



## ASPIRES 2: RESEARCH AND POLICY BRIEFING

### WOMEN IN PHYSICS

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#### Background

Participation in post-compulsory physics remains low and unchanged, with the proportion of students studying physics at A level in the UK noticeably lower than those studying other sciences. Not only do a minority of students tend to see physics as 'for me', but the field of physics itself also shapes and normalises its masculine, elite status.

In this project briefing, we present analyses from the ASPIRES 2 project's national surveys of over 13,000 Year 11 students (15/16 years old) and over 7,000 Year 13 students (17/18 years old). We also provide insights from interviews with students and their parents who were also tracked as part of the study.

#### Key findings

- **Students' interest, enjoyment and aptitude for physics are not necessarily sufficient** to enable them to pursue the subject post-16.
- **Physics is represented as a subject for men** and this lack of representation of women in physics leads to the assumption that women are unable to work in physics, or are unsuited to it.
- **Femininity and 'girlyness' are excluded from physics**, with young people and their parents suggesting that 'girly girls' wouldn't continue with physics because of their focus on appearance and a lack of intelligence.
- **Girls who do physics are exceptional**, possessing high levels of cultural, social and science capital while not conforming to popular 'girly' femininity.
- **Physics is highly effective at maintaining its elite status** by not letting in the 'wrong' type of students and by ensuring that those students who do gain entry accept the status quo.
- **The notion of the 'effortlessly clever physicist'** ensures that students blame themselves for not gaining access to physics education and careers, and maintains physics' status as the 'hardest' science.
- **Gatekeeping practices by schools** work to disbar potential students from studying physics and leads other students to self-exclude.

## Recommendations

These recommended approaches may help to challenge the elitist nature of physics and both widen and broaden participation in post-16 physics. Significant change is needed and this will only be achieved by transforming the field of physics itself.

- Those people who work within the field of physics must understand and accept that they must genuinely address the effects of inequality in their field.
- The field of physics must abandon its strict gatekeeping practices and open up the field to more diverse participants, e.g. post-compulsory physics should be accessible to more than just the 'exceptional' girl. The field of physics should develop a broader acceptance of who can aspire to and 'do' physics.
- Students should be allowed entry onto physics courses with lower attainment scores.
- The split between 'real' and school physics must be addressed.
- A more gender equitable culture must be achieved.
- We propose changes to the way science – and physics in particular – is taught in the classroom.
  - The syllabus should be re-examined and restructured to be more attainable and relevant for a wider range of students.
  - The Science Capital Teaching Approach can help to increase student engagement and participation in physics.

**Methodology: the ASPIRES 2 study**

The ASPIRES 2 project is the second phase of a major national longitudinal research project, funded by the Economic and Social Research Council (REF: ES/L002841/1 & 2), investigating young people's science aspirations and career choices age 10-19. ASPIRES 2 is the second phase of the study, extending the tracking of the cohort from 14-19. ASPIRES 2 commenced in February 2014 and will end in 2019. All findings from both phases of the study can be found at [www.ucl.ac.uk/ioe-aspires](http://www.ucl.ac.uk/ioe-aspires).

The research involves large national surveys of the student cohort (over 40,000 surveys to date) and over 650 in-depth longitudinal interviews with a tracked subsample of students and parents. This briefing reports on findings from a survey of 13,000+ Year 11 students (age 15/16, GCSE year), a survey of 7,000+ Year 13 students (age 17/18) and interview data.

*Survey sample:*

This report draws on data from two surveys. The first was administered to students in Year 11 (age 15/16 years) in the academic year 2014/15 and was completed by 13,421 students who were recruited from 340 secondary schools in England.

The second survey tracked the same cohort of students in Year 13 (age 17/18) in the academic year 2016/17 and was completed by over 7,000 students studying in sixth forms and higher education institutions around the country.

This sample of school represents all regions of the England and is roughly proportional to the overall national distribution of schools as measured by attainment and proportion of students eligible for free school meals.

*Interview sample:*

We conducted two sets of interviews in Year 11 and Year 13. The Year 11 interviews were conducted in spring 2015 with 70 students and 66 of their parents. Students chose their own pseudonyms for the project at age 10/11.

The reported interview data pertains to 132 interviews which were conducted with 70 students and 62 parents (all of whom had been previously tracked since students were at primary school, age 10/11), conducted while the students were in Year 11 (age 15/16 years).

Throughout this briefing, any reference to 'significance' relates to the results of chi-square tests for independence with post-hoc analyses investigating cellwise adjusted residuals. Any odds ratios presented refer to the results of logistic regression analyses. Please contact the authors for further details if required.

## Findings

### Who is studying physics?

The profile of students who study *any* science at A level is very similar. These students are more likely to be Asian (or Middle Eastern) and have high levels of cultural capital. They are also more likely to be in the top set for science and have family members working in science.

Gender was the biggest difference between the science students taking physics and not taking physics at A level. 36% of boys in our survey were planning to study A level physics compared to only 14% of girls; a highly significant difference.

For students wanting to study A level physics, high attainment and the 'hard', exceptional nature of the subject fitted well with their identity, making them well-suited to a subject with a difficult, distinctive image.

### Students' interest, enjoyment and aptitude for the subject are not necessarily sufficient to enable them to pursue physics post-16.

The 'gender problem' in physics is a long-standing issue, with women remaining under-represented despite decades of interventions. Therefore, physics remains a risky, challenging education and careers option for young women. In fact, girls' choices not to pursue post-16 physics are rational and strategic, especially as gender inequality within physics renders their success harder.

### Physics is represented as a subject for men.

The lack of representation of women in physics (both in reality and in the media) leads to the assumption that women are unable or unsuited to working in physics.

Girls within our study discussed being the only girl in their physics classes and the pressure that comes with being in this position:

*"...I knew I was going to be the only girl, I was getting really worried because then I was like ... if I'm the worst in the class it's just going to be like extra pressure because you don't want to ... I guess being a girl can put extra pressure on you, cos you don't want to be like 'oh you're bad because you're a girl'. And you don't want to be the worst and then people would be like 'Oh'" - Hannah*

Hannah was one of the highest attaining students in our qualitative sample and eventually applied to do a physics degree at university, and yet she was still concerned about being good enough to justify her place in the class.

The 'difficult' image of physics as the 'hardest' subject also feeds into the idea that physics education and careers are only suitable for men.

### **Femininity and ‘girlyness’ are excluded from physics**

Evidence shows that ‘girlyness’ is hard to maintain over time in association with science.<sup>1</sup> Both young people and their parents suggested that ‘girly girls’ were less likely to continue with physics as they focused on their appearance and had a lack of intelligence. Furthermore, 57% of boys agreed that girls who are ‘girly’ are less likely to pursue physics, compared to 41% of girls.

Interestingly, a number of young people we interviewed also said that *anyone* can do physics – even ‘girly girls’ – and rejected the idea that ‘girly girls’ are discouraged from physics.

*“I think like, you can’t be stereotypical... If they enjoy [physics] then they can do it, so I think it completely depends on the person.” – Isabel*

These two contrasting viewpoints are not mutually exclusive. Physics participation is seen as both an individual choice and a socialised decision based on stereotypes.

Not only should physics – and science in general – be opened to all, but existing stereotypical constructions of femininity and ‘girlyness’ should also be challenged.

### **Girls who do physics are exceptional.**

Our research shows that young women who aspire to study physics possess high levels of cultural, social and science capital. They are also highly attaining and don’t conform to ‘girly’ popular femininity. As Davina noted in her Year 11 interview, girls who study physics are “*not like your average person*”.

When we interviewed our qualitative sample of students in Year 11 and asked about their post-16 aspirations, only seven girls reported wanting to study A level physics. Six of these girls had the body, mind and capital suited to the ‘hard’, ‘masculine’ image of physics, meaning they were more likely to succeed in post-16 physics.

However, a seventh girl instead identified as a ‘party girl’ and not ‘brainy’. She also lacked family science capital and was largely unsupported in her aspiration to study A level physics. Subsequently she found it harder to succeed and chose to aspire to other non-STEM careers.

**Physics is highly effective at maintaining its elite status** by not letting in the ‘wrong’ students and by ensuring that those students who do gain entry accept the status quo.

**The notion of the ‘effortlessly clever physicist’** ensures that students blame themselves for not gaining access to physics education and careers. In turn, this maintains physics status as the ‘hardest’ science.

For young women in particular, they struggled to recognise themselves as ‘good at physics’, regardless of their actual attainment or whether they continued to study physics post-16.

Their need to 'work hard' concerned them; as Hannah noted "*there'll be people who like completely breeze through it*".

The fantasy of the 'effortlessly clever physicist' deters even highly able, interested young women from aspiring to post-18 physics education and careers. We therefore ask - if the highest attaining young women don't see themselves as 'clever enough' to pursue physics, who does?

**Gatekeeping practices by schools** also work to disbar potential students from studying physics and leads other students to self-exclude. Physics typically demands higher level entry qualifications and is marked more harshly than other subjects<sup>ii</sup>.

The 'failure' of students to gain entry to or remain on post-16 physics courses is attributed to individual students. This maintains the subject's elite and 'difficult' image, and the idea that physics is 'only for the clever'.

## Conclusions and Recommendations

The UK has disproportionately high grade requirements for entry into physics and this restricts who is allowed to choose physics'. This also reinforces physics' 'hard' image so students are less likely to see the subject as 'for me'.

We propose that there should be a change in the way that physics – and science more broadly – should be taught. ASPIRES 2's sister project [Enterprising Science](#) has developed the [Science Capital Teaching Approach](#), which aims to improve student engagement and participation in science and make it more equitable. This approach includes [broadening what is recognised](#) and valued in the science classroom, by drawing on students' own experiences and contributions.

### Publications summarised in this spotlight report:

- Becky Francis, Louise Archer, Julie Moote, Jen DeWitt, Emily MacLeod, & Lucy Yeomans. (2016). *[The construction of Physics as a quintessentially masculine subject: Young people's perceptions of gender issues in access to Physics](#)*. Sex Roles. doi: 10.1007/s11199-016-0669-z
- Becky Francis, Louise Archer, Julie Moote, Jen DeWitt & Lucy Yeomans. (2016). *[Femininity, science, and the denigration of the girly girl](#)*. British Journal of Sociology of Education. doi: 10.1080/01425692.201
- Archer, L., Moote, J., Francis, B., DeWitt, J., & Yeomans, L. (2017). *[The 'exceptional' Physics girl: A sociological analysis of multi-method data from young women aged 10-16 to explore gendered patterns of post-16 participation](#)*. American Educational Research Journal. doi: 10.3102/0002831216678379.
- DeWitt, J., Archer, L. & Moote. (2018). *[15/16-Year-Old Students' Reasons for Choosing and Not Choosing Physics at A Level](#)*. International Journal of Science and Mathematics Education. doi: 10.1007/s10763-018-9900-4.
- Archer, L., MacLeod, E., & Moote, J. (in press). *Going, going, gone: a feminist Bourdieusian analysis of young women's trajectories in, through and out of physics, age 10-19*. In Danielsson, A., & Gonsalves, A. (Eds.), (forthcoming). *Physics Education and Gender: Identity as an Analytic Lens for Research*. Springer Press.
- Archer, L., Moote, J. & MacLeod, E. (in press). *Lighting the fuse: Cultivating the masculine physics habitus – a case study of Victor aged 10-18*. In Danielsson, A., & Gonsalves, A. (Eds.), (forthcoming). *Physics Education and Gender: Identity as an Analytic Lens for Research*. Springer Press
- Archer, L., Moote, J. & MacLeod, E. (under review). *Learning that physics is 'not for me': pedagogic work and the cultivation of habitus among Advanced Level physics students*.

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<sup>i</sup> See Walkerdine, V. 1990. *Schoolgirl Fictions*. London: Verso Books & Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, and Wong, B. 2013. "'Not Girly, Not Sexy, Not Glamorous': Primary School Girls' and Parents' Constructions of Science Aspirations." *Pedagogy, Culture & Society* 21 (1): 171–194.

<sup>ii</sup> See the Institute of Physics' blog on 'Do students choose subjects based on how hard they are graded?' <http://www.iopblog.org/the-effects-of-grading-on-choice/>