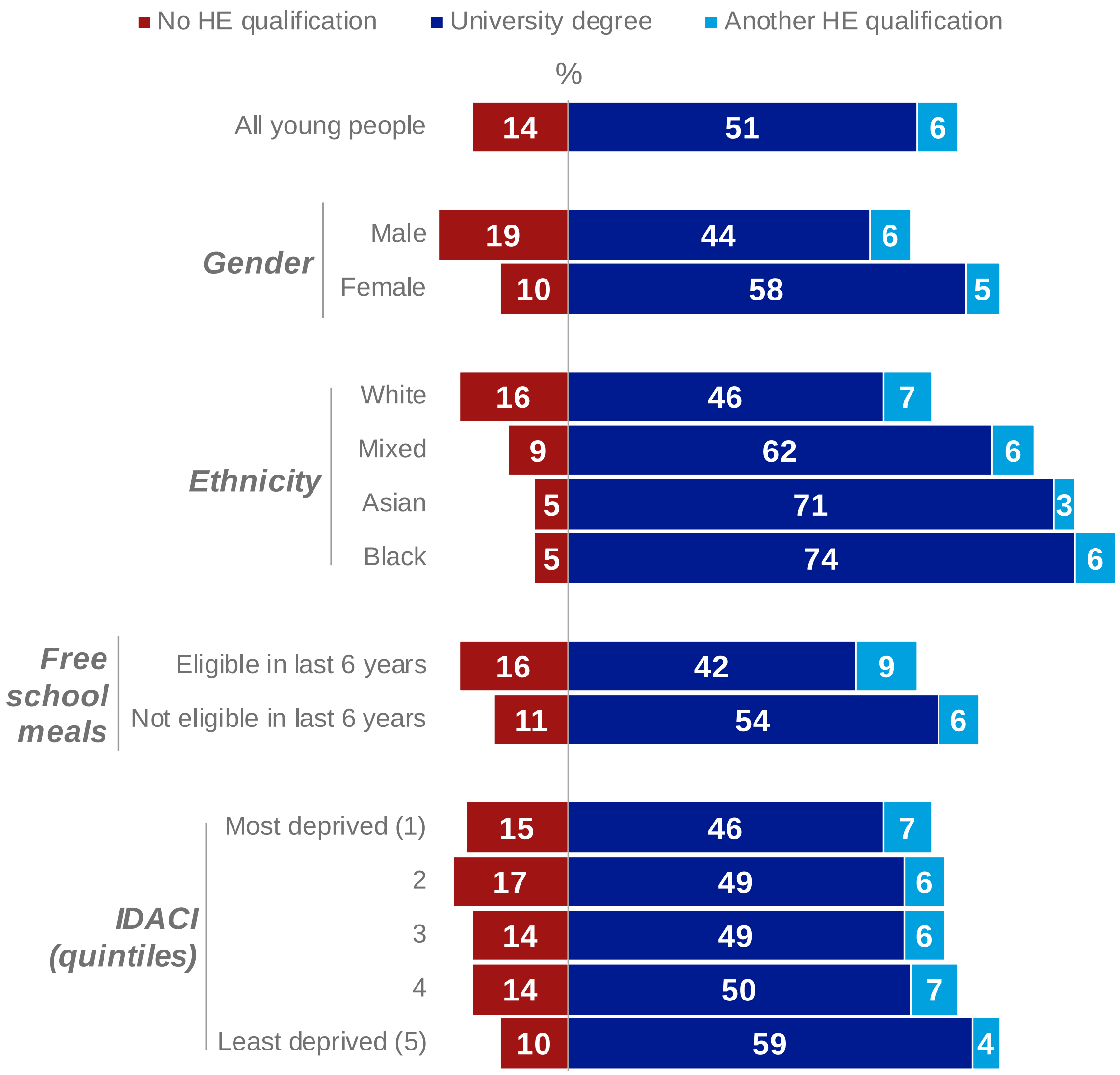
Figure 5.14: Intentions to study for a higher education qualification

Q: Are you thinking about going on to study for a higher education qualification in any subject?

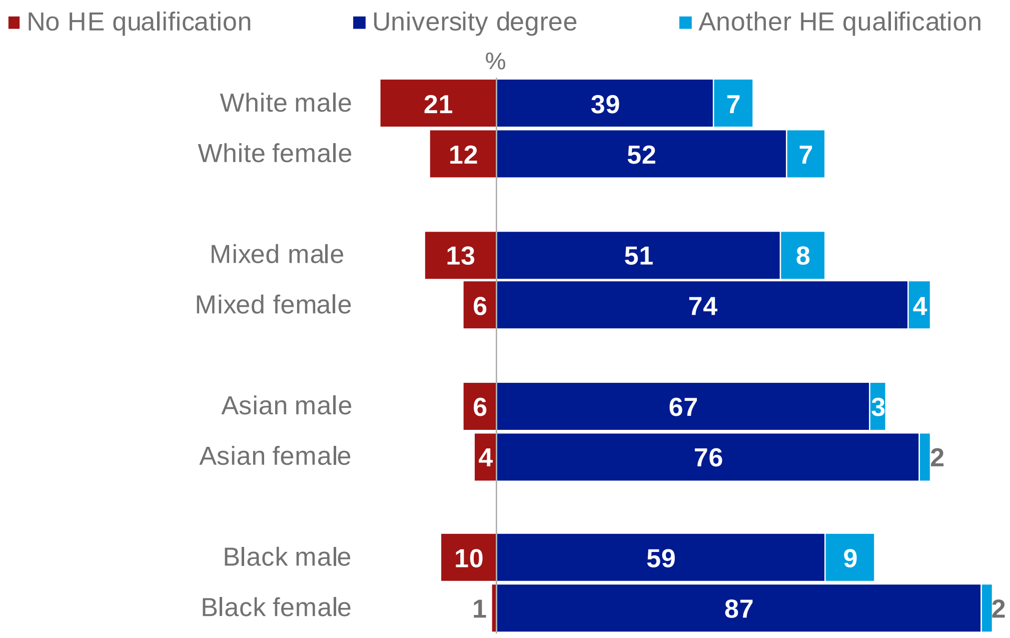


Base (All respondents): All young people (4,032), Male (1,901), Female (2,101), White (3,132), Mixed (177), Asian (440), Black (171),Eligible for free school meals in last six years (680), Not eligible for free school meals in last six years (2,338), IDACI quintiles from most deprived to least deprived (825 / 786 / 774 / 821 / 822)

http://dx.doi.org/10.6084/m9.figshare.4524551

Figure 5.15: Intentions to study for a higher education qualification by ethnicity and gender

Q: Are you thinking about going on to study for a higher education qualification in any subject?



Base (All respondents): White male (1,496), White female (1,617), Mixed male (78), Mixed female (98), Asian male (211), Asian female (226), Black male (71), Black female (100)

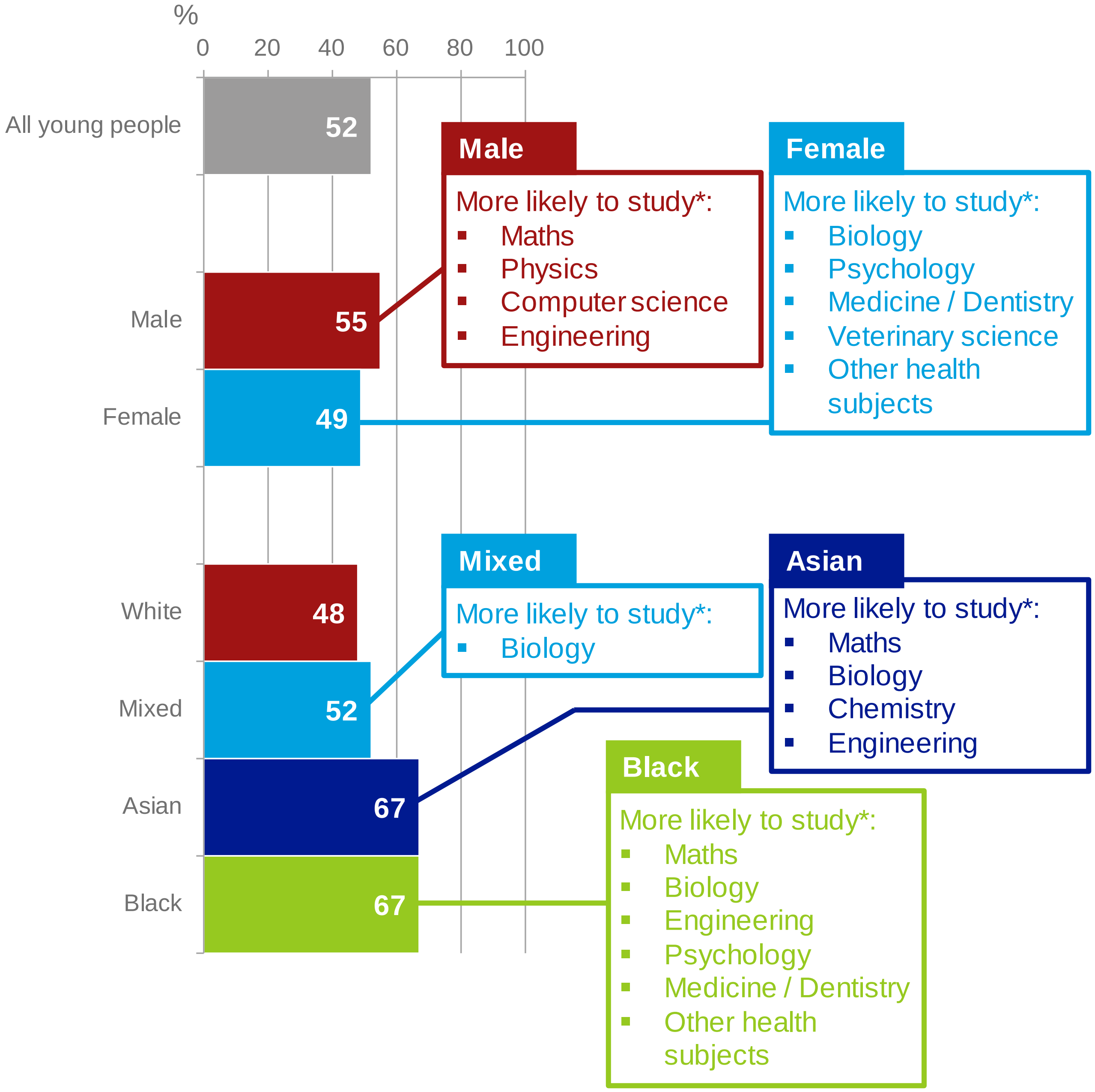
Of those considering studying for a higher education qualification, there were substantial gender differences in the choice of subject, consistent with the differences seen in uptake of subjects for Level 3 qualifications (Figure 5.16). Males were more likely than females to be considering engineering, computer science, physics or maths. Females on the other hand were more likely to be considering biology, psychology and subjects related to health (such as medicine and dentistry). They were also more likely to be considering non-science subjects.

Young people from Asian and black backgrounds also had a heightened propensity to be considering studying a science subject, in particular medicine or engineering. Young people from white and mixed backgrounds, on the other hand, were more likely to be considering non-science subjects.

http://dx.doi.org/10.6084/m9.figshare.4524551

Figure 5.16: Higher education subject choices by gender and ethnicity

Q. Are you thinking about studying for a degree or other higher education qualification in [any maths / science subject]?



**Comparing Male against Female; Mixed, Asian, Black against White*

Base (All respondents considering studying for a higher education qualification): All young people (3,486). Male (1,567), female (1,897), White (2,658), Mixed (164), Asian (410), Black (163)

6. Science as a career

This chapter focuses on young people's attitudes to a future career in science, computer science, engineering or maths. It begins by looking at the general take up of careers advice before narrowing down to interest in a science-related career. It also presents findings on attitudes to science-related careers and access to relevant work experience placements.

Key findings

- A large majority (90%) of young people said they had received careers advice from at least one source, although a third of students (33%) said they had not received advice from their school or college.
- About two in five (43%) of young people were interested in a science-related career with 19% stating that they were 'very interested'.
    - Females (35%) were less interested in a science-related career than males (51%).
    - Young people from white backgrounds (39%) were also less likely to be interested in a science-related career than those from Asian (61%) or black backgrounds (61%). Young white women in particular were less inclined to pursue a science-related career (30%).
- Young people from lower income backgrounds, as defined by free school meal eligibility and area deprivation, were just as likely to aspire to a science-related career as those from higher income backgrounds. They were however less likely to agree that science-related careers are suitable for someone like them.
- Young people with strong family science connections were more likely to be interested in a science-related career (59%) and to have done relevant work experience in this area (22%) than young people with weak family science connections (33% and 8% respectively).
- Perceptions of science-related careers were generally positive: 72% agreed that 'science careers are open to anyone who has the ability, regardless of their background.' Only one in ten agreed they are 'more suited to men than women.'
- Only 13% of young people have participated in a work experience placement in science, computer science, engineering or maths at some stage (from 8% among those in Year 10 to 15% among those in Year 13). This rises to 30% among those with a firm interest in a science-related career. Over a quarter of young people (27%) reported wanting to secure science-related work experience but being unable to do so.

6.1 Introduction

The past five years have seen a number of initiatives designed to improve the quality and provision of careers advice in English schools. Even so, a recent report highlighted a number of shortcomings that should be addressed in order to better prepare young people for the UK job market (House of Commons Sub-Committee on Education, Skills and the Economy, 2016). Another report found that only around one in five schools were effective in providing all relevant information to students to allow them to make informed career decisions (DfE, 2015).

The 2012 Wellcome Monitor (Clemence *et al.,* 2013) also found that this problem may be more acute when referring to careers in STEM areas compared with careers in general. The Monitor survey additionally reported lower levels of knowledge about STEM careers among young females compared to young males.[26]

6.2 Careers advice

The Science Education Tracker asked about the sources used by young people for careers advice (see Figure 6.1). By far the greatest single source of advice for young people was family (74%) whilst half cited friends as a source (50%). Only two-thirds (67%) reported receiving careers advice from a school source (either a teacher or careers advisor), leaving around one in three students (33%) without direct advice from their school on their potential career paths. Although the proportion of students receiving careers advice from their school increases after Year 10 (from 60% of students in Year 10 to 72% in Year 11, 69% in Year 12 and 67% in Year 13) this still leaves a substantial proportion who reported that they had not received any advice from their school. To put this in context, young people in the 2012 Wellcome Monitor rated teachers and careers advisors as the most useful sources of career information after family members.[27]

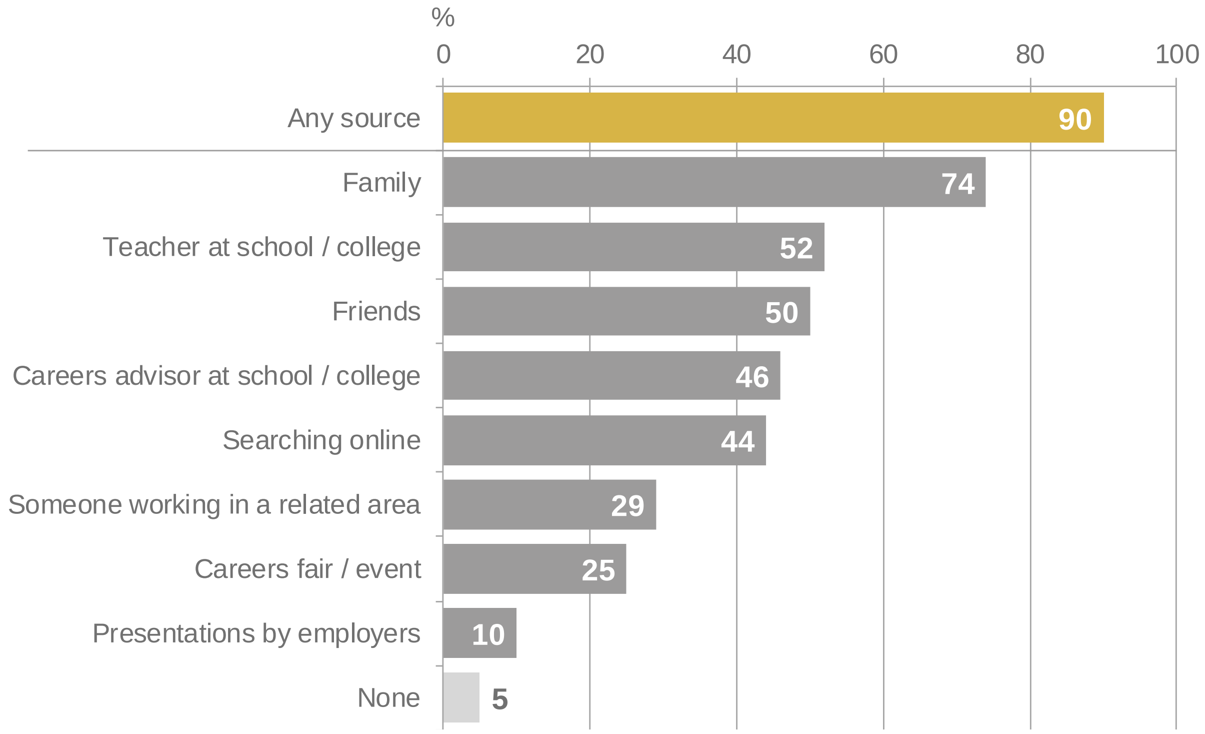
Finally, the Science Education Tracker found there to be a gap between sources of advice used and young people's explanation of interest in a science-related career. Among those interested in a science-related career, only 15% cited family and 7% mentioned teachers as a source of advice (see section 6.4). This may suggest either that young people rely more on themselves for the specific choice of career, even though they have received career advice from multiple sources, or it might suggest that there is a disconnect between young people's perception of how they made their choice and the hidden drivers such as parental influence.

[26] In the 2012 Wellcome Monitor, 71% of young people felt they knew a great or fair deal about their general career opportunities though only 45% thought the same about STEM careers. Young women were more likely to say they knew little about STEM careers (64%, compared to 47% of young men). See Clemence *et al.* (2013).

[27] 37% felt family was the most important, 22% careers advisor and 17% teacher (Clemence *et al.*, 2013).

Figure 6.1: Sources of career advice consulted

Q. Have you ever received any information or advice from any of these sources about what you may do for a career in the future?



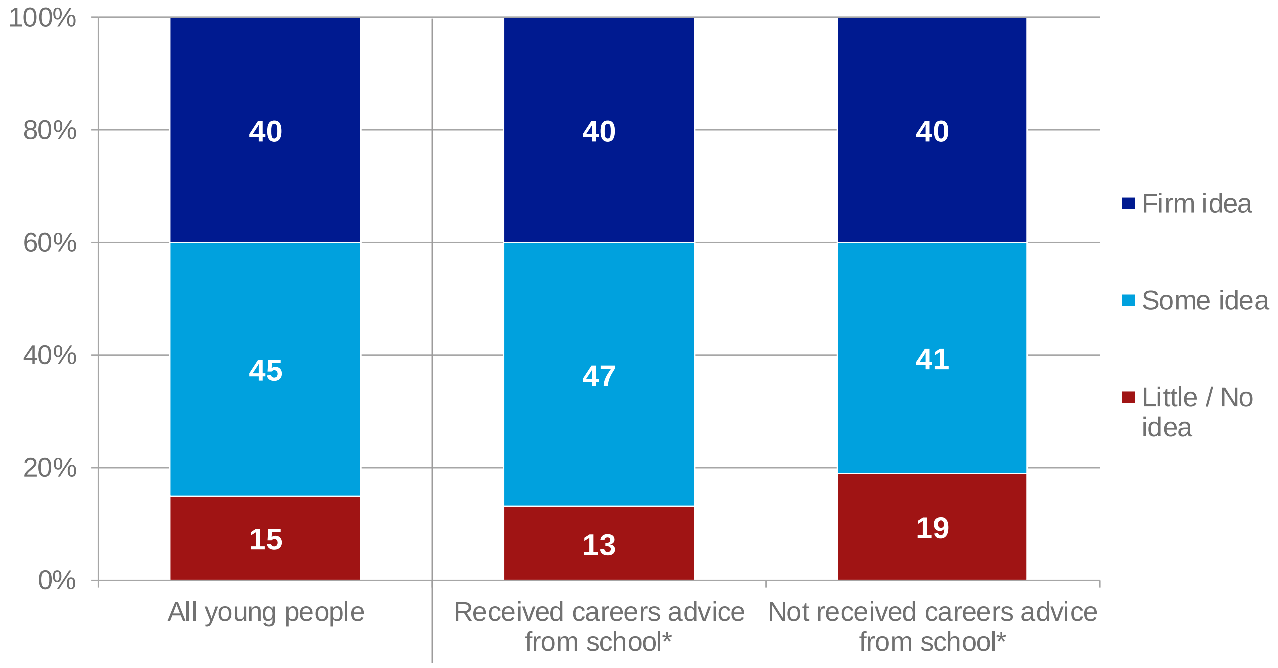
Base (All respondents): 4,045

Overall, two in five young people (40%) have a firm idea of what careers or jobs they are interested in (Figure 6.2). There was little difference in this measure across demographic groups. Students receiving schools-based careers advice were slightly more likely than those not receiving this advice to have some idea about future careers. When we compare those who have not received careers advice from their school with those who have, we see that they are more likely to have little or no idea (19% compared with 13%).

http://dx.doi.org/10.6084/m9.figshare.4524551

Figure 6.2: Sources of career advice consulted

Q. Do you have some idea about jobs or careers you are interested in?



**School careers advice includes advice from a teacher or careers advisor at school / college*

Base (All respondents): All young people (4,043), Received careers advice from school (1,166), Not received careers advice from school (2,754)

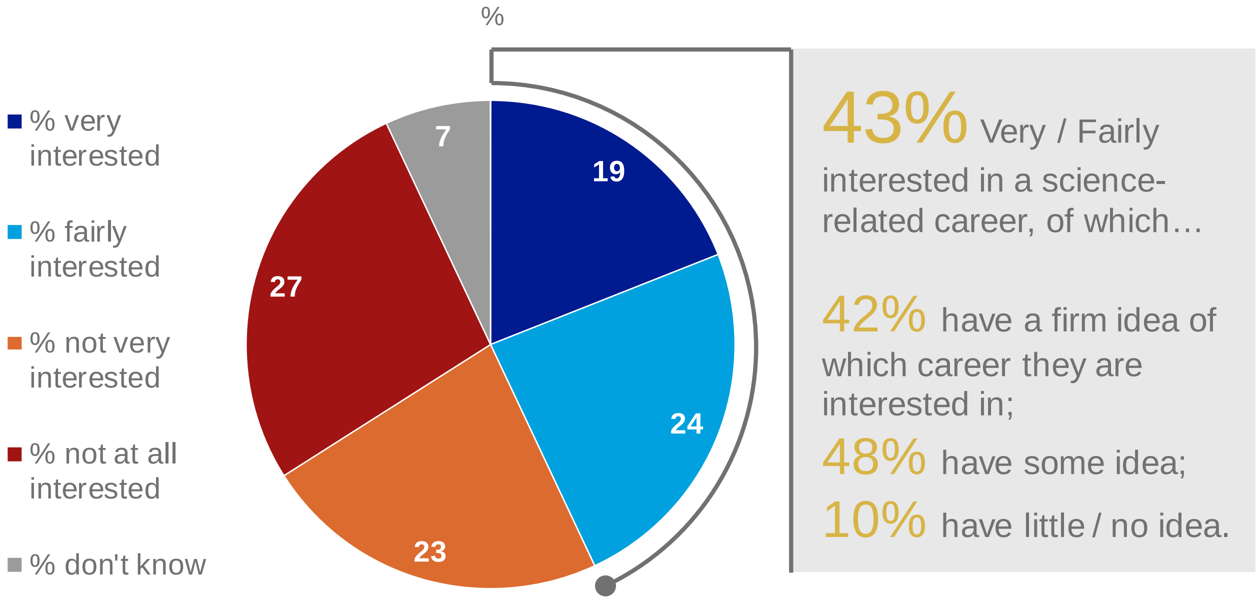
6.3 Interest in a science-related career

All respondents were asked about their interest in a career involving science, computer science, engineering or maths. Just over four in ten young people (43%) showed interest in a science-related career while one-fifth were very interested in this pathway (19%) (Figure 6.3). Interest in a science career also declines by year group as young people narrow down their career choices (51% in Year 10, 46% in Year 11, 39% in Year 12 and 36% in year 13).

Although not directly comparable, the overall level of interest matches the level of interest in the 2012 Wellcome Monitor which found 41% of young people to be interested in a science career (Clemence *et al.*, 2013). Finally, it should be noted that one in ten of those interested in a science-related career in the Science Education Tracker also said they had little or no idea about which careers they are interested in. This serves to remind that many young people are still undecided on their preferred career.

Figure 6.3: Interest in a science-related career

Q. Are you interested in a future career that involves science, computer science, engineering or maths?



Base (All respondents): 4,042

As illustrated throughout this report, gender is strongly related to interest in science, and science-related careers are no exception. Around half of males (51%) were interested in a science-related career compared with just over a third (35%) of females (Figure 6.4). In fact, almost as many females had rejected science-related careers as were interested; while 35% were very or fairly interested, 34% were not at all interested.

Young people from Asian (62%) or black (63%) backgrounds were much more likely to be interested in a science-related career than young people from white backgrounds (39%). This contradicts previous research that found that black students were less likely to have STEM aspirations (Archer, 2013), although the authors also noted that there is a relatively narrow body of work on black students and STEM career aspirations. These SET findings suggest that further research is required on this issue. Among all gender/ethnicity groups, Asian males were the most interested (70%) and white females were the least interested (30%).

Students with a high FSCI score were more likely to be interested in a science-related career (60%) than those with a low FSCI score (33%). This corresponds with previous literature that found that young people often draw from their own life when considering careers (for example, BIS/Mindshare, 2013). More than a third of students with a low FSCI score (36%) had rejected science-related careers, saying they were 'not at all interested'.

Deprivation, on the other hand, did not appear to be related to interest in science-related jobs; young people from deprived areas or eligible for free school meals in the last six years were just as likely to be interested in pursuing these careers.

http://dx.doi.org/10.6084/m9.figshare.4524551
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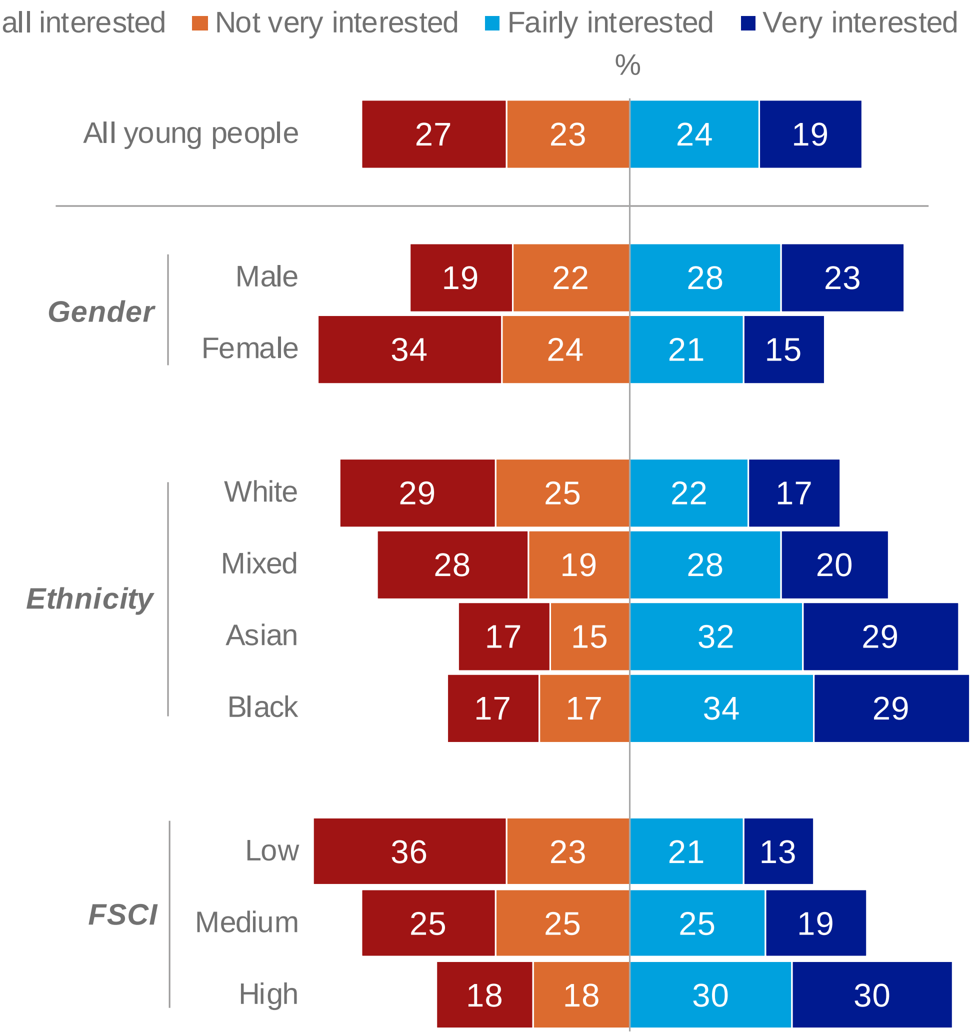
Figure 6.4: Interest in a science-related career

Q. Are you interested in a future career that involves Science, Computer Science, Engineering or Maths?



Base (All respondents): All young people (4,042), Male (1,909), Female (2,105), White (3,147), Mixed (178), Asian (438), Black (168), Low FSCI score (1,018), Medium FSCI score (2,098), High FSCI score (710)

Multivariate analysis

Multivariate analysis was undertaken through ordinal regression to investigate how different factors correlate with a young person's interest in careers involving science, computer science, engineering or maths. Details of this analysis can be found in Appendix C.

After controlling for other factors, gender and ethnicity were still both strongly associated with an interest in science-related careers; **males** were more likely to be interested than females, and young people from **Asian** or **black** backgrounds were more likely to be interested than those from white backgrounds. There was also some regional variation with interest greater in the **East Midlands** and lower in the South East after controlling for other variables.

Family science connections emerged as important factors. Having a **parent who is interested in science** or having a **family member with a science-related jo**b were both associated with a greater interest in a science-related career.

Young people in the older academic years were less likely to be interested in science-related careers than those in the **younger years**. This is largely because young people in Years 10 and 11 were less likely to have *rejected* these as an option for their future. Young people in Years 12 and 13, on the other hand, were more likely to have made decisions about their future plans and so more likely to have decided against pursuing a science-related career.

Interest in specific careers involving science, computer science, engineering or maths

Young people who expressed interest in a science-related career were asked what careers interested them (Figure 6.5). Answers were collected in an open format and coded into categories. Of those interested in a science-related career, a wide range of science-related careers were cited. The most popular careers among this subgroup were medicine (27%), engineering / mechanical engineering (24%) and computer science careers such as programming or software design (11%).

There were, however, large differences by gender: 44% of females interested in science-related careers were interested in medicine (compared with only 14% of males) and 16% were interested in Psychology (compared with just 3% of males). Males, on the other hand, were much more interested in careers related to engineering or computer science. This gender difference matches other research which found that girls, when interested in science, tend to prefer health-based careers whereas boys prefer careers in engineering or computer science (OECD, 2016c). Some of the attitudes underlying these different career paths are explored in the section 6.4.

Young people from Asian or black backgrounds and those with a high FSCI score were also particularly interested in medical careers. Of those interested in a science-related career, 44% of young people from Asian backgrounds, 46% from black backgrounds and 38% of students with a high FSCI score mentioned a medical profession.

Among those interested in a science career, young people with a low FSCI score were more likely than those with stronger family science networks to be interested in a career in computer science (16%, compared with 6% of those with a high FSCI score).

http://dx.doi.org/10.6084/m9.figshare.4524551

Figure 6.5 Type of science career young people are interested in

Base: All respondents

	All young people	Males	Females
	(%)	(%)	(%)
Medicine*	27	14	44
Engineer*	24	34	10
Computer Scientist*	11	17	3
Psychologist*	8	3	16
Teacher/lecturer*	7	5	10
Veterinary science*	6	3	10
Sports science/Physiotherapist	5	5	4
Chemist	5	4	5
Civil engineering/design	5	6	2
Biologist	4	3	6
Forensic scientist	4	1	7
Physicist	3	3	2
Armed forces	2	3	2
Other science career	13	12	14
Non-science career*	16	18	12
Unweighted base	*1,495*	*807*	*683*

**Indicates if significant difference between males and females*

http://dx.doi.org/10.6084/m9.figshare.4524551

6.4 Reasons for interest in a science-related career

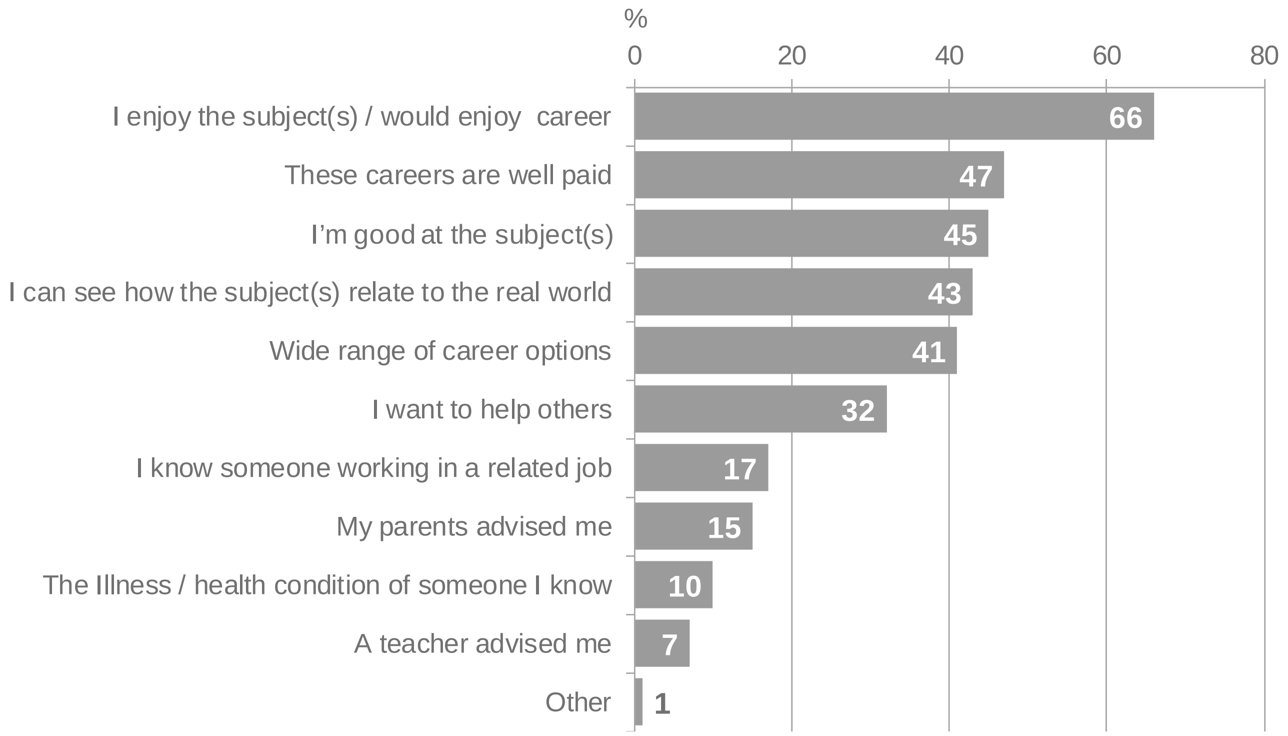
In order to investigate what is driving interest in a science career, young people were asked why they had said they were interested or not interested in science-related careers. It should be noted that this discussion centres on the young people's own perceptions of science-related careers, rather than investigating other factors which may have impacted their career plans.

Two-thirds of those interested in a science-related career cited their enjoyment of the subject or expected enjoyment of the career (66%) as a reason (Figure 6.6). This is followed by the careers being well paid (47%), being good at the subject (45%) and seeing how science-related careers relate to the real world (43%). Around one in three said they were interested in a science-related career because they wanted to help others (32%).

Advice from parents or teachers appeared to play a limited role in students' interest in science-related careers: 15% mentioned advice from their parents and seven per cent advice from their teachers as a reason for their interest.

Figure 6.6: Reasons for interest in a science career

Q. Why are you interested in a career involving science, computer science, engineering or maths?

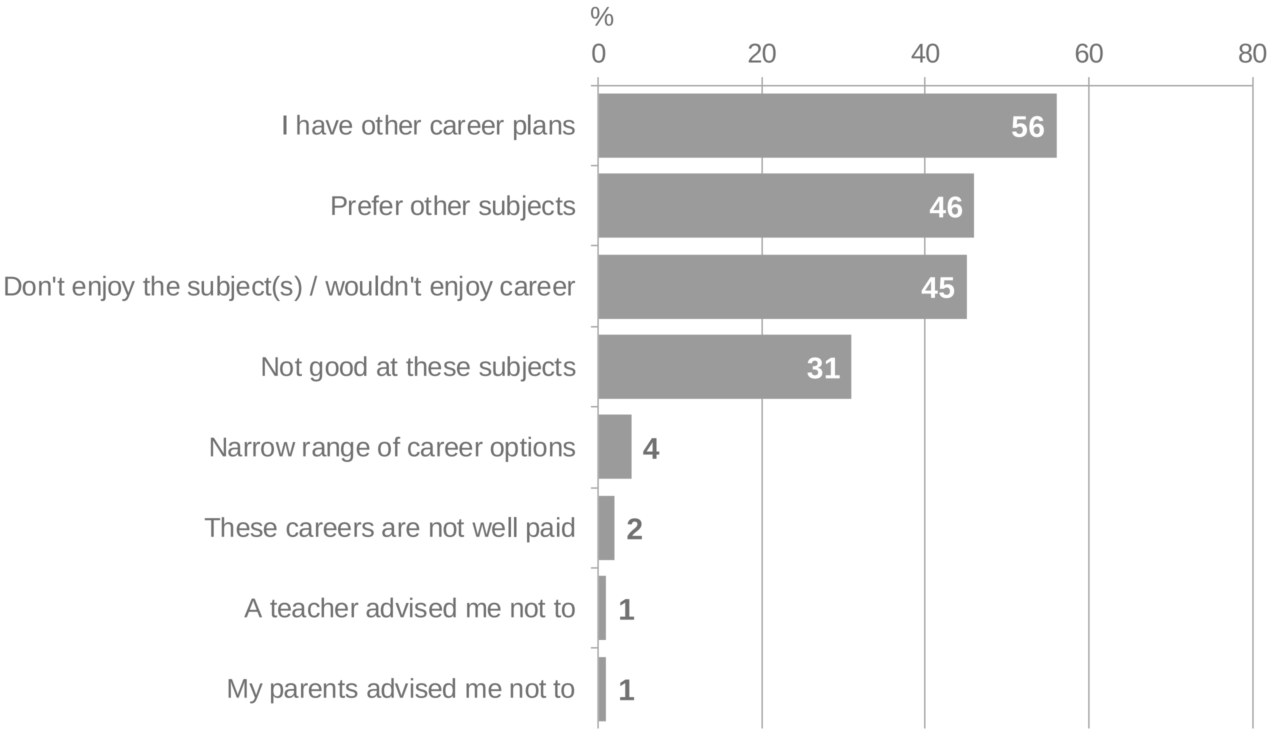


Base (Young people interested in a science career): 1,792

Conversely, having little or no interest in a science-related career was primarily a result of having other careers plans (56%), preferring other subjects (46%), not enjoying the subject / career (45%) or not being good at the subject (31%). Negative perceptions about science-related careers such as thinking that they offer a narrow range of career options (4%) or that they are not well paid (2%) were very uncommon. This gives further weight to past research (Archer *et al.* 2013) which found that negative perceptions about science or scientists are not the driving reasons for not being interested in a science career Instead, this suggests that engaging students in school science is an important element of encouraging more young people into science-related careers.

Figure 6.7: Reasons for not being interested in a science career

Q. Why are you not interested in careers involving science, computer science, engineering or maths?



Base (Young people not interested in a science career): 1,974

There was considerable variability by gender in the reasons given for interest in science-related careers. Just under half of females interested in a science-related career mention a desire to help others (48%) compared with a fifth of males (20%). Females were also more likely to cite the health condition or illness of someone they know (15%, compared with 5% of males) or being able to see how science subjects relate to the real world (47% compared with 39% of males). These differences may partly be explained by the higher percentage of women considering a medical career; for example, 64% of those considering a medical career cited an interest in helping others.

Males, on the other hand, were more likely to say their interest was due to being good at the subject (48%, compared with 40% of females). Similarly, females were more likely to say that they were not interested in a science-related career due to not being good at these subjects (36% compared with 23% of males). These attitudes do not vary by science attainment score. This again points to underlying issues of lower confidence among girls (see also chapter 4 section 4.2.2 for discussion about how weaker confidence among female students influences decisions around triple science).

http://dx.doi.org/10.6084/m9.figshare.4524551

On the other hand, females were also more likely to say that they were not interested in science-related careers because they don't enjoy these subjects / wouldn't enjoy these careers (51%, compared with 37% of males) or because they prefer other subjects (50% compared with 40% of males). This is consistent with findings such as Ceci *et al*. (2009), which suggest that one reason for lower female participation in science-related jobs is that females pursue a wider range of non-science options.

Strong family science networks are related to motivation to consider a science-related career. Those with a high FSCI score reported a wider range of motivations for their interest, citing on average 2.3 reasons compared with 0.8 reasons among those with a low FSCI score. A quarter of those with a high FSCI score (25%) cited knowing someone in a related job as a reason for their interest in a science-related career, and almost as many cited advice from their parents (22%). In comparison, only 10% of those with a low FSCI score mentioned knowing someone in a related job and nine per-cent mentioned parental advice as being reasons for their interest in science-related careers.

Advice from parents plays a particularly important role in the decision-making process for young people from Asian or black backgrounds. A quarter of those from Asian backgrounds (25%) and 22% of those from black backgrounds indicated that conversations with their parents helped spark their interest in a science-related career, compared with only 13% of their white peers.

6.5 Attitudes towards science careers

As well as asking about the reasons for interest or lack of interest in careers involving science, computer science, engineering or maths, respondents were asked how much they agreed or disagreed with a set of attitudes regarding science-related careers.

One very common perception was that entry requirements into science-related careers are high. Almost nine in ten respondents agreed that science-related careers require high grades and one in three strongly agreed (Figure 6.8). Almost two thirds (63%) agreed that science-related careers are difficult to get into, with 12% strongly agreeing. Females were more likely to agree that science-related careers require high grades (91%, compared with 86% of males) and are difficult to get into (65%, compared with 60% of males), again underlining the persistent perceptions of difficulty and a lack of confidence among female students.

Female students were more likely to agree that science-related careers are "boring" (29% compared with 23% of males). This gender disparity was however only apparent within the white subgroup; almost a third of white females (32%) agreed that science-related careers are boring compared with 24% of white males.

There was also a clear recognition that science-related careers make a useful contribution to society: 82% agreed, with 36% strongly agreeing. Only three per cent disagreed with this statement. Despite females being more likely to explain their interest in a science-related career as being motivated by the societal benefits of a science career, females and males had similar levels of agreement to this statement.

Science-related careers were not commonly perceived as exclusive in terms of background. One in three respondents (32%) strongly agreed that science-related careers are open to anyone regardless of background. Furthermore, relatively few respondents agreed that science-related careers are more suited to men than women (9%).

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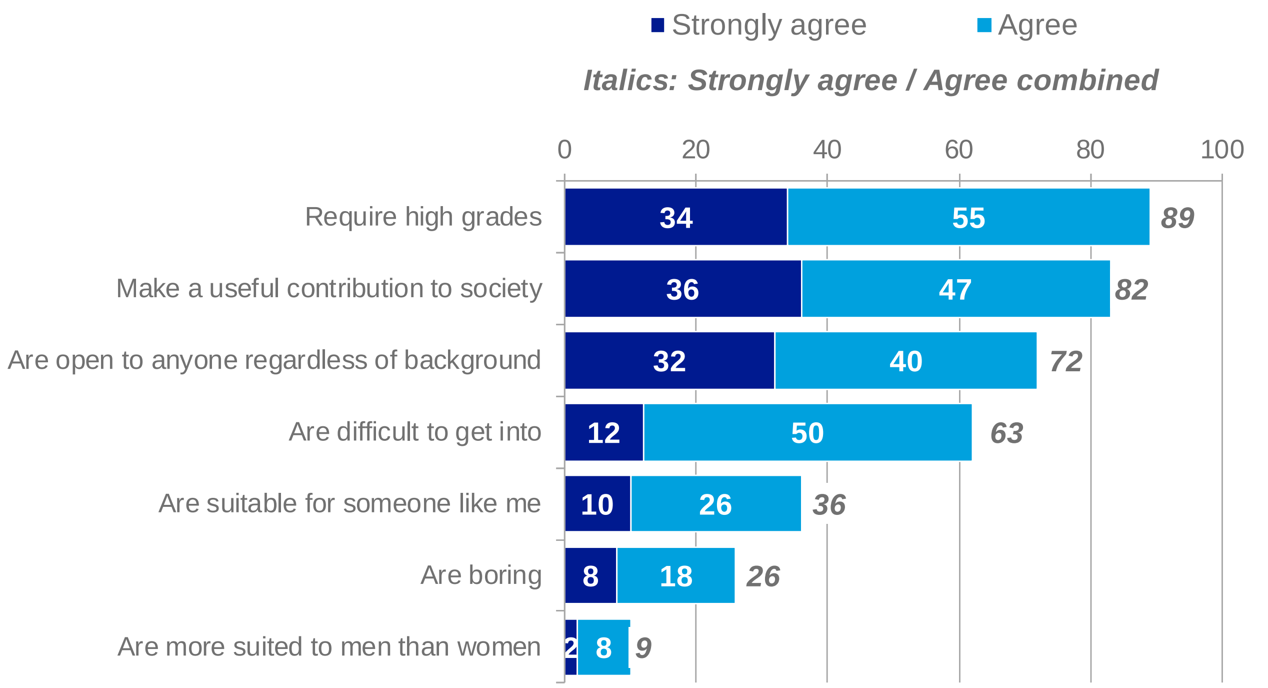
By measures of deprivation, little difference was observed in perceptions that science-related careers are open to anyone regardless of background, indicating that young people from more deprived areas or eligible for free school meals were no more or less likely to consider these careers as available to them. However, young people with low FSCI scores were less likely to agree; just over a quarter of those with a low FSCI score (26%) strongly agreed that science-related careers are open to anyone regardless of background, compared with 39% of those with a high FSCI score. In other words, science-related careers are seen as much more attainable to students with strong science networks outside of school.

Students with low FSCI scores generally held more negative perceptions of science-related careers. In particular, they were more likely to agree that science-related careers are boring (14% strongly agreed, compared with 5% of those with high FSCI scores) and less likely to agree that science-related careers make a useful contribution to society (24% strongly agreed, compared with 49% of those with high FSCI scores). As such, there is a challenge for schools and educators to address these perceptions and persuade students lacking these networks of the value of science careers.

Figure 6.8: Attitudes to science-related careers

Q. Careers that use science…



Base (All respondents): 4,030

6.6 Science careers ‘for someone like me’

The following section takes a closer look at levels of agreement to the statement that science careers are ‘suitable for someone like me’.

Young people were roughly evenly balanced between those who agreed and those who disagreed with this statement (Figure 6.9). More than a third agreed, with one in ten strongly agreeing, while similar proportions disagreed. Males were more likely to agree, as were students with mixed, Asian or black backgrounds. It is also notable that the gender gap was not present for students from Asian or black backgrounds.

Strength of family science connections was strongly correlated with seeing science careers as ‘for someone like me’. More than half of those with high FSCI scores agreed (18% strongly agreed) compared with 23% of those with low FSCI scores (6% strongly agreed).

There was also a relationship between measures of deprivation and perceptions of science careers being ‘for someone like me’. Students from less affluent backgrounds as measured by area deprivation level and free school meal eligibility were less likely to agree that science careers are for someone like them.

Overall the findings are consistent with previous research. Archer *et al.* (2013), for example, found that certain groups are more likely to agree that science is ‘for me’. These include males, students from an Asian background and those with high cultural and science capital. In contrast, females, white students and those with low cultural and science capital were less likely to agree than other groups.

Multivariate analysis

Multivariate analysis was undertaken through logistic regression to investigate the relationships between key variables and whether or not a respondent agreed that careers in science are ‘suitable for someone like me’. Details of this analysis can be found in Appendix C.

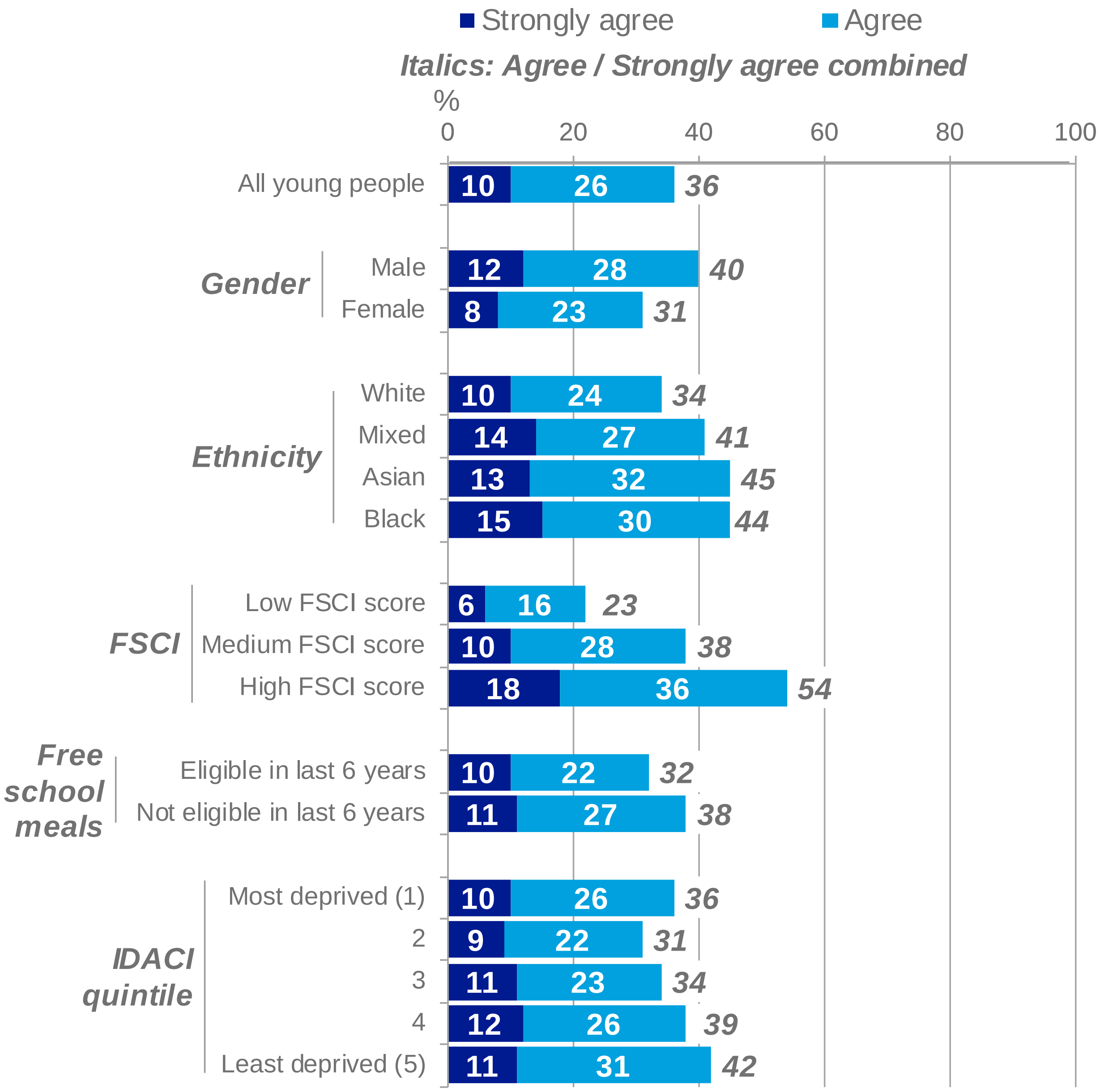
The results were largely consistent with the multivariate analysis to investigate interest in science-related careers (see section 6.3). After controlling for other factors:

- **Males** were more likely to consider science-related careers ‘suitable for someone like me’ than females;
- Young people from **black** or **Asian** backgrounds were more likely to agree than those from white backgrounds;
- Young people with **higher science quiz scores** were more likely to agree than those with lower scores;
- Young people with at least **one parent who is interested in science** or a **family member in a science-related job** were more likely to agree.

This final point supports research which has shown how the place of science in the family environment and the networks available to young people play an important role in making science more ‘thinkable’ for them and encouraging them to see it as a viable career path (e.g. Archer *et al.* 2012).

Figure 6.9: Agreement that science careers are 'suitable for someone like me'

Q. Careers that use science…Are suitable for someone like me



Base (All respondents): All young people (4,030), Male (1,903), Female (2,097), White (3,137), Mixed (178), Asian (438), Black (169), Low FSCI score (1,010), Medium FSCI score (2,091), High FSCI score (708), Eligible for free school meals in the last six years (680), Not eligible for free school meals in the last six years (2,341), IDACI from most deprived quintile to least deprived (818 / 788 / 778 / 822 / 820)

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6.7 Work experience

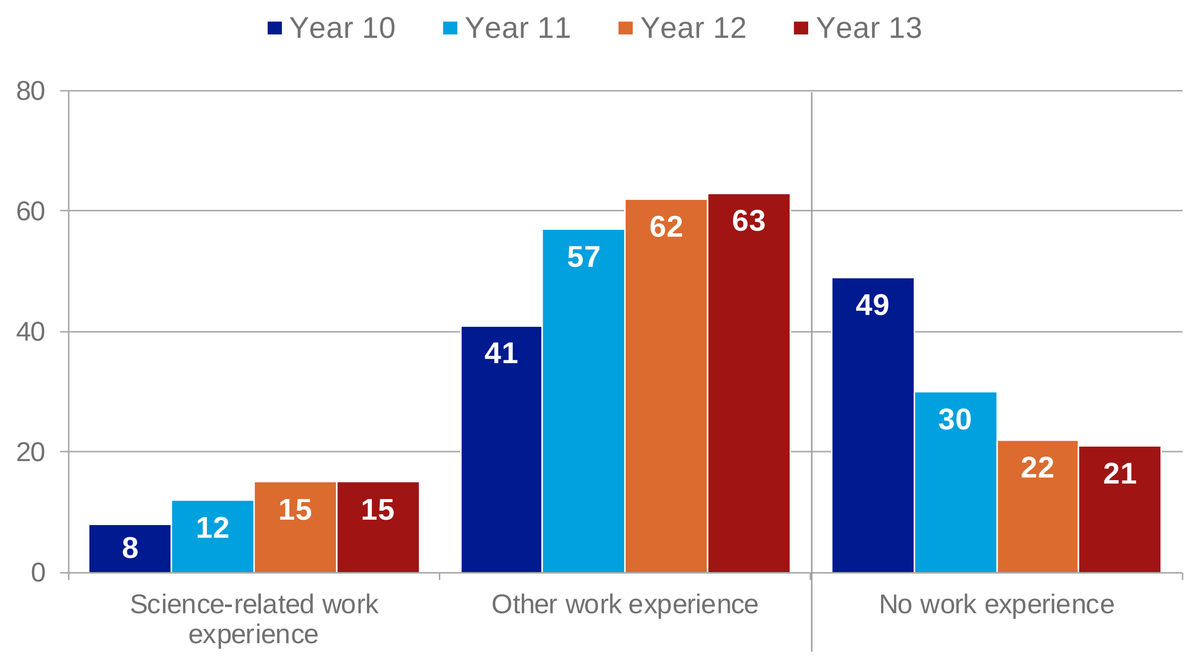
Completion of relevant work experience allows young people to gain exposure to the world of work at an early age. The beneficial nature of work experience is one reason the Department for Education (2015) has identified work placements as a key pillar of effective career guidance strategies. Focusing on work experience in science, there is strong evidence to suggest that participation in STEM work experience boosts uptake of science subjects in post-compulsory education (e.g. Bennett, 2013). However, other research has found that young people interested in science careers are among the least likely to have had work experience (Archer *et al.*, 2016a).

In SET, only 13% of young people had completed work experience in a science-related setting. This figure rises to 30% among those with a firm interest in a science-related career.

A majority of young people (69%) had completed at least one work experience placement in any type of industry, leaving 31% who have not done any work experience. This rate is higher among younger students (49% in Year 10), which is likely to simply reflect that students in Year 10 will generally have had fewer opportunities for work experience. Nonetheless, one in five students in Year 13 (21%) had not done any work experience (Figure 6.10).

Figure 6.10: Work experience by academic year

Q. Have you ever done any work experience?



Base (All respondents): Year 10 (1,105), Year 11 (1,071), Year 12 (941), Year 13 (924)

Males, those living in the least deprived areas and those with a high FSCI score are all more likely to report having done a science-related work placement (Figure 6.11). The 2012 Wellcome Monitor also found that among young people, females are less likely than males to do STEM work experience (Clemence *et al.*, 2013).

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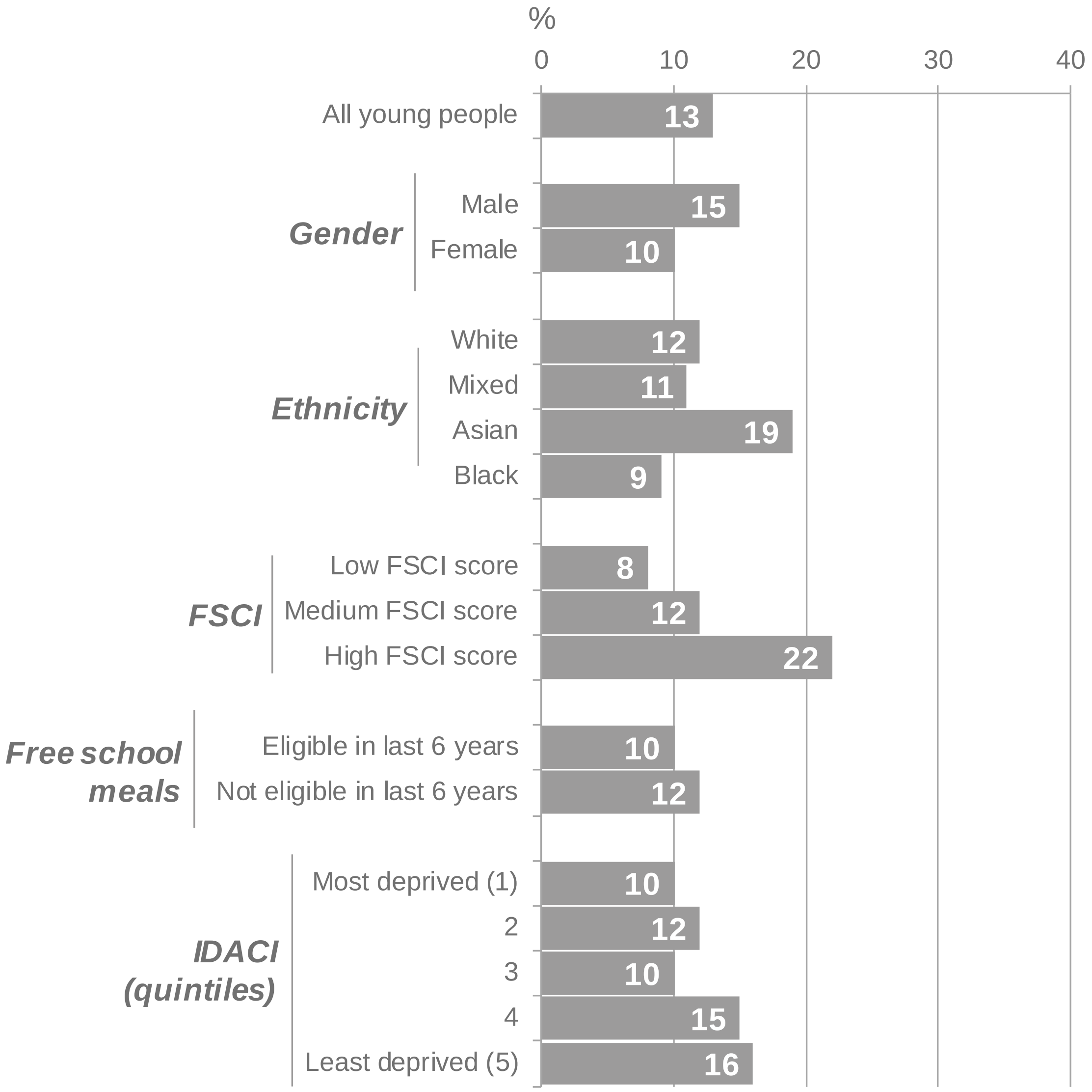
Young people from Asian backgrounds were more likely to have undertaken science-related work experience (18%) than other ethnic groups. This may simply reflect Asian students' greater interest in a science career (see section 6.3). However there does seem to be a disconnect between interest in a science career and work experience for young people from black backgrounds: despite having similar levels of interest in science-related careers to young people from Asian backgrounds (61%) but their rate of relevant work experience was much lower (9% compared with 19% of those with Asian backgrounds).

Figure 6.11: Science-related work experience

Q. Have you ever done any work experience?

% done work experience with an employer involved in science, computer science, engineering or maths



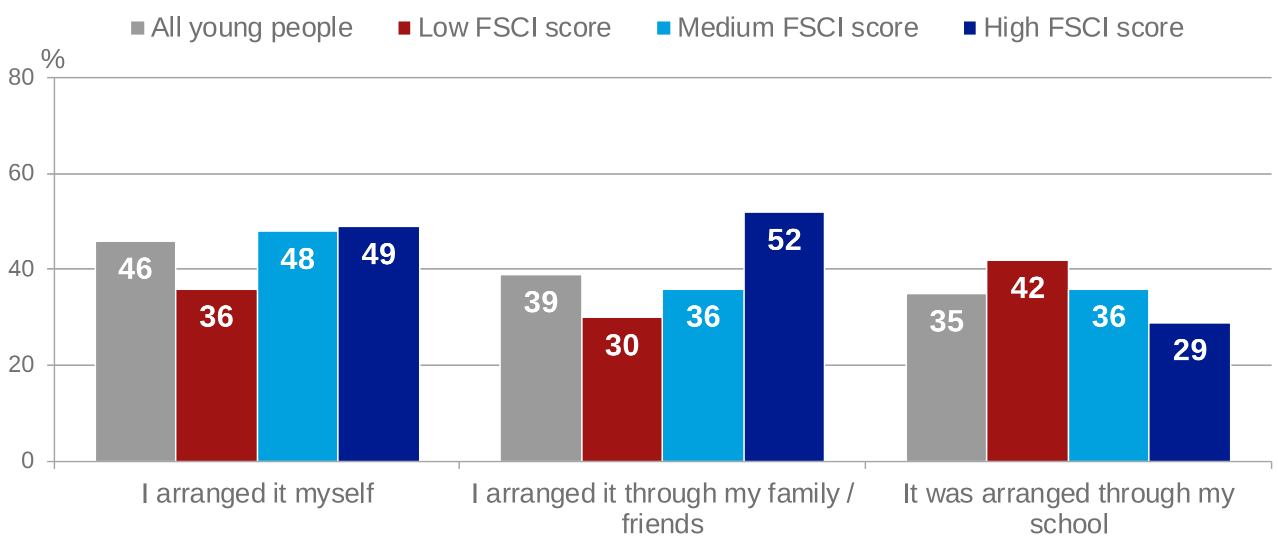
Base (All respondents): All young people (4,041), Male (1,905), Female (2,109), White (3,142), Mixed (178), Asian (440), Black (171), Low FSCI (1,015), Medium FSCI (2,099), High FSCI (711), Eligible for free school meals in the last six years (677), Not eligible for free school meals in the last six years (2,342), IDACI quintiles from most deprived to least deprived (829 / 786 / 780 / 822 / 820)

Young people 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 6.12). Young people were able to indicate if they used more than one means of securing a placement. Just under half (46%) indicated that they arranged their placement personally, while 39% relied on family or friends and 35% arranged it through their school.

The importance of schools facilitating science-related work experience is illustrated in the difference between those with stronger and weaker family science connections. Young people with low FSCI scores were most likely to arrange a relevant placement with the aid of their school (42%). For those with high FSCI scores this drops to 29%. Instead, those with high FSCI score were much more likely to have arranged work experience through friends / family (52%, compared with 30% of those with low FSCI scores). As discussed above, those with high FSCI scores were much more likely to have undertaken science-related work experience. The greater science networks among those with high FSCI scores therefore appear to be facilitating more opportunities for young people to undertake relevant work experience.

Figure 6.12: How science-related work experience placement was arranged

Q. Thinking about your most recent work experience with an employer involved in science, computer science, engineering or maths, how was this arranged?



Base (All those who have been on a science-related work experience placement): All young people (512), Low FSCI score (74), Medium FSCI score (260), High FSCI score (153)

More than a quarter of young people (27%) reported wanting to secure science-related work experience but being unable to do so. The most common reasons for this relate to difficulty in identifying and taking advantage of opportunities, as well as work experience not been offered by the school (Figure 6.13). In this way, one of the major barriers for students taking part in science-related work experience is the responsibility to arrange it themselves. With limited connections in science and limited support from schools, this may simply be too much of an obstacle for many students. There would therefore appear to be a need for schools and the education system more widely to give greater help to pupils to enable them to take part in work experience in science-related areas.

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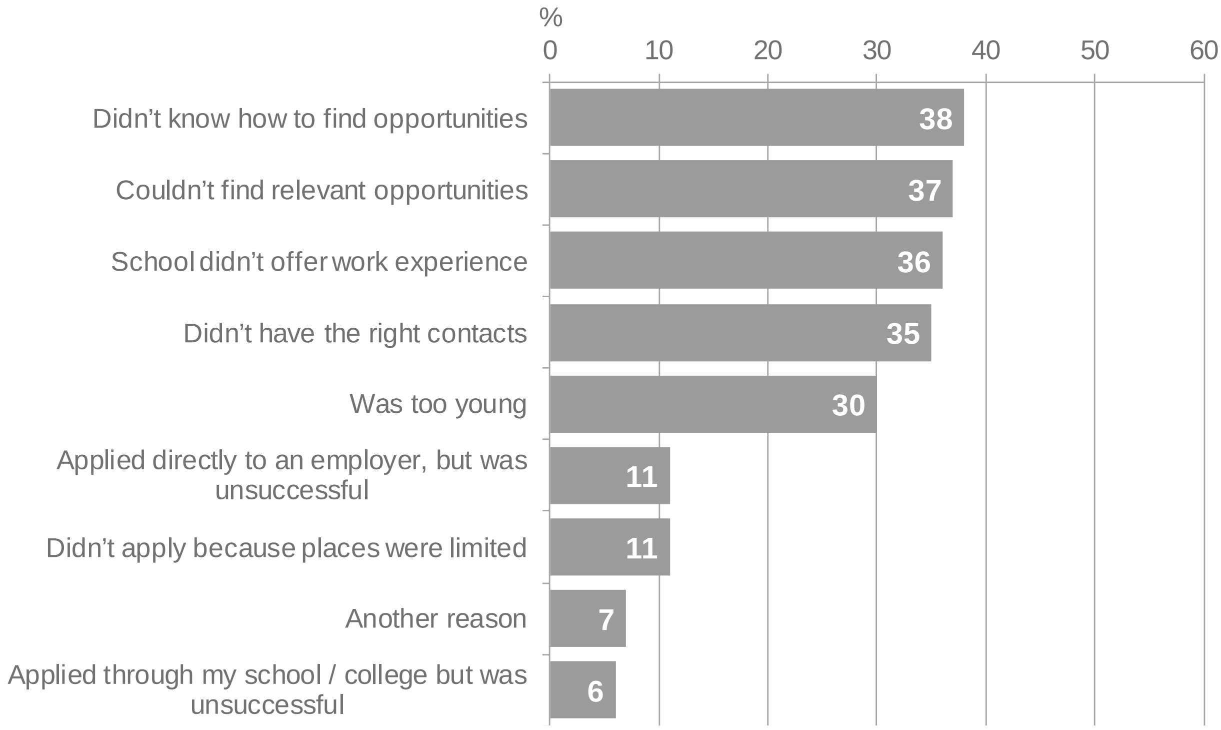
Figure 6.13: Reasons for not being able to do work experience in science

Q. Why were you unable to do this work experience?



Base (All young people who wanted to do a science-related work placement but were unable to do so): 1,143

Reflections

Context

All young people should have access to an engaging and rewarding experience of science, which includes a high quality science education in schools. This will help them understand and appreciate the importance of science in their lives, engage with and enjoy the science they experience in the world around them, and use what they know to make well-informed science-related decisions in their lives, including decisions about their future careers.

As young people progress through their schooling, they have opportunities to make decisions on the subjects they study. There is concern in a number of countries that too many young people move away from studying science, resulting in shortages of people pursuing careers in science and science-related areas. There is also concern that the pool from which future science specialists emerges is restricted, with a lack of diversity in social and ethnic background and an under-representation of women in specific areas.

The Science Education Tracker provides a means of accessing young people's views of their experiences of science in England and gaining insights into how this shapes their thoughts and the decisions they make at 14+, 16+ and 18+. This section of the report provides some reflections on the patterns that have emerged from the data gathered. The general patterns are considered under the three headings of science in school, science outside the classroom, and science careers. This is followed by discussion of the differences in the responses of subsets of young people by family science connections, gender, ethnic background and socioeconomic status. Where these characteristics tend to be associated with each other, this is noted. Finally, key messages and challenges are considered.

Science in school

For the majority of young people, their most direct experience of science comes from their science lessons at school. Very positively, the majority of young people – around two-thirds – report that they find the science they study in school to be interesting.

Unsurprisingly, one of the most influential factors for students is the perceived quality of teaching: young people who feel that they experience good teaching are more motivated to engage with science lessons, while poor teaching is the most commonly cited reason for young people being put off science. Practical work is also an influential factor, with young people seeing 'hands-on' experience as encouraging them to learn science, and more than half of GCSE students saying that they wanted to do more practical work in science lessons.

There is a strong association between the GCSE pathway followed and participation in science beyond the compulsory period of study. Young people taking triple science are more likely to study, or indicate they want to study, science subjects after the age of 16. Two-thirds of young people who take triple science plan a science pathway post-16, compared with only two-fifths of young people taking double science, with the large majority of young people taking chemistry and physics post-16 having taken triple science. Young people taking triple science are also twice as likely to

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indicate interest in a science-based career. Young people with higher science knowledge are more likely to exercise a choice not to do triple science based on a desire to prioritise other subjects.

Beyond the age of 16, the most popular science and science-related subjects are mathematics, biology, chemistry and psychology. Substantial increases in numbers taking mathematics in recent years have now made it the most popular A-level subject.

Science outside the classroom

Science outside the classroom can take many forms, such as extra-curricular activities at school, informal learning experiences at, for example, science museums, and other consumption of science content via various online, broadcast or print media.

Extra-curricular activities at school are most likely to take the form of a talk from a STEM ambassador or someone in a science-related job. Science fairs and science or STEM clubs also feature, and a small proportion of young people report taking a science-related Extended Project Qualification. Views were mixed over the motivational effects of such activities, with around two-fifths feeling that these activities had inspired them to study science and the remainder feeling it made little difference to future study plans.

Engagement with informal science learning outside school is relatively infrequent for the majority of young people. For example, most young people visiting a science museum or similar reported doing so no more than once a year. By way of contrast, more young people participate in arts and cultural attractions and events than in science events. However, young people who do participate in visits to science museums and other science-related attractions outside school are more likely to engage with science through other media, most commonly through television and online, but also through books and newspapers.

Science careers

Over seven in ten young people think that science careers make a valuable contribution to society and are open to people of any background. However, when asked to respond to the statement 'Science careers are for someone like me', only around one-third of young people agree. Around two-thirds also express an interest in pursuing a career involving science. The most popular careers mentioned are medicine, engineering and computer science or computer programming.

The main reasons young people give for wanting to pursue a career in science are interest and enjoyment, followed by pay, belief that they have the ability, wanting to do something that links to the real world, access to a diverse range of career options and wanting to help others. Young people who do not want to pursue careers in science say they enjoy other subjects more than science and have other career plans. Science careers are seen by most young people as open to anyone who has ability, irrespective of background, and very few negative perceptions of science careers were expressed, with such careers seen as making a very positive contribution to society. Rather, those who do not want to pursue science careers simply see them as not something they personally want to do.

Careers advice to young people appears to be very patchy, with around one-third of young people receiving no careers advice at school. Family members are seen as the main source of careers advice, followed by schools and friends.

Young people who express strong interest in a science career are much more likely than those who lack interest to have undertaken a science-related work experience placement, but only a relatively small proportion of young people undertake work experience in science-related areas. Around a quarter of young people reported that they would have liked science-related work experience, but were not able to do so due to lack of help from schools and lack of networks.

Family science connections

The importance of family science connections is a comparatively new area of research, and one which has shown that parents and wider family networks are highly influential in shaping young people's views and experiences of science and the decisions they make about studying science. The Science Education Tracker shows that high levels of family science connections tend to exist in more affluent families and where one or both parents have been to university, while low levels of family science connections are more prevalent among young people living in more deprived areas. Family science connections are lowest for white families from disadvantaged backgrounds.

Family science connections emerge as strongly associated with interest in science. Young people with strong family science connections are more likely to study science subjects beyond the age of 16, see science careers as something for them, express higher levels of interest in careers in science, have been advised by their parents about science-related careers, and have arranged and undertaken a science-related work experience. They are also more likely to talk about scientific issues outside school and attend science-related events outside school.

In contrast, young people with low family science connections have more negative perceptions of science careers, and are more likely to see them as boring and not making a useful contribution to society. Young people with low family science connections are unlikely to be encouraged by family and friends to study science. Of note is that those with low family science connections are less likely to have opportunities in their schools to undertake practical work while also being are more likely to say they would prefer to do more practical work.

Interesting differences emerge in the ways in which young people access visits to museums. Mothers were the most likely route for young people from white backgrounds with university-educated parents. However, for young people from Asian backgrounds, young people with lower science knowledge and young people with non-university educated parents, schools provided the main means of accessing museums and other science-related attractions.

Gender-related patterns

A number of gender-related differences were evident, many of which reflect well-documented patterns that have endured over many years in relation to interest in science and subsequent subject and career choices.

Having a good teacher emerges as crucial to most young people, but with young females being more likely than young males to cite this as important.

Young males enjoy mathematics and physics more than young females, and are also more engaged by undertaking practical work. Gender-related subject preferences carry through into subject choices at age 16, with young males more likely to opt for mathematics, physics and computer science, and young females for biology and psychology.

As would be expected, gender differences emerge in relation to careers. Young males are more likely than young females to agree that science careers are for someone like them, and young females, particularly young white females, are less interested in science-related careers. There are large gender differences in the types of careers in which young people are interested, with young

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males expressing preferences for engineering and computer science and young females mentioning medical and psychology-related careers. Those young females who are interested in science careers attribute their interest to wanting to help others, finding out about a health condition of someone they know, and relating science to the real world, all of which link strongly to aspirations for medical careers. Young males on the other hand are more likely to attribute interest to being good at science subjects. Confidence emerges as important, with more young females perceiving it to be difficult to get into science careers and reporting that they are not good at science subjects. Finally, young males are more likely than young females to undertake science-related work experience.

Confidence and perceptions of ability are recurring themes running through the data. The perceived difficulty of science subjects discourages substantially more young females than young males from engaging with science lessons. Where young people can exercise a choice at 14+, young females are more likely to cite lack of confidence as a reason for not taking triple science.

Gender differences to emerge from the data on science experiences beyond the classroom include young females being more likely to attend arts and cultural events and attractions than science-related attractions, and also being less likely to engage with science content in various online and print formats. The group least likely to participate in extra-curricular science activities outside school is white females.

It is worth noting that computer science, which has recently been introduced into the pre-16 curriculum, appears to be contributing to gender differences, with females in particular expressing lack of interest in the subject. This is reflected in the numbers of young people taking computer science, with 25% of males but only 9% of females being entered for GCSE. There are parallels in these figures with gender differences in numbers studying physics beyond the compulsory period.

Ethnic background

Ethnic background is also associated with responses to science and decisions over subject choices. Young people from Asian and black backgrounds are more likely to say science is interesting. Young Asian people, particularly young males, express a strong preference for science subjects. Young Asian people are more likely than young white people to be studying biology, physics and mathematics beyond the age of 16, and to be considering careers in medicine, as are young black people from affluent areas.

Young white people express much less interest than young Asian and black people in careers in science. Young Asian and black people with strong family science connections are particularly interested in medical careers, and parental career advice is also important for these groups. Young people from mixed, Asian or black backgrounds are more likely than young white people to see science careers as something for them. Young Asian people are more likely than young black people to have done science-related work experience, though levels of interest in science careers are similar.

Socio-economic status

The socio-economic status of families appears to play a key role in determining levels of engagement with science. While aspirations to study science are not strongly related to many background characteristics, young people in the most deprived areas are less likely to take triple science and also less likely to go on to study science beyond the age of 16. Additionally, practical

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work – one of the key factors that encourages students to learn science – is less prevalent in schools in deprived areas.

There are no differences in aspirations for a career in science for young people from more or less affluent backgrounds. However, the young people in the latter group are less likely to see science careers as suitable for ‘someone like me’.

Key messages and challenges

There is certainly some good news in the findings of the Science Education Tracker. A majority of young people feel positive about their experience of science in school, believe that science careers are important, and that people working in science and science-related areas make a valuable contribution to society. Yet the concerns remains - being interested in science and valuing the contribution it makes are not sufficient to persuade more young people to study science subjects beyond the compulsory period. Why is this the case? The answer has very much to do with the ‘not for me’ qualifier that many young people add to the above views. This ‘not for me’ judgement is linked to gender, socio-economic status and family science connections. The findings of the Science Education Tracker also point to areas of possible action, though not to easy solutions.

The teaching workforce and teaching quality

There are clear messages from the Science Education Tracker about the quality of teaching. The Science Education Tracker confirms the crucial role teachers play in influencing young people’s responses to science and participation beyond the compulsory period of study. Good teaching is linked to expertise and confidence with the subject being taught, so points to the need for science to be taught by enthusiastic and skilled specialist teachers of biology, chemistry and physics.

The science curriculum offering

Whilst legislation makes the study of science compulsory for all young people up to the age of 16, schools have considerable freedom in the nature of the science provision they make. In particular, schools are able to decide whether or not they offer some or all of their students the opportunity to choose between double and triple science at age 14+.

The Science Education Tracker data indicate a strong link between studying triple science and subsequent higher participation rates in science pathways. While this might on the surface suggest that there should be more compulsion to do triple science, this is likely to be a rather simplistic solution. What will matter at least as much as the structure of science provision is how interesting and engaging young people find the experiences they have in their science lessons. Within this, particular attention needs to be paid to young people with higher levels of science knowledge, who are the group most likely to have the opportunity to exercise personal preference and elect not to study triple science. Guidance and support need to be provided to ensure that such young people are not making this decision due to lack of confidence and a perception of lack of ability.

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Practical work

The data on practical work have provided a number of new insights. Practical work is one of the key factors stimulating young people's interest in science, but the groups who appear to benefit most from 'hands-on' experience – young people with low family science connections and from more deprived areas – are those least likely to have the opportunities to do practical work.

The nature of the practical work is also important, with suggestions in the data that practical research projects are motivating for young people. Linked to projects of this nature are extra-curricular activities, such as participating in science clubs and science fairs, which are again seen by many to be motivating but only available to limited numbers of young people.

Supporting schools to offer more practical work to students has resource implications. This is particularly the case for practical independent research projects, where teachers may need training and support if such experiences are to be offered to more young people. The impact of engaging in such experiences is an area that would benefit from more research.

Careers guidance and work experience

Too many young people receive no careers guidance at all, and many lack the networks to set up work experience for themselves. It is important to avoid simplistic solutions: although more careers education would clearly be helpful, it needs to be the right kind of careers education provided by the right kind of people. There is evidence that involving science teachers in careers guidance is likely to result in improved uptake after the age of 16, while more general advice to 'keep your options open' makes it less likely that young people will follow a science pathway (e.g., Bennett et al., 2013). Equally, work experience needs to provide the right kind of structured opportunities for young people to engage with the world of work. Many schools do not organise or require students to participate in work experience, and it is left to young people to organise this for themselves if they wish to do it. Crucially, those that do are likely to draw on family science connections to organise placements in science-related areas. Young people unable to make use of such connections are unlikely to be able to undertake science-related work experience without the support of schools. However, schools will need resource and support if they are to organise successful work experience.

Beyond the formal curriculum

Whilst informal engagement with science appears to be comparatively infrequent, where it does occur, there appears to be an association with increased interest in science. Crucially, such activities tend to be the preserve of young people with strong family science connections, so schools have an important role to play in providing opportunities for traditionally under-represented groups to participate in informal science activities.

There is a large programme of research work currently being undertaken to explore the effects of informal science and this will also be an important dimension for a future version of the Science Education Tracker to explore.[28]

[28] Science Learning+, funded by the National Science Foundation (NSF) in the United State, and the Wellcome Trust and the Economic and Social Research Council (ESRC) in the UK.

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Family science connections

The Science Education Tracker has provided a number of very valuable insights into what it has termed ‘family science connections’. Young people with strong family science connections are more likely to be interested in science, more likely to be encouraged to pursue their study of science, better placed to set up science-linked work experience placements, more likely to attend science-related events and more likely to pursue careers in science. While it is comparatively easy to identify the effects of family science connections, it is more challenging for schools and others to redress the balance. Having said this, it is of note that the recent PISA 2015 report commented that ‘The most immediate way to foster interest in science among students with less supportive home environments may be exposure to high quality science instruction in schools … Museums and science centres could be partners in this effort’ (OECD, 2016a).

The data on family science connections add to the evidence that is emerging from the ASPIRES project and the impact of ‘science capital’ (Archer et al., 2013). Work in this area is comparatively new, and the ASPIRES project has only recently begun to explore ways in which connections might be enhanced. The impact of such initiatives may be something a future version of the Science Education Tracker wishes to explore.

Individual differences: gender, ethnicity, socioeconomic status

The most prominent individual factor is gender, and the longevity and persistence of gender issues in science point to the difficulties in overcoming the obstacles to engagement and participation. Of course, gender issues do not exist independently of other societal issues and, despite many initiatives over several decades and some progress being made, society remains highly differentiated in relation to gender roles. This contributes to the persistence of gender issues in science. Factors such as the predominance of males in many scientific professions, particularly engineering-related professions, mean that many young females are likely to see careers in such areas as not for them. However, the variation of the impact of gender in different ethnic and socioeconomic groups suggests that gender differences are not inevitable.

Three areas seem particularly worthy of attention in relation to gender. First, confidence in ability to study science has emerged as a key theme in the Science Education Tracker, and this points to the desirability of building on the PISA work on self-efficacy to gain a clear picture of how this influences responses to science. Second, a large number of gender-focused initiatives and interventions have been undertaken over the last three decades, and there would be merit in synthesizing the findings of research into the effects of these interventions. It might also be that such a synthesis would point to areas of action worth exploring in relation to other under-represented groups. Finally, the data on gender differences in responses to computer science, coupled with the expected rapid growth of the subject as a compulsory component of the school curriculum, suggests that there is an urgent need to understand the drivers behind this emerging picture.

Socio-economic status is strongly associated with family science connections. Young people with strong family science connections are very likely to come from affluent backgrounds, and young people with low family science connections to come from more deprived areas. This plays out in a number of ways to the benefit of the former group and the disadvantage of the latter.

The Science Education Tracker has identified a number of ways in which ethnicity is associated with responses to science. The groups most engaged with science are Asian males, with Asian students most likely to report wanting to pursue science-related careers. The tracker suggests Asian and black students are also more likely to indicate interest in science careers, which is at

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variance with data from the ASPIRES project, so points to an area worth further exploration. A feature of ethnicity which is particularly apparent in the data concerns white students, who are the least likely group to aspire to higher education, particularly males, and white females most likely to report science lessons as uninteresting. Also of note is that gender differences in responses are most likely to exist for young white people. Providing young people from under-represented groups with a non-parental mentor has been shown to have a positive impact on engagement (Beng Huat See *et al.*, 2012). Although the work reported did not focus specifically on science, it does point to an avenue worth exploring in the context of science.

In summary, the Science Education Tracker provides a wealth of insights into the experiences of formal and informal science that shape young people's thinking and decision-making, and ultimately whether or not they pursue their study of science and science-related careers. It also points to possible areas of action, and informs the agenda for future research.

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Appendix B: Additional data tables

Figure B.1: Subject choices for Level 3 qualifications

Base: Years 12 / 13 studying for any Level 3 qualification

		Gender		Ethnicity			
	Total	**Male**	**Female**	**White**	**Mixed**	**Asian**	**Black**
	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Any Maths / Science subject	**62**	**66**	**57**	**60**	**64**	**71**	**71**
Maths / Further maths (including Statistics)	*32*	*40*	*25*	*31*	*40*	*42*	*27*
Biology	*20*	*16*	*23*	*18*	*16*	*26*	*27*
Chemistry	*17*	*19*	*16*	*15*	*13*	*30*	*19*
Psychology	*17*	*11*	*23*	*17*	*19*	*19*	*18*
Physics	*14*	*22*	*6*	*13*	*14*	*18*	*18*
Applied science/ Environmental science / Sports science / Science in society	*8*	*7*	*9*	*7*	*9*	*9*	*15*
Computer science	*7*	*12*	*2*	*7*	*7*	*8*	*3*
Electronics / Engineering	*4*	*8*	*1*	*5*	*1*	*3*	*5*
Geology	*2*	*2*	*1*	*1*	*4*	*2*	*0*
Unweighted base	*1,424*	*625*	*785*	*1,102*	*66*	*173*	*52*

Figure B.2: Expected subject choices for further study after Year 11

Base: Years 10 / 11, if not made final subject choices for Year 12

		Gender		Ethnicity			
	Total	**Male**	**Female**	**White**	**Mixed**	**Asian**	**Black**
	(%)	(%)	(%)	(%)	(%)	(%)	(%)
At least one Maths / Science subject							
Definitely	31	31	13	29	30	43	28
Likely	47	49	44	45	53	47	57
Maths							
Definitely	13	15	11	11	19	23	14
Likely	29	32	27	28	23	32	37
Biology							
Definitely	10	7	13	8	19	17	13
Likely	24	23	25	23	20	31	22
Chemistry							
Definitely	9	7	10	7	13	13	15
Likely	20	23	17	18	22	26	27
Physics							
Definitely	6	7	4	5	3	8	6
Likely	20	28	13	19	28	24	22
Computer science							
Definitely	4	7	0	4	0	4	2
Likely	12	20	4	12	17	11	16
Another science subject							
Definitely	10	9	12	10	10	10	12
Likely	33	35	31	30	46	41	40
Unweighted base	*1,206*	*579*	*621*	*899*	*59*	*143*	*61*

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Figure B.3: Subject choices for Level 3 qualifications by Key Stage 4 Science course

Base: Years 12 / 13 studying for Level 3 qualification, or Year 11 and already chosen subjects for Year 12

	Single science / Other course	Double science	Triple science
	(%)	(%)	(%)
Any science subject	45	54	80
Maths	19	19	50
Biology	6	15	34
Chemistry	6	8	32
Physics	4	6	26
Psychology	9	21	22
Computer science	7	6	8
Applied science	8	8	5
Electronics / Engineering	8	4	4
Geology	0	1	2
Another science subject	2	3	2
Don’t know	*1*	*0*	*1*
Unweighted base	*276*	*946*	*979*

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Figure B.4: Subject choice for higher education by gender and ethnicity

Base: All respondents considering studying for a higher education qualification

		Gender		Ethnicity			
	Total	**Male**	**Female**	**White**	**Mixed**	**Asian**	**Black**
	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Any Maths / Science subject	52	55	49	48	52	67	67
Health subjects other than Medicine / Dentistry (e.g. Nursing, Pharmacy, Sports science)	12	7	17	11	12	13	23
Biology	12	10	14	10	17	20	19
Maths (including Statistics)	11	15	8	9	14	18	16
Psychology	11	5	16	10	15	12	17
Engineering	10	18	4	9	9	15	16
Chemistry	9	9	8	7	10	16	11
Computer science	9	16	2	8	7	11	12
Medicine / Dentistry	8	5	10	6	8	16	17
Physics	6	10	3	6	4	8	7
Veterinary science	3	1	4	3	3	1	2
Environmental science	2	2	2	2	2	1	3
Any non-science subject	37	31	42	39	46	28	29
Don't know	18	20	17	20	11	13	13
Unweighted base	*3,486*	*1,567*	*1,897*	*2,658*	*164*	*410*	*163*

Appendix C: Multivariate analysis

Multivariate analysis was conducted to explore:

- interest in a career involving science, computer science, engineering or maths (Model 1);
- visits to science museums, science centres and planetariums (Model 2);
- agreement that careers using science are ‘suitable for someone like me’ (Model 3).

For each model, 12 variables were considered as potential predictors. Backward stepwise analysis was conducted excluding non-significant predictors until final models were established compromised solely of significant predictors.

Table C.1 summarises the variables tested as potential predictors in each of the models.

Table C.1: Potential predictors included in the multivariate analysis

Variable	Categories
Gender[29]	Male Female
Ethnicity[30]	White Mixed Asian Black Other
Academic year	Year 10 Year 11 Year 12 Year 13

[29] 35 respondents refused to give their gender. For the purpose of the multivariate analysis, gender was imputed at random for these 35 respondents.

[30] 74 respondents either didn’t know or refused to give their ethnicity. For the purpose of the multivariate analysis, ethnicity was imputed for these 74 respondents based on religion, region within England and rural / urban classification.

Table C.1: Potential predictors included in the multivariate analysis (cont.)	
Region	East Midlands East of England London North East North West South East South West West Midlands Yorkshire and the Humber
Rural / Urban classification	Urban conurbation Urban city and town Rural (town and fringe / village / hamlet)
Income Deprivation Affecting Children Index (IDACI)	Quintiles
Eligibility for free school meals[31]	Eligible in the last six years Not eligible in the last six years
Scientific literacy quiz	Low (0-5 correct answers) Medium (6-8 correct answers) High (9-10 correct answers)
Parental interest in science	Yes, both parents interested Yes, one parent interested No, neither parent interested / Don't know / Prefer not to say / Don't live with either parent
Family member with a science-related job	Yes, any family member No / Don't know / Prefer not to say
Whether parents went to university	Yes, at least one parent went to university Neither parent went to university / Don't know / Prefer not to say / Don't live with either parent

Details of each model are given below. For each variable, a reference category is selected and all other categories of that variable are then compared to the reference category. The odds ratio indicates the size of the effect in comparison to the reference category; for example, in Model 1, the first odds ratio of 4.021 indicates that the odds of a greater interest in a science-related career are about four times higher for those with a high quiz score than those with a low quiz score.

[31] Eligibility for free school meals was only available for respondents who agreed for their survey data to be linked to NPD data.

The β values are a measure of how strongly a predictor influences the dependent variable. Confidence intervals (CI) are given to describe the level of uncertainty around the odds ratios and β values; larger confidence intervals indicate a greater degree of uncertainty.

The 'Sig.' column in the tables below indicates the significance level between the reference category and the other category. A value below 0.05 is usually considered statistically significant. For example, in Model 1, a strongly significant difference is observed for interest in science-related careers between those with high science quiz scores and those with low quiz scores.

Model 1: Interest in a career involving science, computer science engineering or maths

Ordinal regression was used to investigate interest in a career involving science, computer science, engineering or maths. The dependent variable had the following values:

1. 'Very interested';
2. 'Fairly interested';
3. 'Not very interested';
4. 'Not at all interested'.

The final model had a Nagelkerke pseudo R^2 value[32] of 0.186. A summary of the model with the significant predictors is shown in Table C.2.

Figure C.2: Summary of Model 1 – Interest in a career involving science, computer science, engineering or maths

Variable and category		B	Std. error	95% CI Lower	95% CI Upper	Sig.	Odds ratio	95% CI Lower	95% CI Upper
Thresholds	*'Very interested'*	*-3.512*	*.136*	*-3.778*	*-3.246*	*.000*			
	'Fairly interested'	*-2.125*	*.129*	*-2.378*	*-1.871*	*.000*			
	'Not very interested'	*-.928*	*.125*	*-1.174*	*-.682*	*.000*			
Science quiz score	High score vs. low score	-1.391	.100	-1.587	-1.195	.000	4.021	3.305	4.891
	Medium score vs. low score	-.576	.079	-.731	-.421	.000	1.779	1.523	2.077
Ethnicity	Black vs. White	-.853	.159	-1.165	-.541	.000	2.346	1.718	3.205
	Asian vs. White	-.833	.102	-1.033	-.633	.000	2.299	1.883	2.808
	Mixed vs. White	-.191	.149	-.484	.102	.200	1.211	.903	1.622
	Other vs. White	-1.080	.313	-1.695	-.466	.001	2.945	1.593	5.444

[32] Nagelkerke's pseudo R^2 is an attempt to estimate the proportion of variability within the dependent variable which is explained by the model.

Figure C.2: Summary of Model 1 – Interest in a career involving science, computer science, engineering or maths (cont.)

Variable and category		B	Std. error	95% CI		Sig.	Odds ratio	95% CI	
				Lower	Upper			Lower	Upper
Gender	Male vs. Female	-.687	.063	-.811	-.563	.000	1.988	1.756	2.251
Academic year	Year 10 vs. Year 13	-.661	.087	-.831	-.491	.000	1.936	1.634	2.295
	Year 11 vs. Year 13	-.471	.091	-.649	-.293	.000	1.602	1.340	1.914
	Year 12 vs. Year 13	-.194	.097	-.384	-.004	.046	1.214	1.004	1.468
Parental interest in science	Both parents interested vs. None	-.659	.092	-.839	-.479	.000	1.932	1.615	2.313
	One parent interested vs. None	-.278	.074	-.424	-.133	.000	1.321	1.142	1.528
Region	East Midlands vs. South East	-.516	.125	-.762	-.270	.000	1.675	1.310	2.142
	West Midlands vs. South East	-.342	.125	-.586	-.098	.006	1.408	1.103	1.798
	Yorkshire and The Humber vs. South East	-.368	.126	-.615	-.121	.004	1.445	1.128	1.851
	North East vs. South East	-.310	.167	-.638	.017	.063	1.364	.983	1.892
	North West vs. South East	-.310	.124	-.553	-.067	.013	1.363	1.069	1.738
	East of England vs. South East	-.125	.115	-.350	.100	.276	1.133	.905	1.420
	London vs. South East	-.182	.122	-.421	.057	.135	1.200	.945	1.524
	South West vs. South East	-.199	.128	-.450	.052	.121	1.220	.949	1.568
Family member with a science-related job	Yes, any family member vs. No, no one	-.274	.066	-.403	-.144	.000	1.315	1.155	1.497

Model 2: Visits to science museums, science centres and planetariums in the last year

Logistic regression was used to investigate which young people had made visits to science attractions in the last year. As well as the variables considered in the other multivariate models, one additional variable was considered as a potential predictor:

Variable	Categories
Visited historical / cultural museum in the last year	Yes No / Don't know / Prefer not to say

This additional variable was included because of the hypothesis that likelihood to visit science attractions might be related to likelihood to visit cultural attractions.

The final model had a Nagelkerke pseudo R^2 value of 0.201. A summary of the model with the significant predictors is shown in Table C.3.

Figure C.3: Summary of Model 2 – Visits to science museums, science centres or planetariums in the last year

Variable and category		B	Std. error	95% CI		Sig.	Odds ratio	95% CI	
				Lower	Upper			Lower	Upper
Intercept		*-3.818*	*.316*	*-4.436*	*-3.199*	*.000*			
Visited historical / cultural museum in the last year	Yes, visited vs. No, not visited	1.537	.089	1.363	1.711	.000	4.650	3.909	5.532
Region	East Midlands vs. Yorkshire and The Humber	.239	.220	-.192	.670	.278	1.270	.825	1.954
	East of England vs. Yorkshire and The Humber	.441	.200	.049	.833	.028	1.554	1.050	2.300
	London vs. Yorkshire and The Humber	.946	.198	.558	1.334	.000	2.575	1.746	3.795
	North East vs. Yorkshire and The Humber	1.093	.244	.614	1.571	.000	2.983	1.848	4.813
	North West vs. Yorkshire and The Humber	.581	.193	.202	.960	.003	1.788	1.224	2.610

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Figure C.3: Summary of Model 2 – Visits to science museums, science centres or planetariums in the last year (cont.)

Variable and category		B	Std. error	95% CI Lower	95% CI Upper	Sig.	Odds ratio	95% CI Lower	95% CI Upper
Intercept		*-3.818*	*.316*	*-4.436*	*-3.199*	*.000*			
Region (cont.)	South East vs. Yorkshire and The Humber	.309	.188	-.059	.678	.100	1.362	.942	1.969
	South West vs. Yorkshire and The Humber	.431	.201	.037	.825	.032	1.539	1.038	2.283
	West Midlands vs. Yorkshire and The Humber	.115	.208	-.292	.523	.579	1.122	.747	1.687
Ethnicity	White vs. Black	.568	.259	.059	1.077	.029	1.765	1.061	2.935
	Mixed vs. Black	.528	.323	-.105	1.161	.102	1.696	.901	3.193
	Asian vs. Black	.941	.275	.401	1.481	.001	2.562	1.493	4.396
	Other vs. Black	.580	.546	-.490	1.650	.288	1.786	.612	5.208
Science quiz score	High score vs. low score	.777	.147	.490	1.065	.000	2.175	1.632	2.900
	Medium score vs. low score	.385	.131	.129	.640	.003	1.469	1.137	1.897
Parental interest in science	Both parents interested vs. None	.538	.113	.317	.759	.000	1.713	1.373	2.137
	One parent interested vs. None	.516	.103	.313	.719	.000	1.675	1.368	2.052
Gender	Male vs. Female	.276	.088	.103	.448	.002	1.318	1.109	1.566

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Model 3: Careers that use science are suitable for someone like me

Logistic regression was used to investigate which young people agree or strongly agree with the statement 'Careers that use science are suitable for someone like me'. The final model had a Nagelkerke pseudo R^2 value of 0.176. A summary of the model with the significant predictors is shown in Table C.4.

Figure C.4: Summary of Model 3 – Agree that careers using science are 'suitable for someone like me'

Variable and category		B	Std. error	95% CI Lower	95% CI Upper	Sig.	Odds ratio	95% CI Lower	95% CI Upper
Intercept		*-2.085*	*.110*	*-2.300*	*-1.869*	*.000*			
Science quiz score	High score vs. low score	1.814	.122	1.576	2.053	.000	6.138	4.833	7.794
	Medium score vs. low score	.772	.106	.564	.980	.000	2.164	1.758	2.664
Parental interest in science	Both parents interested vs. None	.961	.101	.763	1.160	.000	2.615	2.145	3.189
	One parent interested vs. None	.424	.087	.253	.595	.000	1.528	1.287	1.813
Ethnicity	Black vs. White	.507	.164	.186	.828	.002	1.660	1.204	2.289
	Asian vs. White	.470	.117	.241	.699	.000	1.600	1.273	2.013
	Mixed vs. White	.287	.173	-.053	.626	.098	1.332	.949	1.870
	Other vs. White	.791	.334	.136	1.446	.018	2.205	1.145	4.244
Gender	Male vs. Female	.335	.073	.192	.478	.000	1.398	1.212	1.612
Family member with a science-related job	Yes, any family member vs. No, no one	.214	.077	.064	.365	.005	1.239	1.066	1.440

Appendix D: Technical annex

This Appendix provides a summary of the methodology for the Science Education Tracker. Full methodological details are provided in the associated Technical Report.

Methodological summary

- The sample is a random sample of young people in school years 10 to 13 (aged 14-18) attending state-funded education in England. It was drawn from a combination of the National Pupil Database (NPD) and the Individualised Learner Record (ILR).
- All sampled individuals were sent a letter inviting them to take part in a survey; for young people aged under 16 correspondence was directed via parents. Respondents then completed the survey online.
- 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 drew on existing surveys such as the Wellcome Monitor, as well as newly developed questions for this survey. The questionnaire wording and content was also informed by focus groups with young people commissioned by Wellcome at the outset of the project. All new questions were cognitively tested with young people prior to administration.
- A field pilot of c. 200 online survey completions was conducted before the main survey to test and pilot survey procedures.
- Respondents were able to complete the survey on any online device, including PCs, laptops, tablets, and mobile phones.
- 4,081 respondents completed the survey between June 29th and August 31st 2016, representing a response rate of 50%[33]. Questions related to the current school year.
- 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 in order to maximise the representativeness of the sample. The achieved sample closely matched the population on a range of demographic variables.

Sample sources

The SET sample is a random sample of young people in school years 10 to 13 (aged 14-18) attending state schools in England. It was drawn from a combination of the NPD – which covers pupils in state schools, including school sixth forms – and the ILR – which covers young people in other education institutions such as sixth form colleges and further education colleges.

[33] Response rate is calculated as: 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).

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At the time the sample was selected, the latest data available were from the 2014/15 academic year. From these data, school years 9 to 12 were selected on the basis that these would make up the vast majority of the target population of Years 10 to 13 in the 2015/16 academic year. As a result, there is a very limited amount of non-coverage for pupils who had joined the state school system in Years 10 to 13 for the 2015/16 academic year. There is also limited non-coverage for young people not in any educational institution in the 2014/15 academic year. Pupils in independent schools were not included (these are not part of the NPD or ILR databases). Finally, a small number of young people (0.4% of those in the NPD or ILR) could not be included in the sample selection because they did not have a valid address in the sample frame.

Sample selection

A random probability sample was drawn from this combined NPD / ILR sample frame.

A systematic selection of young people was made separately within each academic year to ensure a spread of responses across years proportionate to the population. More cases were selected from Years 9 and 10 as the expected response rates were lower for these year groups due to the need to gain parental permission for respondents aged under 16.

In total, 8,125 young people were selected from the sample frame:

Table D.1: Sample selection within academic years

Academic year 2015 / 2016	Selected from 2014 / 2015 academic year	Available sample	Number selected
Year 10	Year 9	535,493	2,225
Year 11	Year 10	547,573	2,050
Year 12	Year 11	560,119	1,950
Year 13	Year 12	560,342	1,950

Prior to selection, the sample was sorted by the variables listed in Table D.2. This was to ensure a sufficient spread of responses across the categories within these variables so as to achieve a representative distribution of the survey sample.

Table D.2: Implicit stratification	
Variable	**Categories**
Gender	Male Female
Science performance at school	**Years 10 / 11 – Key Stage 2 teacher assessed science Level:** • Level 3 or under • Level 4 • Level 5 **Years 12 / 13 – Key Stage 4 science results:** • Two or more science GCSEs (or equivalent) at A*-B • Two or more science GCSEs (or equivalent) at A*-C, but not A*-B • Not have two science GCSEs (or equivalent) at A*-C
Overall performance at school	**Years 10 / 11:** Key Stage 2 total number of points **Years 12 / 13:** Key Stage 4 total GCSE and equivalents new style point score
Region	Nine former GOR regions
Income Deprivation Affecting Children Index (IDACI)	IDACI score (0-1)
Establishment type	Un-banded version provided in the NPD at the school level

Questionnaire development

The questionnaire and other aspects of the fieldwork were developed over several stages during the period February to May 2016:

- Wellcome commissioned focus groups with young people to scope out potential topic coverage and areas of interest.
- Elements of the first draft of the questionnaire were tested with young people across all relevant year groups using cognitive testing techniques. Two rounds were conducted and the questions were modified as a result.
- A usability testing stage was conducted to ensure that the questionnaire worked well across different online devices, including laptops, tablets and mobiles. This phase was also used to finalise question wording, and to test fieldwork documentation and branding.

- A larger scale pilot was conducted to provide a more robust assessment of the questionnaire, fieldwork procedures and average survey length. Around 200 online survey completions were achieved. As NPD data were not available in time for the pilot, the sample was selected from a ‘lifestyle database’ provider.

Fieldwork

The survey fieldwork was conducted from June 29th to August 31st. This period was chosen as it falls after the exam period and before the start of the new academic year.

For all selected young people, two weeks before the start of fieldwork ***pre-notification letters*** were sent to both the young people and their parents informing them that they had been selected for the survey and that in the next couple of weeks they would receive further information about how to access it online. Contact details for Kantar Public were provided for any young people (or their parents) who wished to ask questions about the study or opt out of the survey.

At the start of the fieldwork period, ***survey launch letters*** were sent, including details about how to complete the survey online. Each young person was given a unique login, which was included in this letter. For young people under the age of 16, the survey launch letters were sent to their parent, rather than directly to the young person. Parents were asked to hand the letter on to the named young person if they were willing for them to take part in the survey. In this way, parents could refuse consent for their child to take part.

During the fieldwork period, ***reminder letters*** were sent to young people who had not yet completed the survey. Rather than sending these reminders to all non-responders, reminders were focused on groups with lower levels of response. This was done so as to achieve a more balanced sample by equalising differential response between groups.

Each reminder letter included details for the young person to log in to the survey and how to complete it online. As with the survey launch letter, all reminder letters for sampled individuals aged under 16 were addressed to the parent rather than the young person. The second reminder consisted of a postcard, reminding young people (or their parents) about the study, followed by a letter a couple of days later. This intention was that the postcard would be more distinctive and as a result be more effective in cases where the original letters had not been opened.

The dates of mailings are given in Table D.3.

Table D.3: Mailings schedule			
Stage	**Number sent**	**Total no. of nonresponders**	**Date**
Pre-notification letters	8,125	-	June 16th
START OF FIELDWORK			
Survey launch letters	8,125	-	June 29th
First targeted reminder letter	2,990	5,296	July 13th
Targeted reminder postcard	1,478	4,530	July 26th
Second targeted reminder letter	1,478	4,530	July 28th
Third targeted reminder letter	844	4,215	August 10th
END OF FIELDWORK			

Incentives

Sample members were offered a £10 shopping voucher, which could be claimed after they had completed the survey. This £10 incentive was mentioned in all of the letters sent to young people and their parents to encourage them to take part in the survey. When they had completed the online questionnaire, respondents were directed to an online portal at which they could choose from a range of vouchers for stores including Amazon, iTunes, River Island and Boots.

Response rates and weighting

4,081 young people completed the survey, a response rate of 50%.[34]

Response rates varied between different groups and non-response weights were calculated to account for this. Data were weighted to the strata used at the sample selection stage to bring the data in line with the total population of young people. Although the sampling fraction varied for each academic year, a design weight was not required as academic year was controlled for within the non-response weighting. The weighting had a modest effect on the precision of estimates; the overall design effect due to weighting was 1.09.

After the weighting was applied, the distributions of demographic variables were compared with the population totals. It was agreed that no further weighting was required as the profile of the weighted sample was a good match for the population profile. Table D.4 gives the unweighted and weighted sample profiles, as well as the population profile.

[34] Response rate is calculated as: 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).

Table D.4: Sample profile			
	Achieved SET sample		Population[35]
	Unweighted % of total	Weighted % of total	% of total
Academic year			
Year 10	*27.9%*	*24.4%*	*24.4%*
Year 11	*26.7%*	*24.9%*	*24.9%*
Year 12	*23.0%*	*25.3%*	*25.3%*
Year 13	*22.4%*	*25.3%*	*25.3%*
Gender			
Male	*47.8%*	*51.1%*	*51.1%*
Female	*52.2%*	*48.9%*	*48.9%*
Overall academic performance			
Low	*18.2%*	*23.8%*	*23.8%*
Medium	*52.1%*	*51.5%*	*51.5%*
High	*29.7%*	*24.7%*	*24.7%*
Ethnicity*			
White	*77.6%*	*76.9%*	*76.3%*
Mixed	*4.4%*	*4.5%*	*4.7%*
Asian	*10.4%*	*10.7%*	*10.3%*
Black	*4.2%*	*4.3%*	*5.5%*
Chinese	*0.5%*	*0.5%*	*0.4%*
Other	*1.1%*	*1.1%*	*1.6%*
Unclassified	*1.8%*	*2.0%*	*1.2%*

[35] Population proportions are from the sample frame, with the exception of Ethnicity. The figures for ethnicity are taken from the 2016 School Census, for all students at state-funded secondary schools.

Table D.4: Sample profile (cont.)			
	Achieved SET sample	**Population**	**Achieved SET sample**
Region	**Unweighted % of total**	**Weighted % of total**	**Unweighted % of total**
East Midlands	*9.1%*	*8.9%*	*8.8%*
East of England	*12.1%*	*11.8%*	*11.3%*
London	*13.5%*	*13.7%*	*14.4%*
North East	*4.8%*	*5.0%*	*4.8%*
North West	*13.3%*	*13.8%*	*13.7%*
South East	*17.0%*	*16.8%*	*15.8%*
South West	*9.8%*	*9.5%*	*9.6%*
West Midlands	*10.7%*	*10.7%*	*11.1%*
Yorkshire and The Humber	*9.6%*	*9.8%*	*10.2%*
Unclassified	*0.1%*	*0.1%*	*0.1%*
IDACI (decile)			
1 (most deprived)	*10.1%*	*11.2%*	*9.8%*
2	*10.0%*	*10.8%*	*9.8%*
3	*9.8%*	*10.7%*	*9.8%*
4	*9.2%*	*9.5%*	*9.8%*
5	*9.6%*	*9.7%*	*9.8%*
6	*10.2%*	*9.9%*	*9.8%*
7	*10.5%*	*9.8%*	*9.8%*
8	*9.1%*	*8.4%*	*9.8%*
9	*9.9%*	*9.5%*	*9.8%*
10 (least deprived)	*11.5%*	*10.3%*	*9.8%*
Unclassified	*0.1%*	*0.1%*	*1.7%*

Science knowledge quiz

Respondents were asked a series of ten true / false questions relating to knowledge of different areas of science such as genetic modification, cloning and DNA. 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 were '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:

- Low: 0-5 correct answers (23% of respondents)
- Medium: 6-8 correct answers (57% of respondents)
- High: 9-10 correct answers (20% of respondents)

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 for NPD data to 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 NPD were considered as measures of science attainment:

- **Overall Key Stage 4 science score:** Scores range from 0 (indicating no science qualifications at Key Stage 4) to 174 (equivalent to three A*s in science at GCSE)
- **Highest category of Key Stage 4 science GCSE or equivalent achievement** : This is divided into three categories, as follows:
  1. i. Achieved two science GCSEs or equivalent at A*-B
  2. ii. Achieved two science GCSEs or equivalent at A*-C (but not at A*-B)
  3. 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: 0.499 with the overall Key Stage 4 science score and -0.411 with the highest category of Key Stage 4 or equivalent achievement.

A number of alternative scoring methods were also considered including negatively scoring of incorrect answers and giving additional credit for 'definitely correct' answers over 'probably correct'. The correlations with achieved Key Stage 4 results were broadly similar to the scoring method described above. We decided to use the scoring method described above as this was also the method used to score the similar science knowledge quiz on the Wellcome Monitor.

It was not possible to use NPD data as the primary measure of science attainment for two main reasons. First, 17% 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 were no recent science attainment data available for young people in Years 10 or 11 as they had not yet completed their Key Stage 4 exams.

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Appendix E: Glossary

Glossary of terms and acronyms	
BME	Black and Minority ethnic. This is used to refer to all ethnic groups other than White
Double science	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 section 1.1 for further details.
FSM	Pupils' eligibility for free school meals – used as an indicator of deprivation
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 Skills Funding Agency
Informal science learning	The learning of science in informal settings outside 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 GSCE and similar exams, typically school years 10 and 11 when young people are usually aged between 14 and 16
Level 3	Refers to educational level after the end of compulsory education. Students are usually aged between 16 and 18 – incorporates AS and A levels and other equivalent academic or vocational qualifications

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NPD	National Pupil Database. A database about pupils in schools and colleges in England, maintained by the Department for Education
Single science	Sometimes referred to as Core science. A GCSE science course worth a single GCSE, covering Biology, Chemistry and Physics.
STEM	Science, technology, engineering & mathematics
Triple science	GCSE science course worth three GCSEs. This may involve studying biology, chemistry and physics as separate GCSE subjects or studying Core, Additional and Further Additional Science GCSEs

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