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Maths? Why Not?

Project Title	Maths? Why Not? Unpacking reasons for students' decisions concerning higher-level mathematics in the senior years
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Concerns are currently being expressed about Australia's capacity to produce a critical mass of young people with the requisite mathematical background and skills to pursue careers in Science, Technology, Engineering and Mathematics (STEM) to maintain and enhance this nation's competitiveness. These concerns permeate all levels of learning and skill acquisition, with programs to assess mathematical achievement of primary and early secondary students regularly identifying areas that require concerted action.

Internationally, Australia's 15 year old students perform very well on the mathematical literacy scale in terms of the knowledge and skills as investigated by the Organization for Economic Cooperation and Development (OECD) in its Programme for International Student Assessment (PISA) for 2002 and 2003 (OECD 2000, 2004). In addition, the Trends in International Mathematics and Science Study (TIMSS) for 1994/5 and for 2002/03 revealed that Australian Year 8 students' achievement in mathematics was significantly higher than the international average in all content areas considered (Thomson & Fleming, 2004).

Along with these indicators of achievement in the early years of secondary schooling, there is encouraging national evidence indicating that these levels of mathematical literacy are translating into increased enrolments in senior mathematics courses. There is a paradox, however, with enrolments in higher-level courses declining and enrolments in elementary or terminating mathematics courses increasing (Thomas, 2000; Barrington, 2006). This trend is not an encouraging basis from which to improve the percentage of university graduates from mathematics-rich courses that lead into STEM careers.

Against this background of perceived need and encouraging student performance in early secondary schooling, the research question identified for the project was:

Why is it that capable students are not choosing to take higher-level mathematics in the senior years of schooling?

The answers are deceptively simple. Nevertheless, it was anticipated that responses to it would provide important insights into a number of critical issues underpinning the learning and teaching of mathematics in Australia and provide a platform for constructive action to address STEM skill shortages.

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Of the four major groupings of questions about perceived influences contained in surveys, the Individual Influences group was perceived by both mathematics teachers and career professionals as having the greatest impact on students' decision making. The specific areas identified as contributing to this impact were students':

- Self-perception of ability;
- Interest and liking for higher-level mathematics;
- Perception of the difficulty of higher-level mathematics subjects;
- Previous achievement in mathematics; and
- Perception of the usefulness of higher-level mathematics.

Further analysis of these data was undertaken to identify any significant item effects and interactions. Three areas of interest were highlighted by this analysis. Firstly, the most significant items from the four groups of perceived influences were:

- Students' experience of junior secondary mathematics;

- The greater appeal of less demanding subjects;
- The advice of mathematics teachers;
- Students' perception of how good they are at mathematics;
- Parental expectations and aspirations; and
- Students' understanding of career paths associated with higher-level mathematics.

Secondly, the interaction between survey group and the groups of items revealed a number of differences. The first of these related to the appeal of less demanding subjects where teachers perceived this to be more influential than did careers professionals. The others related to the advice of students' mathematics teachers, the advice of parents and other adults, students' understanding of career paths associated with higher-level mathematics, and of the way tertiary entrance scores are calculated, where career professionals perceived these to be more influential than did mathematics teachers.

Thirdly, the interaction between location and the groups of influences highlighted three areas which were perceived to be more influential for regional and rural respondents than for metropolitan respondents. These were the likelihood of taking higher-level courses in a composite class and/or by distance education, the perceived difficulty of higher-level courses, and the advice of other teachers.

In addition, a number of recurring themes emerged from the qualitative analysis of the mathematics teachers and career professionals extended response data. Again, these reinforced the central roles of prior learning experiences, student learning needs, and advice about post-secondary options. These themes were:

- Previous learning experiences in mathematics, which neglect the consolidation of understandings, were perceived to be a necessary foundation for learning throughout schooling and life.
- Syllabus and curriculum frameworks which contain so much content that they do not leave sufficient time for the consolidation of understanding and knowledge.
- Heavy student workloads associated with higher-level mathematics courses.
- Teaching and learning practices which do not adequately support the learning of mathematics from primary school through to secondary school.
- Pedagogical approaches that do not engage students because teachers are often required to teach outside their area of expertise.
- Assessment practices which vary in approach to purpose, structure and feedback provided (e.g., formative, summative, holistic, pen and paper tasks, problem solving tasks, grades and/or comments).
- Subject choices which are based more on their mark potential for tertiary entrance scores than on their preparation for tertiary study.
- University information which lacks clarity or is ambiguous about pre-requisites needed to undertake mathematics-rich courses.
- Career advice which gives students an incomplete picture of potential options because of a lack of a holistic approach from relevant stakeholders (e.g., through partnerships between schools, employers, other education institutions, people working in the field).

Overall, mathematics teachers' perceptions are that students need a substantial level of achievement in mathematics prior to choosing a higher-level mathematics subject. This is needed in order to sustain interest in and liking for the study of higher-level mathematics – students need a realistic self-perception of their ability that will then allow them to engage, and persevere, with a challenging senior mathematics course. Career professionals reinforced this message and added that more needs to be done in the area of conveying the usefulness of mathematics.

Coupling this perception about usefulness with the relative importance of mathematics teachers' advice which career professionals acknowledged, there are implications for clarifying the central role that mathematics teachers have in supporting student learning. That role, and associated support, is based on the provision of learning experiences which consolidate concepts and which emphasise personal relevance so that students acquire positive perceptions of their ability and a capacity to understand the role mathematics has beyond secondary schooling.

The additional data that was collected from student surveys and focus group discussions provided supporting commentary for three key areas identified in the study. These comments related to the importance of quality junior secondary school experiences, of engendering a positive self- perception of ability in students, and of highlighting the career and personal relevance of mathematics.

From the student comments, individual and post-secondary considerations accounted for most of the influences on their decisions. The most important of these included the idea that studying mathematics contributes to increased levels of knowledge and understanding that can be applied in other (problem-solving) disciplines, and the notions that positive junior secondary school experiences and acquiring confidence in their ability will support their choices. In addition, the importance of mathematics was acknowledged through its general, career and personal relevance beyond secondary school. Nevertheless, students also identified mathematics as a difficult subject and that the knowledge and skills acquired come at a price in terms of effort and time allocation associated with balancing study and personal schedules.

In their discussion, mathematics teachers focused on the changing culture of students, and the need to respond to a diverse range of competitive academic and social pressures. One important consequence of this competition was identified as an inability, among what was thought to be an increasing number of students, to maintain the effort required to undertake a 'hard' course, such as higher-level mathematics. In responding to this, mathematics teachers indicated that the way mathematics is taught and the nature of support offered by mathematics teachers to their students are two critical components in addressing the change in student culture.

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