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By online submission: http://www.parliament.uk/business/committees/committees-a-z/commons-select/science-and-technology-committee/inquiries/parliament-2015/inquiry3/commons-written-submission-form/

Nuffield Foundation submission to the Science and Technology Committee inquiry on *Closing the STEM skills gap*

1. The Nuffield Foundation is a charitable trust established by William Morris, Lord Nuffield, the founder of Morris Motors. Our aim is to improve social well-being and we do this by:

- Funding research and innovation projects in education and social policy. In 2015 we funded 34 new projects with a total value of £5 million.
- Building research capacity in science and social science, most notably through Q-Step, a £19.5m programme designed to promote a step-change in quantitative social science training for undergraduates (co-funded with the Economic and Social Research Council (ESRC) and the Higher Education Funding Council for England (HEFCE)), and Nuffield Research Placements, which provide over 1,100 Year 12 students each year with the opportunity to undertake a STEM research project in a professional environment.

2. Since its inception in 1943, the Nuffield Foundation has been an active funder of STEM projects, including research into mathematics and science education, curriculum development and support for the 'STEM pipeline' (through programmes such as Nuffield Research Placements). On a day-to-day and strategic basis, our work is intrinsically linked to the education systems in the UK and we have a strong track-record in supporting social equity and the development of scientific thinking and mathematical ability for young people. This experience makes us well-placed to offer an informed view on the STEM skills gap.

3. The call for evidence helpfully sets out some very clear elements to focus on, and our submission deals with each of these in turn, noting where our work has particular relevance.

<u>The STEM skills that were needed but were found to be in short supply or missing</u>

4. For many years the Nuffield Foundation's support for STEM skills in schools and beyond focussed on the development of science curricula, including many popular GCSE and A level courses[1] (from Nuffield Science all the way through to Twenty-First Century Science).[2] In collaboration with the learned societies, we have also sought to address concerns about

[1] http://www.nuffieldfoundation.org/sites/default/files/files/Half_a_century_of_curriculum_dev_v_FINAL_WEB.pdf
[2] http://www.nuffieldfoundation.org/curriculum-projects#Science

the development of practical science skills in school by developing protocols and guidelines which are used extensively by teachers and with notable impact.[3] The Foundation has also acted to address STEM skill shortages in other areas, such as the development of postgraduate research skills in the field of rheumatism.[4]

5. More recently, we have focused on the development of scientific thinking *per se* and would agree with the Organisation for Economic Cooperation and Development (OECD) which recently commented that 'in the context of massive info flows and rapid change, everyone needs to be able to "think like a scientist'.[5] In addition, the Foundation has been a strong advocate for increased uptake and use of mathematics throughout education (and certainly beyond 16).[6] We would certainly concur with the Scottish Government's view that 'all of STEM is underpinned by Mathematics, which includes numeracy'.[7] Indeed, it seems clear that the UK needs to improve the numeracy levels of its graduates[8] and citizens more generally.[9]

6. In considering this issue, it is also important to take stock of what the available labour market evidence tells us about the availability of STEM skills for work and research. The most recent labour market assessment from the UK Commission on Employment and Skills (UKCES) does indeed identify an economic need for more STEM skills, however the gaps tend to be in quite specific occupational areas.[10] To some degree this complements previous research which found that notable proportions of STEM graduates progressed to non-STEM occupations.[11]

7. A related consideration is the assumption that STEM skills are the preserve of STEM disciplines. Whilst the Government concern for the loss of excellence in certain STEM disciplines was crystallised in the 'Strategically Important and Vulnerable Subjects' initiative, the original report also highlighted the need for more quantitatively trained social scientists.[12] The Nuffield-ESRC-HEFCE funded Q-Step Programme was developed to address this need and was recently cited as a way of helping to meet the economic need for more numerically able graduates.[13] Equally, the British Academy has highlighted the way in which quantitative skills are increasingly seen as being central to many disciplines beyond the traditional suite of STEM subjects.[14]

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[3] http://www.nuffieldfoundation.org/practical-biology, http://rsc.li/2iYeO0N, http://practicalphysics.org/
[4] http://www.nuffieldfoundation.org/oliverbird
[5] http://www.oecdmybrochure.org/edu/newsletter/
[6] http://www.nuffieldfoundation.org/sites/default/files/files/Mathematics_after_16_v_FINAL.pdf
[7] http://www.gov.scot/Resource/0050/00509522.pdf
[8] http://www.compareyourcountry.org/
[9] http://www.oecd.org/skills/piaac/Country%20note%20-%20United%20Kingdom.pdf
[10] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/444048/High_level_STEM_skills_requirements_in_the_UK_labour_market_FINAL.pdf
[11] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/32379/11-771-stem-graduates-in-non-stem-jobs.pdf
[12] http://www.hefce.ac.uk/pubs/year/2011/201124/
[13] http://www.publications.parliament.uk/pa/cm201516/cmselect/cmsctech/992/992.pdf
[14] http://www.britac.ac.uk/sites/default/files/Count-Us-In-Full-Report_0.pdf

How this particular skills need has been addressed, including specific details of the measures introduced?

8. The Nuffield Foundation is committed to improving mathematics education for all and we fund many research projects in this area.[15] Our work has been influential in highlighting the problem of low participation in post-16 maths in England and Wales and in developing ways to address it.[16] For example, we have developed attractive and engaging mathematics teaching materials (Nuffield-funded 'Free Standing Mathematics' qualifications)[17] which can be used to support post-16 mathematics education. We have also funded the development of other teaching resources designed to enhance the mathematics curriculum in school, such as 'Key ideas in teaching mathematics',[18] and 'Applying Mathematical Processes'.[19] These materials are widely used and well-regarded by teachers.

9. For over 20 years, the Nuffield Foundation has delivered programmes to foster young people's interests in developing their scientific thinking and STEM skills in the later stages of secondary education. Nuffield Research Placements (NRP) have been offering well-designed, substantive research placements to Y12/S5 students across the UK to help them develop and apply their skills in live research environments. Since 1996, this programme has offered opportunities to over 16,000 young people and engaged universities and businesses of many kinds in supporting it. We have increasingly targeted young people from disadvantaged backgrounds, and have also begun to extend the programme beyond science and engineering into data sciences and social sciences. In doing this, our aim is to demonstrate that STEM skills are increasingly necessary for a range of study and career pathways outside the traditional understanding of 'STEM careers'.

10. Our work with secondary school students is complemented by a Nuffield-funded research project being undertaken by the Royal Geographical Society (RGS). This two-year project[20] aims to raise the quantitative teaching skills of geography teachers and is a response to the revised GCSE and A-level curricula which place a greater emphasis on data skills. Due to finish in September 2017, this project will:

- Work across higher education and schools to inform both sectors of changes and opportunities.
- Produce high quality quantitative skills teaching materials for GCSE and A level complemented by a national programme of CPD.
- Involve collaboration with awarding organisations, those involved in initial teacher education, other learned societies and geographers in Q-Step Centres to secure sustainability for quantitative teaching skills in geography.

11. In a related move, we have also funded the development of materials to support the teaching of mathematics in the sciences. The publication 'The Language of Mathematics in Science: A Guide for Teachers of 11-16 Science' was produced by the Association of Science Education (ASE), working closely with awarding bodies (AQA, Edexcel, Eduqas and OCR), which have all endorsed the guidance.

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[15] http://www.nuffieldfoundation.org/mathematics-education-0
[16] http://www.nuffieldfoundation.org/sites/default/files/files/Mathematics_after_16_v_FINAL.pdf
[17] http://www.nuffieldfoundation.org/nuffield-mathematics
[18] http://www.nuffieldfoundation.org/key-ideas-teaching-mathematics
[19] http://www.nuffieldfoundation.org/AMP
[20] http://www.nuffieldfoundation.org/data-skills-geography

12. In partnership with the ESRC and HEFCE, the Nuffield Foundation is working to address the issue of quantitative skills development for social science undergraduate students. The Q-Step Programme is now in its fourth year of operation and provides undergraduates at 18 universities across the UK (Q-Step Centres and Affiliates) with quantitative skills training that is fully integrated into subjects such as: education; geography; international relations; law; linguistics; political science; population health; PPE and sociology. Q-Step Centres and Affiliates have developed new modules and new degree programmes. In the most recent year, almost 700 new undergraduate students began degree programmes and over 5,000 students were taking one or more of the new modules. A further benefit of Q-Step is that, by the very nature of the typical student intake to social science programmes, many more female students will gain degrees with highly developed quantitative skills.

13. The most notable way in which Q-Step has been able to effect change is by supporting existing and additional (over 50) academic staff to develop integrated (as opposed to 'bolt-on') and novel approaches to quantitative skills teaching. This contextualisation of quantitative skills, and the cumulative exposure to quantitative analyses, is central to engaging students and helping them to understand both their own potential and the opportunities open to them through the acquisition of these skills. Work placements are a major feature of Q-Step, providing students with the opportunity to explore and apply their skills in active research environments (not unlike Nuffield Research Placements). Q-Step is funded until 2018/19, and the universities have committed to maintaining the newly-created posts for five years beyond that point.

14. The Nuffield Foundation has also funded development work to explore assessments aimed at supporting low attaining KS3 maths students[21] and is investigating the use of a Dutch approach called 'Realistic Mathematics Education' which might encourage post-16 progression for students who did not achieve a C Grade (at least) mathematics GCSE in England.[22] This latter project is particularly important given the apparent failure of the 'retake' policy[23] introduced by the previous Government. Both projects will report in 2017.

<u>The cost of the measures and how they have been funded</u>

15. This is a difficult question to answer easily as many of the examples of interventions and activities cited above have been operating over different timescales and in very different ways. Equally, the portfolio of research projects which underpinned the 2014 Nuffield publication 'Mathematics after 16: the state of play, challenges and ways ahead'[24] covers a broad period of time.

[21] http://www.nuffieldfoundation.org/low-attainment-mathematics-investigation-year-9-students
[22] http://www.nuffieldfoundation.org/achievement-and-attitudes-gcse-mathematics-resit-classes
[23] http://www.jcq.org.uk/examination-results/gcses/2016/gcse-full-course-uk-by-age-2016
[24] http://www.nuffieldfoundation.org/sites/default/files/files/Mathematics_after_16_v_FINAL.pdf

16. The following table sets out some very 'top line' figures concerning some of the examples cited above.

Programme	Annual/total budget	Funding approach	Main mechanism for change
Nuffield Research Placements	£700k per annum	Nuffield Foundation, Wellcome Trust, Royal Society of Chemistry, Research Councils UK	High quality and meaningful research placements for Y12 and S5 students
Royal Geographical Society	£194k for 24 months.	Nuffield Foundation	Professional development for teachers and new teaching materials.
Q-Step	£19.5m for six years	Nuffield Foundation, the ESRC and the HEFCE	New staff, integrated teaching approaches, new degree programmes and modules, work placements.
The Language of Mathematics in Science: A Guide for Teachers of 11-16 Science	£32k for 24 months	Nuffield Foundation	Publication and dissemination.
Low attainment in mathematics: an investigation of Year 9 students	£245k for 27 months	Nuffield Foundation	Research and development.
Achievement and attitudes in GCSE mathematics resit classes	£82k for 26 months	Nuffield Foundation	Research and development.

The results of any evaluation of the measures/schemes introduced

17. We set objectives and impact measures for the work we fund, and monitor and appraise projects and programmes as they are underway. Programmes like NRPs and Q-Step may have a beneficial effect on students several years after their participation. There is plenty of anecdotal and case-study evidence from the NRP Programme to infer that it results in high quality student outputs (which are also externally 'benchmarked' by successful submissions for Crest Awards).

18. We are currently undertaking a longitudinal impact evaluation of the NRP Programme and will commission an external evaluation of the Q-Step Programme in 2017. The RGS project will produce a final report which assesses its impact at the end of the funding period.

19. To finish, it is worth reiterating the importance of distinguishing between the differing needs for generic and specific STEM skills. More importantly, however, is the notion that STEM skills can be developed in non-STEM subjects and that numerical fluency and scientific thinking should be fostered in the social sciences, humanities and arts as much as in any other academic disciplines in school and beyond.