Follow up Written Evidence Submitted by Professor Dame Athene Donald, DBE, FRS

(DIV0111)

Following on from the evidence I gave to the Select Committee on May 18th, I would like to add some additional evidence to support the arguments I presented and hence possible actions that could be taken to improve diversity and inclusion in STEM. I believe that the evidence given by several of the speakers in that session, including myself, together with the more recent letter (DIV0106) to the Select Committee from Professor Rachel Oliver, Dr Jess Wade and others, have made clear the evidence does not support the idea that girls just 'don't like hard maths', so I won't rehearse that point again, but provide further evidence pointing to the underlying reasons for the paucity of girls taking A Level in Physics and the actions that might improve diversity and inclusion overall in the STEM subjects.

I believe more attention needs to be paid to early years and the impact messages children receive then have upon their subsequent disciplinary choices. I mentioned in my oral evidence the early years study[1] that showed how young children are when they first identify that boys may be 'smarter' than girls; what is it in the school environment that fuels that belief? Since the perception of brilliance, in much later years, is found to correlate with the percentage of women pursuing PhDs in the USA[2], this early belief is likely to be extremely damaging, narrowing the choices many girls think are open to them. Thus, both the stereotypes of 'scientists are male' portrayed by young children in the long-running Draw a Scientist study[3], and the belief that boys are inherently smarter than girls – despite grades not supporting this belief in general – need to be actively countered within the school environment, and this must start at primary school. Teachers, including head-teachers, have a crucial role to play in countering stereotypes and ensuring the whole school ethos avoids bias of any sort.

It is for this reason I believe OFSTED has a role to play in highlighting equity (gender, obviously, but also racial and in socio-economic terms too) during their school inspections, to remind schools that using outdated stereotypes can reinforce patterns that children may pick up elsewhere and which are damaging both to the individual and society. Teachers should be supported in this, by being presented with tools and evidence to facilitate their actions in this space.

Recommendation: OFSTED inspections to include measures of equity across the protected characteristics and to note progression rates to A Level by gender in key subjects where significant imbalances currently occur.

Mandatory CPD would provide scope for gaining experience in gender-free classroom interventions. Its importance has recently been highlighted in a Royal Society document *Science Education for a Research and Innovation Economy*[4]as important for both

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[1] https://www.science.org/doi/10.1126/science.aah6524

[2] Sarah-Jane Leslie, Andrei Cimpian, Meredith Meyer and Edward Freeland, 'Expectations of brilliance underlie gender distributions across academic disciplines', Science, 347, (2015) pp 262-7

[3] https://srcd.onlinelibrary.wiley.com/doi/full/10.1111/cdev.13039

[4] https://royalsociety.org/-/media/policy/Publications/2022/2022-01-31-sci-uplift-DfE.pdf

recruitment and retention of skilled teachers. Properly resourced and mandatory CPD would permit teachers to gain new skills. The DfE's own work has highlighted the importance of CPD[5]. The current level of resourcing means many schools are hardly able to provide for teachers to engage in this important activity[6], and certainly not at a level equal to international comparators[7].

Primary schools have few teachers with science qualifications, so CPD would also enable teachers to gain confidence in teaching basic science concepts. In the Royal Society's 2014 report *Vision for science, mathematics and computing education*[8], with which I was involved, it was recommended that every primary school should have either in house, or at least access to, at least one subject specialist teacher in both science and mathematics. At that time, it was estimated that a mere 5% of primary school teachers in England held a science degree, and just 3% held a mathematics degree. Teachers at primary school are more likely to be women, and if they themselves lack confidence in teaching the basics of STEM, then this will perpetuate the belief that science is for boys and men. Because SATs are no longer required in science at primary school, there is less incentive for these schools to worry about the problem.

This lack of confidence in teachers whose skillset is not in physics in particular, is even more pronounced at KS3 and 4. The IOP argues forcefully for the importance of subject-specific CPD in order to make Physics a subject accessible to all through good teaching[9]. At every stage, it is important that teachers are aware of how they interact with boys and girls, and whether they exhibit bias in the nature of their interactions. Numerous studies (notably from the Institute of Physics[10]) have shown that teachers are more likely to interact and encourage boys than girls, including specifically in Physics. Such bias reinforces the message that girls don't belong in the subject. The whole school ethos needs to counter indications of bias – which, when it comes to some subjects can be just as damaging for boys –in all subjects and in all interactions.

High-quality teaching is crucial for positive educational outcomes. But good confident teachers also contribute significantly to schools that are diverse, inclusive welcoming places to learn. High-quality teachers who are subject specialists are better able to counter myths about pursuing STEM learning or careers as only being viable for certain groups and help to ensure that all students who wish to can access the full repertoire of science courses. However, nationwide, there is a shortfall in the recruitment of specialist science teachers, particularly in physics, which last year only met 22% of its recruitment target[11], an ongoing problem of long-standing. This is more acute in schools with the highest proportion of disadvantaged students.

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[5] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/704942/Government_consultation_response_-_QTS_and_career_progression.pdf

[6] https://tdtrust.org/2018/01/18/post-code-lottery-teachers/

[7] https://wellcome.org/sites/default/files/developing-great-subject-teaching.pdf

[8] https://royalsociety.org/topics-policy/projects/vision/

[9] https://my.chartered.college/impact_article/towards-a-national-system-of-subject-specific-cpd/

[10] https://www.iop.org/sites/default/files/2019-04/girls-in-the-physics-classroom.pdf

[11] https://explore-education-statistics.service.gov.uk/find-statistics/initial-teacher-training-census/2021-22

Recruitment is not the only problem regarding specialist science teachers; so is retention. Research[12] shows that CPD can play a significant role in retaining teachers, especially in shortage subjects such as physics. It is vital that we retain teachers who are interested and competent, as this will have the biggest impact on ensuring that students of all backgrounds have the opportunity to study the subjects they wish to. Furthermore, for science teachers in particular, it is crucial that they have the opportunity to refresh their subject content knowledge at regular intervals since it is such a fast-moving field.

Recommendation: Introduce mandatory and fully-resourced teacher CPD for both primary and secondary teachers.

Another aspect in the classroom that has the potential to reinforce stereotypes is in the presentation of images and role models. That the national curriculum in science currently include no women is a major failing and could easily be rectified. People of colour should also be explicitly included.

However, there are three further aspects that directly impact on choices children make as they decide about their future directions: the age at which decisions are taken, the breadth of the courses they can take post-16 and the effectiveness of career advice they are given to help them make their decisions. England is an outlier when it comes to the breadth of the curriculum up to age 18, with one of the narrowest education systems in the world: pupils study on average 2.7 qualifications post-16. Often, crucial decisions are taken at the end of KS3, a time when adolescents are particularly impressionable and influenced by those around them, including peers. Thus, children are liable to stick with what is stereotypically seen as acceptable, once again reducing the likelihood of girls continuing with Triple Science, for instance, which can then narrow down what subjects they can stay with post-16.

As the world of work changes with the rising profiles of digital technology, automation and the environment, it has never been more important to ensure that young people are equipped with the necessary skills to thrive and flourish. This needs a broader and more balanced curriculum up to the age of 18. Such a system would inevitably increase the proportion of young people choosing to study maths and science post-16 to the same depth as existing curricula but with a slimmed down content, as having a fourth, fifth and sixth subject would allow this. There are other ways in which these skills could also be developed, such as the promotion of cross-cutting topic areas such as ‘data literacy’ and supporting the implementing of pedagogical approaches which promote inquiry and project-based learning. Further development of Extended Project Qualification could be a route to this. In the interim, the recently developed Core Maths programme might also help facilitate wider numeracy and analytical skills.

Recommendation: Move to a broader post-16 curriculum to allow more subjects to be studied and to defer the age at which decisions are taken until pupils are more mature and able to make better long-term choices.

[12] https://cms.wellcome.org/sites/default/files/science-teacher-retention.pdf

Good quality careers guidance can help to level the playing field, for example in provision of advice about non-A-level routes to careers. This chimes with the findings of the ASPIRES 2 project[13], which found that gender was the biggest difference between students taking physics A level and those taking other sciences at A level. Physics students were also more likely to have high levels of cultural capital, be in the top set for science, have taken Triple Science and have family members working in science. For the benefit of those particular individuals, and for society as a whole, greater linkages are needed between the worlds of school and work, and a professional, active careers service can enable this.

Whilst some of the worst excesses of the careers' advice 'postcode lottery' have been minimised, there remain huge gaps in knowledge. The Sutton Trust publication, *Paving the Way*[14]*,* reports that 36% of secondary students are not confident of their next steps in education training, and 30% of Year 13 students have not completed work experience. For those that have, the placements may have been chosen via gender stereotypes[15]. (This problem relates back to my previous point about schools ensuring gender equity in all they do.) What is frustrating is that there is already a good framework in place for this – the Gatsby Good Career Guidance Benchmarks[16] – but that they are not being properly or comprehensively applied. Benchmark 4 – link curriculum learning to careers – is of particular relevance. It states that "all teachers should link curriculum learning with careers … STEM subject teachers should highlight the relevance of STEM subjects for a wide range of future career paths." The implementation of this, unfortunately, is not uniform. Some broad-brush information about careers should be initiated at primary school.

The launch of T levels, the growth of apprenticeships and the increased complexity of the job market post-COVID, means that careers guidance is more important than ever. According to the Sutton Trust, impartial, high-quality careers advice is a core element of social mobility. Students from lower socio-economic backgrounds are less likely to have access to a wide range of knowledge and guidance from family and friends, or to have networks which provide an insight into a range of career options. This is a space in which local industry may have a key role to play, both in terms of offering placements (for work experience or as part of T-Levels), but also by going into schools and talking about what their world of work actually entails. The Speakers for Schools programme[17] is an excellent initiative in this regard. Diversity of speakers performing different roles will be important.

Recommendation: Improve careers advice in all schools, ensuring pupils are made aware of the full range of opportunities, regardless of their gender, race or socio-economic background, and can see how it links to the school curriculum.

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13 https://discovery.ucl.ac.uk/id/eprint/10092041/6/Moote_9538%20UCL%20Aspires%202%20report%20online%20version.pdf

14 https://www.suttontrust.com/our-research/paving-the-way/

15 https://www.gov.uk/government/publications/girls-career-aspirations

16 https://www.gatsby.org.uk/uploads/education/gatsby-careers-4-pager-updated.pdf

17 https://www.speakersforschools.org/

Finally, since the lack of diversity in those entering the STEM workforce is a major issue for society, including in the framework of 'levelling up', it would be helpful if the DfE worked closely with other departments, most notably BEIS, but also DLUHC. Education needs to join up with the world of work, but also ensure opportunities for satisfying and rewarding careers are equally distributed around the country.

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