Written Evidence Submitted by King's Maths School

(DIV0078)

1. Overview

1.1 Throughout this submission we focus on our specialist area, the mathematical sciences, specifically looking at the issues facing female students, students from disadvantaged socioeconomic backgrounds, and Black students.

1.2 We suggest that students from disadvantaged socioeconomic backgrounds and Black students face similar barriers, namely that of lower attainment preventing access to higher education in the mathematical sciences. Female students have a subtler issue of deselecting from these types of subjects due to a societally constructed idea that these subjects are not for them or that specialising in only the mathematical sciences is not a positive thing.

1.3 We recommend that to fix the attainment barriers for Black and socioeconomically disadvantaged students requires government funding for long-term, high-quality intervention run by organisations with a proven track record of impact in this area where it is diversified by ethnicity or socio-demographic differences.

1.4 We already know that there needs to be a society wide shift in attitudes around females in STEM and that much effort and resource is already being expended on this change. However, there is a crucial change point aged 16 when female students' options for university and beyond are determined by their A level subject choice. We suggest research to understand the decision framework that influences young female students' decision regarding their subject specialist choices at this point, would be an important first step.

2. Who are we?

2.1 King's Maths School was the UK's first Maths school, part of the government's Industrial Strategy to help to address shortages of highly skilled graduates in sectors that depend on science, technology, engineering and mathematics (STEM) skills. We are a state-funded school for students aged 16-19 run in partnership with King's College London and we provide a unique opportunity for the brightest and best young mathematicians to stretch themselves and prepare for further study and work in the mathematical sciences.

2.2 Students take A-levels in Mathematics, Further Mathematics and Physics, as well as an AS in either Computer Science or Economics. Our students have experienced incredible academic success since we opened in 2016 and our results and value added put us as the highest performing school nationally compared to both state and independent schools[1]. Last year, 78% of grades were A*s, and 95% were A or better. Students attained on average three-quarters of a grade per entry better than was predicted by their GCSE results. More than 25% of leavers are going to Oxbridge, with all others progressing to highly competitive options.

2.3 We are uniquely placed to comment on the issues surrounding diversity in the mathematical sciences since we work directly with students from these underrepresented groups at a pivotal point in their journey towards a career in the mathematical sciences. Not only do we experience, and have to overcome, similar challenges in underrepresentation within our own cohort but as part of our commitment to widening participation we run many successful outreach programmes for students aged 9 – 18 from these underrepresented groups.

2.4 As a result of our school's ethos of teaching the mathematical sciences from a subject first rather than an outcomes first perspective, and because of our ability to create a mathematical community within our cohort, every student at our school achieves, regardless of gender, ethnicity or socio-economic background.

3. The nature or extent to which women, ethnic minorities, people with disabilities and those from disadvantaged socioeconomic backgrounds are underrepresented in STEM in academia and industry

1. Department for Education, 2019, *Compare School Performance Service*, viewed 14 January 2022, <https://www.compare-school-performance.service.gov.uk/schools-by-type?step=default&table=schools&region=all-england&for=16to18&orderby=ks5.0.TALLPPE_ALEV_1618&orderdir=asc>.

students, fewer free school meals students, and fewer Black students than is seen in the general population. Interestingly we don't see a lack of diversity from other ethnic groups and 57% of our cohort are from ethnic

minority backgrounds. Regarding the identified groups however, we are significantly overrepresenting these groups when you use comparative populations, such as the percentages studying the mathematical sciences at A level at other institutions.

3.2 For example, at a national level, 20.8% of students in education are eligible for free school meals[2]. However, when we break this down to a more applicable statistic looking at the number of students studying Further Mathematics A level, the percentage of students eligible for free school meals drops to 3.3%[3]. Our targeted recruitment and admissions support means that we overrepresent this group compared to national numbers with 11% of our cohort eligible for free school meals. 8.5% of our students identify as Black or Mixed Black which is above the national percentage of 3.3%[4] but below the London figure of 15.6%[4]. However, once you again make a more applicable comparison, with only 3.5% of the students taking the combination of Mathematics, Physics and Further Mathematics identifying as Black, we are once again over representing this group compared to national figures.

A Level Subject	% A* All	FSM students	% FSM achieving A*	Black students	% Black students achieving A*
Further Maths	25.5%	3.3%	14.0%	3.0%	12.2%
Physics	8.9%	3.9%	3.0%	4.2%	2.9%
Combination of Mathematics, Further Mathematics, and Physics	-	3.6%	-	3.5%	-

Table 1: Percentage of students studying A level Mathematics, Further Mathematics, and Physics that are eligible for free schools or Black and what percentage of those groups achieve A*s in that subject compared to the general population of students taking those subjects[3]

3.3 A similar picture occurs when we consider how well female students are represented within the mathematical sciences at KS5. All of our students study Mathematics, Further Mathematics and Physics at A level and 34% of our 2021 cohort identified as female. This is a direct result of our female applications to the school being roughly 30-35% each year. The table below shows the A level entry figures for Mathematics, Further Mathematics, and Physics for 2021. Taking the subjects individually our figures are 117% of the background proportion for Further Mathematics and 147% for Physics, without controlling for academic performance.

A Level Subject	Male entries (%)	Female entries (%)
Mathematics	61%	39%
Further Mathematics	71%	29%
Physics	77%	23%

Table 2: Percentage of male and female students studying A level Mathematics, Further Mathematics, and Physics in England in 2021

2. Department for Education, 2021, *Explore Education Statistics Service - Schools, pupils and their characteristics*, viewed 14 January 2022, < https://explore-education-statistics.service.gov.uk/find-statistics/school-pupils-and-their-characteristics>
3. Department for Education, 2021, *Explore Education Statistics Service*, viewed 14 January 2022, <https://explore-education-statistics.service.gov.uk/data-catalogue/a-level-and-other-16-to-18-results/2020-21>.
4. Office for National Statistics, 2011, *Ethnicity Facts and Figures Service – UK Population by Ethnicity*, viewed 14 January 2022, < https://www.ethnicity-facts-figures.service.gov.uk/uk-population-by-ethnicity>.

4. Why are these groups are underrepresented?

4.1 The underrepresentation of females in the mathematical sciences seems to have a different root cause to the underrepresentation of students from disadvantaged socioeconomic background or the underrepresentation of Black students.

4.2 Our admissions test data shows that students from disadvantaged socioeconomic backgrounds significantly underperform compared to their less disadvantaged peers and we see an even bigger discrepancy between the

performance of Black students compared to the performance of non-Black students. These figures can be seen in the table below of average scores by groups over the last 3 years.

		Female applicants	Male applicants	FSM applicants	FSM6 applicants	Non-FSM6 applicants	Black applicants	Non-Black applicants
2021-22	Mean Admissions Test Score	40	40.8	34.4	34.5	41.9	29.2	42.7
	Median Admissions Test Score	36	38	31.5	32	39	27	39
2020-21	Mean Admissions Test Score	43.5	47.2	35.3	37.2	48.4	34.7	48.2
	Median Admissions Test Score	42	46	34.5	36	46	36	46
2019-20	Mean Admissions Test Score	49.4	54.1	38.8	44.8	53.9	39.3	54.1
	Median Admissions Test Score	48	51	36	41.5	52	36	52

Table 3: Average admissions test scores for King's Maths School entrance for the last 3 years, by demographic groups

4.3 As the table shows there is a stark difference between the average test scores of students who have been eligible for free school meals in the last 6 years (FSM6) and those that haven't. When we further split the data to look only at the students currently eligible for free school meals the picture becomes even worse with the gap increasing further. This is similarly true for the Black students applying and mimics what we see society wide. Both Black students and free school meals students attain lower than their peers at all levels and this is the primary barrier to them accessing competitive degrees in the mathematical sciences and continuing on to STEM based careers. In order to diversify the mathematical sciences, we must focus on improving the attainment for these groups.

4.4 The issue is exacerbated within STEM degrees in particular. We know that a student that achieves a 6 in GCSE English is more likely to achieve a competitive grade in A level English than a student who achieves a 6 in GCSE Mathematics is to achieve a competitive grade in A level Mathematics. This is then made increasingly more challenging for lower attaining students since the average entry requirements for a mathematics degree (AAB according to the UCAS website but extending up to A*A*A at some top tier institutions[5]) are again higher than the average entry requirements for an English degree (ABB according to the UCAS website but which only extend to AAA at the corresponding institutions[6]). Working on the frontline with these students we can tell you there is no lack of ambition or desire to study these subjects at university or to pursue STEM careers, but they are prevented from doing so by their lower attainment.

5. University of Warwick, 2021, *Warwick Mathematics BSc*, viewed 14 January 2022, <https://warwick.ac.uk/study/undergraduate/courses/mathsbsc/>.
6. University of Warwick, 2021, *Warwick English BA*, viewed 14 January 2022, < https://warwick.ac.uk/study/undergraduate/courses/englishlit/>.

apply to our school? And by extension, why are fewer female students not choosing to enter the mathematical sciences?

4.6 Our own investigations indicate that females value a wider range of subject options at A level. They keep their options open further into their education and therefore are less likely to have the specialist subjects needed for a mathematical sciences degree at university. In the personal interview stage of our admissions process many female students indicate that if they weren't to come to KCLMS they would not choose the Mathematics, Further Mathematics, and Physics combination of A levels. In addition to this, the mandatory Physics A level at our school is frequently given as a reason from female students for not applying or not accepting an offer from us.

4.7 What we're seeing then is that by age 16 female underrepresentation in STEM due to deselection has already begun. This is exacerbated by the discrepancies in entry requirements between STEM degrees and humanities degrees. Looking back to the national picture we know that only 29% of Further Mathematics students last year were female. To study Mathematics somewhere like Cambridge or Warwick it's essential that a student have A level Mathematics *and* A level Further Mathematics whereas if a student wishes to study English at similar tier institutions the only requirement is that they have an A level in English.

5. What has been done to address underrepresentation of particular groups in STEM?

5.1 The outcomes of students at KCLMS are superb irrespective of a student's gender, ethnicity, or socio-economic background and nearly all go on to study the mathematical sciences at top universities. The table below shows the percentage of our cohorts each year that achieved all As and A*s in their A levels, broken down by different groups.

Table 4: Percentage of students achieving all As and A*s in Mathematics, Physics, and Further Mathematics at A level at King's

*We acknowledge that BME is a problematic categorisation and one that is no longer used at the school. However, it is included here for consistency in the data from the school's earlier records

		All students	Male students	Female students	Black and Minority Ethnic students*	Students with no parental history of higher education	Socio-economically disadvantaged students
2021	%A*/A	95%	96%	94%	95%	96%	96%
	Value added	+0.82	+0.80	+0.83	+0.85	+0.79	+0.86
2020	%A*/A	95%	94%	98%	94%	91%	90%
	Value added	+0.77	+0.8	+0.79	+0.81	+0.8	+0.74
2019	%A*/A	91%	96%	79%	86%	83%	81%
	Value added	+0.87	+1.01	+0.48	+0.75	+0.75	+0.74
2018	%A*/A	88%	86%	92%	83%	86%	84%
	Value added	+1.06	+1.1	+0.99	+0.94	+0.98	+0.99
2017	%A*/A	89%	91%	85%	88%	90%	83%
	Value added	+1.09	+1.22	+0.83	+1.12	+1.02	+1.03
2016	%A*/A	77%	77%	77%	73%	-	70%
	Value added	+0.79	+0.96	+0.55	+0.74	-	+0.67

5.2 If students from all backgrounds can be supported to achieve equally in the mathematical sciences at all levels of education this would remove a huge barrier for achieving diversity in STEM. At King's Maths School we are

fortunate to have a cohort of mathematically academic students but, as the value-added scores above show, the success of our students is about more than just accepting the top students. We teach from a subject first perspective rather than an outcome first perspective meaning we never teach to the test and instead focus on exploring the subjects in interesting ways and developing the depth of understanding required to thrive in later education and careers. This is only possible because all our students are taught by subject specialists.

5.3 Research has shown that students from the most socio-economically deprived backgrounds are the students who suffer the most from poor teaching and so to create equity in attainment it is essential that high quality subject specialists are teaching STEM subjects.

5.4 The community created at King's Maths School also plays a big part in the academic success of our students. Providing a community of young people who share an interest in mathematics and physics not only enables them to learn from their peers but also allows them to develop their identity as a mathematician and physicist. It creates a space where they are given permission to love their subject.

5.5 As our university progression data below shows, with this environment for learning established, a very diverse pipeline of students going to top universities to study the mathematical sciences has been created.

Categories	**% at a Russell Group University**	**% at a Sutton Trust Top 30 University**	**% at either a Russell Group or a Sutton Trust Top 30 University**
All	85%	89%	96%
Male	88%	91%	96%
Female	79%	85%	94%
Black and Minority Ethnic	84%	86%	95%
No Parental History of Higher Education	80%	83%	92%
Socio-economically disadvantaged students	80%	84%	93%
Free School Meals	81%	90%	97%

Table 5: Percentage of students progressing to Russell Group or Sutton Trust Top 30 universities from King's Maths School since it opened

5.6 KCLMS runs a substantial outreach and widening participation programme which targets students from backgrounds traditionally underrepresented in the mathematical sciences. We currently work with students as young as 9 and as old as 18 through our various programmes, all of which are delivered either by our teachers or by our alumni. The purpose of our outreach is threefold:

1. To improve the attainment of students who might otherwise not achieve as highly, by recreating the subject first exploratory teaching approach that is so successful with our own students
2. To provide a mathematical community of like-minded peers that encourages students to like mathematics and begin to identify as mathematicians
3. To support and encourage the uptake of the mathematical sciences at A level and university level

6. What could and should be done by the UK Government, UK Research and Innovation, other funding bodies, industry, and academia to address the issues identified?

6.1 In order to create more diversity in STEM it is essential to be focussing on improving the attainment of Black students and students from disadvantaged backgrounds at all levels. It isn't enough to focus efforts on A level or even GCSE as this difference in attainment is seen from KS3 and even earlier.

6.2 We would urge the UK Government to fund pre-existing programmes with a proven track record of impact on attainment where the target groups are diversified by ethnicity or socio-demographic differences.

6.3 To encourage female participation research needs to be undertaken to understand the decision framework that influences young female students regarding their subject specialist choices at age 16. The societal norm of

science and maths ‘not being for girls’ is systemic and we need better action against all the explicit and implicit factors contributing to this mentality. We need to change the culture that currently causes children at primary schools, when asked to draw a scientist, to predominantly draw men. The change needs to be a society wide one if we are to successfully change female students’ desires to opt into mathematical sciences at all levels.

(January 2022)