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Performance in secondary mathematics topics pre- and post-reform

Conference Abstract

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Abstract

In England, a recent major programme of assessment reform replaced the General Certificate of Secondary Education (GCSE) qualifications that young people take aged 16. Qualifications in all subjects were reformed, and in mathematics, the stated aims of reform were ambitious: to ensure mastery of fundamental mathematics by all students, at the same time as creating a more challenging qualification to improve preparation for further mathematical study and careers. This was particularly motivated by concerns about the low numbers of students in England studying post-16 mathematics (Hodgen et al., 2018), and the attendant consequences – both educational and economic, for example in STEM areas.

The reformed mathematics GCSE included new content, and a re-weighting of assessment objectives and topics. In addition, some content previously expected to be taught only to higher-attaining students was re-designated as expected content for all students. Schools were expected to increase teaching time in mathematics. Early qualitative studies (e.g., Grima & Golding, 2019; Howard & Khan, 2019; Humphries et al., 2017) indicated that teachers generally supported the aims of GCSE mathematics reform, and perceived a number of positive effects: wider and deeper mathematical knowledge among GCSE students, better preparation for post-16 study, and improved problem-solving skills. At the same time, teachers had concerns about the reformed qualification's accessibility (particularly to lower-attaining students) and student attainment in algebra.

While these studies offered valuable insight into the perceived impacts of GCSE reform, it is clearly important not to overstate perceived effects without considering other types of evidence. Evaluating the impact of assessment reform is not always straightforward, however. For GCSE mathematics, a challenge was that relevant reference points (GCSEs in all other subjects, and A level assessments taken by 18-year-olds) were reformed concurrently, and National Reference Test results were published only for post-reform cohorts. To better understand the impact of GCSE mathematics reform, we decided to complement the few existing studies by offering a quantitative analysis of student performance in GCSE mathematics examinations. Our research analysed the performance in maths items of approximately 250,000 candidates from the final three years of pre-reform GCSE mathematics (2014-2016) and the first three years of the post-reform GCSE (2017-2019). The candidates spanned the full range of mathematical attainment levels.

Our analyses focused on student performance in different mathematical topics and how this changed (or did not change) with GCSE reform. We first produced descriptive statistics on the proportions of marks achieved across topics, and then investigated the variations observed using regression modelling. A particular contribution of the research was to analyse candidate performance on sets of similar items (i.e., families of near-identical items spanning both pre- and post-reform GCSE papers), to explore whether there was any evidence for changes in candidates' (absolute) levels of mathematical performance. To do this, we used IRT modelling and equating to produce expected facility measures for all items within similar item sets, then used multilevel regression modelling to test for any differences between pre- and post-reform candidates.

The findings confirmed that candidates found post-reform GCSE assessments substantially more challenging. The results showed that the proportion of marks achieved decreased more in geometry and algebra questions than in other topics, but that the variation across topics (in pre-reform to post-reform change) was not statistically significant. Despite this, the

variations may have affected teacher and candidate experiences of GCSE mathematics topics. This in turn may have influenced beliefs about mathematical strengths and weaknesses, and the strengths and weaknesses of the reformed GCSE qualification. Reassuringly, the analyses confirmed that pre-reform and post-reform GCSE candidates at the pass score level performed in very similar ways on items identified as belonging to a family of "similar items". In most topics, there was no evidence of a change in absolute attainment. For items belonging to the Number/Ratio topic, and considering all item similar sets simultaneously, there was weak evidence that post-reform candidates performed slightly better. These findings contribute new evidence on the impact of GCSE mathematics reform. To successfully understand the reform impacts, we should continue to monitor multiple sources of evidence, and remain open to the possibility that longer-term effects may change, keeping in mind that this research considered only the first three years of implementation.

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