REVAMP
Research summary 3

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Mathematics A level for better science degrees

Does A level Mathematics predict chemistry and biology degree outcomes?

In 2011, a Royal Society 'State of the Nation' report argued that those aspiring to undergraduate Science, Engineering and Technology (SET) degrees should study mathematics at A level. A year later, the House of Lords' Select Committee on Science and Technology was critical of the level of mathematics of many 18-year-olds in England, particularly those intending to study SET subjects at university. The case for greater post-16 mathematics participation has widespread support but is there evidence in support of the usefulness of A level Mathematics for these degrees?

The research

This study investigated the link between A level Mathematics completion and undergraduate degree outcomes in chemistry and biology, in particular, the likelihood of attaining a 'first class' honours degree.

A unique linked dataset was constructed using data from the National Pupil Database for England and the Higher Education Statistics Agency. This was used to track the educational trajectories of students from the 2005/2006 GCSE cohort, through their A level studies and onto the completion of undergraduate degree programmes in chemistry and biology over a seven year period.

The statistical models considered the influence of a range of prior educational outcomes, social background measures and the university attended.

Key findings

Based on analysis of the above dataset the following conclusions can be drawn:

- A level Mathematics does not predict degree outcomes in Biology and Chemistry;
- those with a low grade in A level mathematics (C-E), or in other subjects for that matter, achieve lower degree outcomes than those without A-level Mathematics;
- high attainment in A level Biology (i.e. grade A) is associated with higher chances of gaining a first class chemistry degree;
- clear and significant differences in degree outcomes exist between ethnic groups with 'white' students having much better chances of attaining a first class degree than other ethnic groups in nearly all cases;
- in biology degrees, females are 6% more likely to attain a first class award. The gender difference is smaller in Chemistry;
- there is some evidence that students from lower socio-economic status backgrounds do a little less well in biology degrees;
- general academic attainment as evidenced in the average GCSE score is a strong indicator of likely performance at degree level;
- there is no evidence that GCSE mathematics attainment can be distinguished from the general attainment at that age as a predictor of degree success;
- The university attended has greater bearing on students' chances of attaining a first class degree than does their completion of, or attainment in, A level Mathematics. For our reference group (see full paper for details) this probability can range from 5-50% in biology and 5-70% in chemistry degrees.

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Explaining the findings

At first glance, these results seem counterintuitive. Possible explanations include the following:

1. mathematical aptitude is more important that specific qualifications. Those with good general academic ability at GCSE (including mathematics) have sufficient intellectual resources to handle the mathematics that they encounter in their degree programmes;
2. A level Mathematics content and techniques might not be that relevant or easily transferred to the undergraduate biology or chemistry context;
3. there are differences in undergraduate module pathways and course experiences, both within and between universities. Less mathematically confident students chose, or are directed to, less mathematically demanding pathways;
4. universities are better placed to teach discipline-specific mathematics and do it more effectively with better motivated students. Any initial differences in A level completion are smoothed, but underlying mathematical competence and confidence remains important;

"We recommend that...the Government make studying maths in some form compulsory for all students post-16. We recommend also that maths to A2 level should be a requirement for students intending to study STEM subjects in HE."
House of Lords' Select Committee on Science and Technology (2012, paragraph 32)

Implications of the research

Educational transitions are complex and the mathematical needs of learners moving between school and university SET programmes are no exception. Recent A level reforms have mandated that a proportion of new science qualifications must assess relevant mathematical applications within that discipline. It remains to be seen whether this mathematical 'embedding' strategy will improve mathematical continuity into undergraduate SET studies.

The government's commitment to ensuring continued study of mathematics up to the age of 18 for all young people is laudable. This research raises important questions regarding the most appropriate mathematics for students on various study pathways.

New Core Maths qualifications are key to realising the government's 'maths for all' vision, especially for students on academic study pathways. Serious consideration needs to be given to whether A level Mathematics is indeed the best route for prospective biology and chemistry undergraduates.

The full paper in which this analysis is detailed is currently under review but a working paper version can be requested from the authors.

Rethinking the Value of Advanced Mathematics Participation (REVAMP)

The REVAMP project was funded by the Nuffield Foundation and considers the value of A level Mathematics participation from several viewpoints. Five strands of work address the following:

- The economic return to A-level Mathematics (*Research summary 1*);
- The changing nature of A-level Mathematics participation over time (*Summary 2)*;
- The relationship between A-level Mathematics and outcomes in a range of science and social science degree programmes (*Summary 3*);
- The policy trajectory of 14-19 mathematics education; and,
- Attitudes to post-16 study of advanced mathematics amongst 17-year-olds in England (*Summary 4)*.

For more details visit http://www.nottingham.ac.uk/research/groups/crme/projects/revamp.aspx.

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