Differences between A-level and undergraduate Mathematics questions: Doing, reproducing or practising Mathematics

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Abstract

A-level examinations in England are often perceived as becoming easier, and allegations of 'grade inflation' abound which. In the case of mathematics, this is compounded by comments made by observers, educational researchers and university lecturers that A-level Mathematics no longer acts as adequate preparation for undergraduate mathematics courses. With the Government recently announcing reforms to A-levels, it is important that the current structure and content of A-level Mathematics are investigated in order to ensure that any redesign reflects and addresses any shortcomings associated with the current qualification. Whilst A-level Mathematics is not intended to exist solely to prepare secondary students for undergraduate mathematics study, it could be argued that the A-level in Further Mathematics should address this transition stage, so that students have a strong mathematical basis from which to build when beginning their university careers. However, there is little academic literature concerning the nature of A-level *Further* Mathematics.

This research addressed the issue of whether A-level Mathematics and/or Further Mathematics act as sufficient preparation for university mathematics study. In particular, it focused on the nature of the types of examination questions posed and skills required at the secondary and tertiary levels. Secondary mathematics and tertiary mathematics are very different, with the focus changing between school and university from "What is the result?" to "Is it true that..?" (Dreyfus, 1999, p. 106); however, students and educators have commented that new undergraduates are ill-prepared for what faces them at university.

The Mathematical Assessment Task Hierarchy (MATH; Smith et al., 1996), was developed in part as an alternative to Bloom's Taxonomy of Educational Objectives (Bloom et al., 1956) for the advanced mathematics context. Both Bloom's taxonomy and the MATH taxonomy were developed to categorise the types of questions posed in assessment in order that examiners and teachers could use such frameworks to design tests which assessed a range of skills. In this particular context, the MATH taxonomy was applied to a selection of A-level Mathematics and Further Mathematics papers from four different examination boards (OCR, AQA, Edexcel, WJEC), as well as 14 first year pure mathematics papers from a Russell Group university, as a means of analysis in order to identify any similarities or differences between secondary and tertiary mathematics.

The examination papers were analysed with a view to comparing the proportion of questions posed in each of the groups in the MATH taxonomy hierarchy – Group A (factual recall and computation), Group B (application of familiar skills in new situations) and Group C (conjecturing, interpreting, justifying). Subgroups within the main groups were also explored such as 'comprehension', 'factual knowledge and fact systems' and 'routine use of procedures' in Group A. Papers were analysed on a question-by-question basis by a mathematics education researcher with a degree in mathematics. Samples of this analysis were then verified by four different individuals with experience in this area: a current undergraduate mathematician, a professor

of mathematics education, a mathematics teacher, and an academic with a mathematics doctorate.

The differences between A-level Mathematics and Further Mathematics in terms of the proportion of marks available for responses to Group A, B and C questions were small. However, a significant difference between A-level and the undergraduate mathematics papers were found. Undergraduate papers comprised mainly Group C questions, whereas A-level papers were mainly of Group A questions. Nonetheless, a significant minority of marks were available for Group A questions at undergraduate level, specifically in questions entailing factual recall which requires no mathematical skill. Conversely, Group A questions at A-level comprised mainly 'routine use of procedures'. Surprisingly, it was found that it would have been possible to pass all of the papers analysed solely through the use of factual recall, a skill which requires no knowledge or understanding of mathematics. The findings here support calls for reform of the mathematics qualifications at A-level, as well as raising questions regarding the nature of assessment at tertiary level.