The impact of curriculum and assessment reform in secondary education on progression to mathematics post-16

Conference Abstract

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Abstract

Background and research aims

In most education systems around the world there is a strong case for increasing the mathematical skills of young people beyond the age of 16. Evidence from international student surveys such as PISA show that, for example, in the European Union about 23% of 15 year-olds in 2018 did not reach basic levels of skills in mathematics (OECD, 2019). Incentivising young people to continue to study mathematics post-16 should not only help satisfy demands for mathematically and quantitatively skilled people in the labour market, but more generally help ensure that young people have the knowledge to succeed in an increasingly technological society (*e.g.*, Mason *et al*. 2015; Smith, 2017; European Commission, 2022). Moreover, young people with good mathematical knowledge will benefit from the quantitative, analytical and problem-solving skills mathematics qualifications develop, which will support attainment in other disciplines, particularly those with a significant quantitative component.

In England, unlike other countries in Europe and the rest of the world, the study of mathematics post-16 is not compulsory for all students. A recent study comparing upper secondary mathematics participation in 24 countries (Hodgen & Pepper, 2019) showed that in England fewer than 20% of students persist with mathematics education in any form beyond the age of 16. In contrast, 18 countries have post-16 participation rates higher than 50%, with rates at more than 95% in eight of them, including Sweden, Finland, Japan and Korea.

One reason for low progression to post-16 mathematics in England could be a longstanding concern about how well the mathematics qualifications offered to students aged 14 to 16 (GCSE, General Certificate of Secondary Education) prepare students for advanced study in mathematics, with algebra frequently mentioned as the key problem (*e.g.*, Wiliam *et al*., 1999; Hernandez-Martinez *et al*., 2011; Noyes & Sealey, 2011; Rigby 2017).
To increase uptake of mathematics and to improve students' mathematical skills at all levels takes effort, funding and a range of interventions. In England, GCSE qualifications (in all subjects) were recently reformed "to ensure they are rigorous and robust, and give students access to high quality qualifications which match expectations in the highest performing jurisdictions". For mathematics specifically, the new GCSE "focuses on ensuring that every student masters the fundamental mathematics that is required for further education and future careers", and, in particular, aims to "be more demanding" and "provide greater challenge for the most able students" (Gove, 2013).

There were concerns that the new mathematics GCSE could deter students from post-16 mathematics (*e.g.*, by reducing their confidence) and unintentionally reduce uptake (ALCAB, 2014; Lee *et al*., 2018). A decrease in post-16 mathematics entries in 2019 leant weight to these fears but, to date, there has been little published research on how the reform of GCSE mathematics has affected mathematics learning and progression to post-16 study. One of the few studies to consider this issue in detail was carried out by Howard and Khan (2019). Their qualitative research found that, in general, teachers were positive about the extent to which the reformed GCSE prepared students for post-16 mathematics. Their participants also reported that the reformed GCSE had positive implications beyond studying

mathematics and that it would support students studying other subjects with mathematical content. Grima and Golding (2019) and Pearson Education (2019) reported similar findings from qualitative research in schools.

The current research aims to complement the qualitative analyses of existing research described above, by approaching the question of how the reform of GCSE mathematics has affected progression to and performance in post-16 mathematics and maths-related subjects via quantitative analysis of entries and performance data.

Methods

This work addressed the research question via quantitative analysis of national results data available in the National Pupil Database (NPD). The NPD is a longitudinal database for children in schools in England, linking pupil characteristics to school and college learning aims and attainment. It holds individual pupil level attainment data for pupils in all schools and colleges who take part in the tests/exams, and pupil and school characteristics (*e.g.*, age, gender, ethnicity, special educational needs, eligibility for free school meals, etc.) sourced from the School Census for state schools only.

Candidates who completed a GCSE mathematics in each of the years from 2014 to 2017 (2014-2016 pre-reform; 2017 post-reform) were followed up for two years and the post-16 qualifications they achieved included in the research. For example, students who achieved a GCSE in mathematics in 2015 were followed up in 2016 and 2017 and the qualifications achieved identified. Later cohorts could not be included because end-of-course exams were cancelled in 2020 and 2021 due to the Covid pandemic.

Progression from GCSE mathematics pre- and post-reform to the following qualifications was then investigated: progression to a range of different post-16 mathematics qualifications (core maths, maths, further maths); and progression to post-16 maths-related subjects (Biology, Chemistry, Physics, Economics, Psychology).

Descriptive statistics on the number and proportion of GCSE mathematics students progressing to the qualifications listed above (overall and by GCSE grade), pre-reform (2014-2016) and post-reform (2017), were produced and compared. Marginal grade distributions for all qualifications, overall and by GCSE mathematics grade, pre-and post-reform were also produced.

To further explore the effect of GCSE reform on progression to and performance in post-16 maths or maths-related subjects multilevel logistic regression analyses were carried out. The regression analyses differ from the descriptive analyses in that they take into account students' background characteristics when looking at the impact of GCSE reform on progression to or performance post-16.

The outcomes modelled in the regression analyses were as follows:

- progression to post-16 maths (any qualification, core maths, maths, further maths);
- progression to maths-related subjects (Biology, Chemistry, Physics, Economics, Psychology);

- achievement of specific grade thresholds in post-16 maths qualifications, and in maths-related subjects.

The independent variables in the regression models included: year the GCSE maths was achieved (*i.e.*, an indicator of pre- or post-reform), GCSE grade, gender, overall prior attainment at school, level of socio-economic deprivation and type of school attended (*e.g.*, private *vs*. state).

Conclusions

Contrary to fears about reduced uptake, this research showed that progression to mathematics post-16 generally increased following the recent reforms to secondary level mathematics qualifications. The uptake of core maths and further maths increased independently of the grade achieved by the students in their mathematics GCSE. However, for post-16 maths (*i.e.*, the mainstream mathematics qualification, not core maths or further maths), the increase in uptake was higher amongst those who achieved top grades in their mathematics GCSE than for students with just a pass. Performance in all three post-16 maths qualifications was, in general, lower post-reform – in contrast to teacher expectations. However, it should be taken into account that students taking the reformed GCSE would have also taken newly reformed post-16 qualifications, and it is known that performance tends to dip in the first years of a new qualification.

The research also found that progression to five maths-related subjects (Biology, Chemistry, Physics, Economics, and Psychology) was higher post-reform than pre-reform. Compared to pre-reform years, performance in these maths-related subjects was generally worse post-reform. In particular, in science subjects (Biology, Chemistry and Physics) performance was very similar pre- and post-reform for students with the very top GCSE grades in mathematics, but it was lower post-reform for students with lower grades in the GCSE.

In conclusion, this research has shown that some of the aims of the curriculum and assessment reform in secondary mathematics (in particular, increasing uptake of mathematics post-16) seem to have been fulfilled. As with any reforms, changes take time to bed in, but this research has raised important issues for the mathematics education community as countries seek to increase the numbers of people that are well prepared to apply their mathematical knowledge and skills not only in further education and the workplace, but also in society more generally.

For more details on this work, please see the full research report (Vidal Rodeiro & Williamson, 2022) or the forthcoming article (Vidal Rodeiro & Williamson, forthcoming).

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