Why don’t more students do A-level Mathematics? The role of mathematics self-efficacy on enrolment in A-level Mathematics (a summary)

Catherine Porter, AQA, Centre for Education and Research Policy

A paper presented at the British Educational Research Association Annual Conference
London, September 2011

The following is a summary of a study conducted to investigate the extent to which students’ mathematics-related self-efficacy influences the likelihood that they will enrol in A-level Mathematics, including its preliminary findings and implications.

Introduction

The challenge to increase the number of UK students who leave school with A-level Mathematics, a prerequisite of entry into higher education and employment in most science, technology, engineering and mathematics (STEM) related disciplines has occupied the UK government for many years. It is recognised that addressing this challenge is necessary to secure the future competitiveness and prosperity of the UK’s economy (Department for Children, Schools and Families [DCSF], 2009). This necessity is emphasised by a recognised shortage of workers required by the STEM industries (Royal Society, 2008, 2011), with reports that less than 20% of UK students continue to study mathematics beyond 16, compared with between 40-100% of students in other developed countries (Nuffield Foundation, 2010).

Many efforts have indeed been made by the government to increase enrolment in A-level Mathematics. Reports from the National STEM Centre (2010) and the Department for Education (2010) suggest that, although further increase is still required, efforts made have been successful in increasing enrolment in A-level Mathematics. This was evidenced by the figures published by the Joint Council for Qualifications (JCQ, 2005, 2010), which showed that the number of A-level Mathematics entries had increased from around 6.9% of all A-level entries in 2005 to around 8.6% in 2010. Whilst this increase is encouraging, there are some who suggest that making A-level mathematics qualifications more attractive for students has put the academic rigour and standard of the qualifications at risk (Willis & Paton, 2009a, 2009b). This suggests that it would be helpful to investigate strategies to increase enrolment in A-level Mathematics which do not place risk on the perceived rigour and standard of the qualifications.

Theoretical Framework

According to Social Cognitive Theory (SCT), self-efficacy, or individuals’ beliefs in their ability to successfully execute a given behaviour, plays a key role in the way individuals govern their behaviour (Bandura, 1986). SCT posits that individuals are more likely to participate in an activity that they believe they have the ability to succeed in (for which they have self-efficacy). It also posits that individuals are inclined to work harder and persevere despite difficult challenges or set-backs, and consequently perform better in such activity.

In accordance with SCT, this study argues that interventions aimed at increasing mathematics self-efficacy (MSEF) could have a positive impact on A-level Mathematics enrolment. Whilst a plethora of research findings (for example: Mau, 2003; Lent et al, 2008; Brown et al, 2008b) have provided support for this argument, they have primarily focused on the relationship between MSEF and enrolment in post-compulsory mathematics directly after compulsory mathematics education (for example: AS level).
research aimed at university level. Therefore, the extent to which this relationship between MSEF and enrolment in post-compulsory mathematics can be generalised to AS Mathematics students’ enrolment in A-level Mathematics needs to be established. It is to this end that this study was conducted.

**Research Aims and Hypotheses**

The primary aim of this study was to investigate the extent to which MSEF influences AS Mathematics students’ decisions on whether to enrol in A-level Mathematics (A-level Mathematics enrolment), after controlling for the influence of other factors that have also been frequently cited as pertinent (Brown, Brown & Bibby, 2008a; DfE, 2010). These include: 1) gender; 2) ethnicity; 3) outcome expectations, which were measured in this study as students’ perceived usefulness of A-level Mathematics for future academic- and career-related pursuits; 4) AS students’ intentions to enrol in A-level Mathematics, which was measured approximately six months prior to them making their decisions on whether to actually enrol in A-level Mathematics; and 5) previous achievements, which were defined in this study as mean GCSE and AS Mathematics grades.

The present study investigated:

1. the extent to which AS Mathematics students’ MSEF influences their intention to enrol for A-level Mathematics;
2. the extent to which AS Mathematics students’ MSEF influences their actual enrolment in A-level Mathematics; and
3. the extent to which the effect of MSEF on AS Mathematics students’ enrolment in A-level Mathematics can be evaluated by identifying the effect of MSEF on AS Mathematics students’ intention to enrol in A-level Mathematics.

**Methods**

**Design and methods**

This study employed a cross-sectional survey, using a self-report questionnaire as the method of data collection. The questionnaire was administered in March/April 2010, prior to participants sitting their final AS exams or deciding on whether to enrol in A-level Mathematics. This timing was to ensure that their MSEF was not influenced by how well they had actually performed in AS Mathematics. A standard multiple regression and a binary logistic regression analysis were conducted to evaluate the first and second research questions. A mediation analysis was conducted to evaluate the third research question, with bootstrapped sampling used to evaluate the significance of the indirect effect of MSEF on A-level Mathematics enrolment through its influence on A-level Mathematics intention.

**Materials**

MSEF was measured with 10 Likert-scale items. Half of the items in the scale were newly created for this study, whilst the remaining five items were adapted from items in the general self-efficacy (GSEF) scale developed by Schwarzer and Jerusalem (1995). Enrolment intention was measured by asking participants to rate their intention of

---

1 Research shows that mean GCSE is a better indicator of A-level performance across all subjects than the GCSE Mathematics grade alone and is widely used by educational researchers and practitioners to predict A-level candidates’ performance (B. E. Jones, Personal communication, Jan 2010).
studying A-level Mathematics from a scale of 1 – 5 (very unlikely – very likely). Perceived usefulness was measured by asking participants to rate how likely it is that they will require A-level Mathematics to pursue their preferred degree course at university, and how likely it is that they will require A-level Mathematics to pursue their preferred career, from a scale of 1 – 5 (very unlikely – very likely). Subsequent analyses demonstrated that all measures used had good reliability and validity.

Participants

A sample of 11 schools was recruited via an advertisement in a monthly newsletter circulated by AQA to over 400 Mathematics teachers and Heads of Department at schools throughout the UK that offer GCE Mathematics. Of the 11 schools, five were sixth form colleges, two were secondary comprehensive schools, two were further education colleges, one was a tertiary college and one was a city academy.

A total of 898 AS Mathematics students (506 male and 392 female) from the 2009/2010 academic year completed the questionnaire. However, only 505 students (260 male and 245 female) were subsequently included in the final sample for analysis (see Figure 1 below). Analysis showed that there were no significant differences between the initial and final sample in relation to MSEF and intention, the two main variables of the study.

Preliminary Findings and Implications

The preliminary findings of the present study have several practical implications that merit consideration.

First, the findings suggest that MSEF is the strongest predictor of AS Mathematics students’ intention to enrol in A-level Mathematics ($\beta = .45, p < .001, 95\% CI$ for $B$ between .002 and .003, $R^2 = .51$) compared to gender, perceived usefulness of A-level Mathematics and mean GCSE grades. MSEF appears to account for around 45% of the variation in AS Mathematics students’ intention to enrol in A-level Mathematics. This suggests that increasing AS Mathematics students’ MSEF would also increase their intention to enrol in A-level Mathematics, which in turn is likely to have a significant influence on their actual enrolment in A-level Mathematics ($\chi^2(6, N = 505) = 27.17, p < .001$, with 95% $CI$ for odds ratio of between 1.78 and 3.56). For each unit increase in the intention scale used in this study, the results indicate that AS Mathematics students’ likelihood of enrolling in A-level Mathematics increases 2.5 times. Therefore, these findings suggest that increasing AS Mathematics students’ MSEF could potentially increase their enrolment in A-level Mathematics.

Second, the findings also indicate that mean GCSE grade has a significant influence on AS Mathematics students’ enrolment in A-level Mathematics, when the influence of gender, perceived usefulness of A-level Mathematics, MSEF, A-level Mathematics
enrolment intention, and AS grade were controlled ($\chi^2(6, \ N = 505) = 14.72, \ p < 0.001$, with 95% CI for odds ratio between 1.42 and 2.96). The findings suggest that, for each grade increase in their mean GCSE, AS Mathematics students are twice as likely to enrol in A-level Mathematics. Given the positive relationship between MSEF and mathematics achievements (Brown et al., 2008b; Patrick et al., 2010), this suggests that, assuming all things are equal, the earlier during students’ GCSE schooling that interventions which effectively increase students’ MSEF begin, the greater their likely impact on increasing the number of students who enrol in A-level Mathematics would be. This is likely to be the case, as the increase in MSEF as a result of effective interventions could potentially increase students’ mathematics attainment in GCSE, which would contribute to an increase in their mean GCSE grades. This could in turn, as the findings in this study suggest, potentially increase the number of students who go on to enrol in A-level Mathematics.

Third, the findings indicate that the effect of MSEF on AS Mathematics students’ A-level enrolment is partially mediated by their intention to enrol in A-level Mathematics. This suggests that one of the ways by which AS Mathematics students’ MSEF affect their enrolment in A-level Mathematics is by affecting their intention to enrol in A-level Mathematics, prior to them sitting their AS Mathematics exam. This is, however, based on the assumptions that: MSEF affects AS Mathematics students’ intention to enrol in A-level Mathematics (not the other way around); MSEF affects AS Mathematics students’ actual enrolment in A-level Mathematics (not the other way around); and AS Mathematics students’ intention to enrol in A-level Mathematics affect their actual enrolment (not the other way around). Based on these assumptions, the findings suggest that the effectiveness of interventions which aim to increase AS Mathematics students’ enrolment in A-level Mathematics by increasing their MSEF can, to some extent, be evaluated prior to students’ actual enrolment. This could be useful, for example in identifying able students who may be requiring additional encouragement (for example: affirmation of their mathematics ability) to enrol in A-level Mathematics. However, the findings also indicate that not all of the effect AS Mathematics students’ MSEF has on their enrolment in A-level Mathematics is mediated by their intention to enrol in A-level Mathematics. This suggests that some of the effect AS Mathematics students’ MSEF has on their enrolment in A-level Mathematics was either direct or mediated by other factors, for example by their AS Mathematics achievements. This is probable given that students’ intention to enrol in A-level Mathematics were measured prior to them sitting their AS Mathematics exam, and some distance ahead of them deciding on whether to actually enrol in A-level Mathematics. Again, this is based on the assumptions that the directions of the effects between MSEF, enrolment intention, and enrolment are as noted above. Based on these assumptions, this finding suggests that evaluating interventions that aim to increase enrolment in A-level Mathematics solely based on the impact that they have on students’ intention to enrol in A-level Mathematics may be underestimating their impact on actual enrolment in A-level Mathematics. As such, caution would need to be exercised before interventions that aim to increase A-level Mathematics enrolment by increasing MSEF is deemed ineffective based solely on their impact (lack of) on students’ intention to enrol in A-level Mathematics.

Finally, the findings from the present study are consistent with those from previous research which investigated the relationship between MSEF and enrolment in post-compulsory mathematics courses at different stages of academic life. As such, it would be reasonable to argue that the findings from the present study can be generalised to the relationship between students’ MSEF and post-compulsory mathematics enrolment in general.
Conclusions

In conclusion, the findings indicate that MSEF is a significant predictor of, and thus has a significant influence on, AS students’ intention to enrol, and their actual enrolment, in A-level Mathematics. This is the case even after controlling for the influence of gender, perceived usefulness, intention to enrol in A-level Mathematics, mean GCSE and AS grades. These findings are consistent with those from previous research which investigated the role of MSEF on students’ enrolment in post-compulsory mathematics in general. Thus, overall, the findings from the present study suggest that interventions aimed at increasing students’ mathematics self-efficacy could be an effective means of increasing the number of students that continue to study mathematics beyond compulsory level, including A-level Mathematics.

References:


