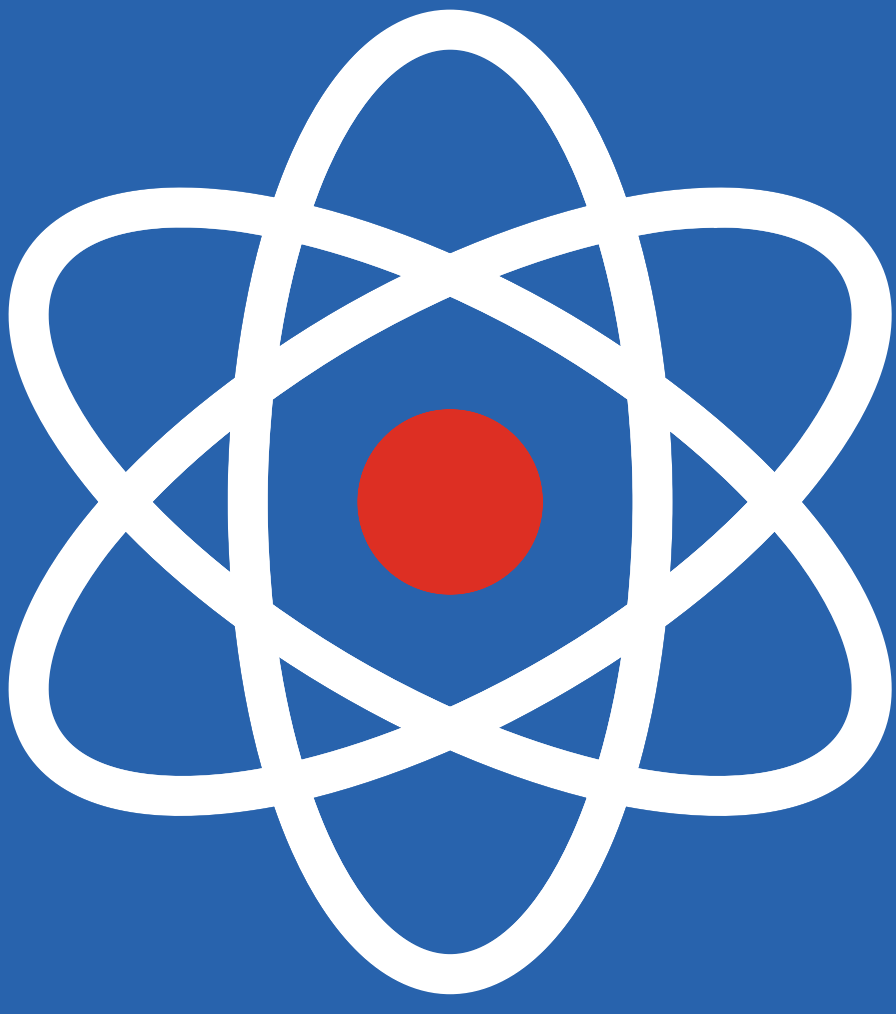
ASPIRES 3

Young People's STEM Trajectories, Age 10-22

PHYSICS



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Executive Summary

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

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

Key Findings

Who studies physics at advanced and degree level in England?

Analyses of HESA and National Statistics data show that:

- Participation in A level physics has remained consistently lower than in biology, chemistry and mathematics, although participation has increased in more recent years, reaching its highest level in 25 years in 2025[1], when 5.1% of the A level 2024/5 cohort took physics, compared with 7.2% chemistry, 8.1% biology and 12.7% mathematics[2]. Post-16 physics remains heavily male-dominated, with only 24.1% of the 2024/5 cohort identified as female. This marks a slight increase from previous years, with more than 10,000 girls opting for physics for the second year running. However, physics continues to have the second lowest female participation rate among core STEM subjects, after computing.

- Participation in physics continues to decline from A level to university, with just over 1% of undergraduates pursuing a physics degree. This figure is comparatively smaller than other STEM disciplines, including mathematics (c.2%), computing (4%) and engineering, at around 5%.

- Participation in physics degrees remains heavily male-dominated. For example, in 2020/21 in England, just 24.4% of physics students were women. This proportion is lower than in all other STEM subjects, with the exception of engineering and computing.

- The profile of who takes physics at degree level is also weighted towards those from more socially privileged communities. For example, 2020/21 figures show that physics records a higher proportion of first year students who identify as white (76.6%) compared with other STEM subjects. It also has a lower proportion of students coming from the most socio-economically deprived areas (10.4%) compared with other STEM subjects and the highest proportion of students from the least deprived areas (30.9%).

- However, on average, physics degrees record the lowest non-completion rates compared with other STEM subjects, with just 4.2% of students not completing their courses – a figure that is half that found in computing.

What are young people's aspirations and experiences in physics?

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

- From Year 9-13 (age 13-18), aspirations to take physics post-16 were consistently lower than those for biology, chemistry and maths. For instance, in Year 9, only 26.8% of students aspired to continue with physics post-16, whereas 32.7% of students aspired to take chemistry, 35.1% biology and 49.6% maths.

- Over time, the profile of those aspiring to take physics became more male dominated (e.g. whereas in Year 9, 44% of those aspiring to study physics A level were female, in Year 13, just 29% of A level physics students were young women). This trend did not appear in relation to maths, chemistry or biology.

- 43.1% of A level physics students identified enjoyment/interest as the 'most important' reason for their subject choice – although this was also the case for students who took other sciences. There were generally few demographic trends associated with the reasons given for subject choices, although basing subject choices on 'interest/ enjoyment' was slightly more associated with class and ethnic privilege (i.e. having high cultural capital and being white).

- Overall, students cited lack of interest as the primary reason for *not* choosing to pursue the sciences at A level. There were few demographic differences in reasons for not choosing subjects. However, those who identified as women were more likely than men to cite subject difficulty as their reason for not choosing physics.

- From Year 9 to Year 11, biology was consistently seen as the most interesting of the three sciences and was the discipline that students felt that they performed best in. In contrast, physics consistently recorded the lowest interest ratings and was seen as the most difficult science. However there were strong gendered trends within these figures, with male students being more likely to say that they find chemistry and physics interesting and perform well in these subjects, whereas female students identified biology as the most interesting science and the subject that they do best in – and named chemistry and physics as difficult.

- Overall, physics degree students were not that positive about their courses. Generally, chemistry, biology and engineering students expressed more positive views about the interest, usefulness and teaching staff on their courses compared with physics, computing and maths students. However, overall, STEM student satisfaction was low, as less than half of students found their degrees interesting[3].

What are the factors shaping young people's physics trajectories?

- Across all science subjects, students explained their interest in a subject as mediated by how "hard"/ "difficult"/ "confusing" they found it. Across the sciences, physics was most often associated with difficulty and was least often associated with the feeling of being good at the subject.

- The difficulty of physics was frequently described as hard to articulate but was often associated with the experience of receiving generally lower grades in physics compared with biology and chemistry. Some students (including those with both high and low attainment and/or interest) found physics difficult due to its mathematical and/or abstract content and the perceived difficulty of physics was strongly mediated by identity and the sense of personal 'fit', or not, with the subject, encapsulated in the notion of being 'suited' (or not) to the subject.

- While students saw all three sciences as being useful and important and could name a range of jobs associated with each discipline, generally, young people found it easier to identify jobs relating to biology, compared with chemistry and physics. Notably, however, what shaped a student's perception of whether a given science was useful and relevant to them personally changed over time and was shaped by interactions of identity, capital and field. For instance, personal experiences, the views of significant others and changing attainment all impacted young people's perceptions of subject utility and relevance.

- Between Year 11 and Year 13, students reported more favourable experiences of teaching and learning in biology compared with physics and chemistry. However, most A level students reported positive experiences. Around 40% of Year 11 students agreed that their various science teachers thought that they are good at the respective subject. However, more male than female students agreed in each case, a trend that was most notable in physics (47% male versus 34% female students agreed).

- In the open-ended survey responses and interviews there were a range of positive and negative views expressed about biology, chemistry and physics teachers. Overall, more positive than negative views were expressed about biology and chemistry teachers whereas in physics, a higher number of negative comments were noted.

- Irrespective of science discipline, students largely expressed similar views about the importance and impact of 'good' vs. 'bad' teachers on their science engagement, with 'good' teachers being associated with positive attainment, good understanding, high interest and engagement – and the reverse being true of 'bad' teachers.

- Students cited the negative impact of high science teacher turnover on their engagement, learning and outcomes in relation to all three sciences, but this issue was noted most often in relation to physics.

- Physics students (and those aspiring to physics) expressed more stereotypical views of scientists compared to their peers, being significantly more likely to agree that scientists are "brainy", "odd", "geeky" and "male".

Recommendations

This report makes five key summary recommendations for policy and practice. Full recommendations are provided at the end of the report.

1. Address imbalances in school physics policy

- Champion the importance of early secondary physics (e.g. Key Stage 3) and focus more attention on improving the quality and consistency of both provision and engagement;
- Bring physics A level entry requirements into line with other subjects;
- Address grade severity in A level physics;
- Reduce 'jumps' in the complexity of physics content between educational stages and phases (e.g. KS3 to GCSE; GCSE to A level; A level to degree level);
- Address the impact of Double/Triple Science GCSE qualification routes on STEM progression.

2. Prepare and support teachers of physics

- Government to take steps to improve the recruitment, retention and retraining of physics teachers, as per the IOP (2025) recommendations and to increase funding and advocate for all science teachers to receive ongoing, high quality professional development in both subject specific and equity areas[4].
- School leaders to foster an institutional culture/ethos that supports and encourages teacher communities of practice and access and engagement in relevant professional development, and to strategically support leadership development for physics teachers.

3. Develop and embed more equitable school physics practice

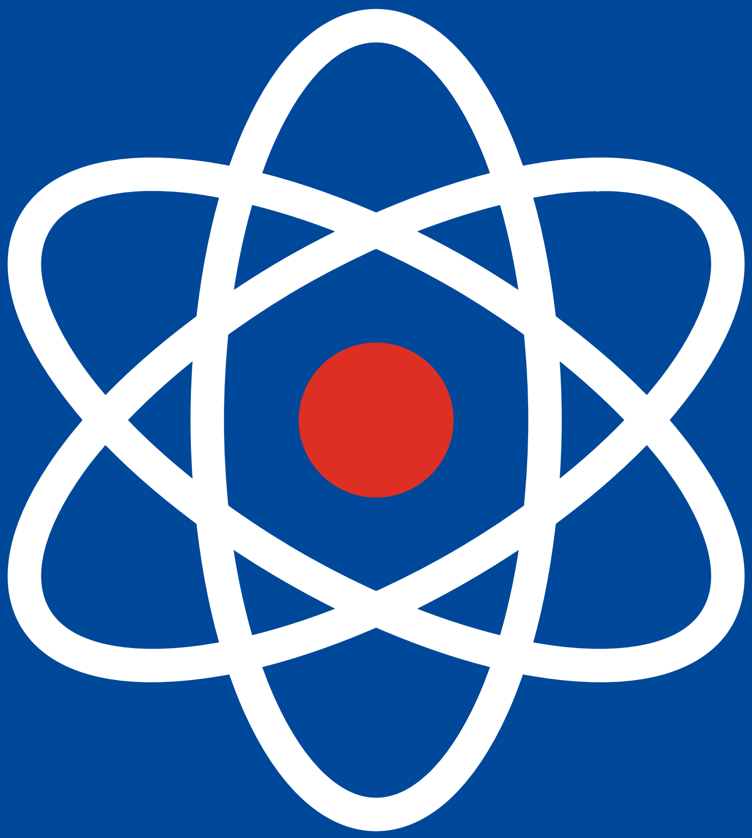
- Government to reduce the volume of content in the curriculum to allow teachers and students more space to build subject understanding, engagement and enjoyment and introduce equity as a core strand in the Early Career Framework.
- Government, school leaders and STEM education organisations to champion equity-based teaching approaches[5] and resources and advocate for the importance of critical reflective practice in teaching[6]. They should also ensure that all science teachers, including physics teachers, have access to ongoing, high-quality subject – and equity-relevant – professional development to support equitable practice.

4. Strengthen school careers support in physics

- Careers education, information, advice and guidance (CEIAG) professionals, providers and lead teachers to continue to strengthen physics-specific careers support, work experience/ engagement opportunities and key messaging around the transferability of physics.
- School leaders to support physics teachers to understand and appreciate their valuable role as trusted sources for students; embed the value of physics for life, work and active citizenship within everyday curriculum teaching; and develop physics-specific responses to the Gatsby benchmarks.

5. Improve experiences, equity and belonging in physics

- HE departments and professional societies to champion and embed a culture of equity, inclusion and allyship[7] with the expectation that all physics staff and students have a duty to proactively support others (but particularly those from under-represented communities) to feel included and a sense of belonging ('rightful presence') in physics.
- HE physics departments to review and strategically connect physics education research that is located within physics departments with wider science educational research and ensure that practice is informed by STEM equity research insights.



Introduction

Despite years of initiatives that have sought to improve participation in physics, the profile of those taking physics at A level[8] and degree level[9] remains disproportionately dominated by men and those from more affluent socioeconomic groups, reflecting persistent inequalities. Physics education faces a number of challenges, including a long-standing shortage of subject specialist teachers, and a relatively low overall uptake of students at A level and degree level, compared with chemistry, biology and mathematics, although it was the second most popular A level choice among boys in 2024[10]. Attention has also been drawn to the ongoing association of physics with masculinity[11] and issues such as grade severity in marking at A level[12].

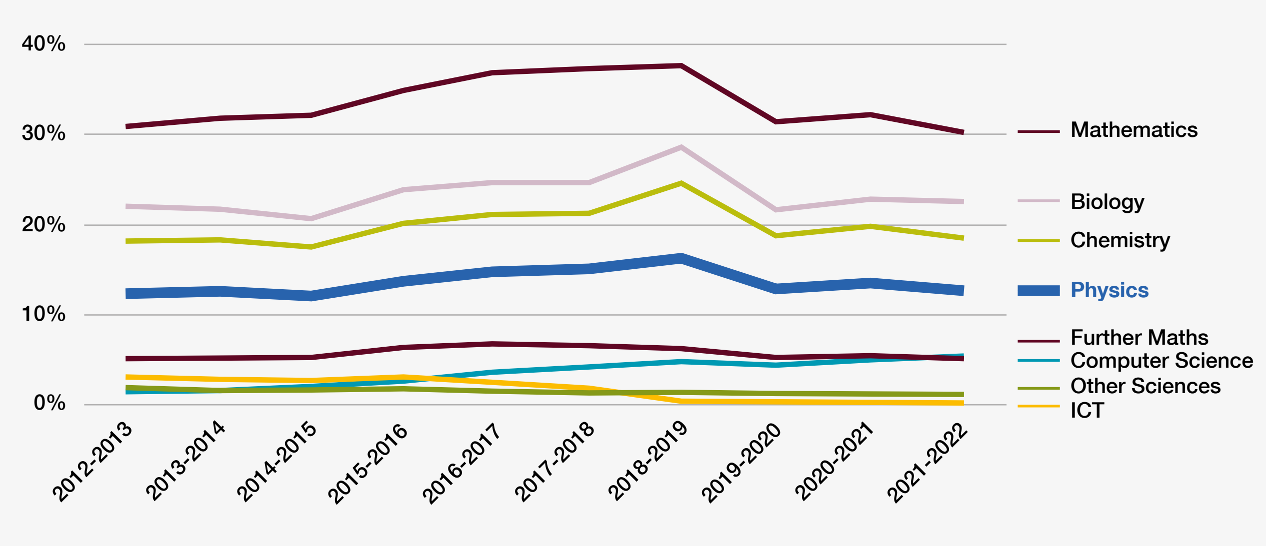
This report presents new analyses of the ASPIRES longitudinal data set that seek to shed light on the factors that shape young people's physics aspirations and trajectories. It makes recommendations for policy and practice on how to support increased and widened participation in school and post-16 physics.

1. What are the patterns in participation in physics from GCSE to degree level?

Declines in participation in physics from GCSE to university

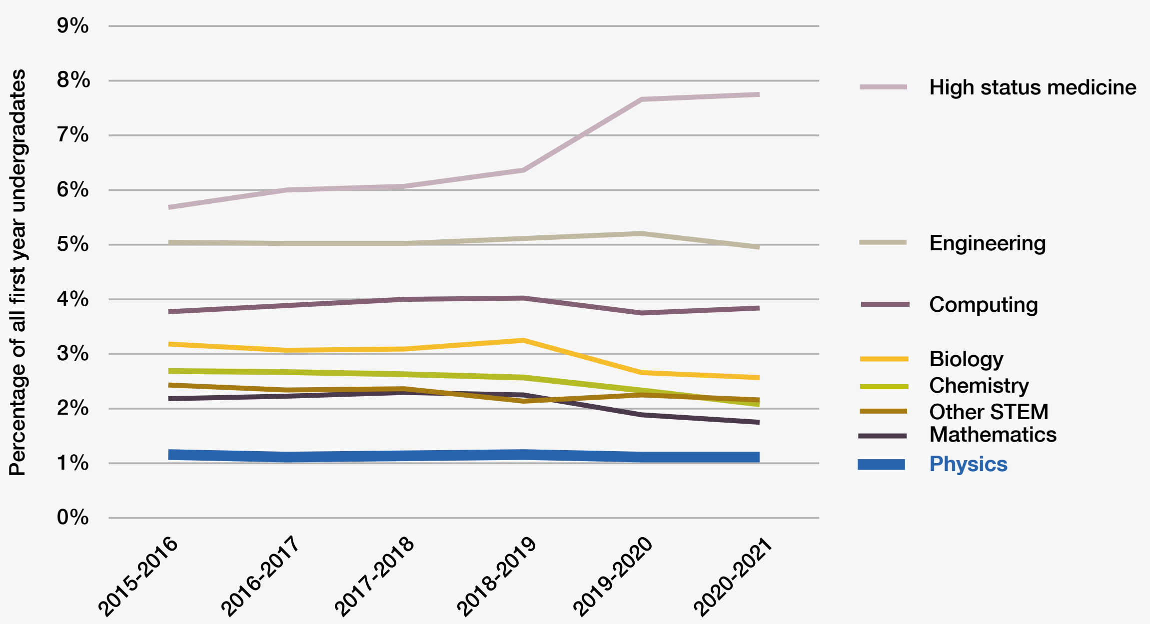
Around 25% of students at GSCE level take 'triple' science, which is strongly associated with progression to study physics at A level[13]. Taking this figure as a baseline, it seems that participation in physics drops by just over half from GCSE to A level, which is a more marked decline than found for chemistry and biology. As seen in Figure 1, participation in A level physics has remained close to 12.5% over a 10-year period, noticeably lower than chemistry and biology.

Figure 1: STEM A level entries as a percentage of young people who sat at least one A level



Participation in physics continues to decline from A level to university, with just over 1% of undergraduates pursuing a physics degree. Moreover, as seen in Figure 2, the proportion of first year undergraduate students pursuing a physics degree (1.1%) is much smaller than all other STEM disciplines, including mathematics (around 2%), computing (4%) and engineering, at around 5%. This is especially noteworthy because participation in A level physics is higher than in A level computing (and an A level in engineering was not available).

Figure 2: Participation in STEM disciplines at undergraduate level from 2015/16 to 2020/21



Despite this marked decline in participation from A level to university, the decline is actually even steeper for other subjects, with maths dropping from around 30% at A level to just under 2% at university, chemistry from 20% to just over 2% and biology from 23% to 2.5% at university. Thus, the biggest drop for physics is from GCSE to A level, rather than from A level to university. There may be a range of possible reasons for this reduction – for instance, it is possible that the popularity of medicine and healthcare pathways post-18 may bolster participation in biology and chemistry at A level.

Moreover, the drop may be considered concerning for the physics community given the high proportion of students pursuing maths A level and, especially, computing and engineering degrees at university, suggesting that students may be choosing university subjects which more clearly lead to jobs or that have a more apparently practical focus, compared with the comparatively seemingly abstract nature of physics study.

Trends in who takes physics

While overall, participation in physics at GCSE and A level may currently be improving[14] and remains proportionally higher than found at degree level[15], there are key concerns about the uneven demographic profile of *who* takes physics at each educational level, with participation being particularly low among young women, and further stratified by ethnicity and socioeconomic background. These trends are discussed next.

Participation by gender

Looking at gender, entries into the 2024 GCSE physics exam were nearly evenly split, with 48.5% of entries being female students, although this is to be expected, given that all students taking both double and triple award must study all three sciences at GCSE. In contrast, at A level, when physics is no longer compulsory, figures show that only 22.9% of students are female (See Figure 3), a sharper decline than found in all other STEM subjects except for computer science (15.1% female).

Figure 3: Percentage of male and female students making up each STEM A level cohort in 2021/22

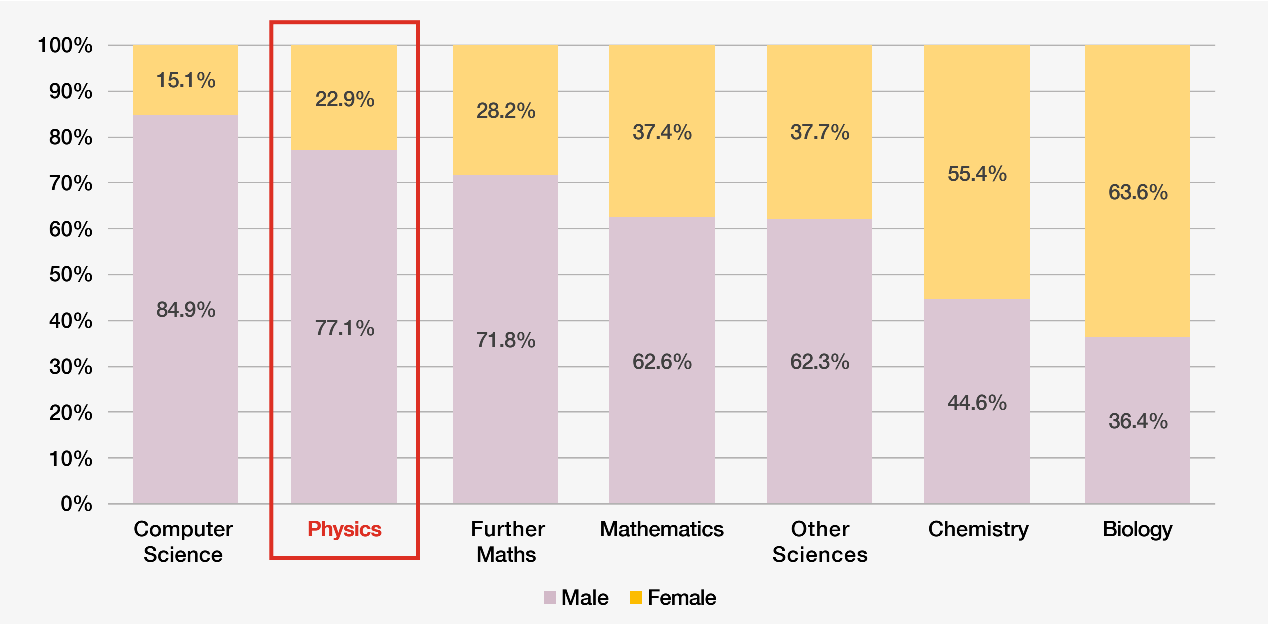


Figure 4 shows that the underrepresentation of women continues at university level, where women constitute around one quarter (24.4%) of physics students. This proportion is lower than in all other STEM subjects, with the exception of engineering and computing. Extensive research suggests that low rates of participation by women in post-compulsory physics reflect the 'chilly'[16] gender climate for women [17].

In particular, attention has been drawn to how even women and girls who are highly competent at physics are regularly made to feel that they do not 'fit' the widespread stereotype of the 'exceptionally clever' physicist[18].

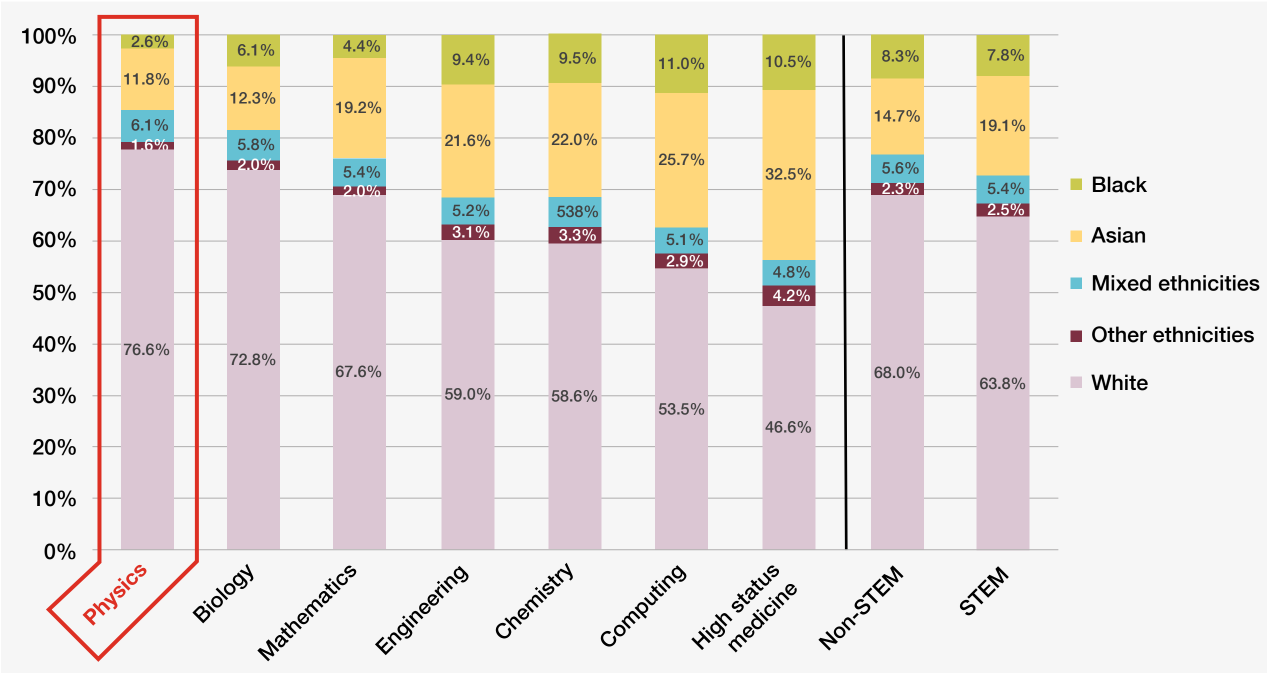
Figure 4: Breakdown by gender of first-year undergraduates in England 2020/21

Participation by ethnicity

Participation in physics is marked by ethnicity, though the picture is somewhat more complex than for gender. A level physics is taken by fewer than 9% of any Black ethnic group (8.4% of Black African A level students, 4.4% of Black Caribbean, 6.1% of Other Black), a proportion that is lower than other ethnic groups, with the exception of those reported as Pakistani (7.6%). However, this contrast is most striking compared with other ethnic minority groups, such as Chinese, where 23% of those at A level study physics, and Indian (16.5%), rather than with White British students, of whom 9.2% study physics at A level.

Figure 5 reflects that this pattern continues into university, where Black students are only 2.6% of those studying physics degrees, a lower proportion than any other STEM subject. Additionally, the proportion of physics students who are from an Asian background is also lower than any other STEM subject (11.8%). Conversely, the proportion of first year students who are white (76.6%) is higher than that of any other STEM subject.

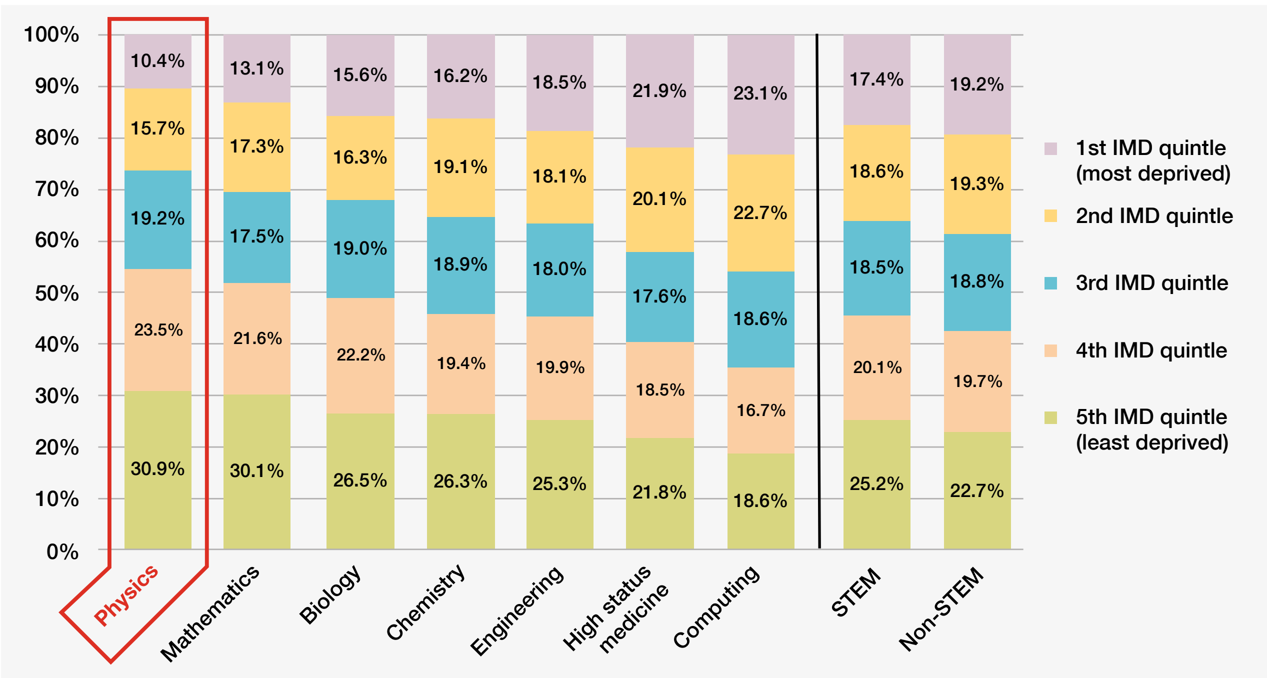
Figure 5: Breakdown by race/ethnicity of first-year undergraduates in England 2020/21



Participation by IMD

At A level, 2.7% of students from the most deprived IMD (Indices of Multiple Deprivation) quintile study physics, compared with 8.1% of those from the least deprived quintile. Put differently, students are about three times more likely to be from the least deprived quintile than from the most deprived. This pattern extends into university level study, where the proportion of first year students coming from the most deprived IMD quintile (10.4%) is the smallest of any STEM subject, and the proportion from the least deprived quintile (30.9%) is the highest.

Figure 6: Breakdown by IMD quintile of first-year undergraduates in England 2020/21



The picture is further complicated when considering retention rates in undergraduate physics. HESA data analysis shows variable non-completion rates among first-year STEM undergraduates in England. On average (across several years) **lowest non-completion rates** were in physics (4.2%), chemistry (4.4%) and maths (4.8%), and highest in computing (9.4%). This suggests that once individuals start a physics degree, they are (relatively) likely to complete it. But this may be because it is a 'welcoming' environment for the individuals from privileged backgrounds who join the courses in the first place. In other words, while current courses could be considered 'successful' in retaining students, this may be more because they are a match for the privileged, rather than because they would be a positive experience for anyone, regardless of background. Thus, we argue that increasing diversity among staff and students in physics at university – or any level – is not simply a matter of encouraging more diverse individuals to apply; the environment needs to change to become a place where such students would feel welcome and supported.

2. Prior research base and conceptual approach

Prior research on physics engagement identifies a range of factors that shape participation in physics. These include the association of physics with masculinity, specifically, 'geeky' forms of masculinity and 'cleverness'[19], gendered teaching and learning practices[20], attitudes to physics[21] and the role of science/ physics identity and capital[22].

The ASPIRES project is informed by sociological and educational research that shows how interactions of identity and capital (social and cultural resources) shape young people's pathways through schooling and into further and higher education, and employment[23]. Young people can accrue capital from home, family, and other educational contexts[24]. In the ASPIRES research, we explore how physics-related capital, through interaction with physics identity and the field of physics education, is translated into resources and practices that help either produce and sustain (or conversely, exclude and restrict) young people's interest, attainment and aspirations in physics. Interactions of identity and capital are key to producing and sustaining physics aspirations and trajectories and where there is close alignment between physics related identity, resources and the field of physics, young people are more likely to feel competent and interested in physics, and so are more likely to choose to continue with the subject. Importantly, we also argue that the strongly gendered nature of the field of physics (permeating across individual attitudes, interpersonal relations, curricula, pedagogy, institutional structures, cultures and practices, and wider representations) entails particular challenges for women's participation and the extent to which women experience physics as fitting, or not, with their ways of being and sense of what is normal, possible and desirable 'for people like me'.

3. The ASPIRES data set

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

Table 1 summarises the quantitative and qualitative data collected at each stage of the research.

Table 1: Summary of ASPIRES project data collection

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

The ASPIRES3 survey comprised a large-scale postal survey of young people in England and was conducted by obtaining a sample of young people born between 1st September 1998 and 31st August 1999 who were registered on the Open Electoral Roll. Following data cleaning, the overall achieved sample of 7,635 young people was roughly proportional to (though not fully representative of) official government population estimates in England for 21- and 22-year-olds based on sex, ethnicity, region, Index of Multiple Deprivation, Urban/Rural classification and long lasting health conditions. The postal survey sample of 7,635 young people included 3,388 current and/or recently completed degree students, of whom 35 were or had been physics degree students (16 were current students at the time of survey completion). Among these young people, the demographic breakdown is:

- Gender: 11 women, 23 men, 1 other;
- Ethnicity: 28 White, 1 Black, 2 Asian, 4 other;
- Social class: 15 IMD 1&2, 7 IMD 3, 13 IMD 4&5; a higher proportion had a parent who had attended university (20 of 35) than for STEM overall.

4. Patterns in physics aspirations

The ASPIRES surveys asked students about their future study plans. Analysis of the survey data over time showed that from Year 9-13 (age 13-18), **aspirations to take physics post-16 were consistently lower than for biology, chemistry and maths** (Table 2). For instance, in Year 9, only 26.8% of students aspired to continue with physics post-16, whereas 32.7% of students aspired to take chemistry, 35.1% biology and 49.6% maths.

Table 2: Students' A level aspirations and choices

	Biology	Chemistry	Physics	Maths
Year 9	35.1%	32.7%	**26.8%**	49.6%
Year 11 (asked of those planning to do A levels)	36.5%	29.5%	**23.3%**	43.5%
Year 13 (% out of those taking A levels in our sample)	26.0%	21.3%	**14.5%**	Maths & stats: 23.5%; Pure maths: 11.3%; Further maths: 7.3%

Note: *In Years 9 & 11 students were asked if they planned to pursue A levels and were then able to select as many subjects as they wished. The table reflects the proportion of A level students taking science subjects and maths.*

There is a notable drop off across the board between the percentage of students who aspired to take an A level in a given subject in Y11, compared with the actual proportion who went on to study the subject at A level in Y13 (e.g. 23% of students in Y11 aspired to take physics A level, vs. 14% of students in Y13 taking the subject).

When aspirations were examined by student demographics, it was found that the **gender** identity profile of those aspiring to/taking biology A level became increasingly female (60% of those aspiring to biology in Y9 were female, while 71% of those taking A level biology were female) whereas for physics, the profile became more male (44% female aspiring to physics in Year 9, 29% female A level physics students). This trend was particularly notable given that in Y9, aspirations to continue with physics were relatively gender balanced. In chemistry and maths, the gender profile remained generally evenly weighted.

When looking at trends by **ethnicity** over time, physics, maths and biology all recorded an increase in the proportion of white students aspiring to/taking the subject – although white students were proportionally underrepresented among those aspiring to these subjects in Years 9 and 11. In contrast, Black and Asian students were slightly overrepresented among those aspiring to physics and other sciences in Year 9. However, Black students' aspirations and participation declined proportionally over time, whereas Asian students were overrepresented among those taking science and maths subjects at A level.

In terms of **cultural capital** (as a proxy measure for social class), students with low and very low cultural capital were under-represented across all sciences and maths over time, in terms of both student aspirations to take these subjects and actual A level subject choices.

5. What factors shape school physics aspirations and trajectories? (Y9-Y13)

5.1 Trends in school science aspirations

5.1.1 Trends in reasons for subject choices (Y9-13): Interest, utility, attainment

The Y9 and Y11 surveys asked students about the reasons for their intended subject choices. The Y13 survey asked students about the reasons for the A level choices made.

Table 3: Reasons for A level subject choices (intended, taken)

	Future Usefulness	Attainment	Enjoyment/Interest
Year 9 (n = 4513)	62.0%	20.8%	17.2%
Year 11 (n = 13421)	56.1%	12.0%	19.5%
Year 13 physics* (n=917)	30.6%	10.8%	43.1%

** **Note:** Year 13 students were asked specifically for each subject they were doing, so there is not an overall measure. However, the proportions were similar across subjects.*

As detailed in Table 3, analysis showed that from Y9 to Y11, there was a **small decline in the proportion of students valuing usefulness** and a slight **increase in the proportion valuing enjoyment/interest** as the 'most important' reason for their subject choice. The importance of perceived attainment (how well a student feels that they do in the subject) declined considerably after Y9 and remained a third-choice reason.

43% of A level **physics** students identified enjoyment/interest as the 'most important' reason for their subject choice, a notably higher figure than found among younger students (Year 9, 17% and Year 11, 20%). In contrast, those taking A level physics were less likely to select usefulness (31%) compared with the overall sample in Year 9 (62%) and Year 11 (56%). However, it should be noted that the proportion of students selecting these as reasons for their subject choices at A level was quite comparable across different subject areas. That is, the age-related trend in being more likely to identify interest/enjoyment as a key reason for A level subject choice is not unique to physics.

While there were few demographic trends associated with the reasons given for subject choices, it was noted that basing subject choices on 'interest/enjoyment' was slightly more associated with **class and ethnic privilege** (i.e. having high cultural capital and being white).

On the Year 13 survey, students were asked why they did *not* choose each of the three sciences, when relevant. Overall, lack of interest was the primary reason selected for *not* choosing biology, chemistry and/or physics at A level. For physics and chemistry, difficulty, being better at other subjects and perceiving the subject as not useful for future studies/job were the next ranked reasons.

There were limited differences by demographics in reasons for not choosing subjects. However, those who identified as women were more likely than men to cite subject difficulty as their reason for not choosing physics. Students with very low cultural capital were also more likely to say they did not take physics due to not getting the required GCSE grade (as was also found for biology and chemistry).

5.1.2 Trends in perceptions of science subjects (Y9-11): Interest,difficulty, attainment

Across the Year 9, 11 and 13 surveys, young people were asked questions related to their experiences of science in school. These helped to contextualise similarities and differences between how students experienced physics vis-à-vis biology and chemistry.

Students in Years 9 and 11 were asked to choose which science subjects they found most interesting, most difficult and which they did best in.

Table 4: Perceptions of science subjects

		Biology	Chemistry	Physics
Most interesting	Year 9	49.1%	47.8%	**33.1%**
	Year 11	55.1%	36.5%	**32.6%**
Most difficult	Year 9	22.4%	30.4%	**39.9%**
	Year 11	23.4%	44.9%	**47.3%**
Do best in	Year 9	38.5%	35.5%	**26.7%**
	Year 11	48.3%	34.0%	**32.2%**

Note: *Students could select up to all three of the sciences.*

Biology was seen as the most interesting of the three science subjects from Year 9 to Year 11. Perceptions of physics remained fairly constant over time, with the lowest interest ratings.

Physics was consistently seen as the **most difficult** over time, compared with biology and chemistry. While ratings of biology were quite similar from Years 9 to 11, both chemistry and physics were perceived as more difficult in Year 11 than in Year 9, perhaps due to more abstract subject matter or an exponential increase in level of challenge.

Students tended to feel that they did best in biology, with the difference between biology and the other two sciences being particularly pronounced in Year 11. Although the proportion of students perceiving that they did best in physics increased from Year 9 to Year 11 (despite an increase in the proportion of students finding it 'most difficult'), physics remained the subject the smallest proportion felt they did best in, which could potentially reflect greater grade severity in physics.

Subject perceptions were also explored by demographics, with the clearest patterns by gender, in a direction reinforcing physics' association with masculinity. Female students were consistently more likely to find biology the most interesting over time from Year 9 to Year 11. Conversely, male students were consistently more likely to identify chemistry and physics as the most interesting Y9-11. Male students were more likely to find biology the most difficult (Y9-11) while female students more likely to identify chemistry and physics as most difficult (Y9-11). Female students were more likely to identify biology as the subject they do best in (Y9-11), whereas male students were more likely to identify chemistry and physics as subjects they do best in (Y9-11).

The picture by ethnicity is more complex, with fewer salient differences. Broadly, Black and Asian students were more likely to find biology interesting (Y9-11), while white students were less likely to find chemistry interesting.

Ethnic patterns are less clear for physics over time, although in Year 11 Black students were more likely to find physics difficult and less likely to say they do best in physics.

Physics follows a similar pattern to biology and chemistry in terms of student views of the subjects by cultural capital. Generally, from Year 9 to 11, students with low levels of cultural capital are less likely to identify all three sciences as 'most interesting', are more likely to find them difficult and are less likely to identify them as subjects they do best in. The converse is true for students with high levels of cultural capital.

5.2 What shapes students' relationships with physics?

As noted above, we understand the factors shaping young people's trajectories into, through and away from physics as produced through **interactions of identity, capital and field**. That is, these interactions influence the likelihood of a young person finding physics interesting or difficult, and whether they aspire to continue with the subject, or not. These interactions also generate the social patterns in responses that were observed in the ASPIRES data, where it was found that identity and gender mediated perceptions of difficulty, irrespective of attainment (and similarly for perceptions of relevance). As noted below in relation to the impact of science teachers on science engagement, the field of school science/ physics plays a part in shaping young people's trajectories and inequitable patterns of participation. The resource (capital) of 'good', consistent physics teaching is unevenly distributed[25], hence privileged students are more likely to benefit and be supported in their trajectories than those from less privileged contexts.

The following two case studies from the longitudinal interviews illustrate these points.

Case Study 1: Hannah is a White, middle-class young woman. Her family possesses considerable STEM-related capital, but particularly physics capital, with Hannah's sibling and sister-in-law both holding postdoctoral physics degrees. From a young age, Hannah aspired to a degree and career in STEM. At school, Hannah attained highly and coped well with being the "only girl" in her A level Physics class. Like other young women, she saw physics as being a "hard", "difficult" and masculine field ("I guess because it has that connotation of manliness", age 16). However, she also described how, as a young woman, she was proud to be different ("I guess I like surprising people… breaking boundaries"). During her A levels, she explained how she would "like to feel" that she is "good at physics", but worried that she did not "breeze through" the subject like some other, male students. At university, she enjoyed her physics degree but described having to navigate experiences of everyday sexism from some male peers. She navigated these issues by working even harder and becoming one of the top attaining students in her class, which grew her confidence and helped "prove" her physics competence and identity to both herself and others.

Case Study 2: Danielle is a White, working-class young woman who defines herself as a "glamorous", "girly" girl. No one in her family has been to university and the family is not particularly 'science-y'. From an early age, Danielle expressed a strong interest in science and aspired to be a scientist up until the age of 16. At age 10, she described enjoying some informal science learning activities and experiences outside school. Over the years, Danielle's science trajectory has been closely interlinked with her negotiations of cleverness and femininity. She states that "all of my family is not clever" and over the years often worried that her family, teachers and others always assume that she is not clever because of the way she looks. At 17, she said: "I'm a bit of a party girl… I like make-up and hair… but then I do like the school side. Everyone thinks I'm really dumb, but I'm not. I seem quite dumb I suppose… because I do all my make-up and hair and just seem a blonde bimbo". Though she was placed in the bottom attainment sets at secondary school, she worked hard and moved up to the "top sets". She took the non-elite Double Science route, worrying that Triple Science would have been "too hard" – "I wouldn't have done it, I'd have failed, so there was no point". She attained B grades at GCSE and applied to do A level Physics but was discouraged by the school, on the basis that she might struggle academically. She took other A level subjects and eventually pursued a social science degree.

Longitudinal analyses of young people's trajectories revealed how possession of valuable forms of STEM-related capital helped to encourage and support young people's STEM trajectories, particularly where this capital was sustained and extensive, providing a 'wrap around' of support over time and context. The uneven distribution of physics capital supported dominant participation patterns, whereby young people from more socially privileged backgrounds were more likely to possess and deploy this form of capital, leading to a greater likelihood of pursuing a STEM trajectory. It also enabled some students from underrepresented communities (e.g. girls in relation to physics) to 'buck the trend' and access degrees in disciplines in which they were underrepresented, as illustrated by Hannah, a young woman who benefitted from considerable family physics-related capital as well as high attainment, and went on to take a physics degree. As also illustrated by Hannah's case, it was the interaction of Hannah's identity and capital that made physics seem like a possible and desirable choice. However, her progress was still hindered and constrained by the prevalence of sexism and the gendered nature of the discipline, as experienced at university.

Danielle's example further underlines how the alignment of disciplines, such as physics, with middle-class masculinity make it difficult for 'glamorous', working-class young women to be recognised as authentic physics students. Her case study also highlights how practices within the field (such as grade severity in physics) result in gatekeeping practices that both formally and informally restrict access to physics for students with good (but not 'top') attainment. The field interacts with and shapes identity, so that Danielle comes to see physics as an 'impossible' route, despite her own interest and competence, exemplifying how 'exclusion works most powerfully as self-exclusion'.

As illustrated by both case studies, the difficulty for young women to see themselves, and be recognised by others, as viable physicists was a common theme across the wider ASPIRES data. For instance, both Kate and Davina, white, middle-class young women who liked physics and had attained highly in it at A level, did not consider pursuing a physics degree because they worried that it would be "too hard". This was despite attaining top grades in the subject, underlining how identity can mediate both interest and attainment within young people's degree choices. In contrast, where young people experienced an alignment and meaningful connection between their own identity and a particular field, this provided strong support and impetus for a particular subject trajectory.

5.2.1 Perceived difficulty of the sciences

Across all science subjects, students explained their interest in a subject as mediated by how "hard"/"difficult"/ "confusing" they found it. However, physics was most often associated with difficulty (and the reverse for feeling good at the subject).

The difficulty of biology was associated with there being "a lot to remember" in terms of content and terminology:

> *"I possibly like biology a little bit less, but that's just cos I find it more confusing. I find it more confusing cos I haven't had a very good background of science, like I was never like taught like stuff which other like boys seem to know, like some of the terms and stuff" (Tom3, Y9).*

> *"I can't like take it all in, like the different body parts and stuff and we're expected to remember them" (Heather, Y9).*

> *"We've just learned about the synapses, so that's quite, there's like some difficult terminology there" (Colin, Y9).*

> *"It's just a bit difficult cos you're learning a whole new language, so it's quite difficult to get on" (Mitchy, Y9)*

The difficulty of chemistry was associated with complicated content:

> *"Chemistry always just seems more complicated, because there's loads of like reactions that you've got to remember and I don't know. It just always seems more complicated" (Pamela, Y9).*

> *"Remembering all this chemical reaction stuff, like I don't have a clue" (Laura, Y9).*

Some students also found the translation and application of ideas difficult:

> *"Yeah, like in my previous test, the first question was something to do in … or a red powder and nitrogen and something and I couldn't remember doing anything in class with a red powder and I asked Sir and he goes 'We didn't do that in class but we did something similar' and I'm like … just had to guess it" (Lucy, Y9).*

The difficulty of physics was frequently described as hard to articulate (e.g. "There's just something about it that I don't really understand", Football Master, Y11) but was often associated with the experience of receiving generally lower grades in physics compared with biology and chemistry. For instance, a number of students recounted how they found it harder to get comparable high marks in physics as they did in chemistry and biology (and indeed other non-science subjects).

> *"So I think in English I have a better chance of getting an A* than I do in say physics even though I enjoy physics" (Gus, Y11).*

> *"I get better grades in chemistry and biology, so therefore I'd enjoy it more, cos I know that I'm going to get the grades in the end" (Demi, Y11).*

> *"I used to be an A and now I'm a D and I don't know how I did that, because I used to love physics" (Carol, Y11).*

Some students associated the difficulty of physics with its mathematical and/or abstract content – a point that was noted by both those who attained highly in maths and those who struggled with it:

> *"I'm terrible at physics, cos I'm not the greatest at maths either" (Millie, Y9).*

> *"I know it includes maths, but it's very much harder ... I think ... I don't know. [Int: Mm. Do you like maths? Do you find maths hard?] I wouldn't say I find it hard – I think it's one of my best subjects. But it's kind of ... physics ... mm, I don't know" (Demi Y11).*

Indeed, it was noted that perceptions of physics as being "(too) difficult/hard" were not simply a product of a student's actual attainment (in either physics or maths), nor were they simply a reflection of subject interest. Rather, as hinted at in the quote below from Joanne (a very high attaining student), it was strongly mediated by identity and the sense of personal 'fit' or not with the subject (being "suited" to physics, as Joanne puts it).

> *"I'm not quite as good at it as I am at the (other) sciences. And it's a bit abstract sometimes, so … it's harder to understand fully... physics is just … well I find it quite a bit harder – harder to understand, harder to … well grasp everything behind it really. It's not that I don't enjoy it, it's just I don't feel I'm quite as suited to it as I am the other sciences" (Joanne, Y11).*

5.2.2 Perceived importance and relevance of the sciences

In general, all three sciences were identified by students as being **useful and important** and in interviews students were able to name a range of jobs associated with each discipline. For instance:

- Physics was associated with engineering-related jobs (e.g. "Mechanics and car designers, astronomers", "For I think like for sort of engineering, aeronautical or robotics or mechanical, um, I think physics and maths are definitely more important than chemistry").
- Biology was most often linked to jobs in health and medicine (e.g. as a "doctor" or "finding a cure for cancer").
- Chemistry was linked with pharmacy and chemical industries (e.g. "Chemistry you can work in the chemical industries and stuff."; "Chemistry obviously it opens up like science teachers, you can be like a chemist or something").

Generally, students found it **easier to identify jobs relating to biology,** compared with chemistry and physics. For instance:

> *"Yeah I think that biology is more useful for general jobs, because things like … if you wanted to do a PE teacher or I don't know, coach at a football club, then it's good to know biology if you had to do any quick reaction thing" (Chloe, Y11).*

> *"I'm not really sure about physics. I mean you can be a physicist obviously, but I think actually yeah I think physics is like if you want to be like a mathematician I think physics would be important for that" (Gus, Y11).*

> *"I kind of feel like there are more jobs if you did like biology, cos of like health and like research and stuff, compared to something like physics. That's kind of what I think like. I know there are jobs to do with physics, but … I don't know, but I kind of feel like there's probably less. Biology would be the most useful, chemistry in the middle because of like industry and stuff, and then physics the least" (Kate, Y11).*

> *"I don't think chemistry is useful. ... I think it's interesting but not useful, unless I want to do something in a lab... Chemistry is probably less useful than some of the other ones, but yeah" (Tom3, Y11).*

However, there was **no single shared view** and there were **contested hierarchies of importance** and job relevance. That is, different students identified different sciences as (the most) important and relevant. However, roughly speaking, physics tended to be seen as less transferable than biology and chemistry:

> *"Chemistry and biology are important, whereas physics isn't I wouldn't say as important as the other two" (Indiana, Y11).*

> *"Overall like practical-ness of it, I'd probably say physics is the least useful out of them all because it's mainly about space and stuff like that, but I think biology is probably the more useful one in work settings" (Celina2, Y11).*

The extent to which a young person perceived a given science as being useful/important (both generally, and as a route to a specific job) **depended on what they wanted to do in the future**. That is, on the whole the sciences were recognised as being important and relevant for society and other people while not being seen as necessarily important/relevant for one's own life and career.

It was also notable that perceptions of the potential r**elevance/importance of science/ physics were often independent from students' perceptions of subject status.** That is, whether or not they felt that science was personally important or relevant, the vast majority of young people recognised science as having a high social status and that science qualifications were markers of distinction (specifically, science qualifications were seen as denoting 'cleverness'), with physics being recognised as having a particularly high social status:

> *"I think science is quite good cos I think … something I've heard from my dad is that like … when companies look at all of your like qualifications and stuff, if they see science, they automatically think 'Oh they're actually quite clever' so like you know they wish to employ them. I think that's the only reason why, like if you're not really sure what you want to go into and you know you're not going to be like something specific like a lawyer, then you might as well just do science, cos it's respected" (Davina, Y9).*

> *"I do think physics is looked upon better than other sciences. Like I don't know why, but I feel like it is, because I think if an employer looked at physics they'd be like wow it's really like clever. Then biology they'd kind of be like it's not really related to the job" (Carol, Y11).*

Perceived relevance was also not a key reason for choosing a science subject at university. That is, those who perceived science/ physics as being important, high status and relevant still did not necessarily pursue it themselves. Conversely, those who *did* choose to pursue a particular science at university did not tend to explain their choices on the basis of perceived relevance – as detailed in sections 5.1 and 6.1, the most frequent reason given for choosing physics at A level or degree level was subject interest. For instance, Davina took chemistry A level and went on to complete a chemistry degree, yet she questioned the relatability and relevance of chemistry to everyday life:

> *"I think in a way chemistry is probably the least relatable one [science], in the sense that you're sort of like 'Yeah but when am I going to mix like sodium hydroxide and hydrochloric acid?' Like 'Really am I going to do that?' I'm just going to buy table salt from the supermarket, I'm not just going to make it. So like I guess you could sort of say okay that's not that relevant. Or like calculations, you're like, 'When am I going to use this?'" (Davina, Y11).*

It was also notable that young people's **perceptions of subject utility and relevance were not fixed but changed over time, as shaped by interactions of identity, capital and field.** For instance, personal experiences, the views of significant others and changing attainment all interacted to shape young people's perceptions of subject utility and relevance.

5.2.3 Role of school science teachers

5.2.3.1 Experience of science teaching (Y11-13)

In the Year 11 and Year 13 surveys, young people were asked questions about their experiences of individual school science subjects. In the Y13 survey, students were just asked these questions for science subjects they were taking at A level. As detailed in Table 5, in Year 11, physics and chemistry generally compared less favourably than biology, although in Y13, while biology still largely rated highest, the majority of science students were very positive about their subject experience.

Table 5: Proportions of students strongly/agreeing with science subject statements

		Biology	Chemistry	Physics
I learn interesting things in x lessons.	Year 11	64.9%	57.0%	**53.1%**
	Year 13	88.9%	84.9%	**87.3%**
Studying x can help me in the future	Year 11	57.5%	49.4%	**50.2%**
	Year 13	89.7%	86.9%	**88.2%**
I like my x teacher	Year 11	66.1%	66.3%	**64.3%**
	Year 13	82.3%	82.8%	**81.2%**
I learn things quickly in x lessons	Year 11	48.7%	39.6%	**38.0%**
	Year 13	60.8%	53.6%	**62.8%**
X teacher thinks I am good at x	Year 11	42.2%	41.0%	**40.0%**
	Year 13	63.8%	60.6%	**69.1%**

(x = biology, chemistry or physics)

In Year 11, more students agreed that they learned interesting things in biology, compared with chemistry and physics. However, there was also a gender difference, whereby a higher percentage of those who identified as female (69%) compared with those who identified as male (60%) found biology interesting. The reverse pattern was found for chemistry (55% female vs. 60% male agreement) and, even more starkly, in physics (47% female vs. 61% male agreement).

A higher percentage of respondents also agreed that biology was useful for the future, compared with chemistry or physics. Around 2/3 of Year 11 respondents agreed that they liked their teachers in each of the three subjects.

In terms of confidence, although nearly half of Year 11 students agreed they learn things quicky in biology lessons, this proportion dropped to just over 1/3 when responding in relation to chemistry and physics.

Around 40% of respondents agreed that their biology, chemistry and physics teachers think they are good at their respective subjects. However, there were clear gender differences within these figures, with more male than female students agreeing in each case. This trend was particularly notable in relation to physics, with 47% of male students agreeing their physics teacher thinks that they are good at physics, a figure that was 13 percentage points higher than found among female students (34%).

The high, similar levels of agreement expressed by Year 13 science students suggests that most science A level students seem to report positive classroom experiences, across the three disciplines. In some ways, this is not surprising given that these students have freely chosen to take these subjects. Reassuringly, there were no notable gender differences in terms of the percentage of male and female students agreeing that they learn interesting things in lessons, a trend that holds across biology, chemistry and physics.

However, there were somewhat lower levels of agreement among females (although still higher than found in Year 11) that they learn things quickly or that their teachers think they are good at the subject – although physics A level students did seem somewhat more positive than their peers in chemistry on both counts.

5.2.3.2 Perceptions of science teachers

There were a range of positive and negative views expressed about biology, chemistry and physics teachers. Overall, across the interview data, there were more positive than negative views expressed about biology and chemistry teachers, whereas in physics, a higher number of negative comments were coded.

Generally, irrespective of the discipline in question, **students largely expressed similar views about the importance and impact of 'good' vs. 'bad' teachers on their science engagement**, with 'good' teachers being associated with positive attainment, good understanding, high interest and engagement (and vice versa, 'bad' teachers were seen as having a negative impact on student attainment, understanding, interest and engagement).

5.2.3.3 Perceived influence of science teachers on student engagement

Students largely agreed that science teachers have a considerable impact on the extent to which students like, understand and aspire to continue with science.

> *"I mean like teachers do influence the subject. Maybe that's why biology is not my favourite, because my biology teachers aren't that enthusiastic like my chemistry and physics" (Mienie Y11).*

> *"I think my interest in biology has definitely increased. Because yeah my teachers really … I really like my teacher, she's really good" (Luna, Y11).*

> *"Biology I've come to like more, because I used to absolutely hate it, but I've had a really good teacher and like I'd started understanding it better and understanding it more and now I'm enjoying it more" (Thalia, Y11).*

> *"The teacher makes a huge difference I find, and so chemistry, like my teacher's amazing … and the same with biology, but physics she's just … I can't explain it, she's just not like as engaging" (Poppy, Y11).*

> *"In chemistry, I think my teacher is much better and I've got a much more … I've got a better interest for chemistry" (Samantha, Y9).*

While students identified issues in teaching across all three sciences, there were notably more negative comments made about physics teachers. For instance:

> *"Um, last year we had a really rubbish teacher. Didn't learn anything in physics at all and in the past sort of month we've got a new teacher, so I'm having to learn the whole curriculum all over again really quickly. I've got a tutor outside of school now as well" (Victoria 1, Y11).*

> *"I don't really know [what puts me off physics]. Like I think a bit about our teaching's a bit kind of all over the place and I don't know. I just don't find it interesting" (Samantha, Y11).*

> *"It's not terrible, I got two Bs and a C in my mocks, but I say I've dropped in physics the most, because I had a really good … I really enjoyed physics last year, cos I really liked my teacher and I learnt really well. But we have a different teacher this year and I don't learn so well from her, so I kind of dislike the subject a bit more ... And I was considering taking physics for A level, but then … now doing it the second year I find it a lot more difficult. And also like I don't learn very well from my teacher. So I find it really difficult to like take in information and learn things, cos I just … I think a lot of … if you … the way you learn from a teacher depends on whether like you really find them a good teacher or not. Cos if you don't then I feel that I don't learn very well from them" (Mitchy, Y11).*

5.2.3.4 Experiences of physics pedagogy

Analysis of the ASPIRES longitudinal interview data found that young women were particularly disadvantaged by a popular notion of the "effortlessly clever physicist," which encouraged even highly interested and high attaining young women not to continue further with the subject[26]. Three common forms of school physics pedagogical practice were identified: attainment-based practices (through which students were excluded, dissuaded or prevented from continuing with physics); curriculum practices (which conveyed that the 'real' physics is deferred until a later future educational stage, such that previous/current versions are perceived as 'inauthentic' physics, often referred to by students as physics 'lies'); and interpersonal practices (e.g. teachers reinforcing stereotypes about physics and/or favouring particular gendered versions of 'doing physics', such as through competitive performances of 'superior' intellect). These practices were found to be implicated in the reproduction of inequitable patterns of physics participation, through which students who most closely conform to stereotypical notions of the 'ideal physics student' become 'cultivated' into the dominant culture of physics, whereas those who do not 'fit' are 'weeded out'.

5.2.3.5 What makes a good science teacher

Students generally expressed **similar views on what makes for a good science teacher, irrespective of the specific discipline.** These qualities included pedagogy, personal qualities and teaching approach and coalesced around four main themes: (a) an engaging, interactive and enthusiastic approach that is not too didactic and not just teaching to the test, (b) being competent, able and willing to clearly explain science content, (c) not being stereotypical or prejudiced, (d) taking an appropriate approach to discipline, being neither too strict or too lax.

a) *An engaging, interactive and enthusiastic approach that was not too didactic, boring, "drony", "just reading off a PowerPoint" or "teaching to the test".*

Students valued engaging teaching which directly influenced the extent of their subject interest and attainment:

> *"My teacher isn't the most enthusiastic at the minute, so that probably changes what you think of the subject as well" (Brittney, Y11).*

> *"So I've got a better chemistry teacher now and I am more interested in the subject, so yeah but it doesn't mean I like it though. It's just I … it's sort of easier to learn now, but yeah ... well I mean my previous teacher in chemistry he wasn't bad, but I mean he was just really boring. Like you know the 'drony' sort of voice and it was just silence in the classroom. He didn't really interact with anyone, but the teacher I have now it's a bit more sort of, he's a bit more loose, so it's sort of loosened up a little bit, so the classroom environment is a lot more sort of chilled and you can talk to everyone else. It's not sort of like in the conditions where you can't work, but you just feel a bit more relaxed and he makes the subject more interesting" (Raza, Y11).*

Unengaging teaching was linked with didactic approaches:

> *"He doesn't teach that well, he just shows us stuff on the board and we have to copy it down" (Kaka, Y9).*

> *"I think the teachers are like … they're like they don't … like my physics teacher or … and some of the other teachers, they don't really like … they just read a … they just … they don't make their lessons interesting, they just make it just like read off like a PowerPoint or something. And then …and they'll make you do some work and then you don't really understand it and then if you don't … I know that sometimes if you don't get … understand the question, they'll like move on and then … and then you don't really get to have your question answered" (Kelsey, Y9).*

Less engaging teaching approaches were also recognised as driven by high stakes national GCSE examinations, in which the extensive content coverage required restricting more engaging pedagogy:

> *"I suppose down in the lower years they were like encouraging curiosity in everything, and then all of a sudden they were like 'No, stop that – now you're learning the stuff you have tlearn'"(Kate Y11).*

b) *Being competent, able and willing to explain science content clearly.*

While it might be regarded as a fairly fundamental aspect of teaching, it was not uncommon for students to report questionable levels of competence and ability to explain subject matter among some of their science teachers. Students expressed a range of views on the perceived competence and professionalism of their teachers, and drew attention to instances where they felt their teachers fell short of core requirements:

> *"Cos a lot of science teachers obviously, because they're good at science, obviously understand it well, I think they explain it in a way that only people who are actually good at science will understand. This is what happens in chemistry lessons a lot. Because our teacher … personally I think he's a great teacher, I understand what he's saying, I understand what he's talking about, but certainly a lot of people on my table that I sit with – they don't actually know what on earth he's on about. And I think it's just because he doesn't explain himself in a way that people who maybe aren't quite as capable at science, like for them to understand" (Davina, Y9).*

> *"The teacher has a big impact. So … like today our teacher got really annoyed because we asked her a question and she just didn't say the answer. So we were just like 'What?' So we just said like what type of energy … explain the form of energy that's released when an atom splits. I said 'Is it heat?' and she just stared at me. [...] And I was like 'What?' – she hasn't actually taught it to us … and she just told us to use a textbook, which we don't have. So we were like 'Okay …' And she said 'Do it for homework' and then made us leave 2 minutes early. That's why I don't like physics" (Poppy Y11).*

> *"My science teacher this year, she said that she didn't ... even last year my teacher said that she didn't want to teach us P7 because it was boring and she didn't understand it herself. And then this year one of the teachers said that she couldn't teach us the maths part because she didn't understand the trigonometry parallax ... the thing that's the parallax part. [Int: What's P7 again?] It's the Triple Science physics module that only Triple Science people do" (Demi, Y11).*
>
> *"Because I don't like … my physics teacher … I've had this teacher that … I didn't have her last year, but I've had her like for four years of being at school and we've never got on and I just … she just – in like a lot of people's eyes now, she just can't teach" (Laura, Y11).*
>
> *"No, the physics teacher that I have isn't exactly the greatest" (Emma, Y11).*

This was felt by some to be more of an issue in physics and chemistry than biology:

> *"Well I think biology, you probably get better teachers just because I guess the kind of people who study biology aren't so much like ana – … I don't know if 'analytical' is the right word … because it's not as maths-y, so they're probably more like … well, better at explaining. And then the people who go into physics and chemistry probably are more maths-y so not so wordy. I don't know if that makes sense" (Hannah, Y11).*
>
> *"Uh … it's quite hard to teach as well, so it's quite hard to find teachers that are quite good at physics, to the extent that they would make other people want to take physics" (Bill, Y11).*

c) *Not being stereotypical or prejudiced.*

Some students, but notably those who identified as young women, complained about a few teachers who, in their experience, had expressed gender stereotypical views about girls and science:

> *"Like today in chemistry … we have a different teacher to normal because the other one's off … and my friend said that she wanted to do higher level maths … and apparently that is really really hard to get a 7 in … and the teacher said … she's a girl … she said 'Oh I think you have to have a boy brain to do that' … The whole class was like 'What?' (laughs) 'You don't say that at this [girls] school'. And like my friend now really just wants to do it because … to prove her wrong. We don't really understand what she was saying by a 'boy brain'. She said 'Oh you get boys that tend to be really geeky and good at maths' but we were like 'Well you get girls like that too' – she's a chemistry teacher!" (Poppy Y11).*
>
> *"My physics teacher said something about this as well which really annoyed me. I don't think … but she said … she was at parents evening and she said 'Why not physics?' and I was like 'I just don't find it as interesting' and then she said 'Oh yeah you can usually tell the girls that want to do physics, they look a bit tomboy-ish' and then she could see my parents' faces and me I was like … and she's like 'Oh you're not tomboyish' and then she tried to change it. But like the fact that she has that opinion. And this physics teacher … I don't know I think I just … it shouldn't be like that at all" (Poppy, Y11).*

d) *Having an appropriate approach to discipline (not too strict or lax).*

The ideal teacher was felt to be one who was neither too strict nor too relaxed in terms of maintaining classroom order and discipline.

> *"Well we're doing physics, but we're quite behind, and I don't think my teacher's one of the best to be honest. I think she wastes a lot of time in lessons telling the students off unnecessarily. And it just kind of makes it seem a bit like I need it explaining again – that type of thing" (Lucy Y11).*

> *"I prefer biology at the moment because of … the teacher can teach, which is good and he has control over the class which is always a great thing so that you can actually work in a good environment" (Victor, Y9).*

5.2.3.6 Negative impact of high science teacher turnover on engagement, learning and outcomes

Students across all science subject areas noted the **negative impact of high science teacher turnover** on their engagement, learning and outcomes. Although following national trends, this issue was noted most often in relation to physics.

> *"We've had – for physics – we've had, I think, six teachers in one year ... I think after the physics teachers, all the what happened between having six teachers, I just find it like more difficult to like … since like Year 10 and Year 9 and all that. But I used to ....to, like, enjoy doing it, but it's like slowly died down over the years" (Dave, Y11).*

Likewise, Louise (Y9) described how she previously had a good biology teacher who had left the school, resulting in the class being "stuck with a supply". As she went on to explain, "a lot of our class didn't do very well on the section that she [supply] taught us. [...] But the bit that our teacher taught we got like loads of marks, good [...] the other day I think a few of my class went to see my head of year about it saying that she's not doing anything". Similar issues were noted by many other students:

> *"In Year 7 we had loads of teachers so it was hard because they all had different ways of teaching us" (Mitchy, Y9).*

> *"Last year science got extremely confusing, because we had three different teachers over the year. Because our first teacher, she was really nice and we had her for pretty much half of the year and everybody got used to her teaching style and then she left and then we had another teacher who was her substitute ... She was really nice and she had a completely different teaching style, so we all had to then adjust to that, and then she went and then we had another teacher. He was really nice. Then we all got used to his learning style for the last quarter of the year, so I think last year out of all the three, out of Year 7, 8 and Year 9, Year 8 was my most like the lowest levels that I'd achieved. ...Because there were so many different, so much change in the teaching styles and how they wanted us to learn things that it just got really confusing. ... But now, this year's better because I've just had one constant teacher and I think this teacher, I think he's going to stay throughout the rest of the year because he's really nice. He's a good science teacher and everybody understands his teaching style" (Laylany Y9).*

> *"Well we've had … we had the headmaster for physics up until … up until Christmas but then after that we had a supply teacher and … and in chemistry, we've had three different teachers so far ... I've started liking physics more because our physics teacher last year was quite bad" (Joanne, Y9).*

> *"One of the teachers we haven't been learning much off – physics, so they've had to give us another teacher where they've changed round all the classes to different teachers, and we've now got a different teacher for different subjects" (Cheeky Monkey Y11).*

Students recognised that high teacher turnover had a disruptive negative impact on their learning and attainment:

> *"Yeah, I used to be a grade A in chemistry and then we didn't have, well we had a teacher for like a month and then she left for like a year and we had supplies the whole time, so then my grade just dropped to an F, so my last mock was an F and my before mock was an A, so it's just such a big change. I have to like get it all back up now ... Yeah, I think I have the ability. I just have to, I have been trying to revise so much lately just to get my chemistry grade up and my physics, but I do think it would've helped, so much easier if we had a better teacher right now or like at least a teacher" (Carol, Y9).*

> *"Yeah in Year 9 it was kind of ... we had two teachers, one of them wasn't actually a science teacher. And the other one kind of didn't stick to the syllabus. So when we were given tests we felt like we hadn't learnt any of it and we didn't know what ... I think it's the whole class who didn't know what they were doing. So this year and last year we had teachers who were quite high up in the department .... Yeah, in Year 9 I was completely disinterested with science lessons. Whereas in Year 10 I gradually got into it more and I enjoyed it more. And then this year it's kind of ... I put in as much effort as I can. [Int: Do you have any idea why you got into it more?] Probably the teacher we had in Year 10, she really wanted us to improve. Cos having known about the experience we had in Year 9. And I just feel like it really paid off in tests. So having a feeling of achieving Ds in Year 9, and having As, A*s in Year 10 is really very rewarding" (Demi, Y11).*

> *"Cos we did have a really really good physics teacher, but then he left, and then we got another replacement one. And she's good, she's nice, but she's not as good as the other one, the one we had before. Which I think has affected some people's attitude to physics and their grades as well" (Indiana, Y11).*

5.2.4 Perceptions of scientists

All six ASPIRES surveys (from age 10-22) asked young people about their perceptions of scientists and people who work in science.

As summarised in Table 6, some potentially surprising patterns were found in terms of students who were planning to take/went on to take Physics at A level and degree level.

Table 6: Young people's perceptions of scientists and people who use science in their jobs (% strongly/agree)

	Yr 6	Yr 8	Yr 9	Year 11 (all)	Year 11 (plan physics)	Year 11 (plan maths)	Year 13 (all)	Year 13 (physics A level)	Year 13 (maths A level)	Age 20-22 (all)
Are brainy	81%	80%	79%	76%	83%	52%	81%	**87%**	85%	80%
Are odd	24%	19%	14%	13%	11%	11%	11%	**17%**	13%	12%
Are geeks	(not asked)	(not asked)	21%	20%	18%	18%	20%	**27%**	23%	20%
Are usually men	(not asked)	(not asked)	(not asked)	19%	23%	17%	27%	**42%**	32%	36%

It was noted that A level **physics students expressed more stereotypical views of scientists** compared to their peers, being more likely to agree that scientists are brainy, odd, geeky and male.

On the whole, over time students from Y6-Y13 fairly **consistently agreed that scientists are brainy**. However, **those planning to take physics (Y11) and those who actually took physics A level (Y13) were markedly more likely to agree**. Y11 students who were planning on taking maths A level were an exception to the general trend. On the Year 6 survey, boys were slightly – but statistically significantly – more likely than girls to agree that scientists are brainy. However, this trend reversed in Year 8 and continued through all of the remaining surveys.

Younger students (Y6-8) were more likely to **agree that scientists are odd**, but this proportion decreased from 24% in Year 6 to 19% in Year 8 and 14% in Year 9, staying low and constant as they got older. The exception was those taking physics A level, who were more likely to agree. Boys/young men were more likely than girls to endorse the stereotypical view of scientists as odd across all surveys. Similarly, those who identified as male were more likely to agree that scientists are geeks.

In both Y11 and Y13, **physics/physics aspiring students were more likely than other students (including those taking maths) to agree that scientists are men**. This perception also **increased** from Year 11 to Year 13. In Year 11, young men were marginally more likely to agree that scientists are usually men. However, this pattern reversed and accelerated through the Year 13 and age 20-22 survey, with more young women agreeing that scientists are usually men.

Across all surveys, individuals with higher levels of **cultural capital** were more likely to agree that scientists are brainy and were less likely to agree that scientists are odd. This pattern reversed for individuals with lower levels of cultural capital.

Differences by **ethnicity** were more variable and unclear, but generally across the surveys, South Asian respondents were more likely to agree that scientists were brainy and Black respondents were less likely to agree.

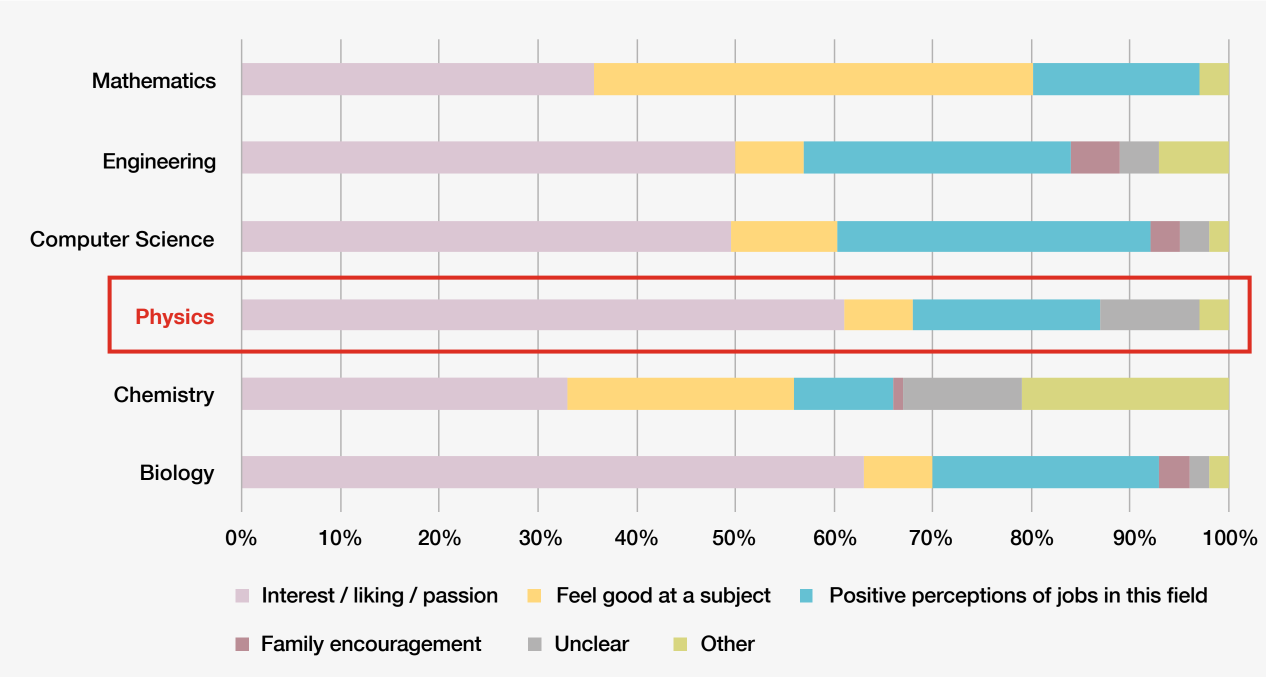
6. What shapes university subject choices?

6.1 Reasons for choices

Figures 7 and 8 summarise the open-ended responses from the final ASPIRES survey of:

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

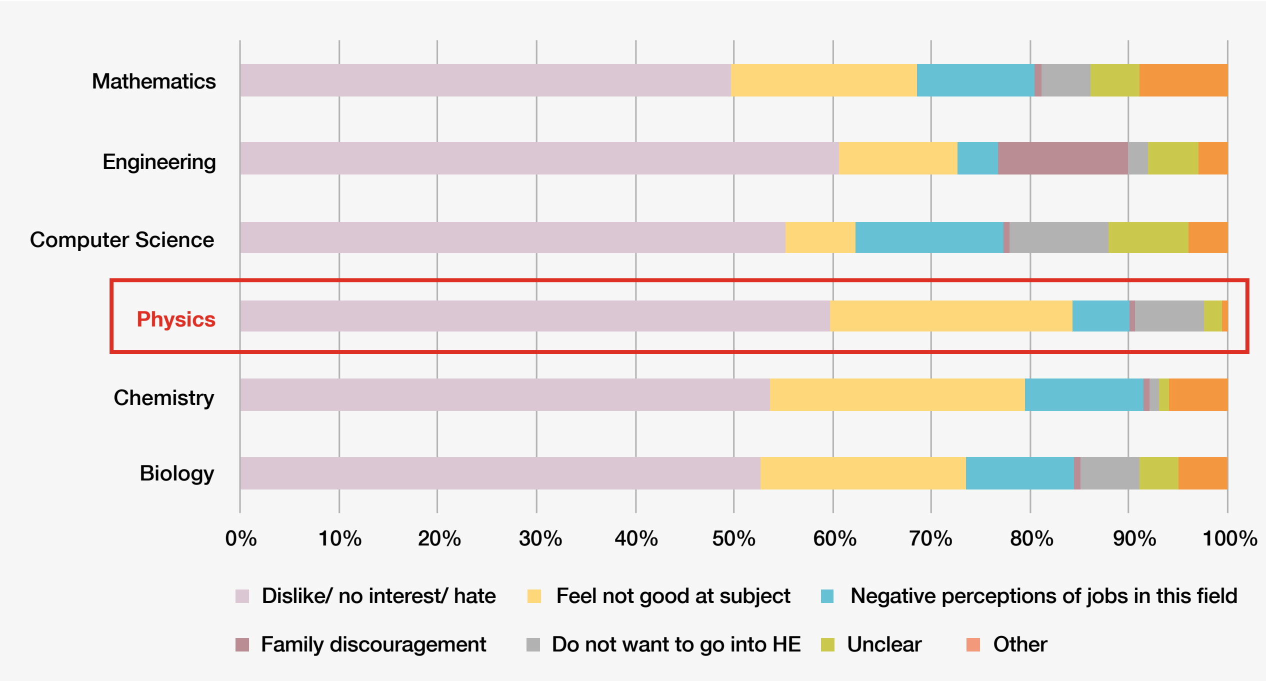
Figure 7: The reasons STEM degree students gave for their subject degree choice



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

- Interest or passion was the top reason given by 61% of physics undergraduates for choosing the subject, a higher rate than found in relation to other STEM degrees except for biology (which was comparable at 63%);
- Physics students were least likely (7%), the same proportion as in biology and engineering, to cite feeling 'good at' the subject as a primary reason for pursuing the subject at degree level, in contrast to 23% in chemistry and 45% in maths;
- Physics students were in between students in other areas in their tendency to cite positive views of jobs in the field (19%) as the main reason for their choice, lower than computing (23%), engineering (27%) and biology (23%) but higher than maths (17%) and chemistry (10%).

Figure 8: The reasons young people who had taken A level subjects that would have enabled them to apply for STEM degrees gave for their decision not to pursue these subjects:



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

- The reasons given by young people for not choosing physics are broadly in line with those for other STEM subjects. 61% of survey respondents cited their dislike or hatred of physics along with feeling less connection with, or interest in, physics compared with other subjects;
- 26% cited feeling 'bad at' or 'not good enough at' physics, which was sometimes due to experience of A level physics;
- Only 6% cited negative perceptions of jobs in physics as a reason for not pursing it at university, though 7% gave not wishing to go to university as their reason, second only to computing (10%).

6.2 HE students' experiences on university STEM courses

University students were asked about their degree experiences. As Table 7 shows, the highly positive views found among young people taking physics, chemistry and biology A levels are less evident among university degree students[27]. Generally, more chemistry, biology and engineering students found their courses interesting than physics, computing and maths students. However, overall, these numbers were quite low in that under half of students found their degrees interesting.

- Generally, chemistry and engineering students were more likely to agree that their degree course would help them in the future, compared with students taking degrees in biology, physics and maths.
- More chemistry and biology degree students agreed that they liked their lecturers compared with those taking physics and other STEM subjects.

- Maths, physics and computing students were least likely to agree that they found their course material easy to learn.

- Chemistry degree students were the most likely to agree that their tutors think they are good at the subject whereas computing students were the least likely to agree. Similar levels of agreement were expressed by physics, biology, maths and engineering students.

Table 7: Experiences related to teaching and learning (agree/strongly agree)

	Chemistry (n=75)	Biology (n=81)	Physics (n=35)	Computing (n=103)	Engineering (n=105)	Maths (n=79)
We learn interesting things on my course	49.3%	45.7%	**40.0%**	38.8%	44.8%	26.6%
The things we learn on my course will help me in the future	48.0%	29.6%	**28.6%**	35.0%	41.9%	22.8%
I like my lecturers and teachers	41.3%	39.5%	**31.4%**	29.1%	33.3%	27.8%
I find the material on my course easy to learn	18.7%	21.0%	**17.1%**	18.4%	23.8%	15.2%
My lecturers and tutors think I am good at the subject	32.0%	23.5%	**25.7%**	19.4%	28.6%	26.6%

Respondents were also asked about their experiences on the course beyond teaching and learning. (See appendix for details.) Due to low numbers, these figures need to be interpreted cautiously, particularly in physics. However, generally it was noted that:

- Under half of students on physics (and computing) courses agreed that A levels had prepared them well for degree study, and biology students felt significantly less prepared compared with other subjects.

- With the exception of engineering (at 30%), under a quarter of students in STEM courses also felt their education was value for money: chemistry (22%), biology (22%), physics (19%), computing (20%), and maths (19%).

- Over half of students in each STEM discipline felt they 'belonged' on their courses. Computing students expressed the lowest levels of agreement (this difference was statistically significant) and nearly two thirds said they would choose the same course again.

6.3 Experiences of sexism on STEM degrees

Drawing on survey data from 798 STEMM students and 1,959 students doing other degrees on their experiences of sexism, women were significantly more likely than men to have experienced sexism in their educational setting during the past year. Women in STEM were significantly more likely than those in other fields to experience sexism in their educational setting. Focusing on STEM and high-status medicine degrees, women in mathematics (3%) and biology (10%) were the least likely to report sexism and women in physics (50%) and engineering (30%) the most likely.

Across the board, women most frequently attributed their experiences of sexism to their male peers. Analysis of the longitudinal interview data showed that peer sexism usually involved gendered microaggressions, and everyday acts of disdain and disrespect, such as questioning women's academic legitimacy, ignoring or patronising them. As suggested in the wider literature, such experiences may reflect the discourses linking STEM with masculinity and broader inequalities between men and women.

Conclusions and Recommendations

This report makes five key summary recommendations for policy and practice:

1. Address imbalances in school physics policy;
2. Prepare and support teachers of physics;
3. Develop and embed more equitable school physics practice;
4. Strengthen school careers support in physics; and
5. Improve experiences, equity and belonging in physics.

1. Address imbalances in school physics policy

The ASPIRES analyses identified that even by Year 9, students are expressing less positive views of physics compared with the other sciences. This lag persists over time and is related to the widespread student perception that physics is "harder" and more difficult than other sciences. Students at KS3 are also less likely to be taught by a specialist physics teacher (*see Recommendation 2*) – an issue that particularly impacts students from lower socio-economic backgrounds[28]. The following suggestions are designed to help address these issues through a rebalancing of school physics policy. The recommendations are primarily aimed at national government and professional bodies.

- **Champion the importance of KS3 physics and focus more attention on improving the quality and consistency of provision and engagement.** Key Stage 3 (Years 7-9) often receives less strategic focus in comparison to high stakes national examination years. Yet KS3 provides a vitally important foundation in subject knowledge and is a key time when students are forming their attitudes towards the subject. A greater strategic focus on KS3 would thus offer considerable potential and opportunity for improving physics participation. A clear national policy emphasis and championing of the strategic value of attending to and investing in KS3 provision could help alert schools to the importance of addressing the attitudinal deficit in physics and provide motivation/impetus to review and address KS3 physics provision within school improvement plans. Note – we are not advocating for high-stakes national assessment to be introduced at KS3.

- **Bring entry requirements for physics A level into line with other subjects. As illustrated by case studies in the ASPIRES data and shown by wider national analyses** by Ofqual[29], it is not uncommon for schools to require higher prior GCSE attainment to enrol on A level physics, compared with non-science courses. This practice arguably restricts the pool of potential physics students and contributes to perceptions of physics as being harder and more difficult than other subjects. It is recommended that – in conjunction with steps to address grade severity and curriculum level in physics – there should be a parity across all subjects in terms of the prior attainment grades required for entry (whilst ensuring that students are suitably prepared and supported for the challenge of any advanced level course).

- **Address grade severity in A level physics.** For many years, it has been widely recognised and evidenced that A level physics sets higher level content and is hence graded more severely than many other subjects. Grade severity is a factor driving higher GCSE entry grade requirements for physics A level. The lower grade boundaries associated with grade severity can negatively impact students' confidence in their achievement and contribute to perceptions of physics being more difficult than other subjects. We thus call for:

  – An independent review and analysis of extent and impact of current grade severity and its impact on student engagement and progression.

  – Exam boards to review grade boundaries and consider the impact that low boundaries have on students, particularly in terms of differential impacts by gender and other under-represented student characteristics.

- **Reduce 'jumps' in the complexity of physics content between educational levels.** ASPIRES found that students found it challenging when there were large jumps in the level and complexity of content between educational stages, such as between GCSE and A level. Many students also did not feel that they had been adequately prepared for degree level study by their A levels. It is recommended that:

  – Steps are taken to identify and facilitate progression in the level of content between key stages of learning. Greater cooperation between schools, examination boards and the university sector may be helpful.

  – Examination boards to consider equity issues when setting content level and be mindful of the differential impact that excessively challenging content and 'jumps' may have on engagement and progression across different learner communities.

  – Universities to consider their entry requirements and whether the physics 'pipeline' might be grown and diversified through less restrictive requirements.

- **Addressing the impact of Double/Triple Science GCSE qualification routes on STEM progression.** ASPIRES found that taking Triple Science was significantly positively associated with the likelihood of a student taking one or more A levels and/or a degree in a STEM subject[30] and that the stratification of GCSE science into the two routes had a negative impact on the views and chances of those taking Double[31]. It is recommended that:

- Policymakers could usefully (i) commission further research into the reasons for poor STEM progression outcomes from Double Science, including reviewing curriculum levels for parity, or otherwise; and (ii) explore the potential for alternatives, based on available evidence and feasibility analyses.

2. Prepare and support teachers of physics

In addition to students generally expressing less positive views of physics compared to the other sciences, the ASPIRES research found that students were comparatively less likely to be positive about their physics teachers, both in terms of the quality of teaching and high rates of teacher turnover. The recruitment and retention of subject specialist physics teachers is a pressing issue nationally, as evidenced by the Institute of Physics (2025) 3Rs report, and is linked to lower progression in the subject. For instance, the report notes that "students in schools without any in-field physics teachers are about five times less likely to progress to A level physics"[32]. In response, it is recommended that:

Government:

- Take steps to improve the recruitment, retention and retraining of physics teachers, as per the IOP (2025) recommendations, for example, by investing in long-term delivery and scaling up of good quality in-service retraining courses for non-subject specialist teachers, such as Subject Knowledge for Physics Teaching (SKPT) and reviewing onerous accountability measures.

- Increase funding and advocate for all science teachers to receive ongoing, high quality professional development in both subject-specific[33] [34] and equity areas.

School leaders:

- Foster an institutional culture/ ethos that supports and encourages teacher communities of practice and all teachers, but particularly physics teachers, to access and engage in relevant professional development (especially in relation to equitable pedagogy, see Recommendation 3).

- Strategically support leadership development for physics teachers (for instance via NPQs or other mechanisms).

3. Developing and embedding more equitable school physics practice

The ASPIRES research found evidence of declining engagement with physics over time, but particularly among girls and other under-represented communities. These findings resonate with the findings of the Science Education Tracker 2023[35], which identified declining engagement among 11–14-year-olds and a growing gender engagement gap in science. ASPIRES data also showed that boys and girls reported receiving differential encouragement from teachers to continue with science. ASPIRES identified a range of common pedagogical practices in physics that reproduce the elite culture of physics and work to exclude less privileged students. We conclude that the engagement 'gap' might be best conceptualised as a 'debt'[36] (Ladson-Billings 2006), which is owed to those who are marginalised and excluded within physics. As a result, it is recommended that:

Government:

- **Reduce the volume of content in the curriculum** to allow teachers and students more space to build subject understanding, engagement and enjoyment.

- **Introduce equity as a core strand in the Initial Teacher Training and Early Career Framework (ITTECF).** Currently this is a significant gap in the ITTECF, meaning that new teachers are not being sufficiently supported and prepared for equitable practice and, as a result, are likely to keep reproducing existing unequal patterns of participation and engagement.

Government, school leaders and STEM education organisations:

- **Champion equity-based teaching approaches and resources** that help physics teachers to understand, identify and change common exclusionary pedagogical practices and representations and to teach in ways that build engagement among all students, but particularly those from under-represented demographics. For instance, approaches such as the Science Capital Teaching Approach can help teachers to build engagement among diverse students by personalising and localising science content to the identities and experiences of the students in their classes. For instance, the SCTA has been found to be effective with physics teachers in Wales. Strengthening physics teachers' communities of practice can also be highly effective and beneficial for supporting and embedding sustainable change.

- **Support and advocate for the importance of critical reflective practice in teaching**. Critical reflective practice (CRP) is key to good teaching and is an important cornerstone of equitable pedagogy. Yet it is still not common practice in many schools. Advocating and supporting teachers to have the necessary time and resource to engage in CRP can be hugely beneficial for the effective embedding of equitable practice. Sharing and promoting existing resources (such as the Equity Compass reflective tool) can also help.

- **Ensure that all science teachers, including physics teachers, have access to ongoing, high-quality subject – and equity-relevant professional development**. Ongoing professional development is valuable for all teachers. But it may be particularly beneficial to support and champion professional development for KS3 teachers of physics, both in relation to engaging inclusive practice and for those who are required to teach outside their specialism. This is key to help address low engagement in physics at KS3 and the entrenched (gender) engagement debt.

4. Strengthen school careers support in physics

ASPIRES found that, compared with other sciences, students tend to see physics as being less relevant for their future lives and trajectories. This is compounded by persistent experiences of physics as being less engaging than other sciences. In response, strengthening careers support and messaging around physics (both in and beyond physics lessons) could be beneficial. It is recommended that:

Careers education, information, advice and guidance (CEIAG) professionals and leads:

- Continue to strengthen physics-specific careers support and ensure that messaging conveys the transferability of physics skills and qualifications for a wide range of jobs both in and beyond physics and STEM.

- Proactive sourcing of physics-related work experiences, placements and opportunities could also be beneficial. Furthering partnerships with businesses and industry may be helpful in this respect.

School leaders:

- Support physics teachers to understand and appreciate their valuable role as trusted sources for students. Encourage classroom teachers to convey the value of physics for life, careers and active citizenship – beyond instrumental engagement with the subject. Use of resources such as the SCTA can also provide practical support and scaffolding on how to do this.

- Facilitate staff to develop physics-specific responses to the Gatsby benchmarks.

5. Improve experiences, equity and belonging in physics

ASPIRES found that physics degree students reported relatively lukewarm experiences of their courses across a range of areas, which wider work indicates may be due to challenging funding and other factors across the sector that look set to exacerbate further. There were also significant issues related to gender inequality, with evidence suggesting that over time, physics students appear to become more gender stereotypical in their views of physics. Relatedly, women STEM students reported significantly more experiences of sexism from peers on their courses compared to those on non-STEM degrees, underlining the ongoing issue of how to challenge gendered STEM cultures. In response, it is recommended that:

HE departments in partnership with professional societies:

- Champion and introduce a culture of equity, inclusion and allyship with the expectation that all physics staff and students have a duty to proactively support others (but particularly those from under-represented communities) to feel included and a sense of legitimate belonging in physics. For instance, this responsibility could be made an expectation of funding received by physics societies. Equity expectations and training might also be usefully provided to those acting as subject ambassadors (students and professionals). STEM allyship resources from the ASPIRES project may also be useful. Ensure that gender focused work is not only restricted to staff (for instance, as per the focus of Athena SWAN) but is also extended to students. The IOP's new Physics Inclusion Award[37], developed as the successor to Project Juno, supports university physics departments in creating welcoming environments for people from all backgrounds.

  The award takes an intersectional approach to equality, diversity and inclusion, with particular emphasis on student inclusion through monitoring gender-disaggregated data and embedding inclusive practices across four key themes: Welcoming and Inclusive Framework, Inclusive Culture, Inclusive Leadership, and Policies and Processes. It encourages reviewing the curriculum to ensure that it is inclusive and representative, to support belonging by showcasing a greater diversity of contributions to physics than is currently the case in most degrees. This is a requirement of the IOP's degree accreditation framework[38], and it is encouraging to see that some departments have improved their curriculum with a wider range of representation.

- Review and strategically connect physics education research that is located within physics departments with wider science educational research. Ensure that practice within university physics departments is informed by STEM equity research insights and physics/ STEM educational insights to ensure that practice is as equitable and effective as possible. Research-practice partnerships may be productive avenues in this respect.

- Provide a career progression framework that ensures physics education researchers are treated equitably to other research active academic staff in all areas including promotion, recognition, and job security.

Further Research

The following areas could benefit from further research and elucidation:

- **What works in terms of improving equitable engagement in physics at KS3?** What does/would good equitable pedagogy look like at KS3 and what impact does it have on student attitudes and choices (and reducing engagement gaps/debts)?
- **What shapes and produces gendered perceptions of the difficulty of physics?** What specific pedagogical practices, societal discourses and wider factors produce and sustain differentially gendered perceptions of the difficulty of physics? For instance, what role does grade severity play? How does student awareness of grade severity influence perceptions of difficulty? To what extent are physics curricula and forms of assessment gendered? How does the framing of physics content reinforce or challenge gendered perceptions of difficulty?
- **What is the impact of the lack of specialist teachers on students' physics engagement and progression?** How/does a lack of specialist teachers influence student engagement and participation? How does this relate, or not, to increases in the perceived difficulty of physics over time and gendered patterns in perceptions of physics?
- **How might we best facilitate culture change within physics towards greater equity and inclusiveness?** What levers and approaches are most effective and able to be used at scale to improve equity and inclusion within physics?
- **What does good equitable practice look like in HE physics?** What impact does this have on student belonging? What are the facilitating and constraining factors to enacting equitable practice and allyship in HE physics?

References

1 Source: A level physics entries hit highest level this century | Institute of Physics

2 A-and-AS-level-trends-June-2025.pdf

3 The survey was conducted in Autumn 2021 and results may have been influenced by experiences of national lockdown and online course provision earlier in the year. However, this would not necessarily account for trends between subject courses.

4 Institute of Physics (2025). The physics teacher shortage and addressing it through the 3Rs: Retention, Recruitment and Retraining (England). London: Institute of Physics.

ASE (2024). *Four election pledges to help transform science education for a brighter future* | www.ase.org.uk

Institute of Physics (2020). *Subjects Matter.*

5 The Science Capital Teaching Approach | UCL Institute of Education

Primary Science Capital Project | UCL Institute of Education

6 Chowdhuri, M.N., & Archer, L. (2023). Getting comfortable with discomfort: supporting primary science teacher educators' capacity for socially just pedagogy, *Journal of Education for Teaching, 50*(3), 479-493.

7 ASPIRES. Additional reports and resources | UCL Institute of Education

8 A Levels are an advanced-level subject qualification that is generally required for university admission. A Level data are collected by National Statistics from awarding organisations that deliver examination entries and results for all qualifications. A Level data are given in the 'A Level and other 16 to 18 results' release series. The A Level data analysed here are from the 'A Level and other 16 to 18 results' release series from 2012/13 to 2021/22. The data set only gives subject entries by sex, rather than any other demographic variables.

9 Archer, L., Moote, J., & MacLeod. E. (2020). Learning that physics is 'not for me': Pedagogic work and the cultivation of habitus among advanced level physics students. *Journal of the Learning Sciences*, *29*(3), 347-384.

10 https://www.jcq.org.uk/wp-content/uploads/2025/01/AS-and-A level-results-summer-2024.pdf

11 Archer, L., Moote, J., Francis, B., DeWitt, J., & Yeomans, L. (2017). The "Exceptional" Physics Girl: A Sociological analysis of multimethod data from young women aged 10–16 to explore gendered patterns of post-16 participation. *American Educational Research Journal*, *54*(1), 88-126.

Archer et al. (2020). See endnote 9.

Francis, B, Archer, L., Moote, J., DeWitt, J., & Yeomans, L. (2017a). Femininity, science, and the denigration of the girly girl. *British Journal of Sociology of Education*, *38*(8), 1097-1110.

Francis, B., Archer, L., Moote, J., DeWitt, J., MacLeod, E., & Yeomans, L. (2017b). The Construction of physics as a quintessentially masculine subject: Young people's perceptions of gender issues in access to physics. *Sex Roles*, *76*(3-4), 156-174.

12 https://ffteducationdatalab.org.uk/2022/06/why-A level-physics-students-are-doubly-penalised-by-grading-severity/

13 Francis, B., Henderson, M., Godec, S., Watson, E., Archer, L., & Moote, J. (2023). An exploration of the impact of science stratification in the English school curriculum: the relationship between 'Double' and 'Triple' Science pathways and pupils' further study of science. *Research Papers in Education*, *40*(1), 1–23.

14 A level physics entries hit highest level this century | Institute of Physics

15 https://www.sciencecampaign.org.uk/analysis-and-publications/detail/school-exam-results-analysis-2024/

16 Hall, R.M., & Sandler, B.R. (1982) *The Classroom Climate – a chilly one for women?* Association of American Colleges, Washington, DC. Project on the Status and Education of Women. ERIC – ED215628

17 Francis et al. (2017a). See endnote 11.

DeWitt, J., Archer, L., & Moote, J. (2019). 15/16-year-old students' reasons for choosing and not choosing physics at A level. *International Journal of Science and Mathematics Education*, *17*, 1071–1087.

18 Archer et al. (2017). See endnote 11.

19 Francis et al. (2017a). See endnote 11.

Francis et al. (2017b). See endnote 11.

20 Archer et al. (2020). See endnote 9.

Gonsalves, A.J., & Danielsson, A. (Eds.) (2020). *Physics Education and Gender: Identities as an analytic lens for research*. Cham, Switzerland: Springer.

21 Boe, M. V., & E. K. Henriksen (2013). Love it or leave it: Norwegian students' motivations and expectations for postcompulsory physics. *Science Education 97*(4): 550-573.

DeWitt et al. (2017a). See endnote 17.

22 Carlone, H. B. (2004). The cultural production of science in reform-based physics: Girls' access, participation, and resistance. *Journal of Research in Science Teaching*, *41*(4), 392-414.

Hazari, Z., Sonnert, G., Sadler, P. M., & Shanahan, M.-C. (2010). Connecting high school physics experiences, outcome expectations, physics identity, and physics career choice: A gender study. *Journal of Research in Science Teaching*, *47*(8), 978-1003.

Mujtaba, T., & Reiss, M.J. (2014). A survey of psychological, motivational, family and perceptions of physics education factors that explain 15-year-old students' aspirations to study physics in post-compulsory English schools. *International Journal of Science and Mathematics Education*, *12*(2), 371-393.

23 Bourdieu, P. (1977). *Outline of a Theory of Practice*. Cambridge: Cambridge University Press.

24 Reay, D., David, M. E., & Ball, S., J. (2005). *Degrees of choice: Social class, race and gender in higher education*. Stoke-on-Trent: Trentham Books.

Walkerdine, V., Lucey, H., & Melody, J. (2001). *Growing up girl: Psychosocial explorations of gender and class*. Basingstoke: Palgrave.

25 IOP (2025). The physics teacher shortage and addressing it through the 3Rs: Retention, Recruitment and Retraining (England)

26 Archer et al. (2020). See endnote 9.

27 It should be noted that the survey was conducted in Autumn 2021 and student responses may have been influenced by their recent experiences of national lockdown earlier in the year, although it is questionable as to whether this would account for variations between individual subjects.

28 Institute of Physics (2025). *The physics teacher shortage and addressing it through the 3Rs: Retention, Recruitment and Retraining (England)*. London: Institute of Physics.

29 Ofqual (2017). *Progression from GCSE to A level: Comparative Progression Analysis as a new approach to investigating inter-subject comparability.*

30 Francis, B., Henderson, M., Godec, S., Watson, E., Archer, L., & Moote, J. (2023). An exploration of the impact of science stratification in the English school curriculum: the relationship between 'Double' and 'Triple' Science pathways and pupils' further study of science. *Research Papers in Education*, *40*(1), 1-23.

31 Archer, L., Moote, J., Francis, B., DeWitt, J. & Yeomans, L. (2016). Stratifying science: a Bourdieusian analysis of student views and experiences of school selective practices in relation to 'Triple Science' at KS4 in England. *Research Papers in Education*, *32*(3), 296-315.

32 Institute of Physics (2025). *The physics teacher shortage and addressing it through the 3Rs: Retention, Recruitment and Retraining (England)*. London: Institute of Physics.

33 Association for Science Education (2024). Four election pledges to help transform science education for a brighter future. https://www.ase.org.uk/news/four-election-pledges-help-transform-science-education-brighter-future

34 Institute of Physics (2020). *Subjects Matter*. https://www.iop.org/about/publications/subjects-matter

35 Hamlyn, B., Brownstein, L., Shepherd, A., Stammers, J., & Lemon, C. (2023). *Science Education Tracker 2023*.

36 Ladson-Billings, G. (2006). From the Achievement Gap to the Education Debt: Understanding achievement in U.S. schools. Educational Researcher, *35*(7), 3-12.

37 Physics Inclusion Award | Institute of Physics

38 IOP-Degree-Accreditation-Framework-July-2022.pdf

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