SCORE and Nuffield Foundation press release
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A-levels not equipping students with appropriate mathematical skills

Evidence provides clear role for professional bodies in science A-level design

New evidence shows that A-levels in a range of subjects fail to equip students with an appropriate level of mathematical skills.

This, and research revealing the differences in mathematical difficulty between different exam boards' papers, has led leading learned societies and education experts to make recommendations for the upcoming A-level reform.

SCORE (Science Community Representing Education), a collaboration of leading science organisations, publishes a new report today, Friday 27 April, which analyses the *type*, *extent* and *difficulty* of mathematics within the 2010 A-level examination papers for the three sciences – Biology, Chemistry and Physics.

Also published today, is the Nuffield Foundation's analysis of the mathematical content in six other A-level subjects that require quantitative skills (Business Studies, Computing, Economics, Geography, Psychology and Sociology).

The reports consider whether the type of mathematics in the examinations was suitable for progression within the subject's field (*type*), the proportion of the examination that depended on mathematical knowledge (*extent*), and the complexity of the mathematical questions (*difficulty)*.

Mathematical content in Physics, Biology and Chemistry

Professor Graham Hutchings, Chair of SCORE, said, "Our findings are worrying. A significant proportion of the mathematical requirements – put in place by the examinations regulator, Ofqual, for each of the sciences - were simply not assessed and, if they were, it was often in a very limited way and at a lower level of difficulty than students will need to progress to degree level or into relevant employment.

"Mathematics enables students to understand and describe many scientific phenomena. Without learning some mathematical techniques, students are missing out on gaining a full understanding of the scientific ideas."

The proportion of the assessments that required the use of mathematics varied between exam boards' papers for each subject and the level of difficulty of the mathematics – judged by number of steps in a calculation, the complexity of the question and the familiarity of the context – also varied.

Professor Hutchings continues, "A framework must be developed to regulate the way mathematics is assessed within science A-levels to ensure parity across exam

boards. We would also like to see a review of the current mathematical requirements for each of the sciences at A-level to ensure the inclusion of underpinning areas of mathematics within that science.

“These reports identify the important role professional bodies can play in A-level design. As independent organisations, capable of bringing together teachers, academics and representatives from industry, the professional bodies are perfectly placed to ensure A-levels are fit for purpose and could provide the basis of a National Subject Committee for the development of A-level qualifications.”

Mathematical content in Business Studies, Computing, Economics, Geography, Psychology and Sociology

The disparity in mathematical content across exam boards was even greater in the A level assessments in the Nuffield Foundation study. For Psychology, for example, one exam board required students to use mathematics in exam questions worth just 10% of available marks, but, for another, this figure was over 40%. This is despite psychology having mathematical requirements set by Ofqual in its subject criteria, akin to the three sciences.

The amount of mathematics required to earn a particular grade is also affected by which units of study the school or student chooses, and by which questions students choose to answer in exams. For example, two students studying Business Studies could get the same grade, with one using no mathematics at all, and another gaining almost 50% of their mark from exam questions that require mathematical work.

The report concludes that with the exception of Computing, the variation in mathematical content is so great that the qualifications do not give universities or employers a meaningful indication of the level of mathematical skill or understanding of students who have them.

Anthony Tomei, Director of the Nuffield Foundation, said, “It is a common complaint from higher education that students come unprepared for the quantitative demands of their subjects, so the question of what mathematics should be required in A level teaching is important.

“These findings are timely given the current review of A-level content. Subject communities and universities should take the opportunity to agree the appropriate mathematical content of their subjects and to work with exam boards and Ofqual on the best way to assess mathematical skills in a consistent manner.”

Research for both reports was undertaken by subject expert groups – comprising practising A-level teachers, teachers with experience in curriculum research and individuals working for exam boards as markers. For the SCORE study, an online survey was undertaken to ask stakeholders in subject communities whether they felt the mathematical content of the examinations was appropriate for progression.

The research was undertaken in response to evidence that two-thirds of undergraduates do not have the necessary mathematical skills for their course (ACME, *Mathematical Needs*, 2011).

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Notes to Editors:

Contact
For further information about SCORE's report, contact IOP Senior Press Officer, Joe Winters, on 020 7470 4815/07946 321473 or email joseph.winters@iop.org.

For further information about the Nuffield Foundation's Report, contact the Foundation's Communications Manager, Frances Bright, on 020 7681 9586/07581 216981 or email fbright@nuffieldfoundation.org

Key findings from SCORE's *Mathematics with A-level Science 2010 Examinations*

- A large number of the mathematical requirements listed in the 2010 Biology, Chemistry and Physics AS and A2 specifications are assessed in a limited way or not at all within the examination papers.

- There is a measurable variation between awarding organisations in terms of the amount and difficulty of the mathematics that is assessed in Biology, Chemistry and Physics AS and A2 examination papers. Participants in our survey felt that in many cases the amount of mathematics assessed in A-level science examinations is too low.

- The examination questions that did require mathematics are felt to be of insufficient difficulty; too many involve only single step questions, require only simple recall, and are set only in familiar contexts. For example in Biology A-level, across all five awarding organisations, only 0-2% of the A-level contained mathematical questions requiring more than simple recall.

- Some mathematical concepts – for example, orders of magnitude and using the slope of a tangent to a curve as a measure of the rate of change of a quantity - included in the science examinations do not follow on logically from mathematics GCSE; the last examination which science teachers can be assured all of their students undertook.

The report will be published on Friday 27 April 2012 and can be downloaded from http://www.score-education.org/home

Key findings from The Nuffield Foundation's *Mathematics in A-level assessments: a report on the mathematical content of A-level assessments in Business Studies, Computing, Economics, Geography, Psychology and Sociology*

- Students who are ostensibly following the same course of study can have widely different levels of exposure to quantitative approaches to their subject.

- There is variation across the different exam boards. For example, in Psychology, the number of marks from questions requiring students to use mathematics ranged from 10% for one exam board, to 46% for another.

- With the exception of Computing, statistics was the most common type of mathematics.

- There is variation according to the different A level units chosen by schools or students. For example, in Business Studies, the A2 Accounting option required mathematics for over 80% of the marks available, but this figure was under 10% for the alternative options.

- There is variation according to individual choices made by students about which questions to answer. As the mathematical content of each question is not equal, students can effectively choose whether or not to use mathematics. For example for one A2 unit in Psychology, a student using almost no maths in their answers could get the same grade as a student using mathematics in about a third of their answers.

- There is variation in the mathematics used by students to answer the same questions. With the exception of Computing, students' choice of quantitative or non-quantitative approaches, for example through their choice of evidence or case studies referenced, meant that marks *requiring* mathematics could be very different to marks that *could be gained* by using mathematics. The table below shows both these measure. The range reflects the different content of the exam boards.

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	Percentage of marks that ***required*** mathematics	Percentage of marks ***that could be gained*** using mathematics
Business Studies	2% - 36%	9%- 49%
Computing	19%-36%	No difference between the marks that required mathematics and the marks that could be gained using mathematics.
Economics	4% - 14%	27% - 57%
Geography	10%- 20%	19% - 35%
Psychology	10% - 46%	24% - 50%
Sociology	1% - 3%	12% - 19%

The report will be published on Friday 27 April and can be downloaded from http://www.nuffieldfoundation.org

SCORE

SCORE is a collaboration of organisations, which aims to improve science education in UK schools and colleges by supporting the development and implementation of effective education policy. SCORE is currently chaired by Professor Graham Hutchings FRS and comprises the Association for Science Education, Institute of Physics, Royal Society, Royal Society of Chemistry, and Society of Biology. www.score-education.org

The Nuffield Foundation

The Nuffield Foundation is an endowed charitable trust that aims to improve social well-being in the widest sense. It funds research and innovation in education and social policy and works to build capacity in education, science and social science research. The Nuffield Foundation has funded this project, but the views expressed are those of the authors and not necessarily those of the Foundation. www.nuffieldfoundation.org

Association for Science Education

The Association for Science Education (ASE) is the largest subject association for education in the UK. Members include teachers, technicians and others involved in science education. The Association plays a significant role in promoting excellence in teaching and learning of science in schools and colleges. Working closely with the science professional bodies, industry and business, ASE provides a UK-wide network bringing together individuals and organisations to share ideas and tackle challenges in science teaching, develop resources and foster high quality continuing professional development. www.ase.org.uk

Institute of Physics

The Institute of Physics is a leading scientific society promoting physics and bringing physicists together for the benefit of all. It has a worldwide membership of around 40 000 comprising physicists from all sectors, as well as those with an interest in physics. It works to advance physics research, application and education; and engages with policy makers and the public to develop awareness and understanding of physics. Its publishing company, IOP Publishing, is a world leader in professional scientific communications. www.iop.org

Royal Society

The Royal Society is a Fellowship of more than 1400 outstanding individuals from all areas of science, mathematics, engineering and medicine, who form a global scientific network of the highest calibre. The Society is committed to an evidence-based approach to supporting responsible policy-making within science and education, drawing upon high quality information and advice from its Fellows and Foreign Members, the wider scientific and education communities and others to achieve this. www.royalsociety.org

Royal Society of Chemistry

The Royal Society of Chemistry is the UK professional body for chemical scientists and the largest organisation in Europe for advancing the chemical sciences. Supported by a worldwide network of over 47,500 members and an international publishing business, the Society's activities span education, conferences, science policy and the promotion of chemistry to the public. www.rsc.org

Society of Biology

The Society of Biology is a single unified voice for biology: advising Government and influencing policy; advancing education and professional development; supporting its members, and engaging and encouraging public interest in the life sciences. The Society represents a diverse membership of over 80,000 - including, students, practising scientists and interested non-professionals - as individuals, or through learned societies and other organisations. The Society supports and recognises excellence in biology teaching and champion a biology curriculum that challenges students and encourages their passion for biology. www.societyofbiology.org