

Written evidence submitted by Professor Rachel Oliver FEng, University of Cambridge, Dr Jess Wade BEM, Imperial College London, Dr Izzy Jayasinghe, FRMS, The University of Sheffield, Angela Saini, science journalist and author, and Professor Christina Pagel, University College London (DIV0106)

Having listened to the evidence given to the committee by Ms Katharine Birbalsingh, Chair of the Social Mobility Commission and Headmistress and co-founder of Michaela Community School, during the oral evidence session on 27th April 2022, we are writing to provide evidence-based counterpoints to some of the issues raised. We will cite appropriate literature in support of these arguments.

When reflecting on the gender imbalance of her school's A-Level physics cohort, Ms Birbalsingh stated that "*Physics is not something that girls tend to fancy,*" and backed this statement up with two assertions: "*There is a lot of hard maths in [physics] that I think that they would rather not do,*" and "*In the research, generally, people say that that [girls not wanting to do hard maths] is just a natural thing.*" We contend that these assertions are not grounded in fact, and embody the types of attitudes which limit girls' access to physics and engineering as subjects for advanced study and as a gateway to future careers.

Addressing first the suggestion that girls avoid physics because of a dislike of "*hard maths*": this seems ill-founded, given that in 2021, 39% of maths A-level students were girls¹, a significantly greater representation than is seen in physics, where only 23% of students are girls. Moreover, girls outperformed boys in both A-level and GCSE maths last year². It is self-evident that there is more "*hard maths*" in A-level maths than A-level physics. The extent to which attributing poor gender balance in the A-level physics cohort to excess "*hard maths*" is misguided is illustrated by the fact that physics education experts are currently concerned about the *low* level of maths in both the A-level and GCSE physics curricula³. Considering the potential impact of training in physics as a means to improve social mobility, it is vital to understand that the same physics education experts suggest that *more* mathematics and problem solving in the A-level curriculum might empower a greater range of students to continue in STEM to University level⁴.

Given that an excess of "*hard maths*" is not a logical explanation for the paucity of women students in the A-level physics cohort, what else might explain this trend? The Institute of Physics (IOP) have researched the under-representation of women in physics for more than 30 years⁵. Their findings

¹ McCulloch, A. (2021) *Females overtake males at A-level maths, as STEM gender gap narrows* <https://www.personneltoday.com/hr/females-overtake-males-at-a-level-maths-as-stem-gender-gap-narrows>

² Richard Adams (2021) *Girls overtake boys in A-level and GCSE maths, so are they 'smarter'?* <https://www.theguardian.com/education/2021/aug/13/girls-overtake-boys-in-a-level-and-gcse-maths-so-are-they-smarter>

³ Warner, M. *Isaac Physics Programme* <https://www.tcm.phy.cam.ac.uk/~mw141/rspp.html>

⁴ Cambridge Assessment (2016) *How questions from the past are creating the physicists of tomorrow* <https://www.cambridgeassessment.org.uk/news/how-questions-from-the-past-are-creating-the-physicists-of-tomorrow/>

⁵ Institute of Physics (2021) *What we're doing to address gender imbalance in physics* <https://www.iop.org/what-were-doing-address-gender-imbalance-physics>

suggest that girls' subject choices are strongly influenced by the opinions of trusted adults around them – teachers and parents – and that they are less likely to choose physics if at school they encounter sexist language, gender stereotypes, and a lack of support⁶ in developing self-confidence and resilience⁷. Crucially, it is not only the behaviour of physics teachers that impacts girls' subject choice: perceptions of physics are formed beyond the physics classroom, and stereotyping or sexist comments by teachers in other subjects can be very off-putting for young women considering physics⁸.

The IOP has shown that schools that exacerbate the gender imbalance in physics also do so in other subjects, e.g. Psychology and English are dominated by girls whereas Physics and Economics are dominated by boys. Their research also shows that girls in independent, single-sex schools were 2.5 times more likely to study physics than those in co-educational state-maintained schools, indicating the reasons girls opt out of physics are rooted in school culture and self-concept. The IOP recommends a whole school approach to addressing gender equity, which must be championed by the senior leadership team, must give students ownership of the strategies to overcome sexism and other biases, and must be supported by training of all staff in gender awareness and stereotypes⁷. Ms Birbalsingh, in her comments to the committee, appears to have overlooked the IOP's research, which uses both statistical analysis from the *National Pupil Database*⁸ and evidence gathered from hundreds of teachers and pupils in schools across the country⁷.

Despite having shown that it has little relevance to the question of the under-representation of girls in A-level physics, we will also briefly address Ms Birbalsingh's second assertion, in which she suggested that girls liking maths is not "natural". The idea that girls are naturally less inclined towards mathematical disciplines has been debunked⁹ on the basis of both poor or biased experimental design, and grossly inadequate statistical evidence. The studies which attempt to prove these assertions very often show very small effect sizes - i.e. the observed differences between men and women are much smaller than the differences seen within the male (or indeed the female) population^{10,11}. Even these small effect sizes have proved extremely hard to reproduce¹². Many such studies attempt to ascribe such (small, irreproducible) observed differences to innate biological causes, overlooking the profound effect of societal conditioning. However, the impact of widespread gender stereotyping and sexism on young women's preferences should not be ignored, particularly given that there is evidence of gendered differences in parental expectations of even infants under 1

⁶ Wade, J. (2022) *Physics is something that girls fancy* <https://physicsworld.com/a/physics-is-something-that-girls-fancy/>

⁷ Institute of Physics (2015) *Opening Doors: A guide to good practice in countering gender stereotyping in schools* <https://www.iop.org/sites/default/files/2019-02/opening-doors-countering-stereotyping.pdf>

⁸ Institute of Physics (2019) *It's Different for Girls: The influence of schools. An exploration of data from the National Pupil Database looking at progression to A-level physics in 2011 from different types of school at Key Stage 4* <https://www.iop.org/sites/default/files/2019-04/its-different-for-girls.pdf>

⁹ Yates, K. (2022) *How true is it that girls just 'don't like' hard maths?* <https://www.independent.co.uk/voices/katharine-birbalsingh-hard-maths-physics-girls-gender-b2069312.html?r=86107>

¹⁰ Ferguson, D (2018) *The book that fights sexism with science* <https://www.theguardian.com/science/2018/aug/11/women-equal-to-men-science-fact-book-angela-saini>

¹¹ Agarwal, P. (2022) *It's not their biology that puts girls off physics, but sexism and low teacher expectations* <https://www.independent.co.uk/voices/katharine-birbalsingh-hard-maths-physics-girls-gender-b2069312.html?r=86107>

¹² Rippon, G. et al. (2014) *Recommendations for sex/gender neuroimaging research: key principles and implications for research design, analysis, and interpretation* <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4147717/>

year old¹³. Furthermore, any attempt to classify men as innately superior at maths or physics must take into account numerous studies which fail to find¹⁴ any gender difference in ability.

In the context of the potential for STEM education to improve social mobility, we must also note that Ms Birbalsingh appears to be inadvertently perpetuating an incorrect stereotype not only about women in physics, but about the discipline of physics itself. Physics is frequently cited as one of the most respected and useful A-Level subjects¹⁵. Physics A-level is a gateway to a range of careers, in finance, broadcasting, policy, data analytics, patent law, clinical science and the whole gamut of engineering disciplines, to name but a few^{15,16}. The implication that the only attribute valued in these careers is an ability to do “*hard maths*”, would be laughable, were it not extremely damaging. The broad range of requirements for management, leadership, communication and interpersonal skills embedded in the UK Standard for Professional Engineering Competence and Commitment (UK-SPEC)¹⁷ help to illustrate the wide variety of traits that can help a student to build a successful career on the foundation of a physics A-level. The opportunities for personal fulfillment¹⁸ and financial security offered by such careers are a compelling reason why the lack of diversity in the physics A-level cohort must be addressed with greater seriousness than was achieved by Ms Birbalsingh in your recent evidence session.

To make these opportunities available to the widest possible range of young people, we recommend that schools nationwide are encouraged to follow the guidelines⁷ provided by the IOP on dismantling gender stereotyping in schools, and that similar guidelines are developed to help counter stereotypes around race or socioeconomic status which may also limit pupil’s access to STEM subjects.

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¹³ Zigic, S. (2021) *Gender Bias in Mothers’ Expectations About Infant Crawling* <https://aceandriley.com/blogs/research-articles/gender-bias-in-mothers-expectations-about-infant-crawling>

¹⁴ E.g. Kish, S. (2019) *Study Finds Brains of Girls and Boys Are Similar, Producing Equal Math Ability* <https://www.cmu.edu/news/stories/archives/2019/november/girls-boys-brains-produce-equal-math-ability.html>

¹⁵ E.g. Success at school *Why Study Physics* <https://successatschool.org/advisedetails/224/Why-Study-Physics>

¹⁶ E.g. University of Surrey (2022) *Top jobs with a physics degree* <https://www.surrey.ac.uk/features/top-jobs-physics-degree>

¹⁷ Engineering Council (2021) *The UK Standard for Professional Engineering Competence and Commitment (UK-SPEC)* <https://www.engc.org.uk/ukspec>

¹⁸ Pagel, C. (2022) *Physics: Do girls avoid it because it’s too hard?* <https://www.sciencefocus.com/news/physics-do-girls-avoid-it-because-its-too-hard/>