Protect Pure Maths submission to the House of Lords' Science and Technology Committee's inquiry into '*People and skills in UK science, technology, engineering, and mathematics'*

1. ABOUT US

1.1. The Protect Pure Maths campaign was originally founded in collaboration with the London Mathematical Society (LMS) and works in close partnership with the Institute of Mathematics and its Applications (IMA) as well as all the UK's leading mathematical societies to protect and promote all the mathematical sciences. The campaign was originally established in response to concerns that some Universities were cutting their mathematics research provision.

1.2. Despite its value to society, maths does not always receive the funding and support it warrants at every stage of education and in research and innovation funding.

1.3. The Protect Pure Maths campaign seeks to engage with the academic community, industry, and government to ensure that maths funding properly reflects the value of maths to society, prevent further cuts to university maths departments, encourage more people to consider further study of mathematics, strengthen the voice of industry in maths policymaking and advance mathematical sciences in the UK.

1.4. We believe that in order to enhance mathematical skills and enhance the pipeline of mathematicians, Government needs to deliver tangible policy change including: (i) focusing on 16-18 mathematics education to ensure that this is on par with our international competitors; (ii) invest in the recruitment, development and retention of maths teachers; (iii) incentivise and support universities to prioritise maths; (iv) deliver on the £300m promised funding for mathematical science research announced in January 2020; (v) support collaboration between business and academia to enable further growth of R&D, including the establishment of a National Academy for the Mathematical Sciences; (vi) reviewing UK visa costs, (vii) re-associate with Horizon Europe and (viii) launch a national strategy for maths. We would also encourage the Committee to recognise and celebrate the contribution of mathematical sciences and mathematical skills by renaming itself the '*Science, Technology, Engineering and Mathematics Committee*'

1.5. Our supporters comprise of over 17 leading universities, top businesses, parliamentarians, and the academic community, including a Field Medallist.

1.6. We have focused our response to the call to evidence on those areas where we have a particular perspective.

2. OVERVIEW

2.1. The mathematical sciences have a huge impact on the whole economy and public life. Deloitte has estimated that the mathematical sciences add more than £200bn to the UK economy. The mathematical sciences are of fundamental importance to the UK. Mathematics underpins today's most exciting and urgent technological developments, including artificial intelligence, driverless cars, the development of quantum computers, and superfast broadband. Maths is also a leading source of IP creation, underpins national security and the finance sector and it has been vital to modelling the COVID-19 outbreak and the rollout of vaccinations.

2.2. The long-term health of mathematics is underpinned by a pipeline of talented mathematicians with support for the whole research spectrum of mathematics from fundamentals to applications. Investing in this continued pipeline is essential if the UK is to

continue to be a world leader in the mathematical sciences and the Government is to meet its objective of making the UK a "Science Superpower". As the bedrock to all the sciences and major technological advancements, investment in the mathematical sciences will be central to achieving this objective and ensuring that the UK retains its place as a world leader in mathematics.

2.3. We need a pipeline of talented mathematicians from diverse backgrounds to continue to deliver in the century ahead. Valuable IP creators increasingly come from mathematical backgrounds. Our supporters from the business community are clear that the skills and expertise of mathematicians must be nurtured and grown and we are working with partners to assess current labour market shortages of mathematicians.

Miquido

"Maths is strictly embedded into computer technology, and IT businesses would not exist without it. Maths provides us with tools to understand science, engineering, and technology. These areas are developing rapidly, and we will need more and more experts in those fields.".

Deep Render

"At Deep Render, we are developing the next generation of compression technology to free the world of all bandwidth limitations. … most of our breakthroughs came from interactions with Pure Mathematicians we inspired to help us in our mission; and most of Deep Render's lead researchers have a Mathematics background."

2.4. Increasing the availability of skilled mathematicians should be a priority for the Government's Science and Technology Strategy as part of its commitment to make the UK a "Science Superpower".

3. INTERNATIONAL TALENT

3.1. Both the costs associated with the visa system and a lack of clarity about our future association with the Europe-wide Horizon programme have harmed the UK's reputation as an attractive place for STEM talent.

3.2. The visa system, both in terms of cost and bureaucracy, is presenting a significant barrier to international talent coming to the UK. The current UK visa arrangements are among the most expensive in the world for international researchers and their UK sponsors.

3.3. As the Committee noted in its report, '*Science and Technology superpower: more than a slogan?',* the lack of association with Horizon Europe post-Brexit is a significant cause of concern and "risks harming the UK's reputation further and jeopardising the quality of its science base". The challenges this creates for the funding landscape for the mathematical sciences are also compounded by the failure of Government to deliver on its pre-existing funding commitment in January 2020 of £300m for research into the mathematical sciences.

4. STEM SKILLS

4.1. Among the campaign's many business, industry and academic supporters, recruitment presents an ongoing cause for concern.

4.2. The London Mathematical Society has commissioned Lightcast, a labour markets analytics company, to undertake a detailed analysis of the labour market for mathematical scientists and would be pleased to share the findings with the Committee when available to highlight the scale of the skills gap.

4.3. The Bond Review, '*The Era of Mathematics'*, underlined the skills shortage for mathematicians across all sectors of the economy from artificial intelligence (AI), flood management, the finance sector to national defence. We support the recommendations of the Bond Review, including in particular the calls for additional investment in PhD placements.

4.4. The Bond Review also called for greater collaboration between industry and academia, including supporting the establishment of a Knowledge Exchange Hub for the Mathematical Sciences (previously known as CCN). We would like to see greater support for collaboration between business and academia to enable further growth of R&D. This should include offering further incentives on top of current tax credits such as the welcome recent change to explicitly incorporate pure mathematics for the first time within R&D tax credits announced in the Spring Statement 2022 and ensuring that national investment in technology includes the mathematical sciences.

4.5. Protect Pure Maths also supports the recommendation of the Bond Review to establish a National Academy for the Mathematical Sciences to work with industry and government to drive mathematical research through to commercialisation and build on stronger knowledge exchange.

4.6. We believe that the Lords' Science and Technology Committee should lead by example, as it has with the title of this inquiry, and consider renaming itself the *Science, Technology, Engineering and Mathematics Committee.*

5. EDUCATION SECTOR

5.1. *Tackling misconceptions*

5.2. The Protect Pure Maths campaign is particularly concerned about societal misconceptions and prejudices that surround the study of mathematics.

5.3. There are a lot of misconceptions about maths - that it is the realm of the lone genius, that it is inaccessible, and that it is 'just for the few'. At the same time, it is seen as societally acceptable to be bad at maths with people saying with pride that they are bad at maths in a way that they wouldn't with other subjects or skills. This was underlined powerfully by the comments made by Katharine Birbalsingh, Chair at Social Mobility Commission to the Commons' Science and Technology Committee that girls don't like "hard maths".

5.4. Protect Pure Maths believes that Government should invest in a targeted outreach to address these mischaracterisations and encourage more people to study mathematics at A Level and beyond.

5.5. Additionally, there needs to be concerted investment at every level of the mathematics skills pipeline.

5.6. 16-18 mathematics education

5.7. Protect Pure Maths believes that there should be a focus on 16-18-year-olds. Professor Sir Adrian Smith's review of mathematics education for 16- to 18-year-olds in England highlighted that the UK is significantly behind its international competitors in core mathematical skills. Despite mathematics being the most popular A Level, the UK is an outlier in Europe, with far less than 50% studying any mathematics, compared with more than 80% in Finland, Germany and Ireland.

5.8. The University of Nottingham is currently working to produce a landmark research report into the mathematics pipeline, which will include linked datasets at school and university-level. As far as we know, this will be the first attempt to understand the maths talent pipeline from 5 to 25 and primary school to PhD. The emerging findings from this report are highlighting some key areas for policy intervention, including a significant drop off at Key Stage 3.

5.9. Supply of maths teachers

5.10. At the same time, recruitment of maths teachers has been below target every year. There are around 4,000 'missing' maths teachers since 2015. We are calling on government to invest more in the recruitment, development and retention of maths teachers. This should include subject-specific CPD for all maths teachers, and upskilling maths teachers without a maths degree.

5.11. Undergraduate degrees and doctoral research

5.12. The number of students enrolling in first degrees in mathematics has been broadly flat over the past six years at around 10,000 per year. The number of students enrolling in doctoral research has also been broadly flat over the same period at around 900 a year.

5.13. Diversity and Inclusion

5.14. There is also a problem with diversity with significant underrepresentation of women, LGBTQ+ communities, ethnic minorities, people with disabilities and those from disadvantaged socioeconomic backgrounds. As we highlighted in our separate submission to the Commons' Science and Technology Committee inquiry into '*Diversity and inclusion in STEM'*, statistics show that there is a problem with diversity at every stage of the maths education pipeline, and it gets worse at each stage. For example, in relation to gender, women account for only about 40 per cent of mathematics A level students, for 37 per cent of mathematics undergraduates in the UK and despite a number of interventions, they account for just 21 per cent of mathematical sciences PhD students – and a mere 12 per cent of professors.

5.15. For many other protected characteristics, there is no subject-specific data available, which is in itself a problem and cause for concern. The low participation rates of individuals with protected characteristics in mathematics particularly at the higher levels of research and teaching, makes our discipline poorer and represents missed opportunities for the advancement of mathematics.

5.16. Supporting maths departments at universities

5.17. Protect Pure Maths was initially established in response to some UK universities cutting back their maths provision. Whilst Government is unlikely to want to intervene in institutional decisions, Government should make clear the strategic importance of maths and to incentivise and support universities to prioritise maths.

5.18. Recent research by Professor Cathy Hobbs, Vice President of the London Mathematical Society also suggests that the trajectory that mathematics is quietly taking is to become an almost exclusively high-tariff degree. Without intervention from universities or policy makers, we believe that this represents significant risks to the health of mathematics.

5.19. The published A Level tariffs for bachelors degrees in mathematics range from CCC to A*A*A*. In practice, Professor Hobbs has highlighted that the vast majority of offers are high-tariff. Preliminary data for UCAS suggests that the distribution of offers has an A grade

in maths as a minimum. This has been accelerated by the removal of the funding cap and the changes in assessed A Level grades during the pandemic.

5.20. This is reflected in some major shifts in the 'market share' of different groups of universities. Preliminary UCAS data suggests that in 2011 high-tariff *(A*AA and above)* universities accounted for 63% of places and low-tariff *(CCC-ABC)* universities accounted for 13.5%. Today it suggests that the high-tariff universities are scooping up 78% and the low-tariff ones are down to 4.5%.

5.21. There has been huge growth at many high-tariff universities. Conversely, the low-tariff universities, many of which are highly regarded, are contracting. This is especially disturbing from a social mobility perspective as students from lower-income backgrounds are much less likely to go to university outside their local area. If maths courses become too small to be viable, we are concerned that we might see the emergence of 'maths deserts', which would limit access to one of the best degrees in terms of future earnings.

5.22. The Department for Education and the Department for Business, Energy, and Industrial Strategy must ensure maths is valued and financially supported, enabling strong and sustainable mathematics departments at universities in all regions of the country in order to widen access and participation, as well as to ensure a sustainable maths pipeline.

6. QUALITY OF ACADEMIC CAREERS

6.1. University maths departments need urgent clarity on the sustainability of maths funding in order to greenlight research and innovation programmes that will last years into the future, and that could provide the next technological breakthrough.

6.2. Back in January 2020 the Government announced £300m for the mathematical sciences to fund investment in mathematical research, people and skills. However, over two years later, the majority of this funding has yet to be received by UKRI, and more worryingly there is no information available about when this will happen.

6.3. UKRI has awarded and/or is expected to award around £124 million of additional funding to the discipline, over and above EPSRC's core Mathematical Sciences Theme budget. This welcome investment has been spent on projects of national importance, including on institutes, small and large research grants, fellowships, doctoral studentships and postdoctoral awards.

6.4. However, the remaining £176 million is yet to be allocated and is not yet forthcoming. Professor Dame Ottoline Leyser DBE FRS, the Chief Executive of UKRI's comments to the Commons' Science and Technology Committee that UKRI "*did not receive the £300m specifically for the mathematical sciences despite the announcement*" are especially troubling.

6.5. Despite repeated requests, no firm assurances have been received from Government that the additional £176 million will remain ringfenced to the mathematical sciences and will be allocated as soon as possible. This will mean that research an innovation programmes, doctoral studentships and fellowships will remain unfunded.

6.6. Without explicit support and investment for all the mathematical sciences, the Government's mission to make the UK a "Science Superpower" and the UK's place as a world leader in the mathematical sciences will be at risk.

7. RECOMMENDATIONS

Protect Pure Maths believes that more could and should be done by the UK Government and other bodies to increase the number of skilled mathematicians:

7.1. In the existing school model, more 16–18-year-old students should be encouraged to take up Core Maths. There should be a focus on 16-18-year-olds, where the UK is an outlier in Europe, with far less than 50% studying any mathematics, compared with more than 80% in Finland, Germany and Ireland.

7.2. Government should invest more in the recruitment, development and retention of maths teachers. This should include subject-specific CPD for all maths teachers and upskilling maths teachers without a maths degree. More maths is also increasingly needed in the sciences, social sciences and humanities subjects.

7.3. Protect Pure Maths was initially established in response to some UK universities cutting back their maths provision. Whilst Government may not want to intervene in institutional decisions, Government should make clear the strategic importance of maths and to incentivise and support universities to prioritise maths. The Department for Education and the Department for Business, Energy, and Industrial Strategy must ensure maths is valued and financially supported, enabling strong and sustainable mathematics departments at universities in all regions of the country.

7.4. More broadly, the Government must ensure that maths funding properly reflects the value of maths to society. This means delivering on the £300m funding for mathematical sciences research announced in January 2020.

7.5. Government should support collaboration between business and academia to enable further growth of R&D, offering further incentives on top of current tax credits and ensuring that national investment in technology includes the mathematical sciences.

7.6. We would encourage Government to launch a strategy for maths to strengthen the UK's world leadership in the mathematical sciences and to equip our country to compete in a global economy increasingly influenced by data, complex systems and AI.

7.7. UK visa costs should be in line with international competitors to ensure that the UK has an approach to immigration that drives scientific and mathematical advancement and the UK should associate with Horizon Europe.

7.8. Government should implement the recommendations of the Bond Review to establish a National Academy for the Mathematical Sciences to work with industry and government to drive mathematical research through to commercialisation and build on stronger knowledge exchange.

7.9. We would also urge Parliament to use its position to recognise and celebrate the contribution of mathematical sciences to the UK economy, thus raising the status and building understanding of careers in mathematical sciences. We would urge you to consider the renaming of the Lords' Science and Technology Committee as the '*Science, Technology, Engineering and Mathematics Committee*' to reflect the importance of mathematics.