Australian Government

Department of Education, Employment and Workplace Relations

Maths? Why Not?

Final Report prepared for the Department of Education, Employment and Workplace Relations (DEEWR)

March 2008

Greg McPhan, Will Morony, John Pegg,
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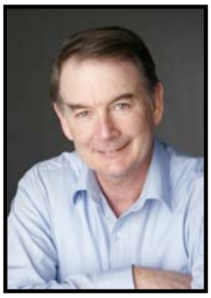

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Professor John Pegg (Project Leader and Director, SiMERR National Centre)
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EXECUTIVE SUMMARY

Background

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[1] 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.

Sources of data

The main source of data for the Project was in the form of on-line surveys completed by mathematics teachers and career professionals[2]. In addition to background information about the respondents, 27 Likert scale questions were asked about perceived influences on students'

[1] This term is used to refer to mathematics courses taken at schools which lead on to mathematics-rich courses at the tertiary level courses.

[2] This is the generic title used in this Report to describe people in schools with responsibilities to provide career and course advice/counselling.

decisions to take higher-level mathematics courses. The questions were considered in four groups. These groups were related to:

- *School influences*, such as, timetable restrictions, course availability, and students' experience of junior secondary mathematics;
- *Sources of advice influences*, such as, job guides, other teachers in the school, and friends in the same year level;
- *Individual influences*, such as, perceptions of ability, interest, and previous achievement; and
- *Other influences*, such as, gender, parental aspirations, and understanding of career paths.

In addition, there were questions relating to enrolment trends in respondents' schools over the past five years, aspects of teaching and learning that encourage students to take higher-level mathematics courses, and strategies to increase student participation in higher-level mathematics courses. Both teachers and career professionals had the opportunity to elaborate on their responses to these questions by providing additional comments.

The information obtained from these surveys was supplemented with student surveys and focus group discussions involving students and mathematics teachers. Both qualitative and quantitative analyses were carried out.

Findings

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[3]. 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.

[3] This was undertaken using a two (survey group: mathematics teacher/career professionals) by two (location: rural & regional/metropolitan) by group of items MANOVA design.

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.

Recommendations

A list of the recommendations from the Project is provided below. Six broad themes were identified to provide a holistic approach for schools, education authorities and universities to respond to the issue of declining enrolments in higher-level mathematics courses. The themes are listed below and the recommendations are provided in the following three pages:

1. Mathematics teaching and learning
2. Career awareness programs
3. The secondary-tertiary transition
4. Further research to obtain a more comprehensive picture of influences on students’ decisions to take higher-level mathematics courses
5. Further research to investigate identified influences more deeply
6. Enrolments in mathematics courses

RECOMMENDATIONS

Implicit in these recommendations is an awareness of the issues that are of particular relevance for rural, regional and remote school communities, and of differences within groups (e.g., gender, ethnicity).

Mathematics teaching and learning

1. That educational authorities actively support the teaching of mathematics in the primary and junior secondary years to ensure that it is directed towards maximising the pool of students for whom higher-level mathematics in the senior years at school is a viable and attractive pathway. School systems need to foster a culture of sustainable professional development within schools that enables mathematics teachers to act on the student-related influences identified as the main findings of this report by:

   - implementing pedagogical strategies that engage students;
   - focusing on conceptual understandings at all levels and at key stages in learning, and
   - having access to intervention programs that address students' particular learning needs.

2. That educational authorities have in place mechanisms that identify students, or which enable students to self-identify, as in need of support programs in mathematics. These students should be provided with opportunities to consolidate their understandings of important aspects of mathematics at critical development points in their learning (e.g., through 'second chance' programs).

3. That the Commonwealth and/or other research funding bodies initiate further research into the range of mathematics-specific issues that emerged in the Maths? Why Not? Project as possible influences on students' engagement and decision making, namely:

   - The conceptual obstacles experienced by students in the middle years of schooling, with a view to developing strategies to overcome them;
   - The role of formative and summative assessment in early secondary mathematics and the effects of each on students' self-efficacy;
   - The links between student-teacher relationships and performance in mathematics;
   - Problematic components of curriculum and teaching that were identified (e.g., lack of rigour, shallow treatment of important ideas, irrelevance of content, lack of opportunities for creativity, subject workload); and
   - The extent to which teachers develop for students a 'world view' of mathematics and mathematicians.

4. That Federal, State and Territory governments, in consultation with education authorities, schools systems and other stakeholder groups, collaborate to develop and implement a range of incentives that:

   - encourage mathematics graduates into primary and secondary mathematics teaching; and
   - address the retention of degree-qualified mathematics teachers in primary and secondary teaching.

Career awareness programs

5. That professional associations involving teachers of mathematics and career professionals work together to develop, trial and implement career awareness programs in the junior secondary and upper primary years of schooling. These learning units should provide information about the potential and value of mathematics-rich careers, and also highlight links between careers and students' evolving understanding of mathematical concepts.

6. That educational authorities, tertiary institutions, and other stakeholder groups form partnerships to work together to support the development of school cultures that promote mathematics-rich careers through the provision of programs that include:

    - The regular production of career-related resources, including, a book of mathematics related career advertisements, 'bullseye' type career posters, and career organization newsletters;
    - Clear advice to mathematics teachers, careers advisers and parents about the importance of mathematics in choosing and successfully pursuing a career;
    - Support for mathematics teachers and careers advisers about what mathematics students can do in terms of career options and pathways; and
    - Encouragement for schools to inform parents about career options and desirable pre-requisites related to mathematics for their children.

The secondary-tertiary transition

7. That tertiary admission authorities, in consultation with State and Territory educational authorities, review its procedures to ensure that the calculation of tertiary entrance scores incorporates positive incentives to recognise those students who take advanced (and to a lesser extent intermediate) mathematics subjects in Years 11 and 12.

8. That Federal, State and Territory governments, in consultation with industry, develop a program of post-secondary scholarships and/or cadetships for studying and completing mathematics-rich courses at university (i.e., those that depend on successful completion of higher-level mathematics courses at school).

9. That tertiary institutions develop realistic minimum and desirable levels of mathematical background required for the study of tertiary mathematics subjects at university. These levels should be clearly and unambiguously identified in all promotional material as "pre-requisite knowledge," "assumed knowledge" or similar.

10. That the Commonwealth and/or other research funding bodies initiate further research into the reasons and motivations which contribute to senior secondary students' decision to enrol in tertiary mathematics-rich courses.

Further research to obtain a more comprehensive picture of influences on students' decisions to take higher-level mathematics courses

11. That the Commonwealth and/or other research funding bodies support an evaluation of the Maths? Why Not? methodology for application to a fully representative sample of Australian students and parents/caregivers to identify students' beliefs and perspectives concerning the influences on their subject, course and career choices. The study should

contribute to a holistic understanding of 'Generation Y' in relation to these matters, as well as clarify issues for particular subjects (e.g., the uptake into science and mathematics) and particular pedagogical approaches. There should be a broad scope of students studied (e.g., Years 5 – 12 and into the tertiary years) to gain a comprehensive picture of:

- The meaning students attach to terms, such as, 'usefulness,' 'relevance,' 'less demanding subjects' and 'difficulty' when used in the context of choosing mathematics subjects in the senior years;
- The characteristics of earlier learning experiences which contribute to positive achievement and high levels of interest in mathematics, and which have the potential to influence decision-making (e.g., curriculum, pedagogy, teaching, encouragement, feedback, performance); and
- The factors which contribute to developing positive beliefs about mathematics and its application to students' lives and aspirations.

12. That the Commonwealth and/or other research funding bodies initiate further research into the extent of career professionals' knowledge and practice concerning the nature and usefulness of higher-level mathematics, and counselling about possible career paths.

13. That the Commonwealth and/or other research funding bodies initiate further research that:

    - Identifies the current benefits and rewards to students of undertaking higher-level mathematics;
    - Identifies potential benefits and rewards (associated with other subjects) that may be transferable to mathematics;
    - Investigates the relatively low rating that career professionals attribute to their advice;
    - Investigates the relative importance of the influences identified in the project that apply to the pre-secondary context, and the efficacy of introducing career programs into the primary years of schooling;
    - Analyses the PISA and TIMSS data concerning enrolments in countries that are more successful than Australia in terms of students studying advanced mathematics, and concerning attitudinal characteristics of students;
    - Determines whether or not there are critical times during schooling when students make formative decisions about subject choices and careers.

Further research to investigate identified influences more deeply

14. That the Commonwealth and/or other research funding bodies initiate further research to investigate aspects of effective advice which are:

    - Characteristic of career professionals (e.g., is the advice subject-specific or motivational; advisory or mandatory; informative or influential); and
    - Common to the range of other advisory influences highlighted in the Maths? Why Not? Project (e.g., are there important social constructs inherent in the advice?).

Enrolments in mathematics courses

15. That State and Territory curriculum authorities adopt a nationally consistent approach to the reporting of student enrolments across subjects.

16. That State and Territory professional associations consult concerning the setting of desirable levels of student uptake into senior mathematics courses.

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SECTION 1

MATHS? WHY NOT? – THE PROJECT

1.1 Background

> Australia will be unable to produce the next generation of students with an understanding of fundamental mathematical concepts, problem-solving abilities and training in modern developments to meet projected needs and remain globally competitive.
>
> [*Mathematics and Statistics: Critical Skills for Australia's Future*; The National Strategic Review of Mathematical Sciences Research in Australia, 2006, p.9.]

The extract provided above encapsulates concerns 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 that will help to maintain and enhance this nation's competitiveness. The malaise permeates 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.

Throughout schooling, the range of issues that impact on the quality of teaching and learning include the qualifications, supply and retention of teachers who teach mathematics; course structures in schools; access to, and uptake of, professional development. At the tertiary and policy-making levels, the nature of teacher preparation courses and the lowering or removal of mathematics prerequisites for entry into courses in science, technology, engineering and mathematics further compound the problem. Reports, such as the House of Representatives' Standing Committee on Education and Vocational Training's *Top of the Class* (2007), the *Audit of Science, Engineering And Technology Skills* (2006), the Australian Academy of Science's *National Strategic Review of Mathematics Research in Australia* (2006), and the Australian Council of Deans of Science's *Preparation of Mathematics Teacher in Australia* (2006) continue to articulate the scope of the consequences of having a reduced skill-base in the enabling subjects. *Australia's Teachers: Australia's Future – Advancing Innovation, Science, Technology and Mathematics* (2003) marked the beginning of a significant attempt to address a number of factors identified through the work of the Committee for the Review of Teaching and Teacher Education as contributing to a lack of vitality in the teaching of science, technology and, in particular, mathematics in our schools.

These are deeply ingrained issues and trends. Sustained, collaborative effort on a range of fronts is required.

Against this background of diverse priorities and urgent needs, the Maths? Why Not? project sought to bring together commentary about participation in mathematics. The purpose is to consider relevant material from the literature covering research in mathematics education, trends revealed in international studies, and data based on the experiences and perceptions of teachers, careers professionals and others.

1.2 Methodology

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?*

This question is deceptively simple. Nevertheless, it was anticipated that it would provide an important 'toehold' to a number of critical issues underpinning the learning and teaching of mathematics in Australia. More importantly, it offered a means of connecting the learning and teaching of mathematics from the perspective of the current and projected skills shortages. The intention was to offer new insights and a platform for constructive action.

1.2.1 Project team

The project was undertaken by a partnership between the Australian Association of Mathematics Teachers Inc. (AAMT) and the National Centre for Science, ICT and Mathematics Education for Rural and Regional (SiMERR) Australia. The co-managers of the project were Mr Will Morony, Executive Officer AAMT and Professor John Pegg, Director of the SiMERR National Centre. The research team included Dr Greg McPhan and Mr Trevor Lynch, with administrative support from both the AAMT Head Office (Adelaide) and the SiMERR National Centre (Armidale). An Advisory Committee was established (see Appendix A for membership and affiliations) to provide advice and guidance at strategic stages of the project. Key contributions of this group during the course of the project included the initial formulation of general categories for coding qualitative data from the surveys, and the formulation of recommendations when it met to reflect on the findings of the project.

1.2.3 Overview of methodology

The methodology adopted sought to explore several clusters of factors that may influence students' choices. The systematic investigation of enrolments undertaken in this project was in line with recent research concerning falling enrolments in the Sciences (Lindahl, 2003; Lyons, 2006; Osborne, Simon, & Collins, 2003; Schreiner & Sjøberg, 2005). The clusters of factors to be explored were:

- Mathematics curriculum;
- Classroom experience of mathematics;
- Teaching and learning practices;
- School and curriculum organization;
- Career information and advice; and
- Preparation for, and access to, further education.

The factual dimension to each of these six areas was identified in a scan of documents and existing research – to the extent that is this reasonable and possible (see Section 2). More important, however, are the perceptions about the (relative) influence of these areas. The project focused on the perceptions and issues at the time of students' formal decision making in relation to choices of senior school mathematics subjects made around Year 10. There are other decision points including the end of schooling — at which time students make formal choices in relation to post-school trajectories — and, possibly, in the later years of primary education during which time attitudes may well be established. These critical stages in the life of students when the decision to ‘opt out’ of mathematics may be made were not explored in this project.

Clearly students’ perceptions are critical because they have the capacity to inform choices. Teachers’ perceptions are also a critical dimension to understanding the issues, and identifying strategies to address these. A third perspective identified as being important was that of school-based careers advisers.

1.2.4 Data sources

The two key instruments used to gather data on perceptions were online surveys and face-to-face focus group interviews. Table 1.1 summarises the use of these instruments for each group.

Table 1.1 Summary of Data Collection

Group	On-line survey	Focus group
Mathematics Teachers	Yes	Yes
Career Professionals	Yes	No
Students	Yes	Yes

Separate surveys were constructed for each of the groups and copies of these survey forms are provided in Appendix B. Each survey comprised a number of sections. There was a large number of common items in the survey forms for mathematics teachers and careers advisers. Approval to conduct the research associated with the project was sought from The University of New England’s Human Research Ethics Committee and was approved on 28th September 2006 (See Appendix C).

1.2.5 Contacting respondents and seeking data

Members of AAMT were used as the means for contacting mathematics teachers and students. Members were invited to complete the online survey form through direct contact – electronic and in hard copy, on several occasions. They were also encouraged to recruit colleagues who may or may not be members of AAMT to complete the survey.

The last item on the survey form asked mathematics teachers to volunteer to further assist with the project. The volunteers from New South Wales and South Australia were invited, through a personal email and some subsequent telephone contact to enlist students at their school as respondents, both to the student survey and, subsequently, as members of a focus group. The decision to limit student input to these two states only reflected the limited resources of this project – the AAMT office is located in South Australia; the SiMERR National Centre is in New South Wales.

Permission to involve students in this research was received from both jurisdictions: the Government of South Australia’s Department of Education and Children’s Services (DECS), on 10th October 2006; the New South Wales’ Department of Education and Training (DET), on 12th December 2006. (see Appendix D for copies of the approvals). For non-government schools the approval of the principal was needed as a first step in obtaining data from students.

As part of the requirements of the jurisdictions and the UNE Ethics Committee, it was necessary to obtain parental approval for their children to be involved in responding to the survey and/or be a member of a focus group. The volunteer teachers were required to take on this task on behalf of the project. Letters were also sent to school principals seeking permission to invite teachers and students to participate in the project (see Appendix E for copies of the information sheets, letters and approval forms provided to the volunteer teachers).

1.2.6 The parent perspective

It was suggested at a meeting of the project's Advisory Committee that the perspectives of parents are also important. Although this had not been anticipated in the contract for the project it was decided to extend the methodology to include an online survey for parents. This was made feasible through the volunteer teachers distributing information that encouraged completion of the parent survey at the same time as parents received information seeking permission for their child to be involved (see Appendix F for a copy of the material about the parent survey distributed by the volunteer teachers in South Australia and New South Wales). Many of the items in the parent survey form were the same as those in the student form (see Appendix G for copies of the forms). This additional dimension to the project proved to be problematic in the context of the time frame for data collection and available human resources to ensure that a sufficiently representative parent sample was contacted. Ultimately, it was not possible to access a sufficient number of parents to complete the survey.

1.3 Data Transformation and Analysis

The surveys and focus group sessions furnished both quantitative and qualitative data. Quantitative data was obtained from the questions that comprised a stem and a scale for indicating endorsement of statements in the stem. Most of the questions had a five-position scale and some had a four-position scale. These Likert scale questions were analysed within clusters of influences in line with the structure of the surveys. Data were tabulated and charts prepared to represent the extent to which each of the groups of respondents endorsed the items. Where relevant, the charts were prepared to provide a metropolitan – rural breakdown of responses.

The qualitative data consisted of extended responses made by respondents when they had the opportunity to elaborate on their endorsements of a number of question stems. Their comments were coded within a general framework comprising ten general categories, each with a number of specific categories (see Appendix H). This grid was developed by two members of the project team using a protocol established at an Advisory Committee meeting as well as by using general themes identified in the literature scan. The comments were read and general categories established according to the content of the comment (e.g., school influences). These general categories were then refined in terms of a number of specific categories (e.g., timetabling; class organisation). This coding grid was refined as the comments were analysed jointly and separately by the two members of the project team. Once completed, the coding grid was applied to all comments made by teachers, career professionals and students. A number was assigned to each of the specific categories and this meant that data could be represented in chart format for further analysis.

Two additional perspectives on the data were obtained. The first was provided by interpreting the Likert scale questions for teachers and career professionals from a Rasch perspective. This process lead to some preliminary interpretations of the results of the survey in terms of how easy some of the items were to endorse. The second perspective was provided by undertaking a two (survey group: maths teachers/career professionals) by two (location: regional & rural/metropolitan) by group of items MANOVA analysis. This analysis was carried out in order to identify any significant item effects or interactions.

SECTION 2

LITERATURE REVIEW

> Australia must improve its percentage of university graduates with a mathematics or statistics major, from the current 0.4% p.a. to at least the OECD average of 1%. This target cannot be achieved without improving school mathematics …
>
> [*Mathematics and Statistics: Critical Skills for Australia's Future*; The National Strategic Review of Mathematical Sciences Research in Australia, 2006, p.52.]

2.1 Introduction

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). Results from the projects carried out in 2000 and in 2003 place Australia 5th (out of 31 countries) and 11th (out of 40 countries) respectively for mathematical literacy (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).

Against this background 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 (Figure 2.1). There is a paradox however, with enrolments in higher level courses declining and enrolments in elementary or terminating mathematics courses increasing. This trend is not an encouraging basis from which to improve the percentage of university graduates with a mathematics or statistics major.

Information concerning the number of Year 12 students undertaking elementary mathematics courses across Australia indicates an encouraging rise during the period 1995 – 1999, whereas there is an associated decline in the numbers taking advanced courses and only moderate increases in intermediate course numbers (Thomas, 2000). It is interesting to note that there is a parallel in the data presented by Thomas and similar data concerning enrolments in physics and chemistry courses for the same period (Lyons, 2005). Enrolments peak in 1992, decline to 1996 and then begin to rise again. Declines are documented also in the audit of Science, Engineering and Technology Skills initiated by the Minister for Education, Science and Training in 2004. The audit identified declines in these skills across all education and training sectors, particularly in the enabling sciences, which include advanced mathematics (DEST, 2006).

More recent data document the continuing downward trend for advanced course numbers and a similar pattern for intermediate courses (Barrington, 2006, DEST Audit Report, 2006). Table 2.1 details the national changes in the percentage of Year 12 students enrolled in higher-level courses during the period 1995 – 2004.

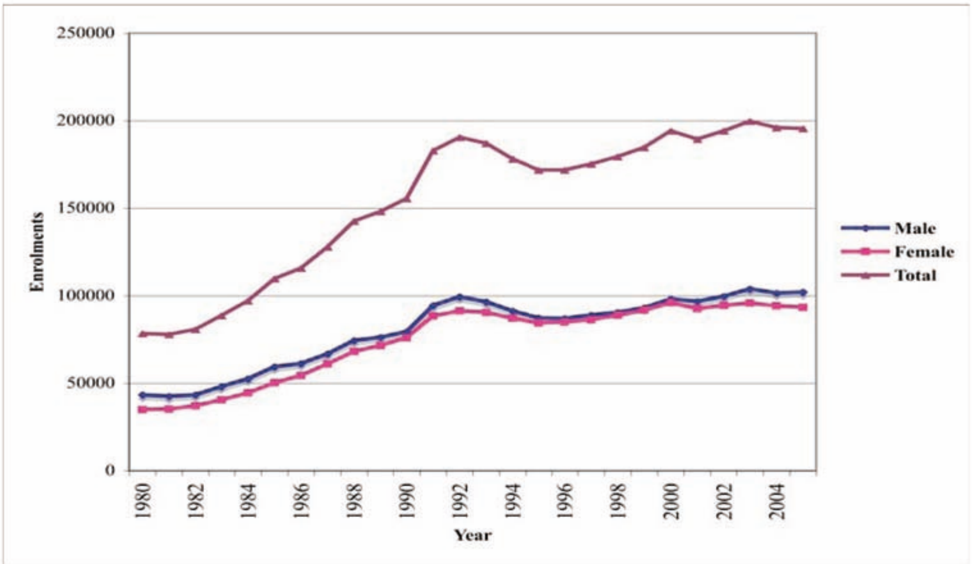

Figure 2.1 Year 12 Mathematics Enrolments for Australia by Gender (Adapted from Forgasz, 2005)

Table 2.1 Changes in the Percentage of Year 12 Students Across Australia Taking Advanced and Intermediate Mathematics Courses 1995 - 2004 (Adapted from Barrington, 2006)

State	Advanced		Intermediate	
	From 1995	To 2004	From 1995	To 2004
NSW	18.9	15	30	20.1
Vic	11.4	12.6*	24.4	24.2
Qld	12.6	8.4	33.7	31.7
WA	12.6	8.2	18.8	13.4
SA	11.8	9.1*	23.6	16
TAS	4.6	5.5	15.3	14.3
ACT	12.2	11.9	27.6	28
NT	5.8	3.2	15.7	14.2

* Overall decline after a rise '96-'97

Barrington noted that information concerning elementary mathematics courses is less clear-cut with over 70 courses falling into this category, e.g., General Mathematics, Modelling with Mathematics, and Mathematics Life Skills. He provided, however, an estimate of 9% as the increase in the percentage of students across Australia enrolling in elementary mathematics courses over the period of the review, i.e., 1995 – 2004. For the same period the national variation for advanced and intermediate courses is given as decreases of 2.4% and 4.6%, respectively. Neither decrease reflects the variation in separate states and the possible curriculum decisions which have prevailed in States, such as Western Australia and Tasmania over this period to give rise to substantial changes in, and relatively stable figures respectively.

Other national studies provide an inconsistent picture of enrolments, with differing breakdowns for the relative proportions of students in each course. The Longitudinal Survey of Australian Youth (Fullerton et al., 2003) reflected the national ratio of approximately 2:1 for advanced and intermediate courses given by Barrington, whereas the Youth Attitudes Survey (DEST, 2006) based on 1830 surveys across Years 10, 11 & 12, and Thomas (2000) indicated a greater proportion of students enrolled in intermediate courses. Within the period 2000-2004, Forgasz (2005), described enrolments for intermediate courses that indicate a pessimistic national decrease that is more pronounced for females than for males.

A number of reasons has been put forward for the change in status of advanced mathematics courses with the single most important affective predictor of enrolment in additional senior mathematics identified as usefulness (Brinkworth & Truran, 1998). 'Usefulness' can take on a number of qualifications, such as its usefulness as a prerequisite for further courses at the post-secondary level courses (Fullarton, Walker, Ainley, & Hillman, 2003). This usefulness is consistent with the widespread view that some students will use advanced mathematics courses as a vehicle to gain entry into university courses with a high cut-off scores (Brinkworth & Truran, 1998).

Whilst the importance of mathematics for further study emerges as the main reason for enrolling in mathematics courses, a range of factors has been identified that influence students' choices. One 'snapshot' of the background to student subject choices is provided in the Longitudinal Surveys of Australian Youth prepared by the Australian Council for Educational Research (ACER) in which patterns of subject participation are described in terms of gender, socio-economic background, ethnicity, location, State and Territory, school sector and achievement in literacy and numeracy (Fullarton, Walker, Ainley, & Hillman, 2003). These influences are encapsulated in a description of the typical advanced mathematics student as a high-achieving Asian boy from a high socio-economic status family, likely to be enrolled in an independent city school and who has aspirations to go to university.

Although a global view such as this one can be informative, it cannot describe individual differences and preferences. Significant groups of influences articulated by students for choosing to study mathematics have been reported as:

- Achievement/liking; usefulness; course requirements; encouragement received (Jones, 1988);
- Gender; socio-economic background; parental education; ethnicity; attitudes/achievement (Ainley, Jones, & Navaratnam, 1990);
- Number of courses offered; subject difficulty; interest and enjoyment; career relevance; ethnicity (Malone, de Laeter, & Dekkers, 1993);
- Keeping options open; previous performance; prerequisite (Brinkworth & Truran, 1998);
- Gender; achievement level; further study; language background (Fullarton et al., 2003);
- Gender-based factors – spatial-visualisation, mathematics anxiety, mathematics achievements, female attribution patterns; and Social factors – mathematics as a male domain, classroom culture, the curriculum, different treatment of girls and boys in the classroom (Conway & Sloane, 2005);
- For Year 10 students: Usefulness; engaging curriculum; career; tertiary entrance score; teachers (DEST, 2006);
- For Years 11 & 12 students: Usefulness; future prospects; performance; parents; advisers; teachers (DEST, 2006).

Factors which have been identified as 'other influences' include career advice, role models, school sector, and congruence with personal needs. Some studies have also considered the influences on students' choice not to do mathematics. Significant groups of influences include:

- Room for creativity/self-expression; level of boredom (Brinkworth & Truran, 1998)
- Boredom; difficulty; lack of usefulness; poor grades (DEST Youth Attitudes Survey, 2006)

The review of the literature that follows has been organised into three main sections. The first provides an overview of the various background reports that provided patterns of enrolments and descriptions of cohorts of students. The second section details the various influences which have been identified as impacting on students' choices. These have been grouped under a number of general headings, each reflecting a different aspect of usefulness. These headings are:

1. Aspirations, e.g., job prospects or further study;
2. Engagement with the Curriculum – learning/structure/teaching, e.g., enjoyment, the number of courses taught or subject availability, encouragement by and engagement of teachers;
3. Family and Peers, e.g., background and the nature/extent of support within the family or whether or not a friend does the subject ;
4. Performance, e.g., because of the previous grades;
5. Subject image, e.g., the way maths is presented in the media or by professionals.

These sections are followed by a summary of the main ideas that have emerged and suggestions for areas of continued investigation.

2.2 Background Information

This section draws mainly on material contained in reports of enrolment patterns (Barrington, 2006; Forgasz, 2006) and of student performance in international studies, such as TIMSS and PISA. This information provides a 'snapshot' of student participation in mathematics in terms of two relevant indicators, namely, the number of students in each course and key aspects of student performance.

The detail of students undertaking courses in advanced and intermediate mathematics as provided by Barrington for the period 1995 – 2004 is given in Figures 2.2 and 2.3 (Barrington, 2006). Allowance has been made in the data to ensure that students are not counted twice if they undertake an advanced course and are simultaneously enrolled in an intermediate course. The Year 12 reference populations for determining percentages are the total Year 12 candidatures as provided by the respective State curriculum authorities. Figure 2.2 indicates that the data for all but two of the States reflect the national trend of an overall decline in the number of students undertaking advanced mathematics. In Victoria, although there was a substantial increase in the period 1995 – 1997, this has been followed by a gradual decline. Only in Tasmania has there been a recent trend towards increasing numbers of students undertaking advanced courses, although the data represented in Figure 2.2 indicate that this increase is from a low baseline level.

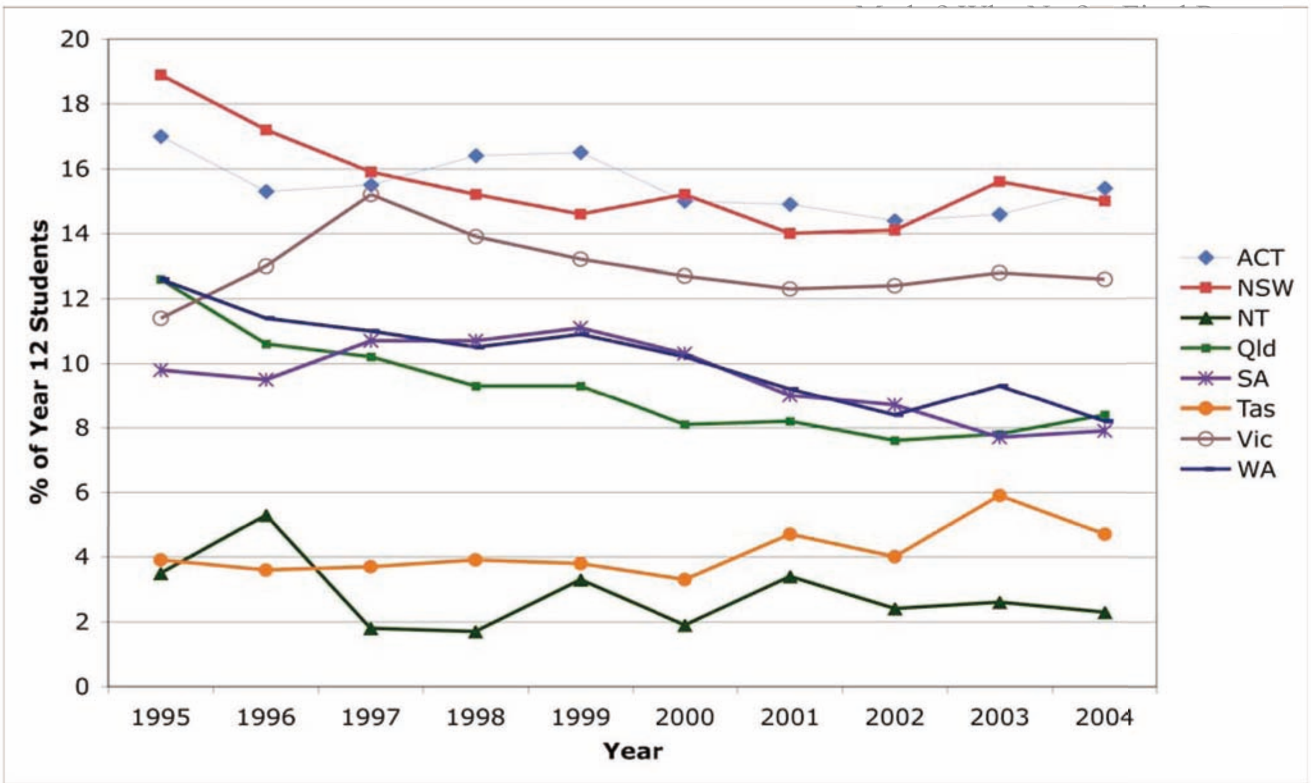

Figure 2.2 Year 12 Students Undertaking Advanced Mathematics as Percentages of Year 12 Students Taking Mathematics 1995 – 2004 (Adapted from Barrington, 2006)

Figure 2.3 illustrates the gradual declines which, again, reflect the national trend evident in intermediate courses. In most States, the overall changes have been small, a result of minor annual fluctuations. Only in the Northern Territory have there been substantial fluctuations and, in Victoria, the trend there mirrors the one for advanced course, namely, a peak in 1997, followed by subsequent declines. Consistent downward trends contributed to the greatest overall declines seen in New South Wales, South Australia and Western Australia.

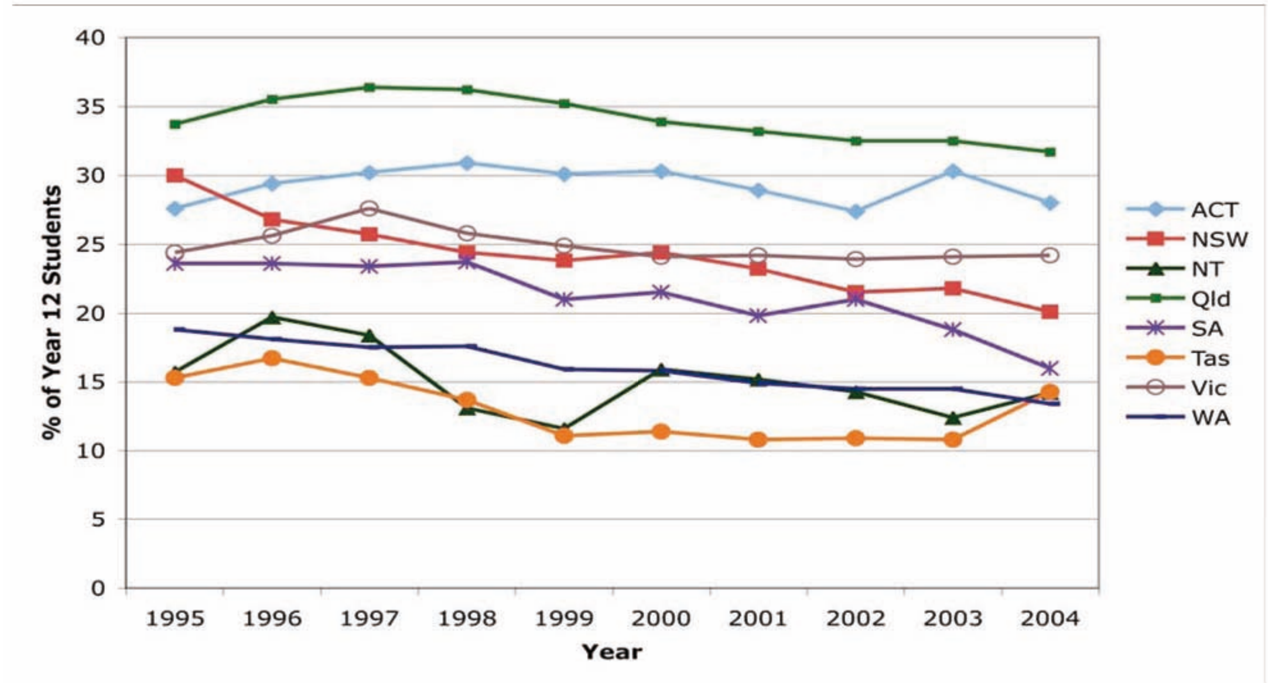

Figure 2.3 Year 12 Students Undertaking Intermediate Mathematics as Percentages of Year 12 Students Taking Mathematics 1995 – 2004 (Adapted from Barrington, 2006)

A comprehensive overview of Australian enrolment patterns in all mathematics courses is provided by Forgasz (Forgasz, 2006). Although the most detailed section of this report covers the period 2000 – 2004, data are also included for the periods 1970 – 1989 and 1990 – 1999. This information is provided against a background of increasing Year 12 retention rates since 1970 as a percentage of the national population and a 150% increase in total Year 12 mathematics enrolments since 1980. The choice of concentrating on the period since 2000 is a consequence of an analysis of the mathematical content of Year 12 mathematics offerings across Australia (Barrington & Brown, 2005). The range of mathematics courses available to students was given classifications of advanced, intermediate and elementary to enable a meaningful comparison between States. Figures 2.4 – 2.11 which follow detail the period since 2000 and are based on the enrolment data provided in this report. These have been updated using information from the respective State curriculum authorities to cover 2005 (ACT Board of Senior Secondary Studies, 2005; Australian Bureau of Statistics, 2005; Board of Studies, 2005; Curriculum Council of Western Australia, 2005; Queensland Studies Authority, 2005; Senior Secondary Assessment Board of South Australia, 2005; Victorian Curriculum and Assessment Authority, 2005; J. Fitzgerald, personal communication, December 7, 2006).

On a national basis, for the period since 2000, there has been a small increase in the number of total mathematics enrolments but this becomes a small decrease when enrolments are considered as percentages of Year 12 cohort sizes, with more male enrolments than female, a pattern which has remain unchanged since 1970. For the individual courses, a small increase has been recorded in advanced enrolments although this increase does not compensate for the sharp decline observed between 1999 and 2000. Enrolments in intermediate and elementary courses have recorded small decreases and stable percentages respectively after substantial increases between 1999 and 2000. These trends do not entirely match those reported by Barrington (Barrington, 2006) and highlights a difference in reference populations when determining percentages. Forgasz expressed enrolments as percentages of Year 12 cohort size and this can lead to inconsistencies if compared with raw enrolment numbers. The gender breakdown reflects the national pattern except in the elementary courses, where more females are enrolled than males. A brief summary of the details for each State and Territory follows.

Australian Capital Territory (Figure 2.4)

- Slight decrease in advanced course enrolments for males with a slight increase for females;
- Declining intermediate course enrolments;
- Increasing elementary course enrolments; and
- More females than males enrolled per course except for advanced.

New South Wales (Figure 2.5)

- Stable advanced course enrolments for males with a slight increase for females;
- Declining intermediate and elementary course enrolments; and
- More males than females currently enrolled in all courses.

Northern Territory (Figure 2.6)

- Stable advanced course enrolments for females with a slight increase for males;
- Declining intermediate course enrolments for females; and
- More males than females currently enrolled in all courses.

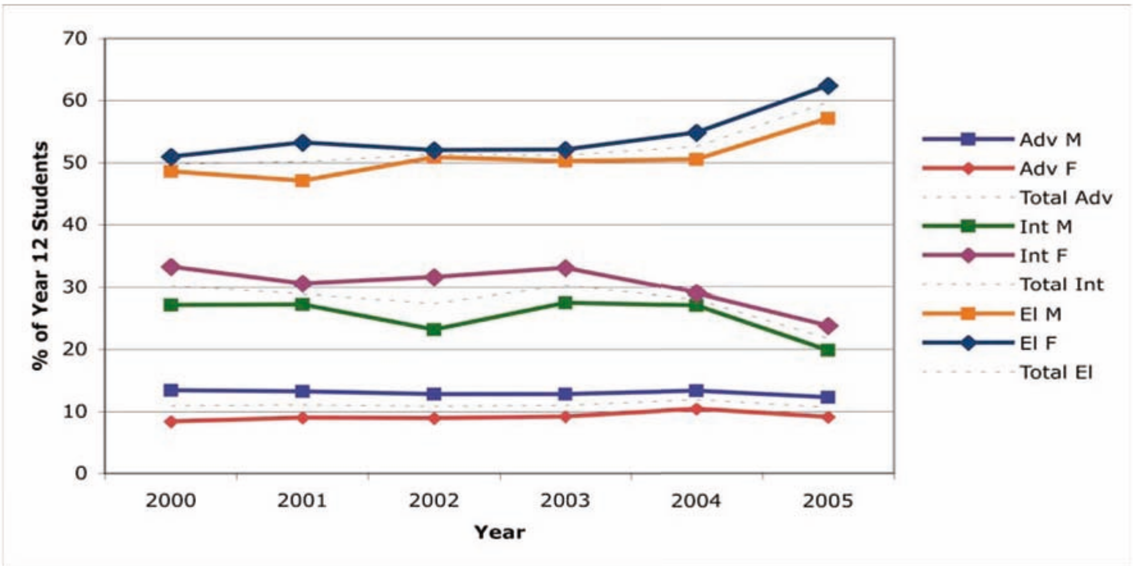

Figure 2.4 ACT: Year 12 Mathematics Courses Enrolments as Percentages of Year 12 Students by Gender 2000 – 2005 (Adapted from Forgasz, 2006)

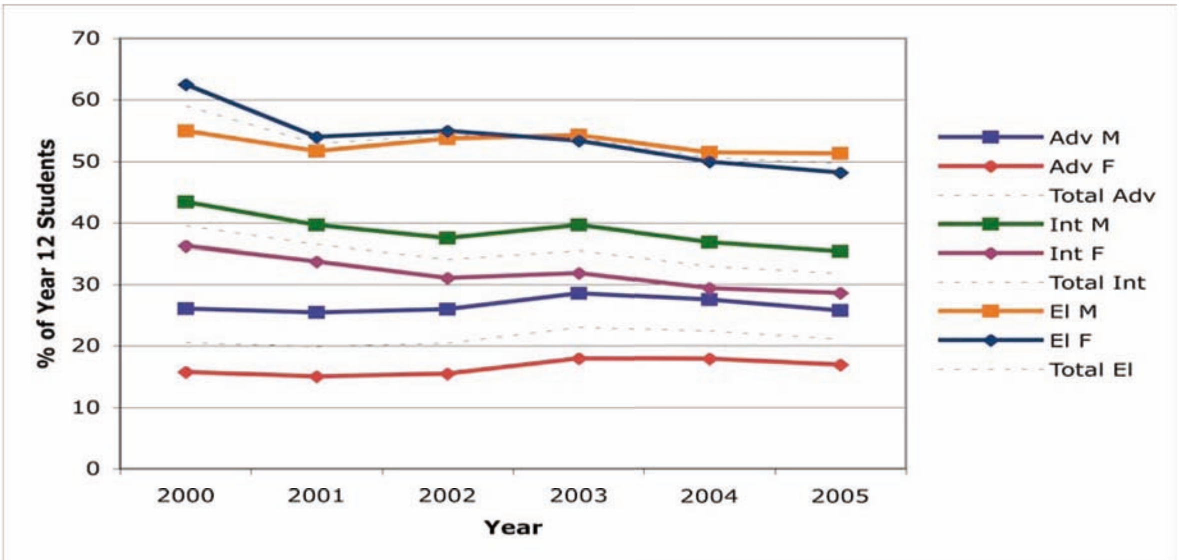

Figure 2.5 NSW: Year 12 Mathematics Courses Enrolments as Percentages of Year 12 Students by Gender 2000 – 2005 (Adapted from Forgasz, 2006)

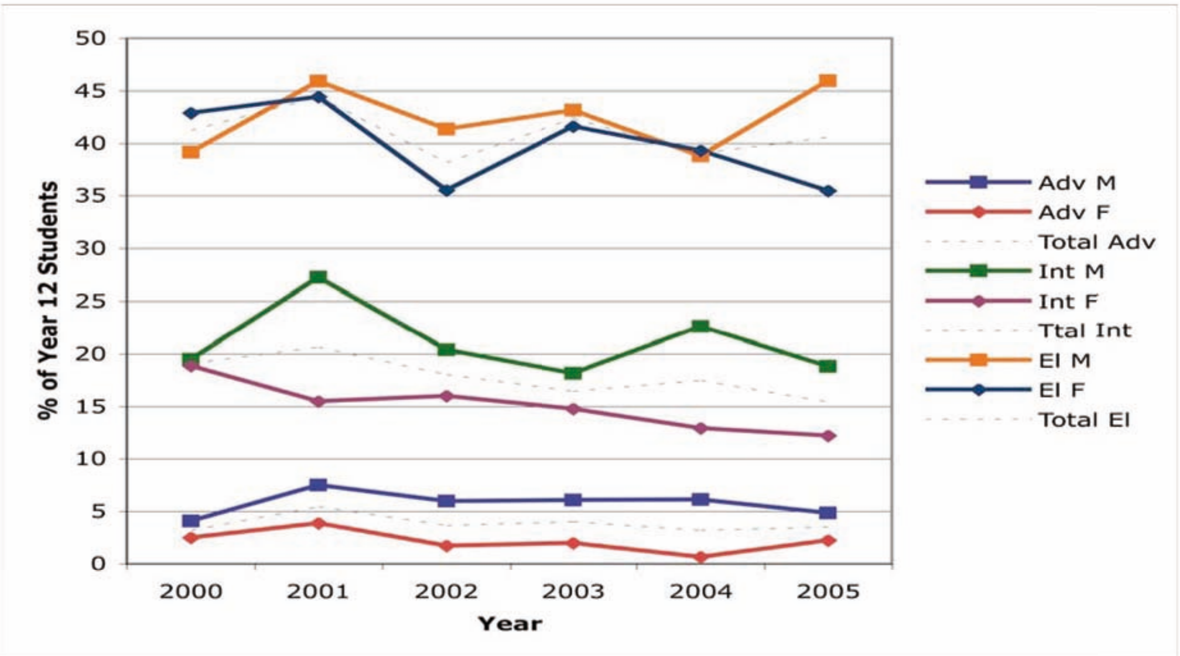

Figure 2.6 NT: Year 12 Mathematics Courses Enrolments as Percentages of Year 12 Students by Gender 2000 – 2005 (Adapted from Forgasz, 2006)

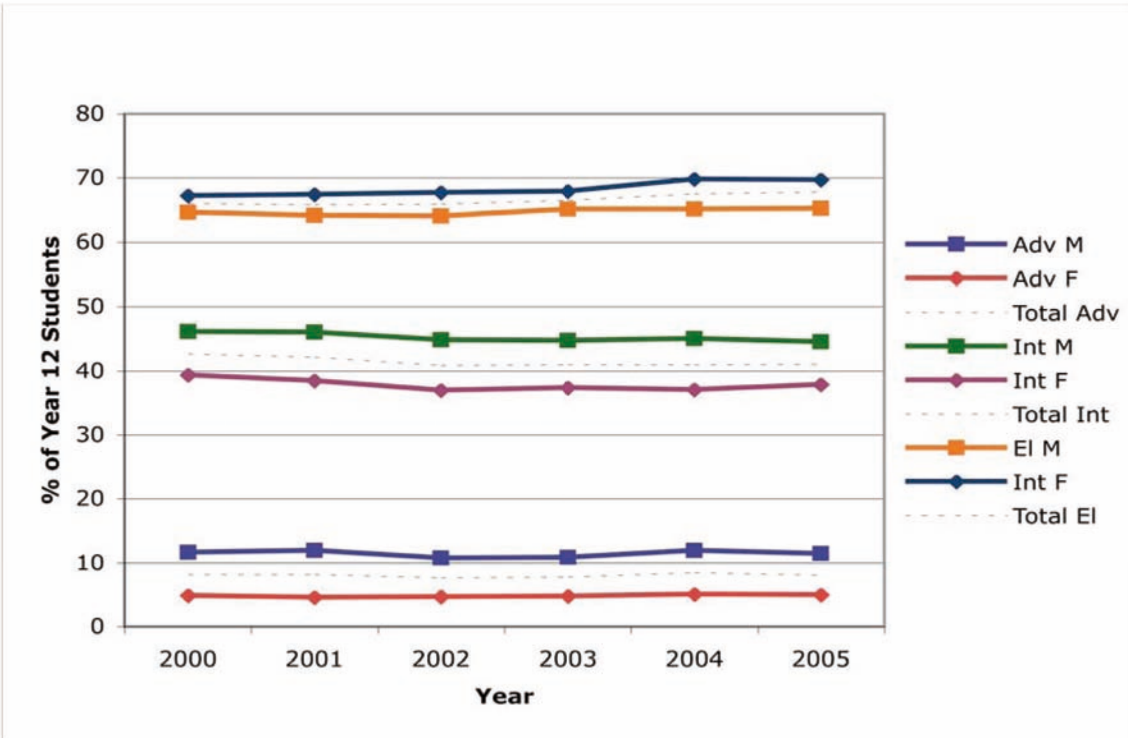

Figure 2.7 Queensland: Year 12 Mathematics Courses Enrolments as Percentages of Year 12 Students by Gender 2000 – 2005 (Adapted from Forgasz, 2006)

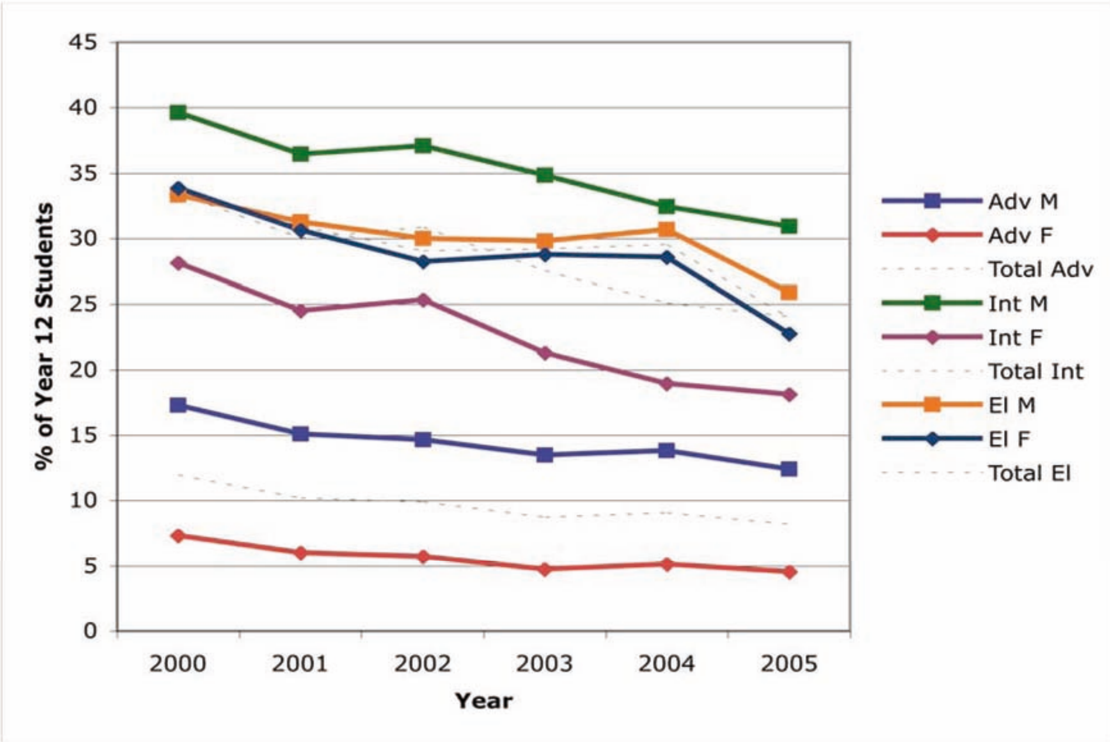

Figure 2.8 SA: Year 12 Mathematics Courses Enrolments as Percentages of Year 12 Students by Gender 2000 – 2005 (Adapted from Forgasz, 2006)

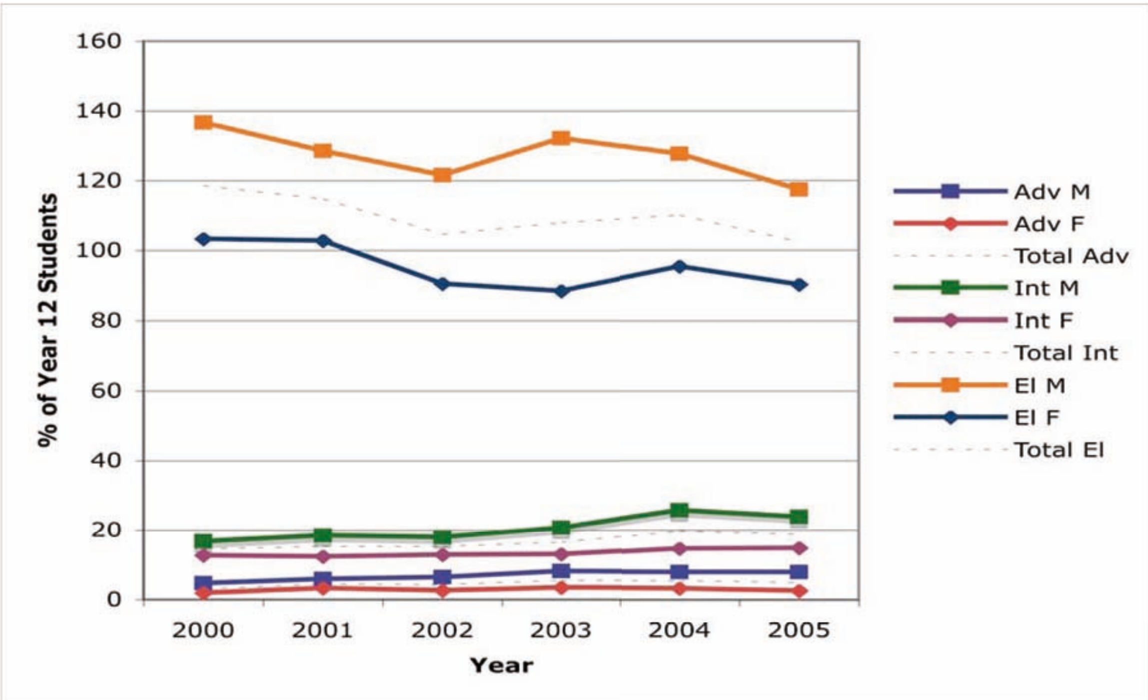

Figure 2.9 Tasmania: Year 12 Mathematics Courses Enrolments as Percentages of Year 12 Students by Gender 2000 – 2005 (Adapted from Forgasz, 2006)

[NB: Students enrolled in more than one course contributes to percentages greater then 100%]

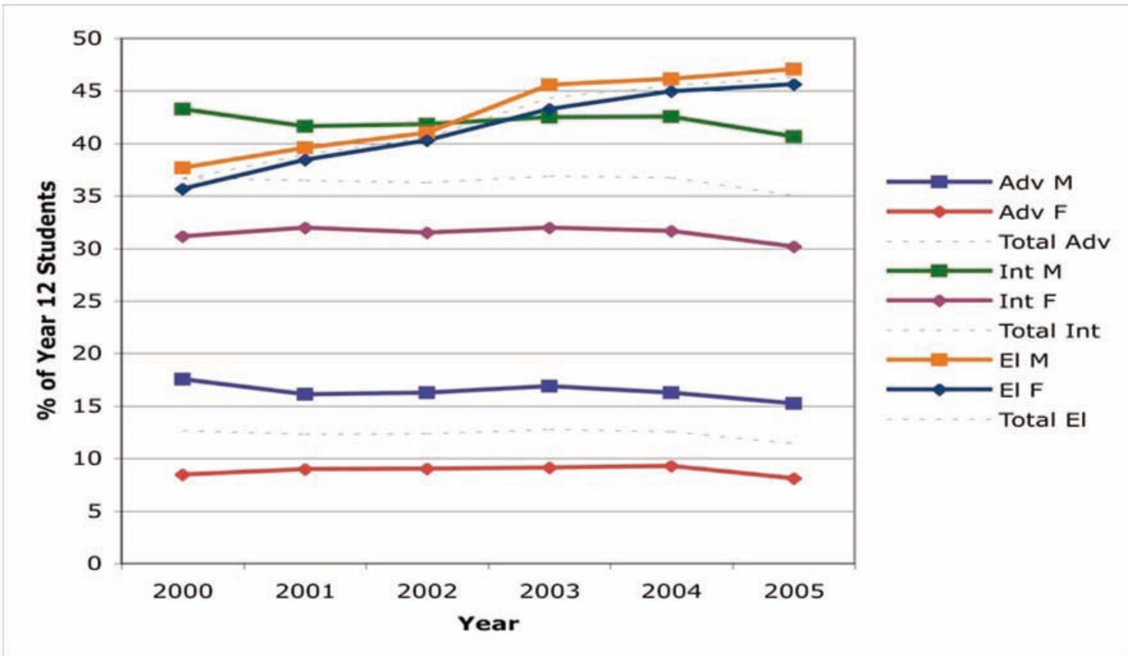

Figure 2.10 Victoria: Year 12 Mathematics Courses Enrolments as Percentages of Year 12 Students by Gender 2000 – 2005 (Adapted from Forgasz, 2006)

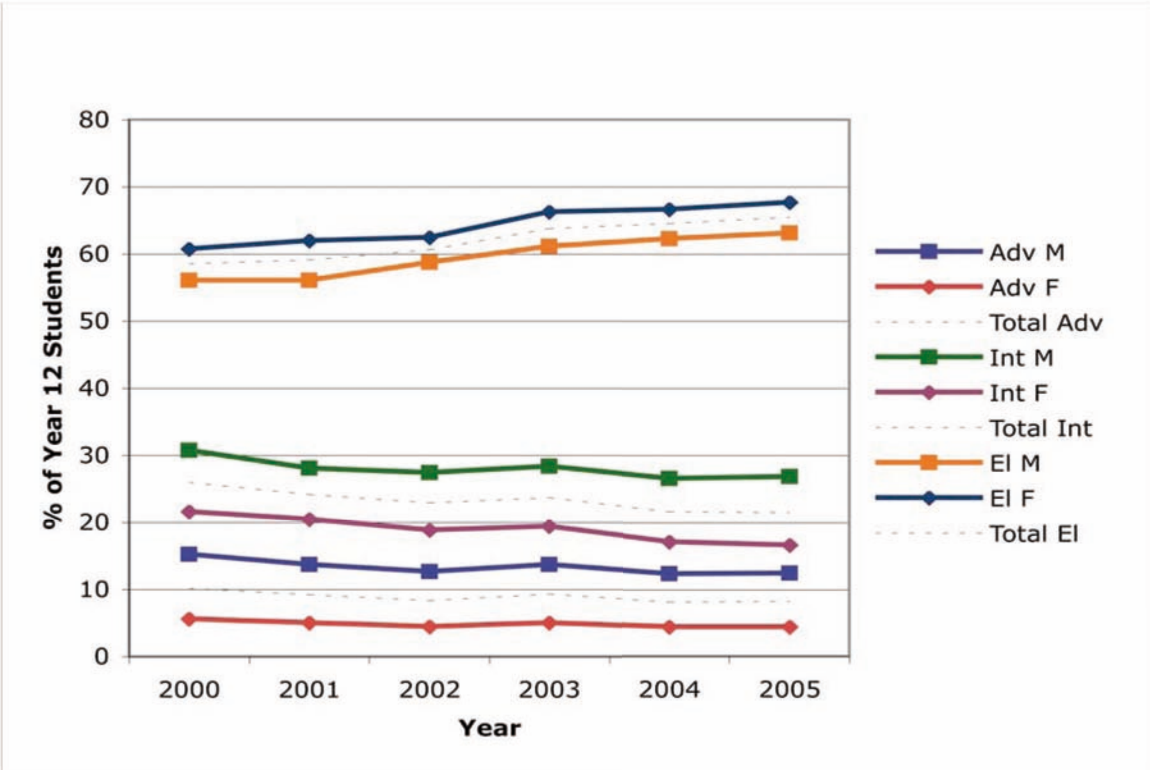

Figure 2.11 WA: Year 12 Mathematics Courses Enrolments as Percentages of Year 12 Students by Gender 2000 – 2005 (Adapted from Forgasz, 2006)

Queensland (Figure 2.7)

- Stable enrolments for all courses; and
- More males than females enrolled per course except for elementary.

South Australia (Figure 2.8)

- Declining enrolments in all courses; and
- More males than females currently enrolled in all courses.

Tasmania (Figure 2.9)

- Stable advanced and intermediate course enrolments overall with a slight increase in intermediate enrolments for males;
- Decreasing elementary course enrolments; and
- More males than females enrolled in all courses

Victoria (Figure 2.10)

- Stable advanced and intermediate course enrolments for females with slight decrease in both courses for males;
- Increasing elementary course enrolments; and
- More males than females enrolled in all courses.

Western Australia (Figure 2.11)

- Slight decreases in advanced and intermediate course enrolments;
- Increasing elementary course enrolments; and
- More males than females enrolled per course except for elementary.

Whilst there is no definite pattern for the States/Territories, when seen against the background of the national pattern described above, it is possible to isolate those areas which contribute to the pattern or which differ markedly. For example, the advanced course pattern of overall slight increase is a result of data from the Australian Capital Territory, New South Wales and Victoria (female enrolments) and the Northern Territory and Tasmania (male enrolments). The elementary course pattern of more female enrolments than male is not evident in New South Wales, Northern Territory, South Australia, Tasmania and Victoria. Queensland is the state which most closely reflects the national pattern and South Australia is the state which records declines in all courses.

The second indicator of participation in mathematics considered in this section is the various aspects of student performance documented in international studies. They are included as they provide a way of describing key influences on students in the middle years of secondary schooling. In particular, the PISA 2003 information relating to 15-year old students is pertinent since these students are at a stage in their schooling when they are about to make important decisions about subject choices.

As part of PISA 2003 (where there was a focus on mathematical literacy), a number of questions were asked of 15-year old students based on the self-regulating learning principle that certain characteristics make it more likely that students will approach learning in beneficial ways. Table 2.2 details these questions which were framed within four categories each of which were then described in terms of a number of student characteristics.

Table 2.2 Characteristics and Attitudes of Students as Learners in Mathematics (Adapted from PISA, 2003, Figure 3.1)

Category of characteristic	Student characteristics
Motivational factors and general attitudes towards school	1. Interest and enjoyment of mathematics. 2. Instrumental motivation in mathematics. 3. Attitudes towards school. 4. Sense of belonging at school.
Self-related beliefs in mathematics	1. Self-efficacy in mathematics. 2. Self-concept in mathematics.
Emotional factors in mathematics	1. Anxiety in mathematics.
Student learning strategies in mathematics	1. Memorisation/rehearsal strategies. 2. Elaboration strategies. 3. Control strategies.

Australian students' interest and enjoyment of mathematics index was comparable with the OECD average and a greater index for males than for females was recorded. It contributes positively to performance in mathematics. The instrumental motivational index was above the OECD average and, again, a higher index for males was recorded than for females. The relationship between extrinsic motivation and performance was positive although not as strong as for intrinsic motivation. Predictably, the average index was higher for students aspiring to complete a university-level program compared with students expecting to complete lower secondary education. Students' attitudes towards school were positive with the female index higher that the male index. No relationship was observed with performance in mathematics. Students' sense of belonging was above the OECD average and the female index was greater than for males. The relationship between a sense of belonging and performance was observed to be weak for individuals and more pronounced at the school level, suggesting that where schools provide a basis for students to be engaged there will be improved overall performance.

Motivational factors considered in the TIMSS 2002/03 study of Year 4 and Year 8 students were enjoyment of mathematics, valuing of mathematics and educational aspirations (Thomson & Fleming, 2004). Although Australia registered a significant increase in the number of Year 8 students who agreed that they enjoyed learning mathematics, the average was below the international value. About half of the Year 8 students placed a high value on mathematics in terms of its role in a future career and 40% envisaged themselves completing a university degree. In line with the international pattern, valuing mathematics and educational aspirations were positively associated with achievement.

Self-efficacy is one of the strongest predictors of student performance at the individual and school levels and Australian students' index was comparable with the OECD average with the average index for males higher than for females. This higher index for males is interpreted as having confidence in their mathematical ability. This self-concept is also closely related in a positive way to performance both at the individual and school levels. The confidence expressed by 15-year old students in the PISA study is similar to the self-concept trend identified in the TIMSS 2002/03 study where a large percentage of students expressed high confidence in learning mathematics. The gender difference was significant with more males than females expressing high levels of confidence and there was a strong positive association with achievement (Thomson & Fleming, 2004). Also strongly associated with performance at the student and school levels is the anxiety that students feel when dealing with mathematics. Reflecting the pattern for all OECD countries, females in Australia have a higher average index than males.

Australian students' capacity to manage their own learning is comparable with the OECD average with very little difference in the average index for males and females. The relationship between the use of control strategies and performance tends to be weak.

In addition to the questions about student approaches to learning, questions were asked in PISA 2003 about learning and school environments. These questions were part of an overall investigation of school climate, school policies and practices, and school resources. One focus when considering learning environments was the notion of school effectiveness, and the capacity to provide support structures that will raise performance levels. Australia was amongst a group of countries where students reported the most positive perceptions of teacher supportiveness for individual learning in mathematics. The report pointed out that across all OECD countries, poor student-teacher relations has the strongest negative impact on mathematics performance (OECD, 2004, p. 257). This was seen to be the case, even when adjustments were made for a range of demographic and socio-economic factors – economic, social and cultural status; gender; country of birth; language spoken at home; early education attendance.

In outlining the features of schools which can influence student performance, the following list was provided after allowances were made for the various socio-economic factors:

- disciplinary climate – positive influence;
- student morale and commitment – small positive influence;
- sense of belonging – small positive influence, not statistically significant;
- selective admission policies – strong influence;
- avoidance of ability groupings – positive influence;
- provision of additional mathematics activities – positive influence;
- large school size – positive influence;
- located in small communities – positive influence;
- educational resources – positive influence;
- teacher shortage – small negative influence.

No significant relationship was detected between the frequency of teacher-developed tests, or between student/teaching staff ratios and student performance.

A similar, statistically significant list of school factors which influence student performance in mathematics was provided in the TIMSS 2003/03 report. This list identified nine student, and school and classroom level variables. These were:

- self-confidence in mathematics – large positive influence;
- indigenous status – large negative influence;
- educational aspirations – positive influence;
- computer usage – positive influence;
- number of books in the home – positive influence;
- parents' education – positive influence;
- emphasis on mathematics homework – strong positive influence;
- principal's perception of school climate – strong positive influence;

- general school and class attendance – positive influence.

The two lists highlight the range of variables which, in different contexts, have been identified as associated with student performance. It is of interest to note in each case the significance of student characteristics, namely, attitudes to learning in the OECD study and self-confidence in the TIMSS study. This is in line with the analysis in a Longitudinal Survey of Australian Youth in which the role of social background and school sector are identified as explaining, at best, 20 per cent of the variation in student performance at the Year 12 level (Marks, McMillan, & Hillman, 2001).

2.3 Influencing Factors

This section provides an overview of the influences which have been identified as impacting on students' decision to undertake higher-level and further mathematics. These influences have been grouped within a number of categories which represent common themes in the diverse lists of variables reported in the literature.

2.3.1 Aspirations

This category deals with the strategic nature of mathematics and the importance of a tertiary entrance score in helping students realise post-secondary options. Whether or not students are interested in mathematics, this score ranks highly as an influencing factor across Years 10 to 12 for two key reasons. Firstly, as a rationale for learning the subject and, secondly, when deciding to include mathematics within a pattern of study in Years 11 and 12 (DEST, 2006). Mathematics has considerable prerequisite currency in terms of maintaining patterns of study or securing a career pathway and this is a view expressed by students whether they are interested in mathematics or not (Brinkworth & Truran, 1998; DEST, 2006). In addition, the aspirations for further study have been associated with higher levels of numeracy in junior and early secondary school (Marks, McMillan, & Hillman, 2001; Rothman & McMillan, 2003).

Of the students who aspire to undertake post-secondary education, more are likely to be enrolled in advanced level mathematics courses (Fullarton et al., 2003) and there are high percentages of Year 10, 11 & 12 students intending to study business, health, engineering, science and technology at university who undertake tertiary accredited mathematics (DEST, 2006). These percentages can be misleading, however, as there has been a decline in the number of students undertaking an advanced course and this has been linked to the removal of such courses as internal prerequisites in many discipline areas by universities (Thomas, 2000; Fullarton et al., 2003). The single digit percentage decreases quoted in the Introduction translates into an alarming 23% when expressed as a total of university enrolments (Thomas, 2000).

An important implication of the change in internal prerequisite requirements at universities is the notion that students may be taking courses in science, engineering and technology (SET) at university without a solid foundation in the enabling subjects – which includes advanced mathematics. Some of the longer-term consequences can include a lack of flexibility in the labour market, frustration at university and unnecessary failure. The notion of decline is further reflected in the number of domestic students enrolling in and completing science, engineering or technology courses (DEST Audit Report, 2006).

High visibility of mathematics at school does not carry over into careers. It is clearly a requirement for economics- and science-related careers, but in all else it is regarded as peripheral; jobs requiring mathematics qualifications do not confer higher social status, even though they might be well paid (Brinkworth & Truran, 1998). One of the main reasons given by teachers for students not continuing with mathematics at university level is the inability to see a career in mathematics (Crann, 2006). The peripheral message about mathematics and careers is reinforced in the extent of qualification "wastage" that is evident in professions, such as engineering, where a significant proportion of SET qualified people do not work in related occupations (although this is perhaps an increasing trend with many people being embarking on career journeys in a highly dynamic and evolutionary context).

The notion that students see mathematics as peripheral to careers, such as law, where an understanding of mathematics is becoming increasingly essential, does highlight a need for specific counselling about the relevance and benefits to future careers of mathematical studies (Brinkworth & Truran, 1998).

2.3.2 Engagement with the Curriculum – Learning/structure/teaching

Included in this category are the motivational aspects and general educational experiences within the curriculum that can influence a students' decision to enrol in mathematics courses. These experiences relate to enjoyment, excitement, challenge, good grades, access to real-life examples, concurrent patterns of study and cognitive style. With more boys undertaking mathematics courses, the reporting of gender effects is common and this influence in mathematics appears most pronounced where students have the option to choose more than one course, with boys demonstrating a stronger preference (DEST, 2006).

High achievers disagree with the notion that success in mathematics requires good luck and memorisation of notes/textbooks. They also disagree with the idea that computers are essential for learning, although students who intend to study at TAFE regard them as essential (Brinkworth & Truran, 1998). This attitude towards learning support has been documented in a Victorian study in which Year 11 students were surveyed for their ideas about computer use in mathematics (Forgasz, 2004). That study found that although computer use was widespread in mathematics, only a minority of the students surveyed believed that computers had assisted their understandings in mathematics.

Students' perceptions of mathematics have considerable influence over levels of participation with some of the reasons for not choosing the subject given as the need for hard work, memorisation, learning and practising rules constantly, that it is a technical subject, boring and lacking in creativity. In addition, classroom practices are still dominated by teacher-focused strategies, such as copying from the blackboard, rather than students being given the opportunity to share or present their understandings (Brinkworth & Truran, 1998). Although memorisation is seen as a necessary feature of mathematics, it is less of a burden with more and more rules and formulae provided for assessment tasks. A strong teacher focus would account for the large number of students who indicate that the relative lack of quality teaching in mathematics compared with language-rich subjects is influential in deciding whether or not to continue with mathematics.

After the importance of strategic factors, a survey of Year 10 students revealed that teachers have an important role to play in developing their interest in mathematics and they look to them to be engaged in a curriculum that is exciting and challenging through events, such as experiments and field trips (DEST, 2006). The findings of an extensive investigation into effective mathematics teaching and learning in Australian secondary schools (Ingvarson, Beavis, Bishop, Peck, & Elsworth, 2004), were summarised in the surprising notion that what took place in the classroom was largely responsible for contributing to quality learning. Good relations with teachers have been identified as having a positive effect on students' self-perceived achievement in mathematics (Marks, 1998).

The curriculum for mathematics up until Year 10 could be described as socially relevant, i.e., students are likely to associate mathematics with the solving of everyday problems. This aspect of the curriculum continues to be accessible to students who undertake the applied courses in Years 11 and 12 and is, for the most part, removed for students who choose "pure" or higher-level mathematics courses (Brinkworth & Truran, 1998).

Teachers and parents have a moderately strong influence on students' choice to study mathematics whereas, those who choose not to study mathematics rely more on personal considerations, such as finding the subject hard, not being good at it and finding the teaching uninspiring. Students in independent schools and country school students are more likely than city students to access support from teachers/advisers/parents. The place of pastoral care and the sense of community in these respective contexts have been put forward as possible explanations.

There is a potential for careers counsellors and advisers to assume an important supportive advisory role, particularly in the light of the number of students who choose to continue with mathematics in order to "keep options open." Reasons for this default setting hint that the information offered from these areas is unclear about pathways provided by universities and TAFE, or is unfriendly towards mathematics (Crann, 2006), and therefore is an inadequate basis for making decisions (Brinkworth & Truran, 1998). The majority of teachers surveyed in a study about increasing the supply of mathematical science graduates indicated that there was uncertainty about the capacity of careers advisers to deliver quality information about careers (Crann, 2006). Improving information and awareness about careers is identified as a key influence in encouraging students studying Science Engineering and Technology courses and aspiring to further study and careers in these areas (DEST, 2006).

Brinkworth & Truran (1998) have suggested that students' views about the nature and relevance of mathematics is predicated on the following problems and that teachers can play an important role in addressing them:

- Inadequate information about its positive values and its role in study and careers;
- A distorted view of those who use it;
- A lack of exposure to appropriate content and methods.

Participation in higher-level courses is highly dependent on previous educational experiences. Although students achieving in the top quartile are more likely to be enrolled in specialist mathematics courses, Ridd (Ridd, 2004) referred to a "condition" of mathematics in Year 8, 9 and 10 which contributes to a level of ignorance about senior course and a "discontinuity" at the Years 10/11 interface. This lack of knowledge can reduce students' ability to make informed decisions. Drawing on Queensland information, Ridd referred to a "weak data set" of assessment and auditing systems in place during these Years that can be used by students for making strategic choices about further study.

Reference is also made to the correlation between tertiary entrance scores and Year 9 numeracy and literacy performance, highlighting the long-term implications of lower secondary schooling. One implication of this link – in addition to quality assessment practices, is the provision of quality learning experiences during these Years. In particular, students are not given enough experiences with algebra, regarded as the most important enabling tool (and a "gateway to higher mathematics") in the context of problem solving and a student's capacity to generalise. Instead, quoting the opinion of one "expert", this lack of exposure to algebra is a consequence of doing *"foolish, fuzzy investigations instead of mainstream mathematics …"*

Access to co-curricular events in mathematics has indicated that students can build up a bank of positive experiences and also gain a deeper enjoyment, understanding, an awareness of the applications of mathematics and of its potential in careers (Crann, 2006).

Where the curriculum is offered, in terms of school system and geographic location, has been identified as having a moderate effect on the number of students enrolled in higher-level courses. There are indications that students at independent schools are more likely to enrol in advanced mathematics courses than in government schools (Fullarton & Ainley, 2000). There are few reports concerning the effect of geographical location on enrolments in higher-level mathematics courses. One study that included an investigation of the patterns of participation in Year 12 across courses has revealed a trend towards a majority of students undertaking intermediate mathematics in rural schools (Fullarton et al., 2003).

The PISA 2003 Project used four constructs to investigate positive dispositions of 15 year olds towards school and learning and their impact on achievement in mathematics. These variables were interest in and enjoyment of mathematics, the instrumental (or life relevance) nature of mathematics, attitudes towards school, and sense of belonging at school (OECD, 2004). Compared with the positive feeling students felt about reading demonstrated in PISA 2000, students expressed less enthusiasm for maths. The general trend from the data indicated that students with a greater interest in and enjoyment of mathematics tend to achieve better results than those expressing less interest and enjoyment. There are interesting individual country results, such as Japan where student performance in mathematics is high but where expressions of interest and enjoyment are comparatively low. There is an interesting gender difference, with boys in the majority of countries expressing greater interest than girls leading to questions about how schools and society promote motivation and interest in mathematics. Australian students' interest rating on the PISA standardised score is average – zero on a -1 to +1 scale.

Australian students' extrinsic motivation rates slightly better than the intrinsic factor above, although the same gender effect is noticeable. An overall positive relationship was noted between instrumental motivation and students' expected level of education. This gender pattern is reversed for most countries when students' perception of how well school has prepared them for life. Overall, Australian students rank 8th in their positive attitudes towards school. Again, Australian girls express a greater sense of belonging at school than do boys. Other gender differences described in PISA 2003 indicated that Australian boys are more instrumentally motivated, are more interested in and enjoy mathematics, are less anxious in mathematics, report greater self-efficacy and a stronger self-concept, and use elaborations strategies more frequently than girls.

2.3.3 Family and Peers

Families have a moderate influence on students' choice to study mathematics and the influence appears to be more pronounced if there is a history of university study. Parents' negative feelings about mathematics are influential in the choice not to study mathematics, particularly at university (Crann, 2006).

Parent occupational and educational levels have an influence on students' participation in mathematics courses. As parental occupational and education levels increase (Low – low middle – upper middle – high), the number of students undertaking advanced courses increases. Also, the difference in the number of students in advanced courses compared with elementary courses increases (Fullarton & Ainley, 2000; Fullarton et al., 2003), and students are more likely to undertake multiple mathematics courses if their parents were classified as professionals or had trade or advanced clerical skills (Fullarton & Ainley, 2000; DEST, 2006).

Ethnicity also is a predictor of the distribution of students across courses in mathematics. Across elementary, intermediate and advanced courses, the total numbers for students whose first language is not English (LBOTE) is, respectively, much lower than, comparable with and much higher than the number of English speaking students undertaking those courses. A clear preference for higher-level courses is demonstrated by Asian students, with 73% of those undertaking mathematics enrolled in the advanced courses (Fullarton et al., 2003).

Whether or not a friend is studying/not studying mathematics consistently rates as having little or no influence (Brinkworth & Truran, 1998; Crann, 2006; DEST, 2006). However, it has been noted that the potential for peer sanctions within a particular classroom culture will result in students not trying or underachieving (Sullivan, McDonough, & Harrison, 2004).

PISA 2003 noted that, regardless of students' own socio-economic background, in schools where there is a high average socio-economic background, performance in mathematics is likely to be enhanced.

2.3.4 Performance and Ability

It would come as no surprise that advanced mathematics courses, along with the physical sciences, attract high-achieving students. Based on Year 9 achievements in literacy and numeracy identified in the various Longitudinal Surveys of Australian Youth, the majority of students (75%) enrolled in advanced mathematics courses are drawn from the top two quartiles of achievement (Lamb & Ball, 1999, Fullarton & Ainley, 2000; Fullarton et al., 2003). Of the two, numeracy achievement has the strongest link with tertiary entrance performance (Marks, McMillan, & Hillman, 2001)

This trend of high-achieving students opting for advanced mathematics courses reinforces findings noted by Ainley and Jones concerning participation in science and mathematics (Ainley & Jones, 1990; Ainley, Jones, & Navaratnam, 1990; Fullerton & Ainley, 1990). From the information contained in ACER's Study of Subject Choice, it was evident that participation in physical science courses is more likely for students who achieve in the top quartiles for numeracy and literacy early in schooling. Whilst there is no clear association given for mathematics, because of sample size factors, it might be possible to infer on the basis of similar descriptions given of student types for physical sciences and for mathematics. They also add that measures of achievement early in schooling can help to contribute to a sense of competence and interest, and a disposition towards further study. They give a clear message that a curriculum and teaching strategies in the early Years which engage students in investigative activities and which provide them with a sense of competence are central to increasing participation rates in mathematics. These factors have also been identified in later studies into participation rates which indicate that what happens in the middle and early years of school can influence educational intentions and subsequent participation (Khoo & Ainley, 2005).

Attempts to find the causes of the difficulties students experience during the middle years of schooling (ages 10 – 15 years) have not come up with clear reasons to explain a lack of engagement. In a study involving a small number of Year 8 students from a regional Australian city, Sullivan, McDonough, and Harrison (2004) found that students saw themselves as persistent in the face of difficult tasks, provided that this persistence lead to the correct answer. These students also realised the important link between effort and achievement, and that you can get better by trying. The majority of the students in the study, and in particular the higher-achieving students, were classified as performance oriented based on a social cognitive approach to motivation and personality.

Such students rely for success on tasks that have limited challenge and they easily experience a loss of confidence, plunging expectations, low persistence levels, and will seek positive judgements and avoid negative ones. This view has implications for structuring the curriculum in such a way as to provide students with sufficient engaging learning opportunities that will promote deeper learning in the face of challenges. A suggestion for teachers is that rather than respond to students experiencing difficulties by providing easier tasks which provide the desirable positive feedback, there is a need to focus on longer term goals related to learning. More work needs to be done in this area of students' self-perception, their views of success, the nature of intelligence as it relates specifically to learning in mathematics and the type of tasks teachers provide as a learning context for students. If the curriculum and teaching in the early Years are to contribute to increasing participation rates in mathematics courses, then engaging students in investigative activities that provide them with a sense of competence is regarded as central to this process.

At the Year 12 level, students' perception of their ability in mathematics ranks comparably with the strategic importance of mathematics for future study. For students who do not choose mathematics, subject appeal, rather than ability is a major influence (Brinkworth & Truran, 1998). Being good at mathematics is associated with a perception that mathematics may enhance prospects of a good job, and students who achieve in higher-level courses are more optimistic than lower achievers about the number/pay/interest of jobs requiring mathematics. There is an additional, concurrent study advantage in undertaking a "hard" subject as this can give students the confidence to succeed in other subjects in the curriculum (Brinkworth & Truran, 1998; Ridd, 2004). Reasons for not continuing with mathematics at university included its perception as a hard subject, a lack of natural ability and passion for the subject (Crann, 2006).

In Queensland, a high correlation has been reported between Equivalence National Tertiary Entrance (ENTER) scores and Year 9 performance in numeracy and literacy (Ridd, 2004). It was also reported that males are more likely to be affected by poor mathematical schooling in the earlier years than females.

2.3.5 Subject Image

One gender perspective to emerge concerned the respective views expressed about mathematics. Girls, more than boys, certainly do not regard mathematics as uncultured, conventional, dull or lacking in creativity (Brinkworth & Truran, 1998). Creativity was identified as an important influence in this study that reported 60% of all students saying that there was not enough creativity in Year 12 mathematics and 68% of non-mathematics students said that the lack of room for creativity and expression influenced their decision to drop mathematics.

Generally, students views about mathematics were summarised as "a relatively uncreative subject, more usefully related to scientific/numerical/financial pursuits rather than language-rich/humanistic/creative ones … not essential for succeeding in life, but is a necessary stepping stone …" (Brinkworth & Truran, 1998, p.31). The perceived lack of creativity has been put down to an emphasis on test and examination preparation, and the pressures of covering a syllabus, all of which are factors external to students and may give rise to the notion that students are not able to express themselves through the current assessment/evaluation procedures.

Students' beliefs about mathematicians and users of mathematics paint a picture of a collaborative profession, either teaching or working in groups and, with the assistance of appropriate technology, which devotes much thought to the solving or problems. Paradoxically, despite this focus on problem solving, students do not believe that mathematicians deal with important social issues (Brinkworth & Truran, 1998) and this could impact on choices made by students who might be contemplating careers which focus on legal or environmental issues. An additional component in the formation of beliefs about mathematics is the influence of role models and an interesting comparison is made between the high school music and mathematics teachers. Mathematics departments might examine strategies which exist in music departments – and possibly sports departments, concerning the way that extra-curricular participation and involvement is productively encouraged and sustained in those areas (Brinkworth & Truran, 1998)

Students who choose pure mathematics courses are not being given a balanced view of mathematics with respect to their relationships with the community and society, i.e., lack of creativity, absence of social issues, applications or opportunities for self-expression. The subject needs to be humanised (Brinkworth & Truran, 1998), a notion that is in keeping with a concern expressed in the Third International Mathematics and Science Study (TIMMS) and the OECD's PISA international comparative studies. The concern raised relates to the extent to which school mathematics is connected to real-world contexts. One option for teachers to explore important links between mathematical and social contexts, and in the process raise the self-expression aspects of mathematics, is by "engineering" gossip amongst students (Callingham, 2004).

2.4 Summary

School students who *aspire* to further study at university perceive mathematics, and particularly the higher-level courses, as having considerable prerequisite currency. Whilst it counts strategically towards a tertiary entrance score and for managing the transition to university, there is a perception that higher-level mathematics courses lose their prerequisite value for students once they are at university. This may, in part be due to the notion that jobs requiring mathematics qualifications do not confer higher social status. Fewer domestic students at universities with a foundation in the enabling subjects suggests that mathematics is less strategic for the transition from university to the workforce. Strategies encouraging a more positive disposition towards the continuation of studies in mathematics reflect some degree of deficiency in the information provided to students at school. The implication is that students are not adequately equipped to make informed decisions and that teachers and school counsellors may have an important role to play in changing attitudes and perceptions.

Engaging students with the curriculum in a sustained way can be considered within four general areas, namely the nature of mathematics, the support needed, the relationships students establish as they learn mathematics, and the learning experiences provided within the curriculum.

Mathematics is perceived as a hard, technical subject where there is an emphasis on learning rules, constant practice and little room for creativity. The capacity for hard work appears to be the most significant quality for learning mathematics with high achieving students demonstrating self-reliance rather than relying on good luck, memory or even computers to support their learning. The relationships students build up with parents, teachers and advisers, influence those who intend to continue studying mathematics more than those who choose not to study mathematics. With this later group of students, personal factors predominate. Generally, an ideal set of circumstances for sustaining participation in mathematics courses would comprise university educated professional parents, learning experiences which are not predominately teacher-focused or which rely on excessive copying, and access to careers advisers who can provide relevant information about further study and careers which directly relate to students' aspirations. An extension of the importance of advisers and counsellors can be detected in the notion that pastoral care and a sense of community in country and independent schools provide an additional, if somewhat intangible, layer of support.

The importance of considering a social dimension of learning is brought out in the observation that the socially oriented curriculum with a focus on solving problems from everyday contexts is not an integral part of the pure, higher level, mathematics courses undertaken after Year 10. Appropriate problem-solving activities alone do not seem to be sufficient to help students manage the transition to senior courses. A range of learning experiences, which includes quality assessment practices and stimulating co-curricular participation are critical long-term support structures, particularly in the middle years of schooling.

Whilst there are gender and ethnicity effects in participation levels in mathematics, most information collected about the relative influences of *families and peers* indicates that families have only a moderate influence, which increases with the education level of the parents. Overtly, peers have very little effect on choice, however, a culture of peer sanction may operate in some learning contexts which may lead to underachievement. Such cultures have the potential to affect a student's capacity to contribute to their own success and, hence, to their enjoyment of schooling.

In terms of external indicators of *performance and ability*, it has been noted that the majority of students enrolled in higher-level senior mathematics courses will be drawn from the top two quartiles of Year 9 achievement in literacy and numeracy. This trend reinforces the notion that good experiences in the middle years of schooling can influence students' dispositions for future choices. Dispositions, on the other hand, may also be the result of a number of interacting factors and there have been some indications that investigating the links between student self-perception, general views of intelligence and teachers' approaches to managing challenges may furnish insights about how to engage more students.

There is some conjecture about whether or not enjoyment of schooling and success in mathematics are related particularly in the light of the PISA 2003 data where students from high-achieving countries do not necessarily express high levels of school enjoyment. In these contexts the strategic advantage of mathematics for further study, its capacity to enhance job prospects and its concurrent study advantage may help students endure it rather than enjoy it.

The notion of whether the study of mathematics is to be enjoyed or endured reflects an important belief that students hold about mathematics. For most, the *image* of mathematics is one of a relatively uncreative subject which can act as a stepping stone, provided you can negotiate the pressure of frequent testing and examinations of syllabus content that is not related to important social issues. The perceived lack of creativity, absence of social issues and little opportunity for self-expression contribute to an unbalanced view of pure mathematics courses in terms of their relationship with the community and society. It does not automatically follow that engagement in pure mathematics courses will equip students to engage in society.

SECTION 3

TEACHER SURVEYS

> Many students find that they do not have the accumulated knowledge necessary to continue higher-level maths. They have not appreciated early enough that higher-level maths is important in many career choices and now they can only get there by repeating Year 10 maths, which they won't do.
> [Northern Territory teacher, metropolitan]

> Students are influenced by … the workload they perceive involved in maths and the irrelevance of much of the content. Also, their need to get maximum points for university entrance and they feel they will be more successful in other subjects with less demands.
> [South Australian teacher, Regional/rural]

3.1 Introduction

The two comments above introduce the notion of successful transitions as an outgrowth of accumulated knowledge and personal relevance. There is an implication that students are in a position to choose higher-level mathematics during secondary school, and use it as part of their post-secondary plans, if they have acquired the appropriate knowledge and work ethic. In the absence of relevance and a timely realisation of career importance, mathematics appears relegated to the "too hard basket".

This section details teachers' perceptions of the influences on students' decision-making concerning higher-level mathematics. These perceptions are based on responses to the Teacher Survey (see Appendix B) and they are presented in a number of sub-sections in line with the groupings of questions presented in the survey. The first of these groupings relates to background information about the teachers who responded. This is followed in the second sub-section by quantitative aspects of the survey dealing with the groupings of influences related to school, sources of advice, the individual, and other influences. This sub-section concludes with teachers' perceptions of enrolment trends over the past five years, and the extent to which students are encouraged by the syllabus, teaching practices, and assessment practices to take higher-level mathematics courses. The third sub-section provides a summary of teachers' open-ended responses to survey questions where they often provided supportive detail for a number of their survey selections.

3.2 Background

A total of 399 teachers from each of the States and Territories responded to the survey with a metropolitan and rural (non-metropolitan) breakdown of 240 and 159 teachers, respectively. Most responses were obtained from New South Wales, Queensland, South Australia and Western Australia. The distribution between metropolitan and rural teachers is presented in Figure 3.1.

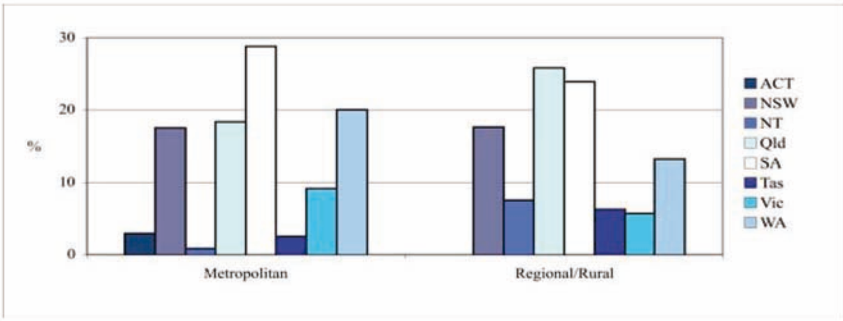

Figure 3.1 Distribution of Metropolitan and Rural Teachers Responding to the Survey

The distribution was not even across the States and Territories. Most teachers (80%) were AAMT members and, at the time of the survey, fifty-eight percent had been teaching 15 years or more.

A comparison of the percentages of teachers from each State and Territory compared with the AAMT membership for 2006 is provided in Figure 3.2.

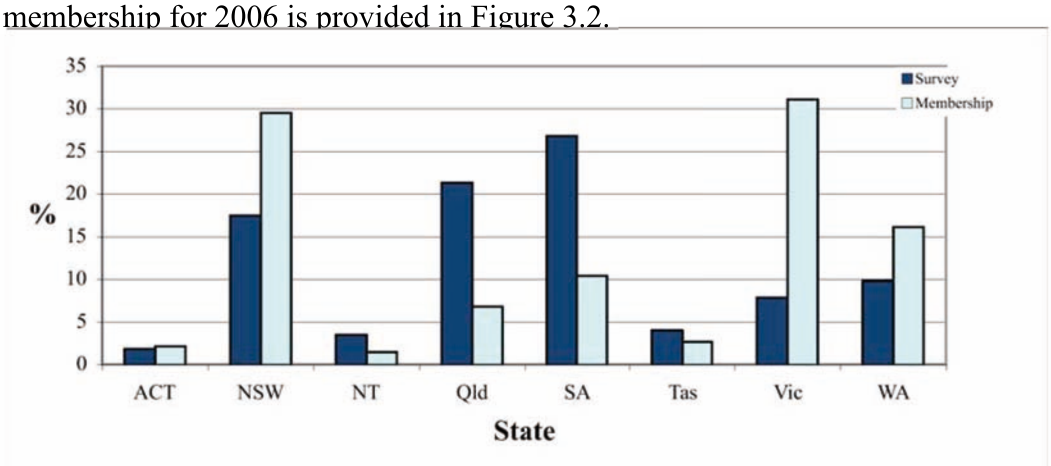

Figure 3.2 Comparison of Teachers Responding to the Survey with the 2006 AMMT Membership

The respondents' teaching experience encompassed a full range of junior secondary and senior secondary courses. Primary teachers were under-represented in the sample. A range of school types was represented – general secondary (52.4%); combined primary and secondary (24.1%); senior secondary (14.5%); secondary to Year 10 (2.7%); combined primary and secondary to Year 10 (1%); other (5.3%). Teachers were drawn from a range of school sizes and this distribution is presented in Figure 3.3.

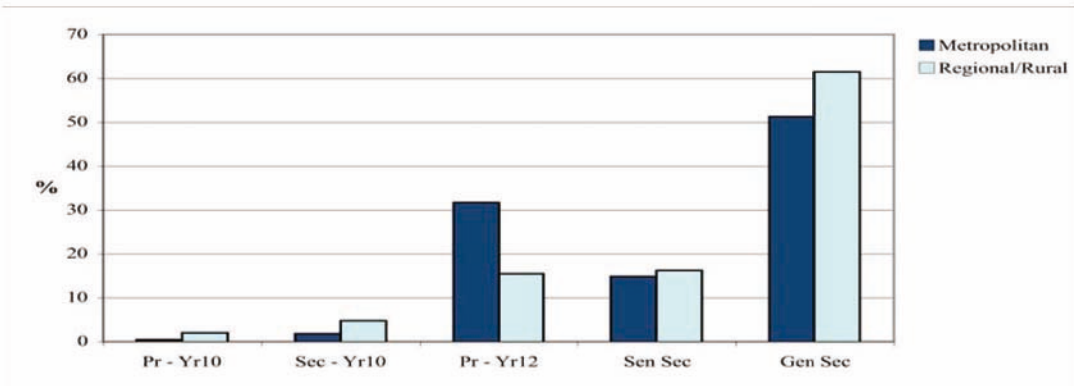

Figure 3.3 Distribution of School Sizes of Teachers Responding to the Survey

3.3 Survey Data: Quantitative Aspects

This sub-section is structured to reflect the way questions were presented in the survey: four groups of questions about teachers' perceptions of influences on students' decisions to take higher-level mathematics followed by a fifth group relating to enrolment trends. Each of these groups is discussed separately referring to charts prepared from the total number of responses. A metropolitan – regional/rural breakdown is provided for each of the areas of influence, along with any comments provided by the Rasch analysis.

3.3.1 School influences (Questions 8 – 13)

There were six questions in the survey relating to school influences. Teachers were asked to rate the influence on students' decision-making of the following:

- Timetable restrictions (e.g., clashes with other more preferred subjects);
- The availability of particular senior courses in the school;
- The likelihood of having to take the course in a 'composite' class and/or by distance education;
- The greater appeal of subjects students perceive as less demanding;
- Students' experience of junior secondary mathematics; and
- The quality of teaching resources (e.g., textbooks, technology) students anticipate encountering in the senior years.

Their responses are summarised in Figure 3.4.

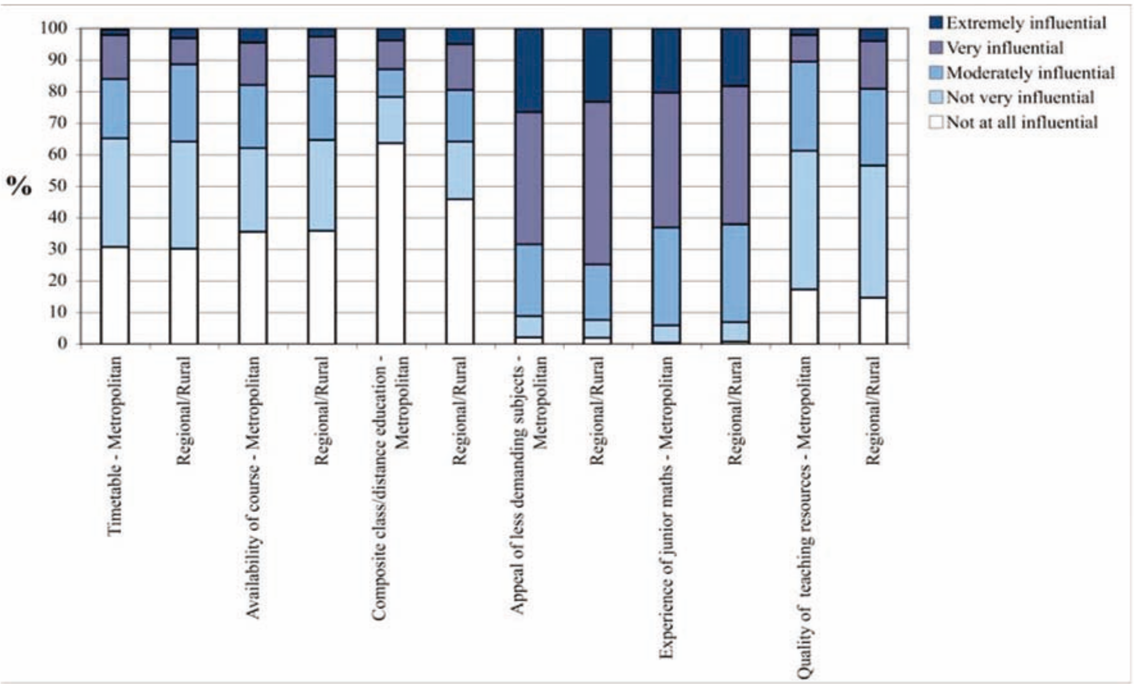

Figure 3.4 Teachers' Perceptions of School Influences on Students' Decision Making re Higher-level Mathematics (Questions 8 – 13)

Overall, there was general agreement between metropolitan and rural teachers' perceptions concerning this group of influences, with the option of taking a course in a composite class and/or by distance delivery recording a notable difference in the *not at all influential* response category.

There are three additional features of interest in teachers' responses. Firstly, ratings of *very influential* and *extremely influential* accounted for 71% of responses concerning students' perceptions of the appeal of less demanding subjects. This proportion suggests that teachers recognise the competition from other courses that mathematics faces in terms of effort required and this view is consistent with the notion that higher-level mathematics is a difficult subject requiring sustained effort.

Secondly, a similar proportion of responses was observed for views about students' experience of junior mathematics where 62% of the responses comprised the *very influential* and *extremely influential* categories. The importance of prior experiences requires some qualification since there are benefits and disadvantages inherent in the learning experiences in which students engage, and a review of teachers' additional comments provided clarification.

The third feature of interest relates to non-student factors (i.e., those external to students) associated with timetabling, course delivery and resourcing. Overall, these non-student factors are perceived to be relatively uninfluential.

Within this group of questions, the Rasch analysis indicated that this group of questions functioned together as a cohesive sub-group. From the average measures for each item, the influences were amongst the easiest to endorse suggesting that teachers perceive this group to be amongst the least influential. There was clear separation between item measures.

3.3.2 Sources of advice influences (Questions 14 – 20)

There were seven questions in the survey relating to sources of advice influences. Teachers were asked to rate the influence on students' decision-making of the following:

- Careers advisers in the school or elsewhere;
- Job guides, websites with career information etc;
- Students' mathematics teacher(s);
- Other teachers in the school;
- Friends in students' year level;
- Older students and friends/siblings; and
- Parents and other adults.

Their responses are summarised in Figure 3.5.

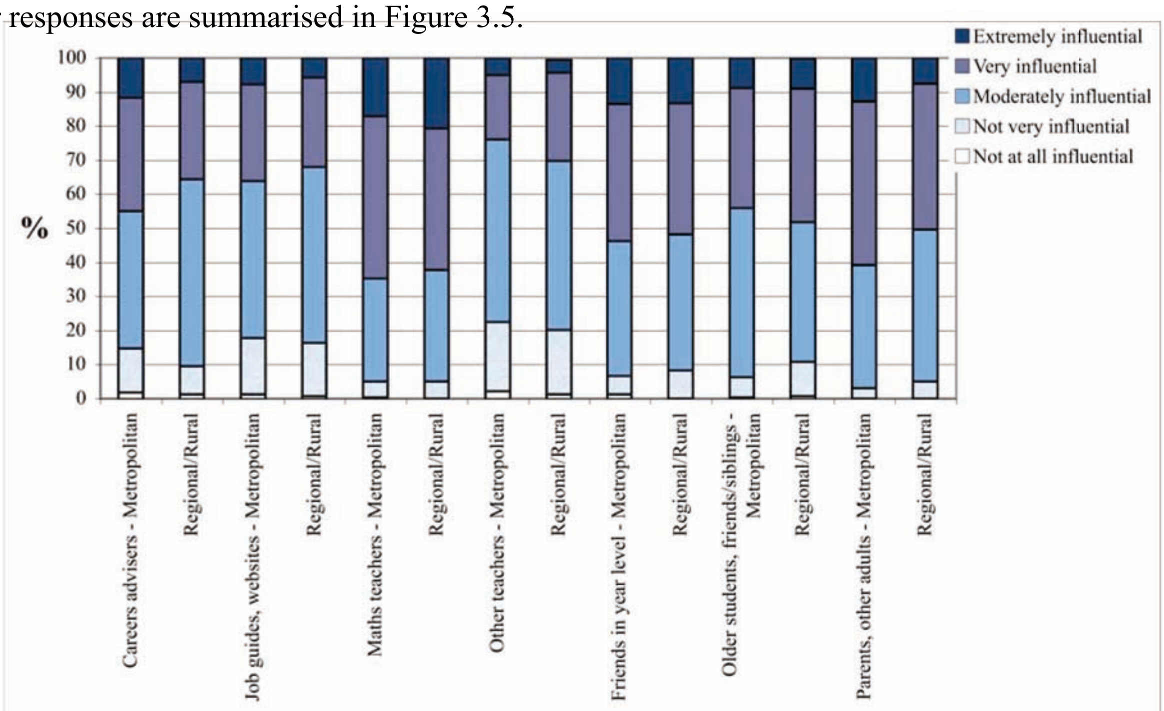

Figure 3.5 Teachers' Perceptions of the Influence of Sources of Advice on Students' Decision Making re Higher-level Mathematics (Questions 21 – 26)

Overall, there was general agreement between metropolitan and rural teachers' perceptions concerning this group of influences and Figure 3.5 reveals the relative importance of mathematics teachers' advice, something which would be consistent with teachers' knowledge of the students they teach and of students' capacity to manage the different courses.

There are three additional points of interest in the way teachers perceive advice. Firstly, teachers were somewhat cautious in their rating with 63 % placing their advice in *the very influential* and *extremely influential* categories.

Secondly, metropolitan teachers place the influence of parents on an almost equal footing as their own advice. Parents are within the next cluster of sources of advice, along with friends in the same Year, and other students with overall ratings of 55 %, 52 % and 45 % respectively.

The third aspect of interest is the placement of other sources of advice which could be regarded as having a professionally informed basis, such as other teachers, careers advisers and job guides. The combined ratings in the *extremely influential and very influential* categories given to this group of 25%, 40% and 34%, respectively, place them after the influences of the group comprising parents, siblings and friends. Beyond their own advice, teachers appear to have made a distinction between social and professionally-based influences.

Within this group of questions, the Rasch analysis indicated that this group of questions functioned together as a cohesive sub-group. From the average measures for each item, the influences were easy to endorse and these values placed this group as more influential than school factors. There was clear separation between all of item measures except for Question 18 concerning the advice of friends in the same Year level which indicated that distinction between the *not at all influential* and *not very influential* categories was not easy to make. Question 15 concerning the influence of job guides and websites did have a relatively high Infit score indicating a certain randomness in the responses and suggesting that this question may need further qualification if the intrinsic influences are to be identified.

3.3.3 Individual influences (Questions 21 – 26)

There were six questions in the survey relating to individual influences. Teachers were asked to rate the influence on students' decision-making of the following:

- How good students thought they were at mathematics;
- Students' interest in and/or liking of mathematics as a subject;
- The perceived difficulty of higher-level mathematics;
- Students' previous achievement in mathematics;
- Students' perceptions of the usefulness of higher-level mathematics; and
- Students' perceptions of the teachers and teaching they will encounter.

Their responses are summarised in Figure 3.6.

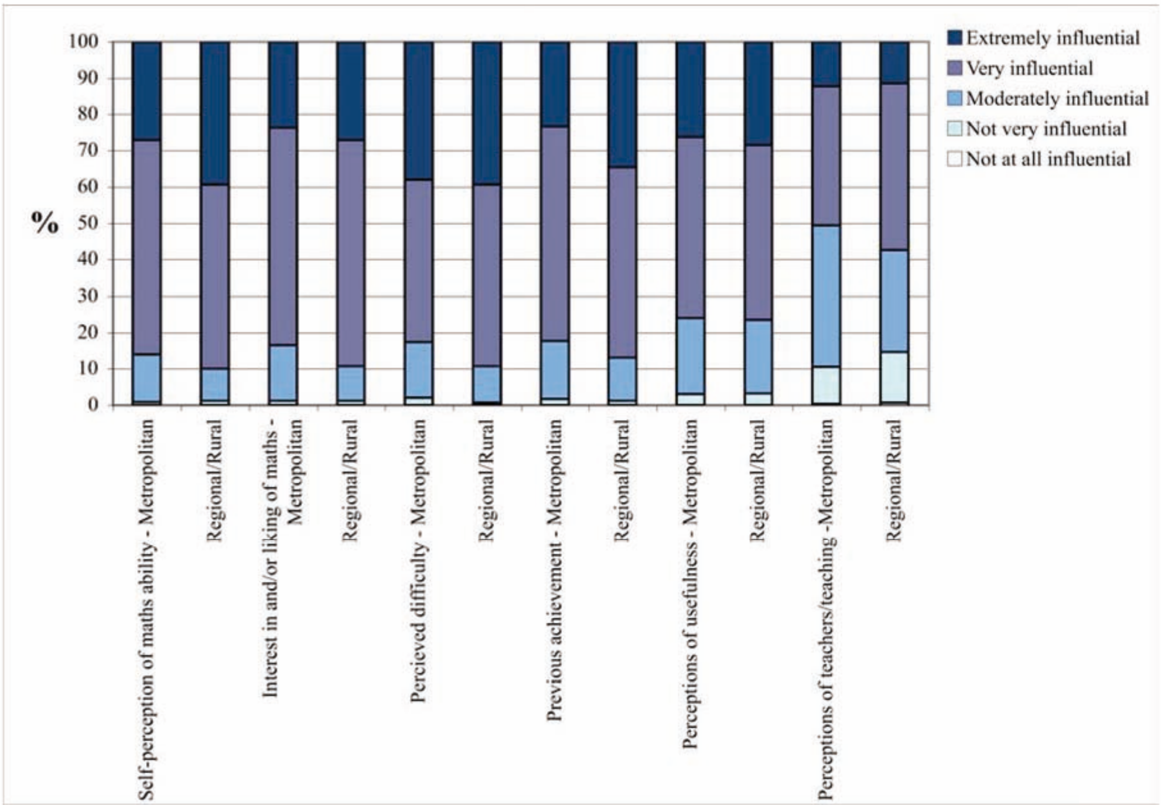

Figure 3.6 Teachers' Perceptions of Individual Influences on Students' Decision Making re Higher-level Mathematics (Questions 21 – 26)

The group of questions relating to individual factors provided teachers with a number of attitudinal aspects that might influence students' choices. Once again, there was general agreement between metropolitan and rural teachers, and all but one of the questions attracted a large percentage of responses in the *very influential* and *extremely influential* categories. It is of interest that teachers are (almost equally) divided concerning the influence of students' perception about them and their teaching.

The Rasch analysis for this group of questions indicated that, whilst they operated as a good sub-scale, they were the most difficult group of questions to endorse suggesting that teachers perceived these influences to be considerably important. Question 26 about students' perceptions of the teachers and teaching to be encountered was associated with a high degree of randomness and is suggestive that the feedback link between teachers and the students they teach is a more complex construct than this question can probe and is therefore an area for further investigation.

3.3.4 Other areas of influence (Questions 27 – 34)

There were eight questions in the survey which were grouped together as other influences. Teachers were asked to rate the influence on students' decision-making of the following:

- Students' Gender;
- Students' socio-economic background;
- The mathematics students had completed at primary school;
- Parental aspirations and expectations;
- The involvement of mathematics teachers in providing subject, course and careers advice;
- Students' understanding of career paths associated with higher-level mathematics;
- Students' knowledge of pay and conditions of types of jobs that use mathematics; and
- The way tertiary entrance scores are calculated.

Their responses are summarised in Figure 3.7.

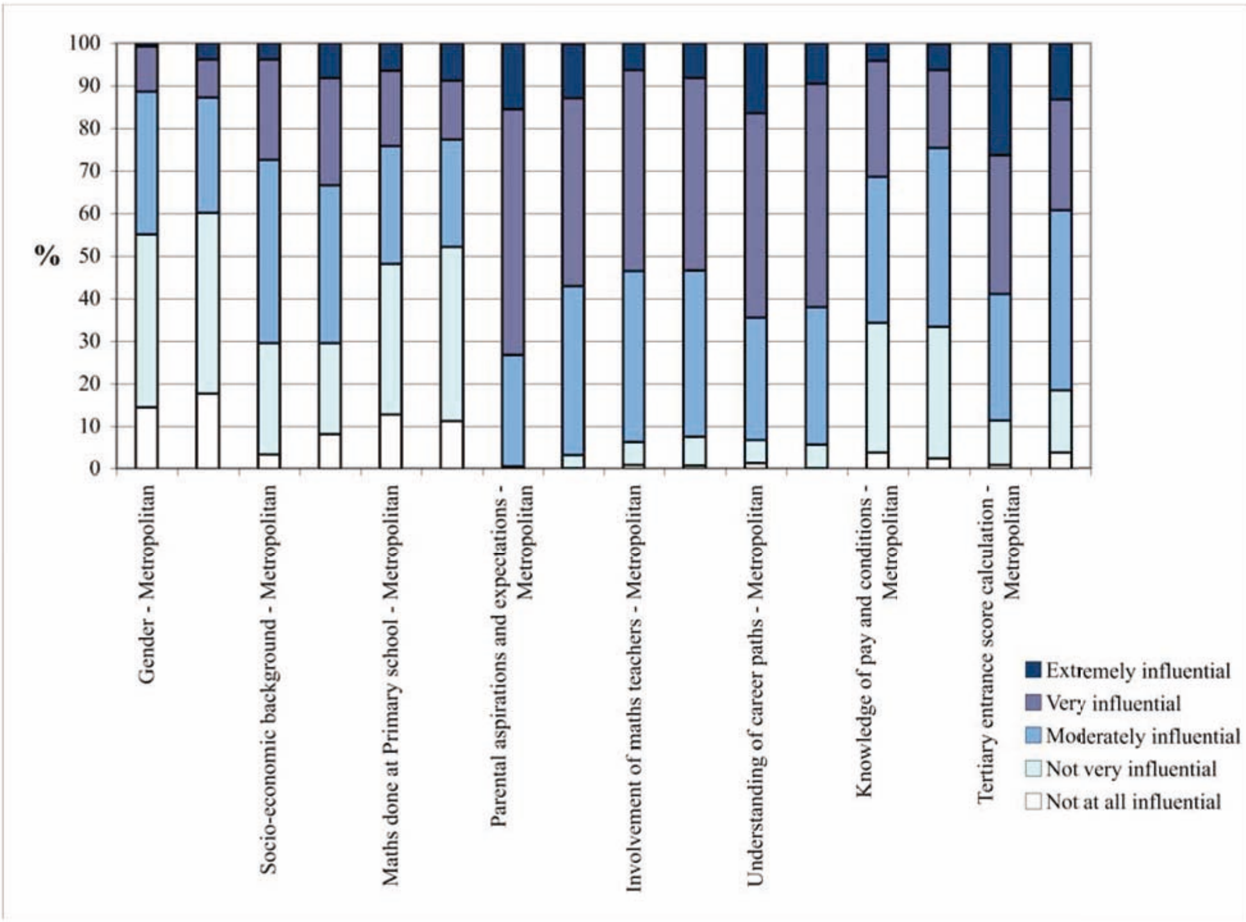

Figure 3.7 Teachers' Perceptions of Other Influences on Students' Decision making re Higher-level Mathematics (Questions 27 – 34)

From within the group of questions detailing a list of Other Factors influencing students' decisions, teachers' ratings of *very influential* and *extremely influential* accounted for 66% of the responses for parental aspirations and expectations. Once *moderately influential* was included as a rating, the involvement of mathematics teachers, an understanding of careers paths, and how tertiary entrance scores are calculated became important influences. Taken together, this group of influences highlights two key elements for students, namely, support needed and the place of mathematics in post-secondary options.

Also of interest is the perceived relative unimportance of mathematics study at primary school (Question 29). Again, teachers' additional comments provided further clarification about this influence since they have already expressed definite ideas in Question 12 of the survey about the relative importance of previous achievement and experiences of junior mathematics.

There are two areas where the agreement between metropolitan and rural teachers differs slightly. The first concerns parental aspirations (Question 30) where metropolitan teachers perceived parental aspirations to be more influential than do rural teachers. This emphasis is similar to that observed in Question 20 concerning parents' advice. The second is related to the calculation of tertiary entrance scores (Question 34) where, again, metropolitan teachers regard this as more influential than do rural teachers. Taken together, these two areas may reflect important differences between the priorities of the two groups.

The Average Measures obtained for this group of questions in the Rasch analysis indicated that this group of questions was relatively easy to endorse. Questions 29 – about the mathematics done in primary school, and Question 34 – about the way tertiary entrance scores are calculated, were associated with a degree of randomness that suggests that there may be a range of influences and/or opinions informing teachers' selections that warrants further investigation.

3.3.5 Enrolments trends and encouragement (Questions 36, 38, 40, 42 and 44)

The five questions which made up this section of the survey are discussed in two groups. The first two questions (Question 36 and 38) related to the proportion of students undertaking higher-level mathematics and teachers were asked to consider changes over the past five years in:

- The proportion of senior students taking higher-level mathematics; and
- The proportion of students entering their first year of secondary school who are capable of taking higher-level mathematics.

Their responses to these two questions are summarised in Figure 3.8.

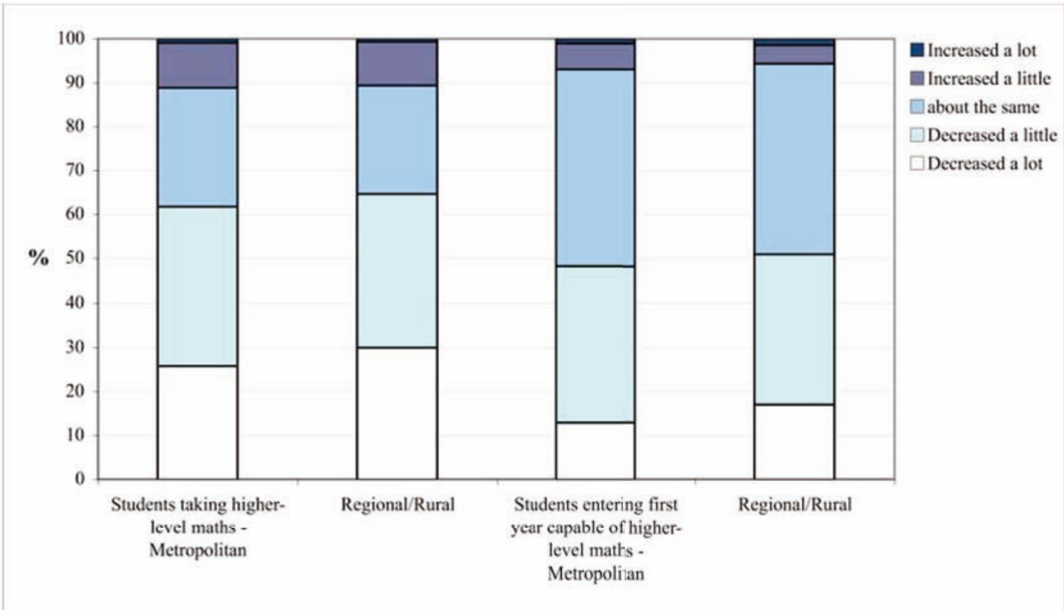

Figure 3.8 Teachers' Perceptions of Enrolment Trends Over the Past Five Years (Questions 36 and 38)

For both questions, metropolitan and regional teachers were in agreement concerning the extent of decline, perceptions which are consistent with the enrolment trends for each of the States and Territories, mentioned in the literature review (Section 2). Taken together, the *decreased a little* and *decreased a lot* categories accounted for 58% and 43% of the responses respectively.

The second group of questions that related to enrolment trends comprised three questions (Questions 40, 42 and 44) about sources of encouragement. Teachers were asked to rate the extent to which students are encouraged to undertake higher-level mathematics by:

- The current junior secondary syllabus or curriculum framework;
- Current teaching practices in junior secondary mathematics; and
- Current assessment practices in junior secondary mathematics.

Their responses are summarised in Figure 3.9.

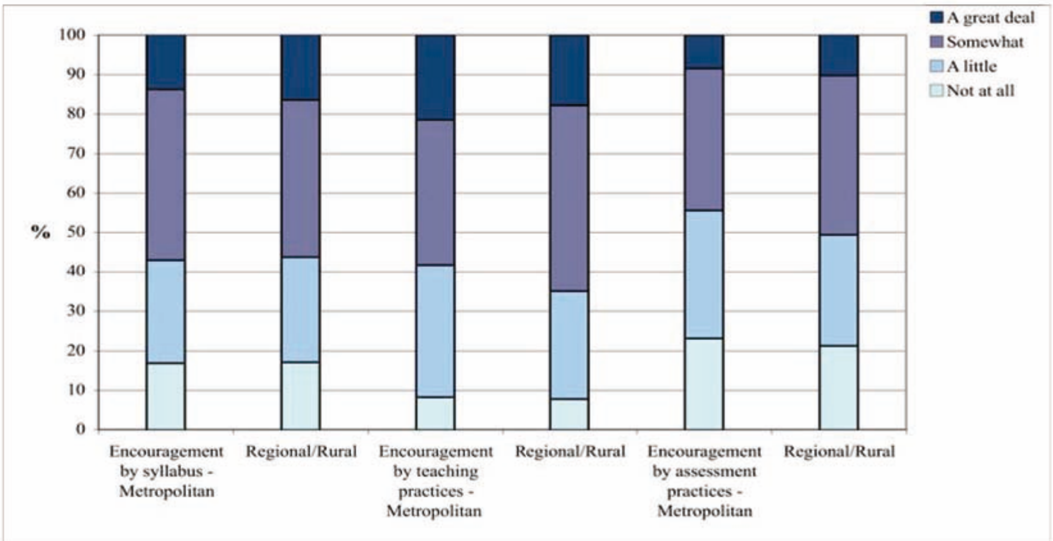

Figure 3.9 Teachers' Perceptions of Syllabus, Teaching Practices, and Assessment Practices as Sources of Encouragement (Questions 40, 42 and 44)

An overview of teachers' responses indicated that teaching practices are perceived to be more encouraging than the syllabus, followed by assessment practices, although no single source is substantially more influential than the others when responses in the *somewhat* and *a great deal* categories were considered. The greatest difference was evident in the responses in these categories from rural teachers concerning encouragement by mathematics teachers (51%) and from metropolitan teachers concerning encouragement from assessment practices (44%).

3.4 Survey Data: Qualitative Aspects

This sub-section focuses on the six questions in the Survey that provided teachers with the opportunity to elaborate on their responses to Questions 34 (other influencing factors) and Questions 36, 38, 40, 42 and 44 (enrolment trends and encouragement). These comments were coded within the framework of general and specific categories developed as part of the coding grid (see Appendix H). In the discussion which follows, charts are included which indicate the relative proportion of comments coded within each of the ten general categories. References are also made to specific categories which apply to selected comments and these are indicated in square brackets after the comment.

3.4.1 Other factors (Question 35)

This open-response question was part of the group of survey questions related to 'other factors' which influenced students' decision-making in the senior years of schooling. Teachers were asked to outline any additional important influences and a summary of their coded responses are presented in Figure 3.10.

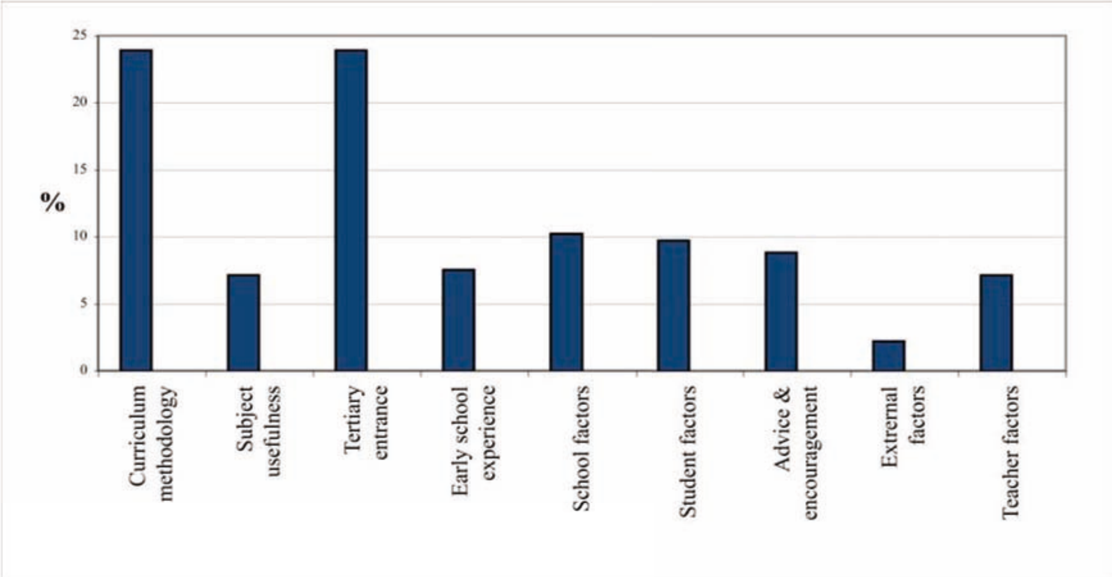

Figure 3.10 General Categories Associated with Comments from Teachers about Perceived Additional Influences on Students' Decision Making re Higher-level Mathematics (Question 35)

Much of the commentary contained in the additional comments provided by teachers in this section of the survey related to the two general categories of Curriculum/methodology, and Tertiary Entrance. Within the Curriculum/methodology general category, the majority of comments related to the specific categories of *Structure* – of courses offered (17% of the comments), and the *Perceived difficulty of mathematics* (67% of the comments). Typical comments included:

> Interest and enrolments in Maths C in Qld has dramatically reduced since the syllabus changes which made different strands optional for schools (*Structure*).
> [South Australian teacher, metropolitan]

> ... as a result of the Curriculum Framework, all mathematics strands are valued equally and as such, there doesn't seem to be enough time spent consolidating the knowledge and skill in the Number and Algebra strands (*Structure*).
> [Western Australian teacher, regional/rural]

> Students have discovered that selection of the easier course (Discrete M) cf the more difficult (Applicable) gives them a higher TER. Students do not want to do more work than they have to (*Perceived difficulty*).
> [Western Australian teacher, metropolitan]

> The perceived heavy workload of higher courses is very off-putting for most students especially if easier options are available (*Perceived difficulty*).
> [Western Australian teacher, metropolitan]

> Many students in recent years are looking for an easier pathway without a willingness to extend or challenge themselves intellectually (*Perceived difficulty*).
> [New South Wales teacher, regional/rural]

The comments presented above highlight the view that curriculum changes can have a destabilizing effect on attitudes towards mathematics and that the "hard yards" associated with studying higher-level mathematics and the intrinsic qualities of the subject are losing their appeal for students.

The comments concerning Tertiary Entrance general category were evenly distributed across issues associated with *Maximising tertiary entrance scores* (46% of comments), and *Internal university pre-requisites* (54% of comments). Typical comments included:

> The fact that there are very few courses that requires a pre-requisite for Year 12 mathematics means that students will primarily choose the subjects they must complete to get into the course they want and the other subjects are made up of those subjects that will give them the highest TER on the lowest amount of work (*Maximising tertiary entrance scores*).
> [South Australian teacher, metropolitan]

> Students perceive that if they do very well in General Mathematics, as opposed to moderately well or poorly in 2/3/4U mathematics, their UAI will be better. Students are also looking for the most gain in marks for the least amount or work; there are many HSC subjects where the students can 'wing it' or put in some work, and achieve well. With mathematics, students generally need to put in time and practice to maintain levels of knowledge/understanding, and cannot just work for two weeks before an exam (*Maximising tertiary entrance scores*).
> [New South Wales teacher, regional/rural]

> Mathematics is no longer a pre-requisite for many university subjects that inherently need maths (*Internal university pre-requisites*).
> [South Australian teacher, metropolitan]

> The information about pre-requisites downplays the need for students to study these harder courses. Stating "highly recommended" as a pre-requisite is often interpreted by students and others as there is no need to study that subject in Years 11 & 12 (*Internal university pre-requisites*).
> [Queensland teacher, metropolitan]

These additional comments also provided some qualifying statements about *Early school experiences* in mathematics. This was an influence where the need for clarification was identified in relation to the influences of primary school, junior school and early achievement. The main issues identified in these comments apply to teacher training, appropriate pedagogy, and the consolidation of basic understandings. Typical comments included:

> The lack of appropriate teaching in primary school sets the students up for failure in maths. Maths teachers' unimaginative teaching coupled with social 'fear' of maths coupled with non-specialist primary teaching of maths is a major issue.
> [South Australian teacher, metropolitan]

> The quality of teachers they experience firstly at primary level and then secondary. It is the teacher, through creative pedagogy that can bring the subject of mathematics alive.
> [Queensland teacher, regional/rural]

> Students often seem to believe that previous demonstrated understanding of concepts will not influence success in Senior schooling. This previous understanding is a factor not taken into account sufficiently.
> [Western Australian teacher, metropolitan]

The important influences identified by teachers in their comments to Question 35 can be summarised as:

- Course structures which do not leave sufficient time for the consolidation of understanding and knowledge;
- Heavy workloads associated with higher-level courses;
- Teacher training and pedagogy which do not adequately support learning in mathematics from primary school through to secondary school;
- ‘Playing’ the tertiary entrance game; and
- Unclear messages from universities about pre-requisites.

3.4.2 Enrolment trends and encouragement (Questions 37, 39, 41, 43 and 45)

This group of open-response questions was linked to the survey questions related to enrolment trends over the last five years and the extent to which students are encouraged to take higher-level mathematics by the curriculum, teaching practices and assessment practices. Teachers' responses were coded according to the general coding grid and the relative proportion of their comments in each of the general categories is summarised in the Figures which follow. In the discussion, Questions 37 and 39 are treated separately, Questions 41 and 43 together, followed by Question 45.

In the first of these open-response questions, teachers provided their perceived reasons for any increases or decreases in the proportion of students undertaking higher-level mathematics over the last five years. The codings for their responses are presented in Figure 3.11.

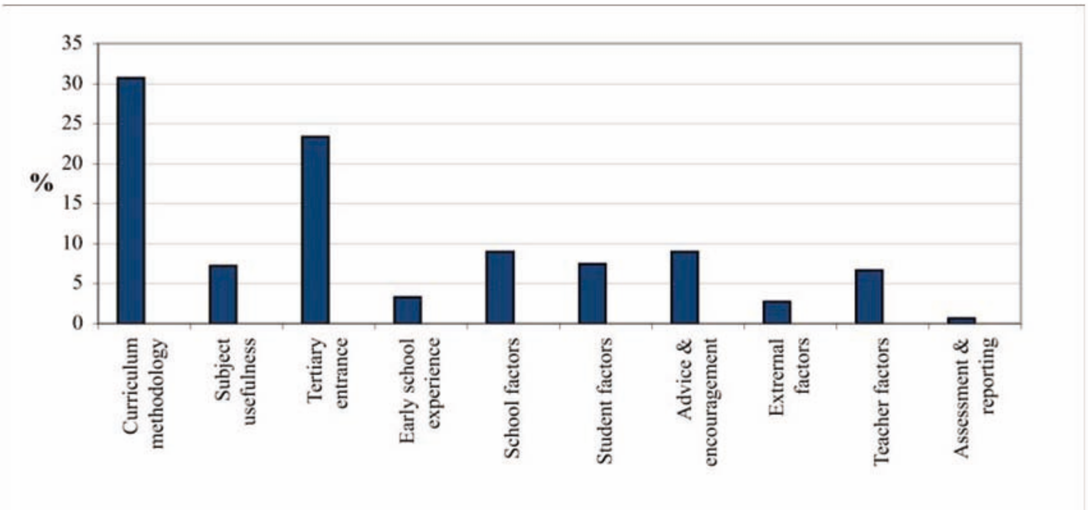

Figure 3.11 General Categories Associated with Comments from Teachers about Perceived Influences on the Proportion of Students Taking Higher-level Mathematics Over the Last Five Years (2002-2006) (Question 37)

The relative importance of the curriculum structure and tertiary entrance influences was reinforced in comments made by teachers in response to questions about enrolment trends (see Figure 3.11).

Most of the comments within the Curriculum/methodology general category related to *Structure* (22% of the comments) and to *Subject difficulty* (69% of the comments). Some typical comments are included below and they convey a message about higher-level mathematics courses as losing their appeal and not providing the incentive for students to take on demanding subjects.

> The Specialist maths course has not attracted anywhere near the numbers of the old Maths 2 course. The examination has been way too hard and the word gets out so that students have moved to the Maths Studies course. The old Maths 1S cohort has not been captured by our new courses (*Structure*).
> [South Australian teacher, metropolitan]

> Our timetable structure has changed. Previously students chose 7 subjects, now they only choose 6. Maths C has been adversely affected (*Structure*).
> [Queensland teacher, metropolitan]

> Other subjects such as Outdoor Education and Physical Education have been chosen over mathematics (*Difficulty and competition*).
> [South Australian teacher, metropolitan]

> The students perceive maths (and rightly) as requiring more work and having a higher degree of difficulty than other subjects with the equivalent potential score (*Difficulty and competition*).
> [Tasmanian teacher, regional/rural]

> The higher-level maths courses are not rewarded in scaling. Students think they are disadvantaged by doing a harder subject and believe they can instead do bridging course if they get into their course of interest (*Difficulty and competition*).
> [South Australian teacher, metropolitan]

> The students see it as a 'hard' option and can achieve a higher TER taking other subjects. Given that few university subjects have mathematics as a pre-requisite, they have little incentive to take the subject (*Difficulty and competition*).
> [South Australian teacher, metropolitan]

The comments within the Tertiary Entrance general category also reinforced the responses from Question 35 where there was an equal focus on either the need to *Maximize UAI/TER scores* or the issue of *Internal university pre-requisites*. Typical comments for the Tertiary Entrance general category included:

> They get a better UAI if they get a better mark in an easier subject (*Maximize UAI/TER scores*).
> [New South Wales teacher, metropolitan]

> Students perceive that they can get high scores from less demanding subjects (*Maximize UAI/TER scores*).
> [Tasmanian teacher, regional/rural]

> Students taking subjects that they see as easier options, aiming for highest TER rather than knowledge/understanding in subjects that may help them at tertiary level (*Maximize UAI/TER scores*).
> [South Australian teacher, metropolitan]

> Universities have changed their pre-requisites and the higher order mathematics subjects are often no longer required (*Internal university pre-requisites*).
> [Western Australian teacher, metropolitan]

> University courses seem to drop Mathematics at a senior level as a prerequisite. Very few students are motivated to do mathematics (*Internal university pre-requisites*).
> [South Australian teacher, regional/rural]
>
> Universities are taking students with lower TERs into courses that traditionally had higher demands and have reduced their expectations in terms of prerequisites in high school mathematics courses (*Internal university pre-requisites*).
> [South Australian teacher, metropolitan]

The comments above concerning university prerequisites highlight a theme of standards within the school-university learning continuum. It raises the questions of whether students are choosing less demanding subjects because universities are not requiring them as prerequisites, or universities are changing requirements because fewer students are choosing higher-level mathematics.

In the second of this group of open-response questions, teachers provided their perceived reasons for any increases or decreases in the proportion of students entering their first year of secondary schooling who are capable of undertaking higher-level mathematics. The codings for their responses are presented in Figure 3.12.

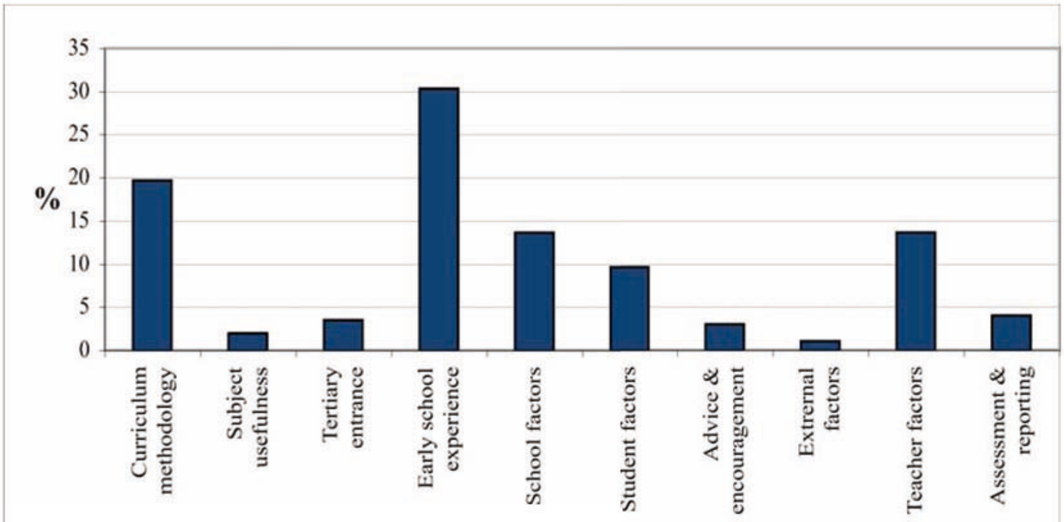

Figure 3.12 General Categories Associated with Comments from Teachers about Perceived Influences on the Proportion of Students Entering High School Over the Last Five Years (2002-2006) who are Capable of Taking Higher-level Mathematics (Question 39)

The proportion of comments in the Curriculum/methodology general category reinforced this area as an important influence identified by teachers. Of these comments, almost half were concerned with the rigour associated with mathematics and the preparation of students for higher-level mathematics.

In line with the importance of student preparation, there were many comments which were coded within the Early School Experiences general category, particularly the quality of experiences in the primary years of schooling. This quality was perceived in terms of student preparation and the skills base they bring to secondary schooling, and attitudes to teaching and learning held by teachers. Typical examples included:

> Students entering Year 8 do not have the basic skills (particularly number) that the students of the past years have had. They have good technology skills or they can undertake a social impact study but when it comes to the rigour of higher order mathematics, their knowledge base lets them down. Students no longer want to remember, they just want to do then forget. Instantaneous gratification.
> [Queensland teacher, regional/rural]

> The reduced rigour and increased 'play' that happens in primary schools does not prepare students as well.
> [South Australian teacher, regional/rural]

> They (students) have a weaker background coming from some of the feeder primary schools due to perhaps teachers not as interested in mathematics.
> [New South Wales teacher, regional/rural]

> It is my belief that many primary teachers do not like maths themselves; (some) openly admit to having been hopeless at maths at school …
> [Queensland teacher, regional/rural]

> Many students enter secondary with big gaps in knowledge: usually fractions, tables and ability to do long division and multiplication.
> [Victorian teacher, metropolitan]

Along with the need to consolidate the mathematical foundations and preparation of students, teachers had definite views about how the structure of courses is/is not supporting students' learning. When asked about the extent to which the various syllabuses supported students to undertake higher-level mathematics courses (Figure 3.13), the message that came through in the comments was the importance of meeting students' learning needs, even though the different curricula were given various endorsements, including "a mess," "too outcomes-based," "watered down," " a serious heap of detritus," " a disaster," and "too content driven." Typical comments that were coded in the Curriculum/methodology general category about how teachers perceived the links between the curriculum and students' needs included:

> Curriculum Frameworks does not provide any useful information to students in terms of their potential to succeed at higher-level maths. They don't understand band levels and the automatic promotions that result (*Structure*).
> [Northern Territory teacher, regional/rural]

> The current syllabus for upper school is very good … for top level students. Unfortunately, the mis-match between expected outcomes levels and what students need to be capable of to undertake maths at the top level is significant … the gap between the "dumbed-down" Year 10 and the academically rigorous (Year 11) course is too great (*Structure*).
> [Western Australian teacher, regional/rural]

> The junior syllabus is too unstructured in content to allow for full confidence in mathematics (*Structure*).
> [Western Australian teacher, metropolitan]

> In NSW, if a teacher extends students in the early years of high school so that they are able to achieve Stage 5.1 by the end of Year 8, it offers the opportunity

for students to feel very comfortable with their mathematics by the end of Year 10 and thus more willing to attempt the higher levels in the senior years (*Structure*).
[New South Wales teacher, regional/rural]

To go into the higher Year 11 courses, the students should be at level 6 … we arrange our programs so that this can be achieved if the student is able (*Structure*).
[Western Australian teacher, regional/rural]

The last two comments raise an interesting point concerning how the syllabus can encourage students to undertake higher-level courses and it relates to how the various courses in schools are planned and delivered by teachers.

In the next two open-response questions, teachers provided commentary concerning the potential for the current junior syllabus, and current teaching practices in junior secondary mathematics to encourage students to undertake higher-level mathematics. The codings for their responses are presented in Figure 3.13.

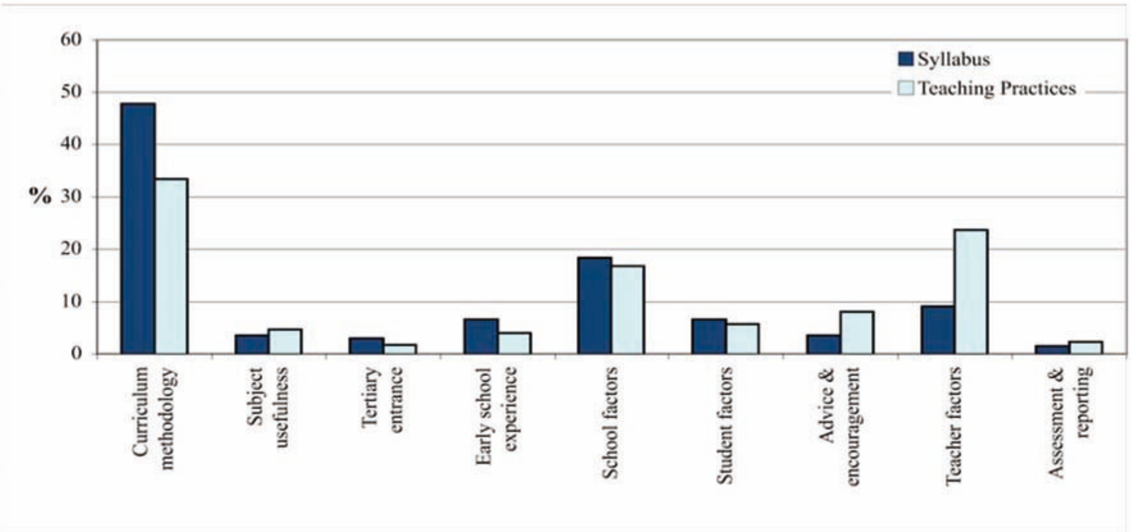

Figure 3.13 General Categories Associated with Comments from Teachers about Perceived Aspects of Syllabus and Teaching Practice which Encourage Students to Take Higher-level Mathematics (Questions 41 and 43)

The role teachers play in encouraging students, as reflected in the general coding categories, is the second feature represented in Figure 3.13. As with syllabus encouragement, the largest group of comments was coded within the Curriculum/methodology general category.

The typical comments about teachers' influences included below highlight differing needs: students' needs for extension, relevance and success; teachers' need for an appropriate pedagogical approach.

We do lots of extension on the normal syllabus requirements, eg some students are capable of handling the sin/cos rules in Year 9 (*Structure*).
[Queensland teacher, metropolitan]

> Students want relevance and success. They also want to enjoy what they are doing particularly at the junior levels. If these factors are being met it is likely that they will continue with mathematics (*Image of mathematics*).
> [South Australian teacher, metropolitan]

> Topics difficult to teach are ignored … if it's needed, then senior staff will teach it; so poorly taught that it's made optional, then dropped from the curriculum (*Difficulty*).
> [New South Wales teacher, metropolitan]

> If the teachers "teach" maths rather than engaging students in mathematical thinking, many teachers are still using the same old content-driven (textbook-based) methodologies as have been used for many years. Hence, the students find mathematics boring and irrelevant to their lives (*Pedagogy*).
> [South Australian teacher, metropolitan]

> At junior secondary, students need to develop their basic maths skill (arithmetic, algebra, geometry) through a routine type of work. This can help them in dealing with more advanced (investigative) type of maths problems (*Rigour & preparation for higher-level mathematics*).
> [South Australian teacher, metropolitan]

In the last of this group of open-response questions, teachers provided commentary concerning the potential for assessment practices to encourage students to undertake higher-level mathematics. In response to how assessment practices encourage students, teachers identified a number of influences. Although comments were coded within all general categories of the coding grid, the majority (73%) related to Assessment/reporting and the distribution within this category is summarised in Table 3.1.

Table 3.1 Distribution of General Coding Categories for Comments Related to Assessment/Reporting

Specific Category	Percentage of Comments
Formal testing	24.5
Common testing	1.1
Experience gained as preparation for the future	6.4
Assignments, projects & alternative tasks	31.9
Extension work	1.1
Outcomes	4.3
Quantitative feedback	19.1
External assessment	5.3
Internal assessment	6.4

The type of tasks set (e.g., assignments), formal testing, and the nature of feedback drew the most comments about assessment.

Typical comments included:

> The formal, so called rigorous, narrow assessment doesn't reinforce student competence in their abilities; policy needs to reflect a balance of knowledge, skills and application of maths in action, which is the most difficult to manage and assess (*Formal testing*).

[South Australian teacher, regional/rural]

We try to ensure that the basis of our assessment practices will reflect the type of assessment they will encounter in the senior years of their current maths pathway, but is modified … (*Formal testing*).
[South Australian teacher, metropolitan]

Our junior practices mirror those that will be encountered in the senior years … we have recently reverted to using good old-fashioned percentages as well, so the students know what to expect in the senior years and they and their parents better understand their potential to succeed at the higher-level courses (*Formal testing*).
[West Australian teacher, metropolitan]

There is no emphasis on proper tests and exams; only an emphasis on the alternative assessment methods. This hinders students in their performance in higher-level maths in which the main emphasis is on exam-style assessment (*Assignments, projects & alternative tasks*).
[South Australian teacher, regional/rural]

Trendy assessment methods don't determine abilities and test understanding (*Assignments, projects & alternative tasks*).
[South Australian distance education provider]

We try alternative assessment tasks so students can experience success in as many ways as possible (*Assignments, projects & alternative tasks*).
[New South Wales teacher, regional/rural]

Teaching using projects and investigations does not prepare student for senior mathematics. Students need to be able to pass tests and exams (*Assignments, projects & alternative tasks*).
[South Australian teacher, regional/rural]

With levels replacing marks, it is harder for students to see the progress they are making and to compare themselves to their peers (*Quantitative feedback*).
[Western Australian teacher, metropolitan]

There is an increasing number of other subjects that are rarely if ever using tests. Students do not get enough overall practice and hence … they perceive maths as being very hard. Also, students who fail maths at one year are promoted to the next year level, even though they are condemned to failure (*Quantitative feedback*).
[South Australian teacher, regional/rural]

(Students) gain high marks for very little skill in middle school. They are aware of an increase in standards for senior school maths and know they haven't the skills required (*Quantitative feedback*).
[South Australian teacher, regional/rural]

Where assessment is concerned, teachers' comments revealed a tension between a number of key elements: assessment for senior preparation or for learning and understanding; exam-style tasks or a range of alternative tasks to cater for different learning and assessment needs; feedback through numbers or levels of achievement. This tension suggest the need for balance between preparing students for the requirements of a future course that they have yet to experience and providing students with constructive feedback about the learning that they are currently experiencing.

3.4.3 Strategies for increasing participation in higher-level mathematics (Question 46)

In the final survey question, teachers provided commentary about strategies which would encourage greater student participation in higher-level mathematics. The codings for their responses are presented in Figure 3.14.

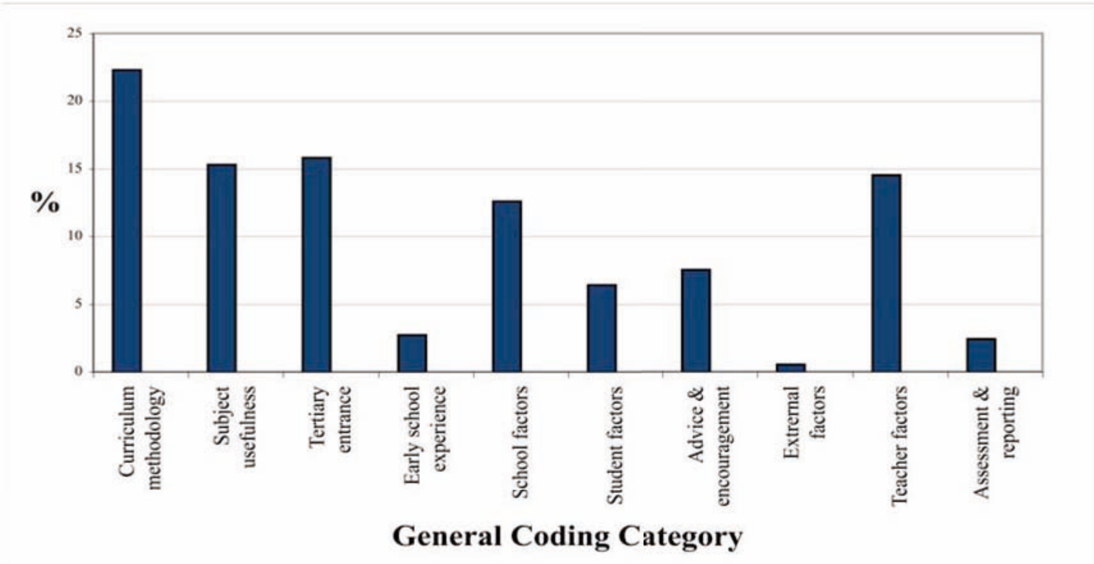

Figure 3.14 General Categories Associated with Comments from Teachers about Strategies to Encourage Greater Participation in Higher-level Mathematics (Question 46)

The majority of comments were coded within the Curriculum/methodology general category, indicative of teachers' priority with the material and the structure of the courses they are required to teach. One comment in particular summed up the balance referred to above concerning what students are currently engaged in and for what they are being prepared. It reflects a number of key concerns: teacher quality and pedagogy; student engagement; consolidation of learning; a good "diet" of tasks; an appropriate framework for teachers to work from; and preparation for the future.

> Sound teaching practices and methodology that maintains interest and develops a sound basis for future learning in conjunction with appropriate and varied assessment tasks. Plus, a syllabus that investigates and develops an understanding of mathematical concepts to enable students to attain their true potential while keeping options available for the future.
> [South Australian teacher, metropolitan]

These key concerns were further elaborated and reinforced in other comments coded within the Subject Usefulness, Tertiary Entrance, School Factors and Teacher Factors general categories. From the recurring ideas that came through in these comments, teachers identified a number of areas for action which, they perceived, would encourage students to undertake higher-level mathematics courses. These areas are listed below, followed by typical comments.

1. Clarify the need for undertaking higher-level mathematics courses through an emphasis on links with real-world contexts, comparability with other subjects, and how students will be equipped for the future;
2. Implement appropriate rewards to recognise the effort associated with undertaking higher-level courses;
3. Ensure that higher-level mathematics courses are given appropriate recognition at the tertiary level;
4. Consider alternative class structures to ensure that the individual learning needs of students are met;
5. Provide more time and resources for the teaching of difficult concepts associated with higher-level mathematics courses; and
6. Ensure that the teaching of mathematics, particularly in the junior secondary years, is undertaken by teachers whose practice is based on genuine interest, enthusiasm, and broad pedagogical and content knowledge.

> Students need to have a clearer or better appreciation of why they need to do a topic and how it is linked to the real world situation. Also if the maths teacher can make frequent reference to why this maths is needed in the future job perspective, then this can help the students think about the type of maths they may want to do. (*Career relevance*)
> [Queensland teacher, metropolitan]

> Students deserve to be taught an interesting and challenging curriculum by people who are genuinely interested in them and the subject. They need to be shown how maths will equip them for the future. They need to know the types of jobs and career paths which rely on mathematics. (*Career relevance*)
> [Queensland teacher, regional/rural]

> Senior mathematics courses need a radical overhaul if they are to compete with other subjects. The reality is that nearly all other subjects hold a substantial real-world interest for students whereas mathematics keeps removing our students from it. (*Relevance of mathematics for learning and life*)
> [New South Wales teacher, regional/rural]

> Students need to be reassured that levels of achievement in mathematics are strong relative to other subjects. An appreciation for the broader skills developed through the study of maths, not just for engineering or other quantitative fields, needs to be developed in schools and the community. (*Relevance of mathematics for learning and life*)
> [South Australian teacher, metropolitan]

> Giving the higher maths greater recognition and reward for effort by, for example, being a requirement for more third level courses, and through more advantageous scaling of higher maths courses. (*Maximising UAI/TER scores; Internal university prerequisites*)
> [Western Australian teacher, metropolitan]

> Give students weighted scores for doing harder subjects, e.g., calculus, physics; change university prerequisites. (*Maximising UAI/TER scores; Internal university prerequisites*)
> [Western Australian teacher, metropolitan]

Have universities regard it (higher-level mathematics) as important for more courses rather than offering bridging courses which often don't meet the needs of their students. (*Internal university prerequisites*)
[Western Australian teacher, metropolitan]

Identify the top group of students as early as possible at junior secondary level (maybe year 8) and encourage them through special programs … (*Class organization*)
[Northern Territory teacher, regional/rural]

Accelerating high ability students in junior secondary, e.g., doing 2U maths course in Year 10 or Year 11. I think this will improve self-efficacy and hence motivate them to pursue higher mathematics. (*Class organization*)
[New South Wales teacher, metropolitan]

Courses that are aimed more at the student's ability level – i.e., back to streaming. (*Class organization*)
[Victorian teacher, metropolitan]

A bigger push to advance the best earlier on – right from Year 7 (*Class organization*)
[New South Wales teacher, metropolitan]

The preparatory requirements for Year 12 have probably been slightly increased over the last thirty years, yet the time available to cover this material in Years 8 to 10 has probably been halved, partly due to the false belief that all subjects in Year 12 are more accessible (*Time*)
[South Australian teacher, regional/rural]

More time needs to be given to the teaching of higher-level mathematics. It needs to be recognised that the work is very difficult and that it takes time for students to absorb difficult concepts. (*Time*)
[New South Wales teacher, regional/rural]

Resources to help teachers provide students with engaging contexts and help them see the usefulness of the mathematics. (*Resources*)
[South Australian teacher, regional/rural]

Students deserve to be taught an interesting and challenging curriculum by people who are genuinely interested in them and the subject. They need to be shown how maths will equip them for the future. They need to know the types of hobs and career pathways which rely on mathematics. (*Attitudes to the profession and teaching*)
[Queensland teacher, regional/rural]

Having an enthusiastic and passionate maths teacher – particularly from an early stage (year 8), work with them for a number of years; most will choose higher-level. (*Attitudes to the profession and teaching*)
[Queensland teacher, metropolitan]

To encourage students to take up these courses, the courses must be taught by a teacher who is enthusiastic about his/her subject area, is able to make the

> subject 'live' for their students by making it relevant to what they see around them. (*Attitudes to the profession and teaching*)
> [Northern Territory teacher, regional/rural]
>
> A properly qualified and professionally up-to-date mathematics teacher for every student in every year of junior secondary would be a fine start. (*Preparation and training*)
> [South Australian teacher, metropolitan]
>
> Students given individual encouragement. Teachers experienced in all senior courses able to extend junior students so they feel successful and comfortable at a level that suits them (*Preparation and training*)
> [New South Wales teacher, metropolitan]
>
> Having more enthusiastic and experienced teachers of mathematics at junior secondary levels. At present, there tends to be a perception that anyone can teach mathematics. (*Preparation and training*)
> [Tasmanian teacher, regional/rural]

3.5 Summary

Of the four major groupings of 27 questions about influences which were contained in the teacher survey, the Individual group was perceived to have the greatest impact on students' decision making based on the number of responses in the 'extremely influential' and 'very influential' categories. Within the group, four specific influences were acknowledged as contributing to this impact and they are:

- self-perception of ability;
- interest and liking for higher-level mathematics;
- the perceived difficulty of the higher-level mathematics; and
- students' previous achievement in mathematics.

There were three groupings of the remaining specific influences identified as impacting on students' decisions based on 50% or more of teachers' responses made in the 'extremely influential' and 'very influential' categories.

Firstly, there were the two influences of:

- the greater appeal of subjects perceived as less demanding; and
- the perceived usefulness of higher-level mathematics.

Secondly, there were the four influences of:

- parental aspirations and expectations;
- the advice of students' mathematics teacher;
- students' experience of junior mathematics; and
- students' understanding of career paths.

Thirdly, there were the five influences of:

- the advice of parents;
- the advice of friends in the same Year;
- the perception of teachers and teaching to be encountered;

- the involvement of mathematics teachers; and
- how tertiary entrance scores are calculated.

The remaining twelve influences, for which less than fifty percents of responses were in the extremely influential and very influential categories, decreased in impact as indicated below:

- the advice of older students or friends;
- the advice of careers advisers;
- quality of teaching resources;
- the availability of a course;
- the advice contained in job guides;
- timetable considerations;
- socio-economic background;
- knowledge of pay and conditions;
- whether the course is composite or distance delivery;
- the mathematics done at primary school;
- the advice of other teachers;
- gender.

For all 27 questions, the contribution from the moderately influential categories was least for the individual influences and then increased for school influences, other influences and contributed most for the sources of advice influences.

Concerning enrolment trends, few teachers indicated that the number of students entering high school with the capabilities for undertaking higher-level mathematics had increased. As for sources of encouragement for students, teachers did not identify syllabuses, teaching practices or assessment practices as being particularly influential.

The qualitative comments provided by teachers gave additional detail about many of the influences impacting on students' decisions. Important recurring themes in these comments can be summarised as:

- course structures which do not leave sufficient time for the consolidation of understanding and knowledge;
- heavy workloads associated with higher-level courses;
- teacher training and pedagogy which do not adequately support the transition in learning mathematics from primary school through to secondary school;
- the nature, purpose and structure of assessment;
- 'playing' the tertiary entrance game; and
- unclear messages from universities about pre-requisites.

The scene was set at the beginning of this section with two quotes which conveyed the perception that students regard mathematics as important, as requiring hard work to consolidate content – much of which is irrelevant, and that these two aspects need to be balanced in order to facilitate the transition to post-secondary options. From teachers' perceptions presented in this section, individual (student) influences have emerged as having the most impact on decision-making. If these decisions are to be modified in favour of higher-level mathematics courses, teachers are suggesting that students' achievement in mathematics (at any stage prior to choosing a higher-level course) needs to be consolidated sufficiently in order to sustain interest, liking and a realistic self-perception of their ability that will then allow them to engage, and persevere, with a difficult senior course.

SECTION 4

CAREER PROFESSIONALS SURVEYS

> Students recognise the value in higher maths and aspire to do the maths they are most capable of. They are very much swayed by their experiences at lower levels and their results. Many start off in the higher maths at Year 11 but then switch back … at Year 12 if they can't cope. It's always a fine line of counselling – how well can you do in the harder maths taking into account it's scaled up compared to how well you can go in the lower maths taking into account it's scaled down …
> [Victorian Career Professional, metropolitan]

> There is so much in the syllabus that every topic is rushed through, so that kids don't have time to absorb concepts, so they don't feel they are any good at Maths. Also, they disengage because they do not see that the Maths is relevant to their lives. They don't have the maturity or experience to understand that they may need it when they leave school.
> [New South Wales Career Professional, regional/rural]

4.1 Introduction

The two comments above introduce the notion of engagement as an outgrowth of previous experiences. There is an implication that students choose higher-level mathematics during secondary school, and as a post-secondary option, if experiences at lower levels are appropriate. There is, however, an inherent dilemma: learning experiences which do not consolidate concepts or which do not emphasise personal relevance do little for students' self-perception of ability or their capacity to understand the role mathematics has beyond secondary schooling.

This section details career professionals' perceptions of the influences on students' decision-making concerning higher-level mathematics. These perceptions are based on responses to the Career Professional Survey (see Appendix B) and they are presented in a number of sub-sections in line with the groupings of questions presented in the survey and which are similar to the structure used in Section 3. Firstly, background information about the career professionals who responded is presented. This is followed in the second sub-section by quantitative aspects of the survey dealing with the groupings influences related to school, individual, sources of advice, and other influences. This sub-section concludes with career professionals' perceptions of enrolment trends over the past five years, and the extent to which students are encouraged by teaching practices to take higher-level mathematics courses. The third sub-section provides a summary of career professionals' open-ended responses which gave them the opportunity to provide supportive detail for a number of their survey selections.

4.2 Background

A total of 120 career professionals from most of the States and Territories responded to the survey with a metropolitan and rural (non-metropolitan) breakdown of 81 and 39, respectively. career professionals from Victoria provided most of the responses and there were no responses from Queensland. The distribution between metropolitan and rural was not even across the States and Territories, and this distribution is presented in Figure 4.1.

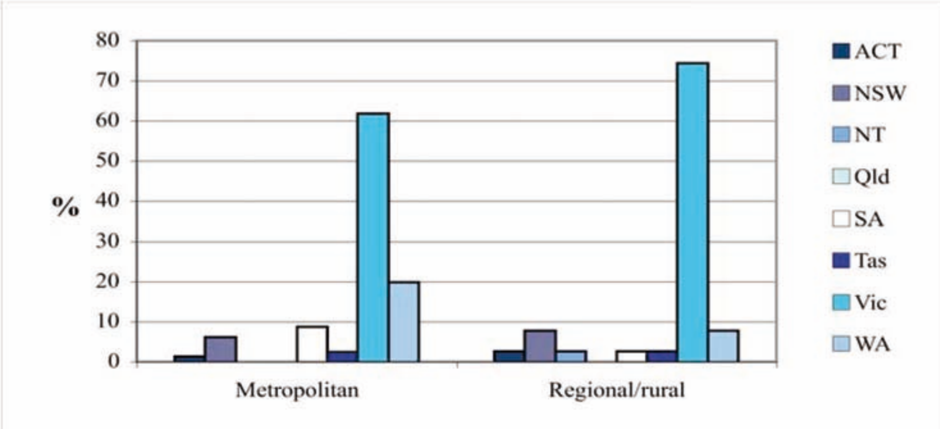

Figure 4.1 Distribution by State and Territory of Metropolitan and Rural Career Professionals Responding to the Survey

A range of school types was represented – general secondary (60%); combined primary and secondary (26.1%); senior secondary (12.2%); secondary to Year 10 (0.9%); combined primary and secondary to Year 10 (0.9%); other (4.3%).

Career professionals were drawn from a range of school sizes and this distribution is presented in Figure 4.2.

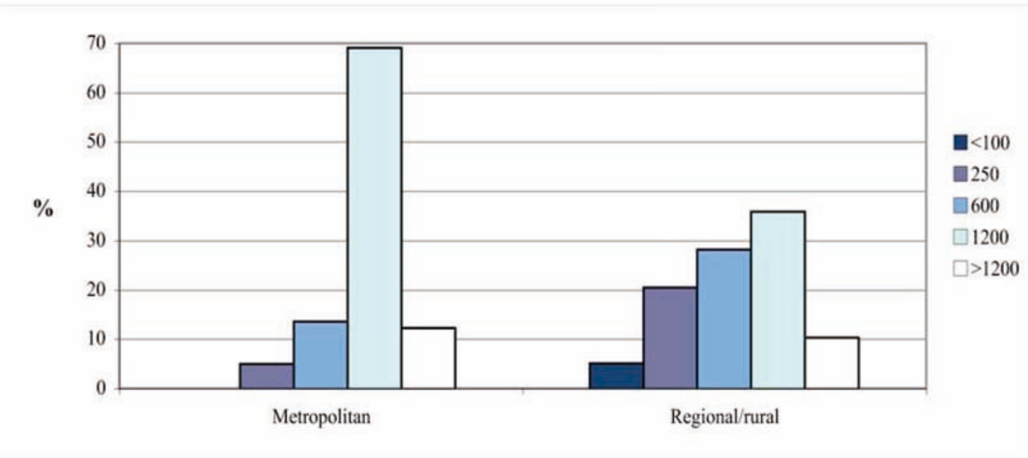

Figure 4.2 Distribution of School Student Populations for Career Professionals Responding to the Survey

4.3 Survey Data: Quantitative Aspects

This sub-section is structured in line with the way groups of questions were presented in the survey. Each group of questions is discussed separately according to the charts prepared from the total number of responses to each question. Where relevant, a metropolitan – regional/rural perspective is provided for each of the areas of influence, along with any comments provided by the Rasch analysis.

4.3.1 School influences

There were six questions in the survey relating to school influences. Career professionals were asked to rate the influence on students' decision-making of the following:

- Timetable restrictions (e.g., clashes with other more preferred subjects);
- The availability of particular senior courses in the school;

- The likelihood of having to take the course in a 'composite' class and/or by distance education;
- The greater appeal of subjects students perceive as less demanding;
- Students' experience of junior secondary mathematics; and
- The quality of teaching resources (e.g., textbooks, technology) students anticipate encountering in the senior years.

Their responses are summarised in Figure 4.3.

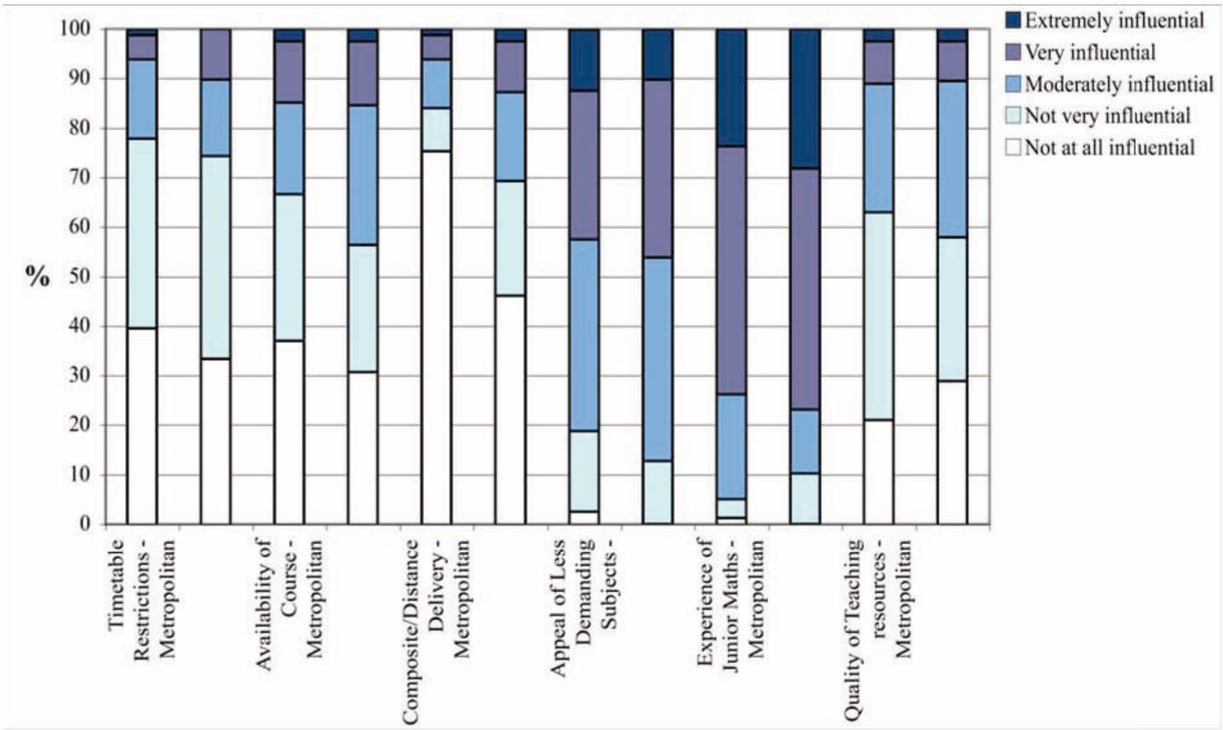

Figure 4.3 Career Professionals' Perceptions of School Influences on Students' Decision Making re Higher-level Mathematics (Questions 5 – 10)

There are three features of interest in the responses to school factors that influence students' decisions (see Figure 4.3). Firstly, ratings in the 'very influential' and 'extremely influential' categories accounted for 74% of responses concerning experiences of junior mathematics. Such experiences can be interpreted as both rewarding and unproductive, and so further details about this influence in terms of benefits and/or disadvantages was provided from a review of career professionals' additional comments.

Secondly, the appeal of less demanding subjects was also considered to be an important influence with 'moderately influential', 'very influential' and 'extremely influential' ratings accounting for 81% of responses. The responses of career professionals to these two factors indicate the importance placed on school influences that require a degree of student engagement, namely, the necessity for choice from within the range of subjects offered, and how students are affected by teaching and learning throughout schooling.

The third feature of interest relates to non-student (i.e., external) factors where timetable restrictions, course structuring, and resourcing are relatively less influential.

There was general agreement between metropolitan and rural career professionals for most of the questions. The one question where there was a noticeable variation concerned the issue of course delivery which was less of an influence for the metropolitan group and may reflect the capacity of these schools to offer a comprehensive range of courses, and rural students' view of the relative benefits of undertaking course by distance delivery.

The Rasch analysis of this group of questions indicated that career professionals found it easy to endorse the questions which were student-related, namely subject appeal and experience of junior mathematics. Question 7 which related to course delivery, had a degree of randomness about it with disorder occurring for the 'very influential' and 'extremely influential' categories.

4.3.2 Sources of advice influences

There were seven questions in the survey relating to sources of advice influences. Career professionals were asked to rate the influence on students' decision-making of the following:

- Careers advisers in the school or elsewhere;
- Job guides, websites with career information etc;
- Students' mathematics teacher(s);
- Other teachers in the school;
- Friends in students' year level;
- Older students and friends/siblings; and
- Parents and other adults.

Their responses are summarised in Figure 4.4.

The group of questions relating to sources of advice revealed the relative importance of mathematics teachers' advice. Career professionals have reinforced teachers' responses with a higher percentage of responses in the 'very influential' and 'extremely influential' categories and, again, this is recognition of teachers' knowledge of the students they teach and of students' capacity to manage the different courses (Figure 4.4). There are three points of interest in the way career professionals perceive advice. Firstly, they were somewhat cautious in rating themselves with less than fifty percent placing the influence of their advice in the 'very influential' and 'extremely influential' categories. Secondly, they place the influence of parents and friends in the same Year level above their own.

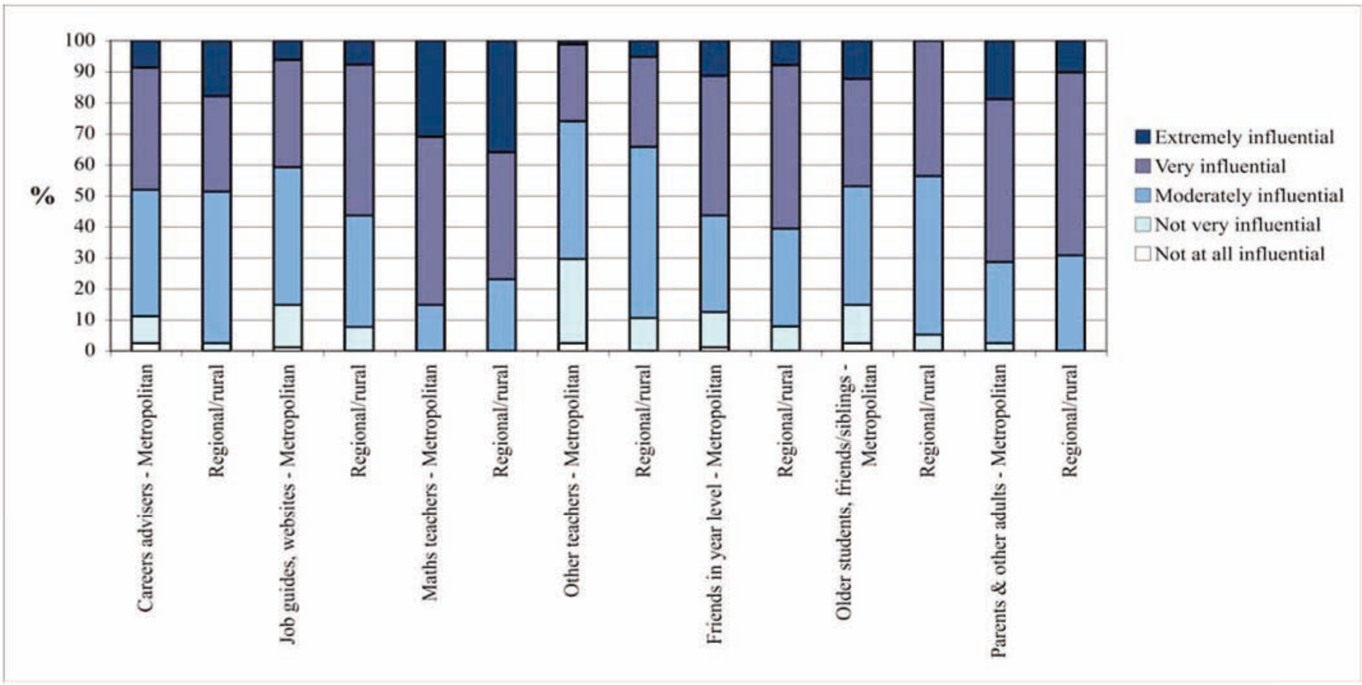

Figure 4.4 Career Professionals' Perceptions of Sources of Advice Influences on Students' Decision Making re Higher-level Mathematics (Questions 11 – 17)

Overall, the group of questions relating to sources of advice revealed the relative importance that mathematics teachers' advice is perceived to have. The majority of career professionals' responses were in the 'very influential' and 'extremely influential' categories, and is a possible recognition of teachers' knowledge of the students they teach and of students' capacity to manage the different courses.

There are three additional points of interest in the way career professionals perceive advice. Firstly, they were somewhat cautious in rating themselves with less than 50% placing the influence of their advice in the 'very influential' and 'extremely influential' categories. Secondly, they place the influence of parents and friends in the same Year level above their own.

The third aspect of interest is the placement of other teachers as a source of advice. This group was perceived as least influential and may be an artefact of the competition which exists between mathematics and the 'appeal of less demanding subjects.'

Although the responses indicated that career professionals perceived the influence of job guides and websites to be similar to that of their own advice, the Rasch analysis for both questions indicated a degree of disorder in the 'not very influential' and 'moderately influential' categories. This may suggest that there are other influencing components in these areas which require further investigation.

4.3.3 Individual influences

There were six questions in the survey relating to individual influences. Career professionals were asked to rate the influence on students' decision-making of the following:

- How good students thought they were at mathematics;
- Students' interest in and/or liking of mathematics as a subject;
- The perceived difficulty of higher-level mathematics;
- Students' previous achievement in mathematics;
- Students' perceptions of the usefulness of higher-level mathematics; and
- Students' perceptions of the teachers and teaching they will encounter.

Their responses are summarised in Figure 4.5.

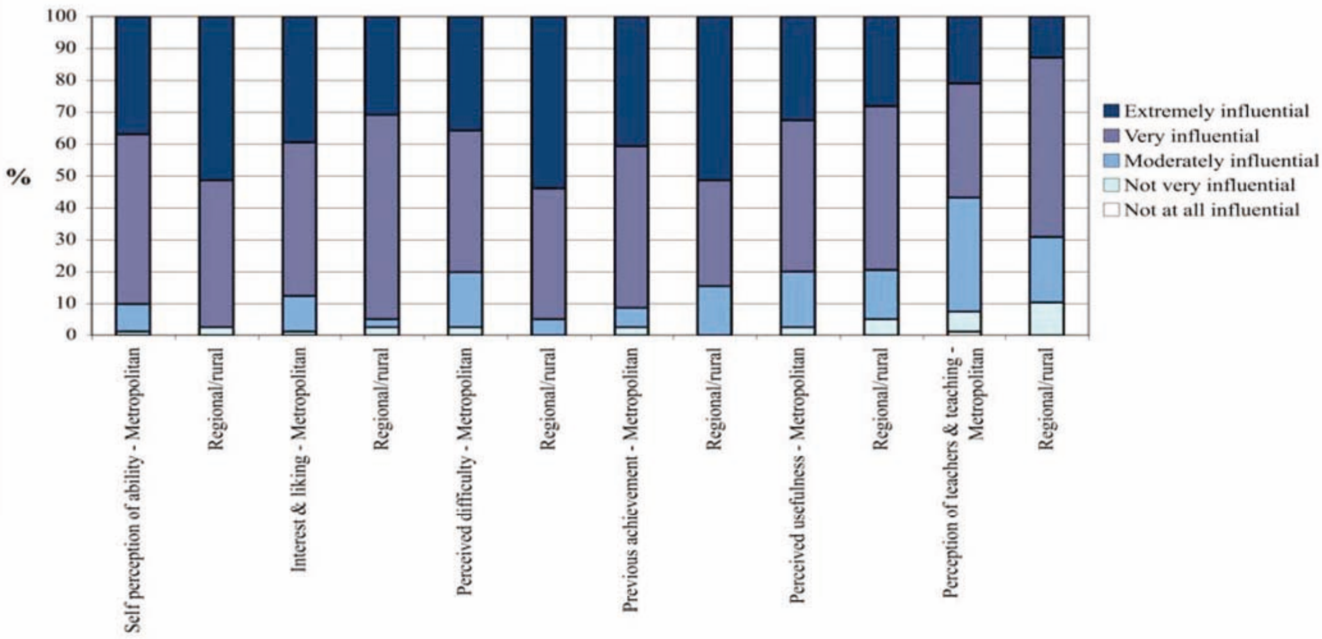

Figure 4.5 Career Professionals' Perceptions of Individual Influences on Students' Decision Making re Higher-level Mathematics (Questions 18 – 23)

All but one of the attidudinal aspects associated with individual factors attracted high percentages of responses in the 'very influential' and 'extremely influential' categories. The individual factor that received the highest of the ratings was self-perception of ability, followed by interest and liking, previous achievement, and perceived difficulty. The importance placed on this group of influences suggests that career professionals may have particular views about the manner in which the subject and student performance are communicated. Their additional comments provided further clarification.

Career professionals in rural regions recorded higher percentages than the metropolitan group in the combined 'very' and 'extremely influential' categories for the questions related to students' interest and their perceptions of teachers to be encountered, subject difficulty, and their own ability.

The Rasch analysis for this group of questions indicated that they operated as a good sub-scale, and that they were the most difficult group of questions to endorse suggesting that career professionals perceived these influences to be the most important. Question 23 about students' perceptions of the teachers and teaching to be encountered was associated with a high degree of randomness and mirrored the result observed in the teachers' survey.

4.3.4 Other areas of influence

There were seven questions in the survey which were grouped together as other influences. Career professionals were asked to rate the influence on students' decision-making of the following:

- Students' gender;
- Students' socio-economic background;
- Parental aspirations and expectations;

- The involvement of mathematics teachers in providing subject, course and careers advice;
- Students' understanding of career paths associated with higher-level mathematics;
- Students' knowledge of pay and conditions of types of jobs that use mathematics; and
- The way tertiary entrance scores are calculated.

Their responses are summarised in Figure 4.6.

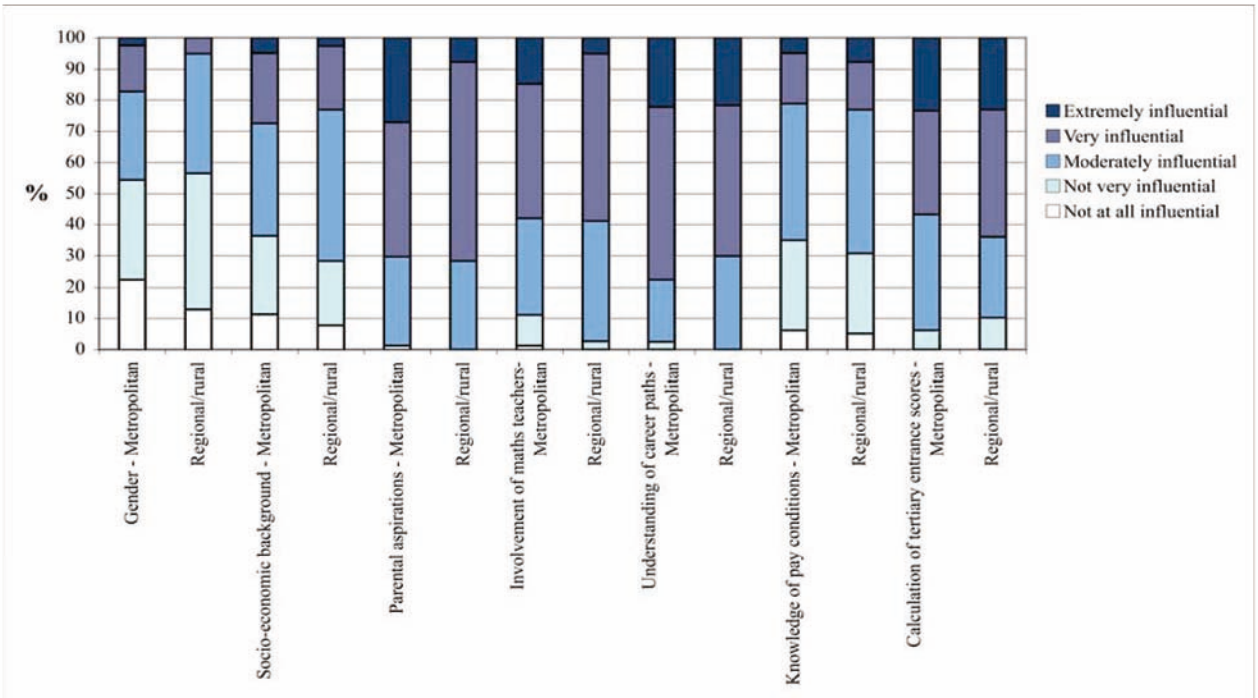

Figure 4.6 Career Professionals' Perceptions of Other Influences on Students' Decision making re Higher-level Mathematics (Questions 24 - 30)

From within the group of questions detailing a list of Other Factors influencing students' decisions, career professionals' ratings of 'very influential' and 'extremely influential' accounted for 74% of the responses to the influence associated with knowledge about career paths. When 'moderately influential' was included as a rating, parental aspirations, the calculation of tertiary entrance scores, and the involvement of mathematics teachers make up a group of influences where guidance and an understanding of the place of mathematics in post-secondary options are key elements.

Again, there was general agreement between the metropolitan and rural groups of career professionals across the categories of responses. The relative proportions of responses in the 'very influential' and 'extremely influential' categories in the areas of gender, parental aspirations and understanding about career paths may reflect different contextual priorities for the two groups.

The Rasch analysis indicated that this group of questions worked cohesively as a sub-scale. There was good separation between the item measures and the average values for each item suggests that this group was moderately difficult to endorse, a reflection of their relative importance.

4.3.5 Enrolments trends and encouragement (Questions 32 and 34)

The two questions which made up this section of the survey related to enrolment trends over the past five years are presented separately. Both questions also provided the opportunity for career professionals to provide additional commentary and these are considered in the next section.

The first question (Question 32) related to the proportion of senior students undertaking higher-level mathematics and career professionals were asked to consider perceived changes over the past five years. Their responses are summarised in Figure 4.7.

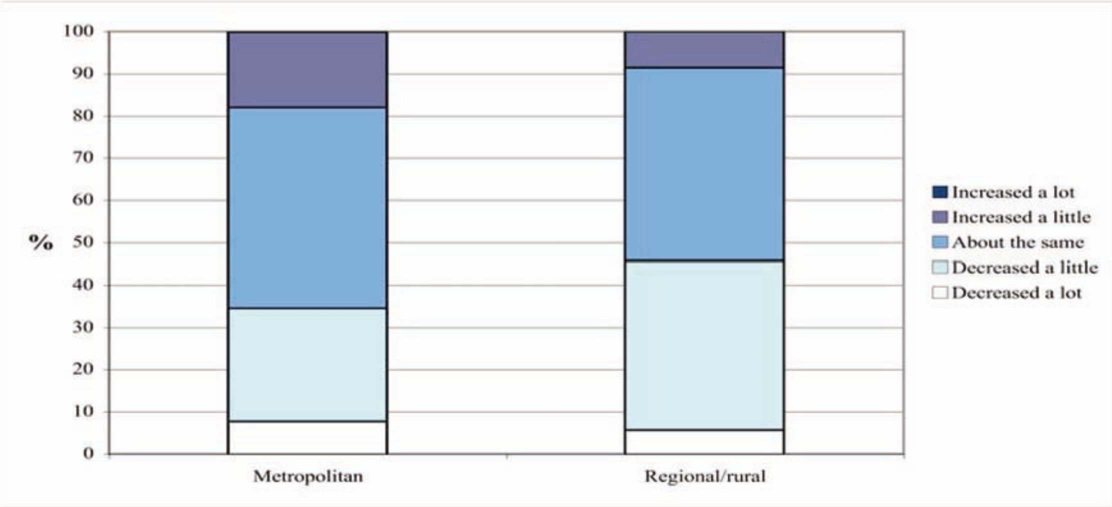

Figure 4.7 Career Professionals' Perceptions of the Proportion of Students Taking Higher-level Mathematics Over the Past Five Years (2002-2006) (Question 32)

Rural career professionals provided more responses in the 'decreased a lot' and 'decreased a little' categories than the metropolitan group.

In the second question, career professionals were asked to rate teaching practices as a source of encouragement for students (Question 34). Their responses are summarized in Figure 4.8.

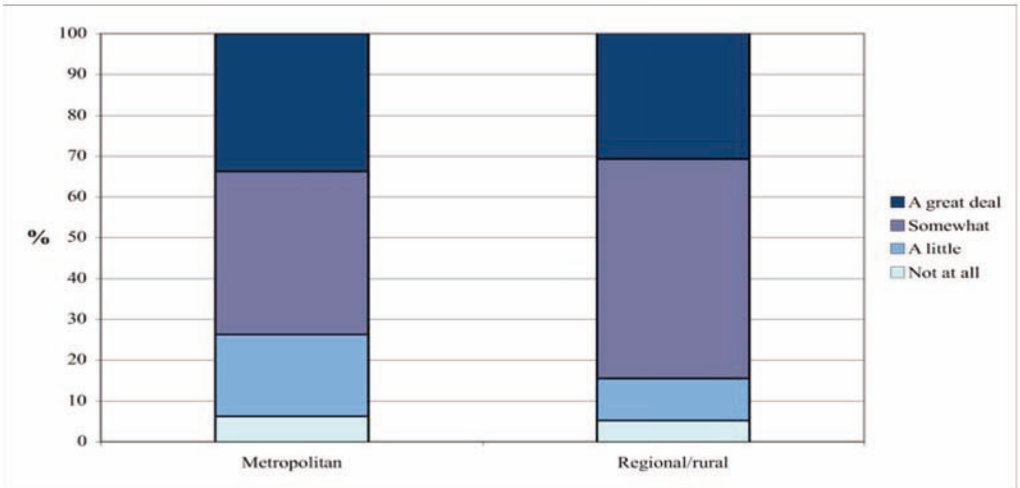

Figure 4.8 Career Professionals' Perceptions of the Extent of Encouragement to Take Higher-level Mathematics Provided by Teaching Practices (Question 34)

From the percentage of responses in the 'a great deal' and 'somewhat' categories, there was an indication that the regional/rural group recognised the impact of teachers more than the metropolitan group.

4.4 Survey Data: Qualitative Aspects

This sub-section focuses on the five questions in the Survey that provided career professionals with the opportunity to elaborate on their responses to Question 31 (Other Influencing Factors) and Questions 33 and 35 (Enrolment Trends and Encouragement). These comments were coded within the framework of general and specific categories developed as part of the coding grid (see Appendix H). In the discussion which follows, charts are included which indicate the relative proportion of comments coded within each of the ten main general categories. References are also made to specific categories which apply to selected comments and these are indicated in italics after the comment.

4.4.1 Other Factors (Question 31)

This open-response question was part of the group of survey questions related to Other Factors which influenced students' decision-making in the senior years of schooling. Career professionals were asked to outline any additional important influences and a summary of their coded responses are presented in Figure 4.9.

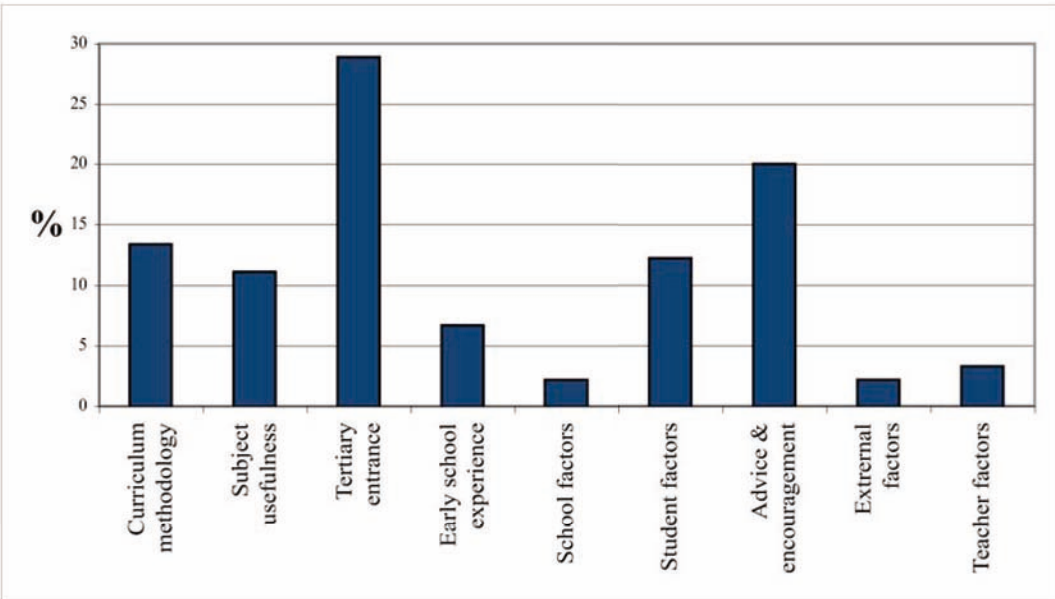

Figure 4.9 General Categories Associated with Comments from Career Professionals about their Perceptions of Influences on Students' Decision making re Higher-level Mathematics (Question 31)

Much of the commentary contained in the additional comments provided by career professionals in this section of the survey related to two of the qualitative coding general categories, namely, Tertiary Entrance, and Advice and Encouragement.

Within the Tertiary Entrance general category, the majority of comments were made about the *Need* for a tertiary entrance score (46% of comments). Two other aspects were discussed and these were *Internal university pre-requisites* (35% of comments), and *Maximising TER/UAI scores* (19% of comments). Typical comments included:

> Students understand that maths is a pre-requisite for many further education programs and will usually do the highest level of maths they can do to keep their options open (*Need*).
> [Victorian Career Professional, metropolitan]
>
> The main influence is whether this subject is a pre-requisite for further study (*Need*).
> [Victorian Career Professional, metropolitan]
>
> Many students select two maths subjects in Year 12 … as they perceive this to help with their ENTER sore. Maths is perceived as essential if a student is wanting to study at University (*Need*).
> [Victorian Career Professional, metropolitan]
>
> … students can gain a higher UAI by doing well in General Maths than by doing moderately well in Mathematics is extremely influential (*Maximising UAI/TER Scores*).
> [New South Wales Career Professional, Regional/rural]
>
> … (students) would prefer to do an 'easier' subject because they do not think that they will need the maths in the future, due to a relaxation of university pre-requisites (*Internal university pre-requisites*).
> [South Australian Career Professional, metropolitan]
>
> Whether it is a pre-requisite course for further study. There is a perception that you need Maths so most students choose it (*Internal university pre-requisites*).
> [Australian Capital Territory Career Professional, metropolitan]

The comments presented above highlight the notion that students need to balance a number of requirements when planning further study. In particular, balancing subject difficulty associated with gaining an appropriate tertiary entrance score with the capacity for that course to provide preparation for the university course of interest.

The additional comments also provided qualifying statements related to Advice and Encouragement and provided some clarification of the particular views that career professionals have about the messages students receive and the way the subject and their performance is communicated. The main issues identified in these comments relate to the specific categories of *Reporting* (33% of comments), *Parents/siblings*, *Careers counsellors*, and *Maths teachers*. It is worth reiterating that, earlier in the Survey, career professionals rated sources of advice as teachers being the most influential, followed by parents, friends in the same Year, then careers counsellors and job guides/web sites with an approximately equal rating. Typical comments included:

> The most influential aspect of a student's decision on mathematics is their results in previous years (*Reporting*).
> [Victorian Career Professional, metropolitan]
>
> Students choose maths on the basis of their demonstrated past ability to pass the subject, they choose it if they can do it … If they can't do it they have to reassess their proposed course choices. The difficulty of the subject and students' ability to pass comfortably is the issue (*Reporting*).
> [Victorian Career Professional, metropolitan]

> Students will choose not to do maths if they don't enjoy it … and don't realise the ramifications. But, Yr 8 maths results determine Maths in Y11 and Y12. So, teach parents that maths results are critical …
> [New South Wales Career Professional, metropolitan]
>
> Students usually have a pre-conceived idea of maths and what career options are available to them should they continue or not with maths. It is a career advisor's role to unpack all the student's ideas and to provide them with all the relevant career/maths information, rather than direct a student's choice.
> [Victorian Career Professional, metropolitan]
>
> A really big influence is maths teachers – they have a system of training up the good students and weeding out those they believe will harm their statistical performance. Many students who, based on objective testing, should be good at maths are turned off early or discarded as lazy.
> [Victorian Career Professional, metropolitan]
>
> Asian parents of all socio-economic groups choose 3 Unit maths even if poor results in the junior school.
> [New South Wales Career Professional, metropolitan]

In the comments presented above about other influences, career professional have identified the important role of previous performance for students, and the notion that their aspirations to continue with mathematics have to mesh with the aspirations and advice of others. Given that this group of career professionals did not rate their advisory influence very highly, there is a subtle message that their professional role may have other dimensions in this context.

4.4.2 Enrolment Trends and Encouragement (Questions 33 and 35)

The two open-response questions presented here were linked to the two survey questions about enrolment trends over the last five years and the extent to which students are encouraged to take higher-level mathematics by current teaching practices in junior secondary mathematics. Career professionals' responses were coded according to the General Coding grid and the relative proportion of their comments in each of the General Categories is summarised in each of the Figures which follow.

In the first of these open-response questions, career professionals provided their perceived reasons for any increases or decreases in the proportion of students undertaking higher-level mathematics over the last five years. The codings for their responses are summarized in Figure 4.10.

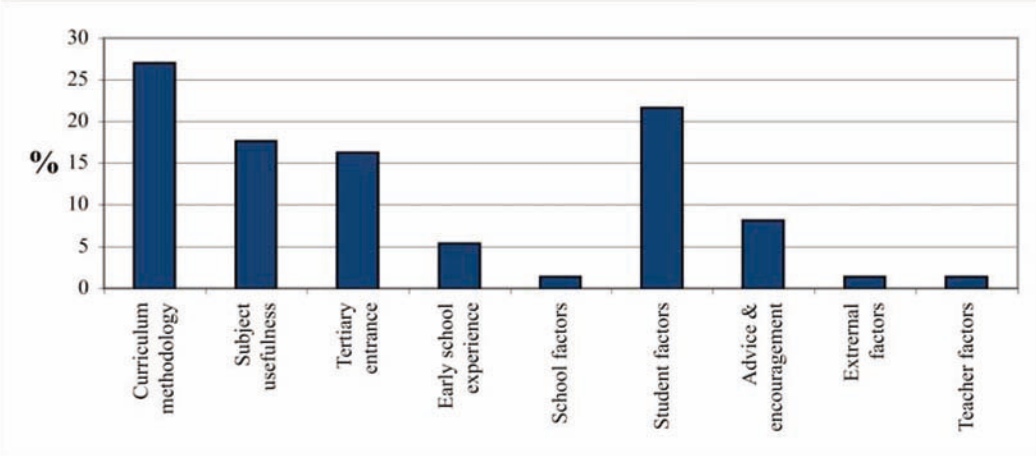

Figure 4.10 General Categories Associated with Comments from Career Professionals about their Perceptions of Influences on Enrolment Trends in Higher-level Mathematics (Question 33)

The majority of the comments were coded within four of the general categories, namely, Curriculum/methodology, Subject Usefulness, Tertiary Entrance, and Student Factors. Within these general categories, *Difficulty and competition*, *Relevance*, *University pre-requisites*, *Attitudes to school*, and *Cohort quality* emerged as important aspects from the specific categories. Representative comments are included below and they highlight some important perceptions of student priorities. In particular, in a subject that is perceived to be difficult in terms of content, effort and achievement, students are choosing easier options in preparation for post-secondary pathways.

> Students have become very clever at choosing pathways – why do an extremely difficult and boring course when it is not necessary (*Difficulty and competition*).
> [Western Australian Career Professional, metropolitan]
>
> Students are looking for a perceived easier load in their final year (*Difficulty and competition*).
> [South Australian Career Professional, metropolitan]
>
> Specialist mathematics is perceived as hard, and also not many tertiary courses have it as a pre-requisite (*Difficulty and competition*, and *University pre-requisites*).
> [Victorian Career Professional, metropolitan]
>
> The students find Year 10 mathematics difficult after a 7 – 9 curriculum which is not always trying to aim for excellence rather than enjoyment. It needs to be both (*Difficulty and competition*).
> [Victorian Career Professional, regional/rural]
>
> Fewer students interested in pursuing science and engineering courses at university (*Relevance of Mathematics*).
> [Victorian Career Professional, metropolitan]
>
> Our school provides VCE, VET and VCAL subjects and higher maths is not a priority. The priority is to keep students in school till Year 12 (*Relevance of mathematics*).
> [Victorian Career Professional, regional/rural]

Students are becoming aware of the usefulness of maths across all professions, especially those with a trade focus (*Relevance of mathematics*).
[Victorian Career Professional, metropolitan]

Students are always looking for easier options, and pre-requisite requirements have eased in some tertiary courses (*Internal university pre-requisites)*.
[South Australian Career Professional, metropolitan]

(Students) don't want to work and don't see the benefits (*Attitudes to school*).
[New South Wales Career Professional, metropolitan]

Many students do not want to put in the hard work to ensure that they have the grounding in junior maths first but later want careers which require higher level maths (*Attitudes to school*).
[Victorian Career Professional, metropolitan]

Students seem to be finding maths more difficult and perceive they are not achieving the results they need to go on to higher maths study thus their results in maths rule out maths/science courses at tertiary (*Cohort quality*).
[Victorian Career Professional, metropolitan]

Students' perceptions and experiences of the difficulty of mathematics and lack of classroom success in lower levels. Students not having the basics from primary level (*Cohort quality*).
[Victorian Career Professional, metropolitan]

In the second open-response question in this section, career professionals provided commentary concerning the potential for teaching practices in the junior years to encourage students to undertake higher-level mathematics. The codings for their responses are summarized in Figure 4.11.

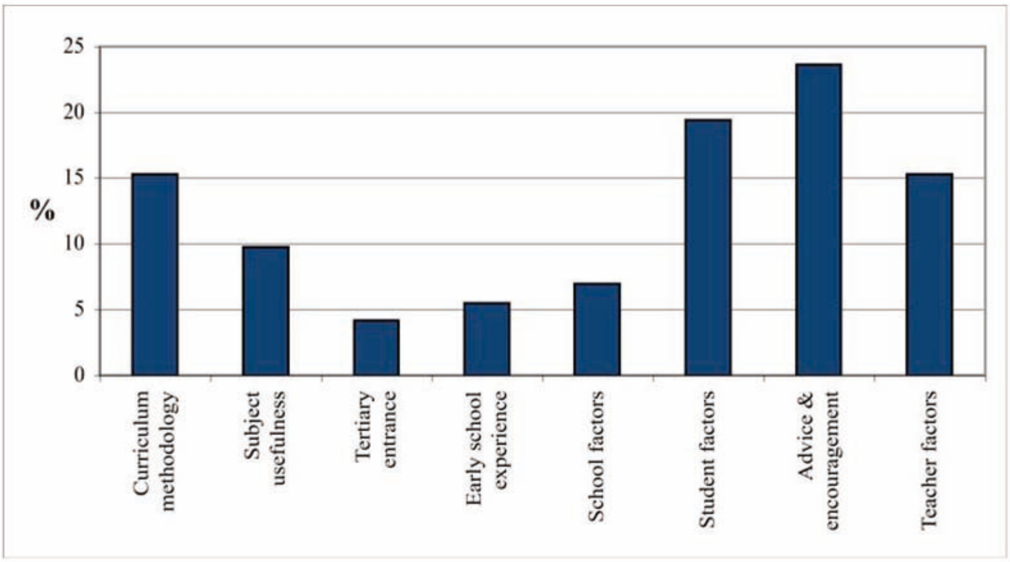

Figure 4.11 General Categories Associated with Comments from Career Professionals about their Perceptions of Aspects of Teaching Practices Influencing Students' Decision Making re Higher-level Mathematics (Question 35)

The majority of comments were coded within the Advice and Encouragement general category and is consistent with responses from a previous question in the survey (Question 31) where career professionals identified advice and encouragement as an important Other influence. There is a clear message that comes through from their comments: do some maths; do the best you can; listen to the advice carefully. There was an additional idea expressed in their comments, and that related to the perceived lack of coordination between the various groups offering advice. Typical comments included:

> Students are encouraged to do at least one maths subject in Year 11 (*Careers counsellors*).
> [Victorian Career Professional, metropolitan]

> Students are encouraged to make an informed decision about career pathways. We always advise a student to consider the limited options when not choosing maths but ultimately the decision rests with the student (*Careers counsellors*).
> [Victorian Career Professional, metropolitan]

> Every Year 10 maths teacher at our school is expected to advise students as to which maths combinations they should study in Year 12 (*Maths teachers*).
> [Victorian Career Professional, regional/rural]

> Before sitting down to select their subjects for the next year all students must talk to their math teacher about their capabilities. They get a form signed and must bring that form with them to the interview. Students are encouraged to do the highest level of maths that they are capable of. If they do not wish to take the recommendation they are able to go with their own choice. At this school maths is seen as being very important but students are advised against it if they are not strong (*Maths teachers*).
> [Victorian Career Professional, regional/rural]

> (Students) with little ability are advised to either reduce their level of maths or to alter their subject selection completely. This is done by teachers and coordinators – not careers staff (*Other staff*).
> [Victorian Career Professional, regional/rural]

> Our advice to students in the light of test and exam results is to always take the highest level that they are capable of; this advice is not always taken (*Reporting*).
> [South Australian Career Professional, metropolitan]

Other general categories that were perceived to be pertinent aspects of teacher practice in the junior years were Student Factors (19% of comments), Teacher Factors (15% of comments), and Curriculum/methodology (15% of comments).

> If they have a negative feeling about the subject or teachers, this is a discouragement for the students (Student Factors).
> [New South Wales Career Professional, metropolitan]

> Often students reach the VCE maths stage without getting the necessary grounding to enable them to build on (Student factors).
> [Victorian Career Professional, metropolitan]

> Depending on the ability level of students; they need to have success at an early age to enjoy maths as a subject (Student Factors).
> [New South Wales Career Professional, metropolitan]

> This subject more than most struggles to survive poor junior experiences, i.e., teacher they don't like, lots of staff changes, poor teaching etc. To some extent the bright capable student will get through – often selected for advanced activities etc. – it's the middle range students who waver – they just lose confidence. It can be an easy option to not rise to the challenge of the more difficult maths (Student Factors).
> [Victorian Career Professional, metropolitan]

> Middle years staff do not teach at senior levels (most never have) and this influences the emphasis they put on processes etc which affects success and whether they continue on with maths (Teacher Factors).
> [Victorian Career Professional, metropolitan]

> … many primary generalist educators have no grounding in algebra – they consider it irrelevant and this links into higher levels of mathematical understanding … so their lack of appreciation of higher levels of maths restricts their appreciation of their curriculum outcomes (Teacher Factors).
> [Victorian Career Professional, regional/rural]

> The (other) restraining factor is that higher-level maths often requires studying two maths – i.e., at Year 11, the recommendation is that if you want to study Specialist at Year 12, you should do General and Methods at Year 11. Then at Year 12, to do Specialist, you must do methods. This can restrict their other subject choices (Curriculum/methodology).
> [Victorian Career Professional, metropolitan]

One interpretation from the comments presented above is the notion that mathematics is struggling to survive as a result of deficiencies in student preparation, a restricted discipline view on the part of teachers, and an over-complicated course structure in the senior years.

4.4.3 Strategies for Increasing Participation in Higher-level Mathematics (Questions 36 and 37)

In the final two survey questions, career professionals provided commentary about encouraging greater student participation in higher-level mathematics. The first question related to the importance of encouraging participation in higher-level mathematics and the second to strategies for encouraging participation. The codings for their responses are presented in Figure 4.12 and Figure 4.13 respectively.

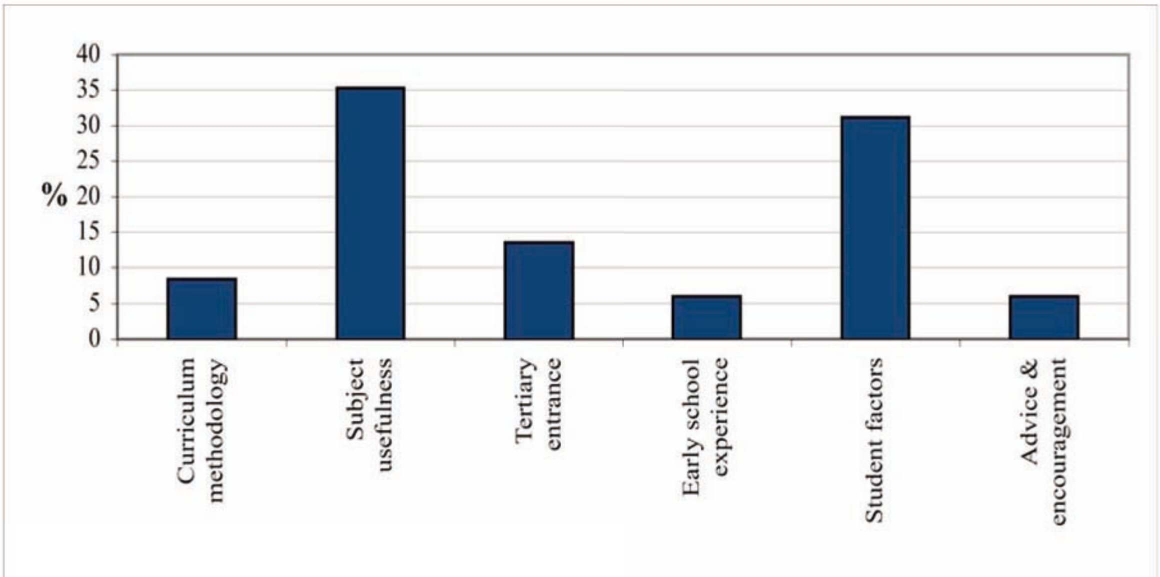

Figure 4.12 General Categories Associated with Comments from Career Professionals about the Importance of Encouraging Greater Participation in Higher-level Mathematics (Question 36)

The majority of comments for Question 36 were coded within the general categories of Subject Usefulness (35% of comments), and Student Factors (31% of comments), indicative of career professionals' priorities in the context of their advisory role to students. One comment that encapsulated the relative importance of these two areas in a blend of aspirations and long-term planing was:

> Of course, it is a bit of a game plan – what's the point of participating in higher-level maths if you are going to perform poorly and not gain access to any university and your aim is to go to university. However, you need to be careful of your advice – if the student wants to be an engineer then the higher maths is more appropriate and if they don't get the ENTER look at a TAFE pathway back up to higher education. At least the higher maths has prepared them for this pathway. My philosophy is to always get students to do the best maths they are capable of – so we have students studying higher maths who want to do a trade – that's great and certainly gives them other options if they change their mind.
> [Victorian Career Professional, metropolitan]

A number of additional comments are included below which elaborated on perceptions of usefulness and address, in part, "what's the point of participating" from the comment above.

> Clearly there are still courses where higher-level mathematics courses are necessary, e.g., Engineering, but students seem to currently look for 'softer' options (Subject Usefulness).
> [South Australian Career Professional, metropolitan]

> If it is needed for a career; most of it is irrelevant to everyday needs. I would rather see the majority of students do simple arithmetic and processes that are necessary to live in this world. Calculators have ruined this (Subject Usefulness).
> [Victorian Career Professional, metropolitan]

Make mathematics more relevant to life skills, e.g., Making money, share markets, super, credit rates, and compound interest (Subject Usefulness).
[Victorian Career Professional, metropolitan]

If they can excel in maths it gives them the confidence to try other higher-level subjects and careers, e.g., sciences, environment, engineering etc., all areas in demand (Subject Usefulness).
[Tasmanian Career Professional, metropolitan]

Higher order problem-solving skills are valuable in society (Subject Usefulness).
[Western Australian Career Professional, metropolitan]

As teachers and career advisors, we must provide the student with the very best chance of attaining their educational goals (Student Factors).
[Western Australian Career Professional, metropolitan]

Students need to take an informed approach to any course choice. Students who enjoy maths should be encouraged to continue as this is a life-giving choice for them (Student Factors).
[New South Wales Career Professional, metropolitan]

Mathematics opens up an increased range of courses and employment opportunities (Student Factors).
[Victorian Career Professional, metropolitan]

The self-esteem of girls and their ability to problem solve need to be addressed so that they see the links to what they can achieve, how they can achieve it and they can believe in their ability to cope with maths (Student Factors).
[Victorian Career Professional, regional/rural]

It is important that students do not limit their options based on a poor maths choice if they are capable of taking on a higher-level mathematics course (Student Factors).
[Victorian Career Professional, regional/rural]

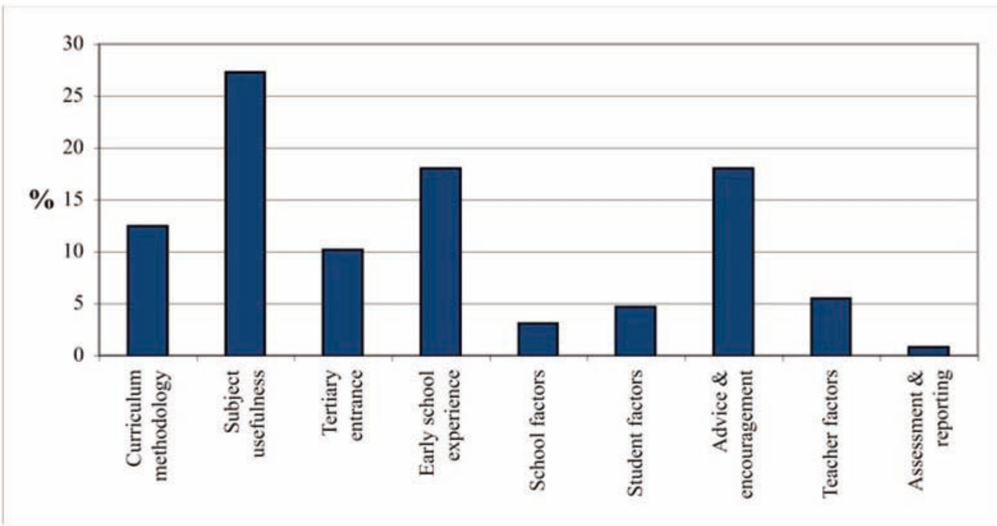

Figure 4.13 General Categories Associated with Comments from Career Professionals about Strategies for Encouraging Greater participation in Higher-level Mathematics (Question 37)

The majority of responses for Question 37 about strategies to encourage greater participation in higher-level mathematics were coded within the general categories of Subject Usefulness (27% of comments), Early School Experience (18% of comments), and Advice and Encouragement (18% of comments). There were as many different strategies suggested as there were comments made, reflecting the richness of the qualitative data obtained. Two comments that linked these three areas were:

> We need to make parents and students aware of the importance of mathematics very early. Discussing this at Yr 9/10 is too late. Students have fallen well behind by that stage. When the family participates rather than fearing maths, the whole support is in place for students.
> [Victorian Career Professional, metropolitan]

> Students need to relate to maths and see its relevance in their future. They also need to enjoy it as a subject in earlier years. Applying maths to real life situations through projects and competitions.
> [Victorian Career Professional, metropolitan]

From the recurring ideas that came through in their comments to both questions, career professionals identified a number of areas for action which, they perceived, would encourage students to undertake higher-level mathematics courses. Their advice in these areas is outlined below, followed by typical comments.

1. Reinforce the long-term benefits of studying higher-level mathematics by highlighting career relevance and skill acquisition;
2. Ensure that students are fully informed of their inherent capabilities to undertake higher-level courses;
3. Recognise that the junior secondary years of schooling are formative ones in the preparation for participation in higher-level mathematics course and ensure that students in these years are taught by inspiring, committed and quality teachers; and
4. Introduce students to career planning early in secondary schooling and consider ways that this can be supplemented by outside organizations through appropriate learning experiences and advice.

> It is important to have differing levels/genres of mathematics that are relevant to the different student needs. Students wishing to go into Psychology or Biology or Social Sciences would benefit from a greater emphasis on statistics (including hypothesis testing) than calculus, for example. Students need to be able to see a benefit or use for the knowledge/content/understanding they would receive from attempting a subject (*Relevance of mathematics for learning or life*).
> [Victorian Career Professional, metropolitan]

> It is also recognised that maths learning is continual throughout life and dependent on the intellectual capability and learning style of the person (*Relevance of mathematics for learning or life*).
> [Victorian Career Professional, regional/rural]

> It is important for students to see the direct link between what they are studying and how it can and will impact on their life – if the link is not evident there is little motivation or reason to study the subject at a higher level (*Relevance of mathematics for learning or life*).
> [Western Australian Career Professional, metropolitan]

(Mathematics) provides students with another way of thinking, another tool with which to approach problems (as opposed to 'scientific' thinking approach or 'humanities' thinking approach) (*Relevance of mathematics for learning or life*).
[South Australian Career Professional, metropolitan]

Students need to take an informed approach to any course choice. Students who enjoy mathematics should be encouraged to continue as this is a life-giving choice for them (*Relevance of mathematics for learning or life*).
[New South Wales Career Professional, metropolitan]

(Mathematics) is the second-most significant literacy for survival – and for some individuals it is their preferred literacy. The basis of advanced skills and higher-order thinking; a required global intelligence … absolutely paramount (*Relevance of mathematics for learning or life*).
[South Australian Career Professional, metropolitan]

Students need to understand the relevance of higher-level maths to the content of courses and occupations (i.e., not just about the ENTER score but about helping the student achieve greater success in what they go on to) (*Relevance of mathematics for learning or life*).
[Victorian Career Professional, metropolitan]

Make students aware of the benefits of maths – either as a stand-alone subject or an adjunct to many tertiary subjects that require some math background; awareness of the personal benefits of some maths skill, e.g., personal finance (*Relevance of mathematics for learning or life*).
[Victorian Career Professional, metropolitan]

Promote higher-level maths as a subject which is taken by both girls and boys and leads to an amazingly wide range of careers, e.g., provide role models to young women. Explore the 'challenge' issue – confronting difficulty is not an indication that you need to immediately withdraw from a subject (*Relevance of mathematics for learning or life*).
[Victorian Career Professional, metropolitan]

Good and 'inspiring' teachers at the junior levels; giving students the skills to learn and become independent learners (*Teaching and learning in junior school*)
[Victorian Career Professional, regional/rural]

The basics need to be clearly understood in the junior levels to give confidence to continue with senior mathematics (*Teaching and learning in junior school*)
[South Australian Career Professional, metropolitan]

So much … depends on the teachers they have encountered over their junior secondary schooling; students require consistent, quality teachers (*Teaching and learning in junior school*)
[Western Australian Career Professional, metropolitan]

Students attitudes to tackling maths at the senior level are shaped from their primary and then junior secondary experiences – important that these are

positive, build confidence, and give reasons for aspiring to pursue maths at a senior level (*Teaching and learning in junior school*)
[Victorian Career Professional, regional/rural]

To do less than you are capable of is a waste of talent, but if you are going to get a higher UAI doing General Maths, of course students take the easy option (*Cohort quality*).
[New South Wales Career Professional, regional/rural]

It is important that students understand the consequences of not pursuing Maths at the highest level of the individual's capability (*Cohort quality*).
[Victorian Career Professional, metropolitan]

If students can excel at maths it gives them confidence to try other higher-level subjects and careers (*Cohort quality*).
[Tasmanian Career Professional, metropolitan]

Students (should be encouraged) if they are interested and capable. They should not be misled into taking on higher-level maths in the false belief that they will automatically get a better ENTER regardless of their level of performance (*Cohort quality*).
[Victorian Career Professional, metropolitan]

Student should be challenged to achieve the highest level possible (*Cohort quality*).
[Victorian Career Professional, regional/rural]

Students need to understand the relevance of higher-level maths to the content of courses and occupations (i.e., not just about the ENTER score but about helping the student achieve greater success in what they go on to) (*Relevance of mathematics for learning or life*).
[Victorian Career Professional, metropolitan]

Career development starting in at least Year 8 so they can appreciate the importance of maths which will open up so many more career options (*Careers advice*)
[Western Australian Career Professional, metropolitan]

Maths teachers need to be more aware of career options and to really push this aspect of choosing maths at a higher level (*Careers advice*)
[New South Wales Career Professional, regional/rural]

A clear statement from tertiary institutions (is needed) about the maths they strongly recommend rather than just writing down minimum prerequisites (*Organisations and community*).
[Victorian Career Professional, regional/rural]

Contextualisation; have students undertake a project in an appropriate industry using mentors from that site. Encourage real-life mathematics at this higher level (*Organisations and community*).
[South Australian Career Professional, regional/rural]

4.5 Summary

Of the four major groupings of 26 questions about influences which were contained in the careers professionals survey, the Individual group was perceived to have the greatest impact on students' decision making based on the number of responses in the 'extremely influential' and 'very influential' categories. In addition to five specific Individual influences, one Source of Advice influence made up this group of influences, namely:

- self-perception of ability;
- interest and liking for higher-level mathematics;
- students' previous achievement in mathematics;
- the perceived difficulty of the higher-level mathematics;
- students' perceptions of the usefulness of higher-level mathematics; and
- mathematics teachers as a source of advice.

There was some variation in the way metropolitan and rural careers professionals viewed these influences with the rural respondents indicating a greater influence for ability, interest, and difficulty. Metropolitan respondents rated previous achievement, and the advice of mathematics teachers as more influential and both groups were in agreement concerning usefulness.

There were two groupings of the remaining specific influences impacting on students' decisions based on 50% or more of the career professionals' responses made in the 'extremely influential' and 'very influential' categories.

Firstly, there were the four influences of:

- students' experience of junior mathematics;
- students' understanding of career paths associated with higher-level mathematics;
- parental aspirations and expectations; and
- the advice of parents and other adults.

Of these influences, metropolitan and rural career professionals rated students' understanding of career paths as a more influential source of advice than did rural respondents.

Secondly, there were the four influences of:

- the perception of teachers and the teaching to be encountered;
- the way tertiary entrance scores are calculated;
- the involvement of mathematics teachers; and
- the advice of friends in the same Year.

Of these influences, there was a noticeable difference in the responses of metropolitan and rural career professionals concerning the perception of teachers, tertiary entrance scores, and the advice of friends in the same Year. Rural respondents rated them substantially higher in each case than did metropolitan respondents.

The remaining twelve influences, for which less than 50% of responses were in the 'extremely influential' and 'very influential' categories, decreased in impact as indicated below.

- the advice of careers advisers;
- the advice contained in job guides;
- the advice of older students or friends;

- the greater appeal of less demanding subjects;
- the advice of other teachers;
- socio-economic background;
- knowledge of pay and conditions;
- the availability of a course;
- gender;
- quality of teaching resources;
- whether the course is composite or distance delivery; and
- timetable considerations.

For all 26 questions, the contribution from the 'moderately influential' categories was least for the Individual influences and then increased for School influences, Other influences and contributed most for the Sources of Advice influences.

Concerning enrolment trends, declines were indicated by more rural career professionals than by metropolitan respondents. They also identified the encouragement provided by teaching practices as more influential than metropolitan respondents.

The qualitative comments provided by career professionals gave additional detail about many of the influences impacting on students' decisions. The important recurring themes concerning higher-level mathematics in these comments can be summarised as:

- needed as a 'stepping stone' to further study;
- 'playing' the tertiary entrance game;
- students' attitudes to workloads associated with higher-level courses;
- the importance of previous learning experiences and the consolidation of understanding from earlier years;
- the nature, purpose and structure of advice offered; and
- unclear messages from universities about pre-requisites.

The scene was set at the beginning of this section with two quotes that conveyed the idea that engagement in higher-level mathematics courses was an outgrowth of previous experiences. From career professionals' perceptions presented in this section, individual (student) influences along with the advice of their mathematics teachers have emerged as having the most impact on decision-making. If these decisions are to be modified in favour of higher-level mathematics courses, career professionals are suggesting that students' achievement in mathematics (at any stage prior to choosing a higher-level course) needs to be consolidated sufficiently to sustain interest, liking and a realistic self-perception of their ability which will then allow them to engage, and persevere, with a difficult senior course. This approach to student achievement mirrors that expressed by teachers. In addition, career professionals perceived that more needs to be done in the area of conveying the usefulness of mathematics. Coupling this perception with the relative importance placed on the advice of mathematics teachers, there are implications for the role of mathematics teachers in helping to resolve the dilemma (expressed at the beginning of this section) concerning the perception that learning experiences which do not consolidate concepts and which do not emphasise personal relevance do little for students' self-perception of ability or their capacity to understand the role mathematics has beyond secondary schooling.

SECTION 5

STUDENT AND FOCUS GROUP DATA

> I'm probably going to end up doing specialist maths next year simply so I can get Uni accreditation.
> [Richard, student during focus group discussions]

> … from my parenting experience if my child comes home with an exercise of fractions to decimals or something like that and he said he was stuck and I said come on we'll have a look at it. "No…… tell me what set to do". It's instant gratification of getting the answer not understanding the way. And I think oh no no no, it's important to them that that's the answer so move on that's what they are used to rather than an understanding of the concepts …
> [Teacher during focus group discussions]

5.1 Introduction

The two comments presented above highlight two important, but seemingly opposing options facing students when choosing higher-level mathematics: is the product important – in this case, university accreditation, or are subject-related processes important – in this case, understanding?

This section comprises four main sub-sections that summarise the material obtained from student surveys and focus group discussions concerning influences related to the study of higher-level mathematics. The first sub-section relates to the student surveys and contains background information about the student group, their perceptions of mathematics, and the influences on their decision to choose higher-level mathematics. These influences are discussed within four groups, namely, individual influences, career and post-secondary usefulness, school influences, and sources of advice. The second and third sub-sections give an overview of the focus group discussions for students and teachers respectively and the comments are discussed within the framework of the general coding grid (see Appendix H). These sub-sections are followed by a summary of the key points from this additional data.

5.2 Student Surveys

5.2.1 Student background

The majority (89%) of students who responded to the survey were from a regional/provincial area and were predominantly drawn from moderately large or large general secondary schools. A high percentage (80%) of students had access to higher-level mathematics courses, but only 37% indicated that they would be doing such a course in 2007. Of this group, the majority (94%) was male. The students were in the 14 to 17 years age range (Year 10 and Year 11) and 68% of the respondents were male.

Many students (60%) considered that they were well informed about how different mathematics courses lead to careers. In terms of their career aspirations, 51% of the students indicated a preference for areas where the course of study leading to their chosen profession involved one or more of the Science, Engineering and Technology fields using the definitions provided in the DEST Audit of SET Skills (DEST, 2005). The professions chosen included those based on the pure sciences, such as, geologist, those based on the practical applications of pure science, such as, engineering or architecture, and those based on the practical application of both science and technology, such as, biomedical engineering or software development. The figure quoted above increased to 58% when the skill base which includes professions, such as, nursing, electrician and dietician are included

A point of interest concerning career choices is the age when students first started thinking seriously about what they wanted to be when they grew up (Question 7). Figure 5.1 presents their responses indicating that the early secondary years of schooling is an important time.

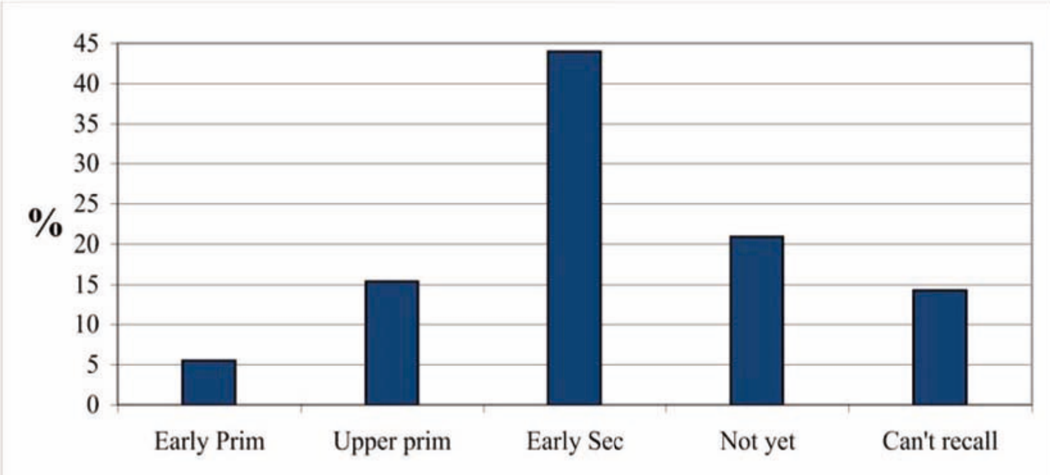

Figure 5.1 Students' Indications of When They Seriously Started Thinking About Future Careers

Some students took the opportunity to provide further information about their careers and their comments reflected a number of considerations, including a tendency to be undecided, wanting to keep options open, and the need for alternative plans. Typical comments included:

> My options are still broad and I am going to view them with an open mind.
>
> … I am constantly changing my mind so if you asked me tomorrow they would more than likely have changed.
>
> If you want a good job, you have to go the city.

5.2.2 Students' views of themselves and mathematics

The Survey contained a group of questions which prompted students to rate their preparation, performance and relative enjoyment of mathematics. There was moderate support for the notion that primary schooling provided good preparation for secondary mathematics with 40% of students in agreement. When asked to self-rate their mathematical ability in comparison with their peers at the beginning of high school, 72% of the students regarded themselves as 'above average', or 'well above average' at the start of secondary schooling. Students were, generally, evenly distributed in their perception of current ability in mathematics with 31% considering that they were better than they were at the start of secondary school, and 32% of the students gave themselves a lower rating compared with the beginning of secondary school. It is of interest that a similar proportion of students (37%) rated themselves the same as at the beginning of secondary school.

5.2.3 Influences on choosing mathematics

The Survey contained 19 questions about influences on students' choice of mathematics subjects for 2007. Regardless of choice, 90% of students indicated that their decisions met with parental approval. This set of questions can be considered within four groups and the discussion which follows is structured to reflect this breakdown.

Group 1: Individual Influences (Survey Questions 18, 19, 20, 23 and 36)

Responses to this group of questions were in line with students' personal experiences or internal motivational aspects related to their time management, interest in, liking of, and ability in mathematics when making decisions. Figure 5.2 provides a breakdown of the responses and indicates the importance of perceived ability.

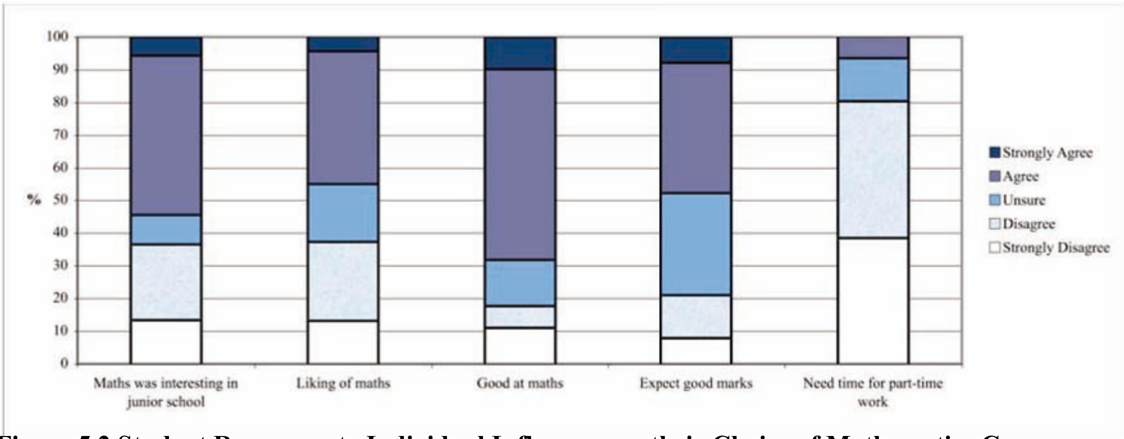

Figure 5.2 Student Responses to Individual Influences on their Choice of Mathematics Courses

Group 2: School Influences (Survey Questions 21, 22 and 35)

This group of questions related to aspects of school organization where decisions about the learning environment are external to students, or where student have an expectation about future learning experiences. These aspects included the allocation of teachers, and timetabling constraints. The responses from students represented in Figure 5.3 indicate that timetabling constraints do not impact on decisions in any substantial manner, and any teacher effect that might attract students to a particular mathematics course appears low.

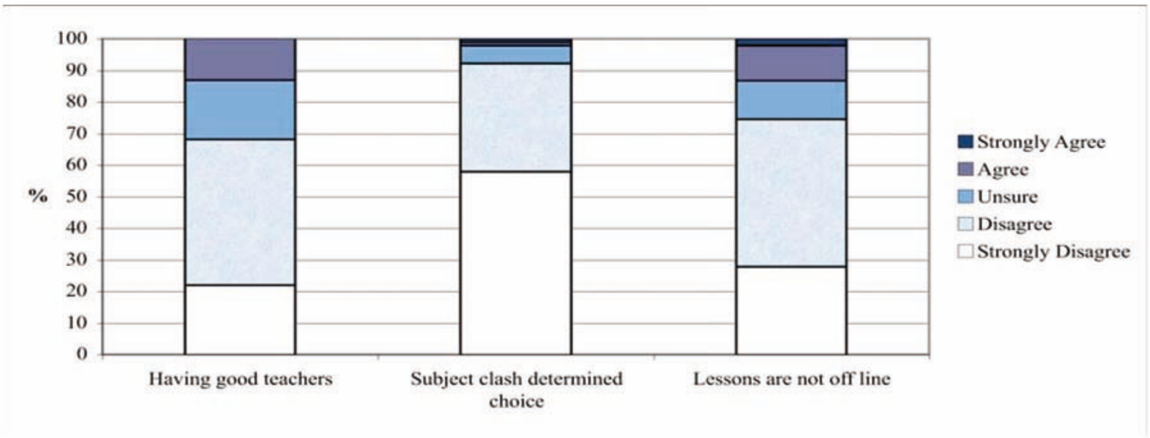

Figure 5.3 Students' Responses to School Influences on their Choice of Mathematics Courses

Group 3: Career and post-secondary Influences (Survey Questions 24, 25 and 26)

These questions also related to students' future learning experiences, but focused more on the transition between school and post-secondary options. They cover the immediate concern of maximizing a Year 12 score, the notion that mathematics is a 'stepping stone' to further study, and the broad life-long learning value of mathematics. Figure 5.4 gives the relative importance of these influences for this group of students with the most important being the notion that mathematics will be good for them in life.

A gender perspective was considered for this group of questions and Figure 5.4 gives a breakdown for each of the questions in terms of total males, males who indicated that they would be undertaking higher-level mathematics in 2007, and total females. Given that there were only two females in this group who indicated that they would be taking higher-level mathematics (mentioned at the beginning of this Section), they are not recorded. The most noticeable gender difference in responses was evident in the stronger preference that males indicated for undertaking higher-level mathematics in order to maximise a tertiary entrance score.

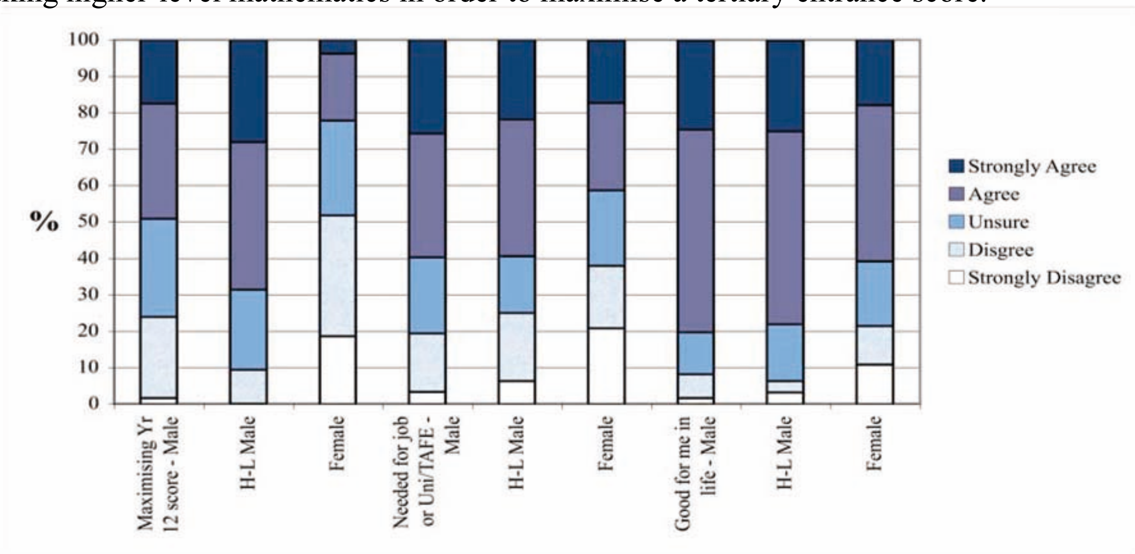

Figure 5.4 Gender Breakdown of Students' Responses to Post-secondary Influences on their Choice of Mathematics Courses

Group 4: Advisory Influences (Survey Questions 27 – 34)

This group of questions provided the opportunity to determine if there were individuals or groups that particularly influenced students' decisions. Figure 5.5 presents the responses and it indicates that students rely on a number of advisory sources, with maths teachers emerging as the preferred source.

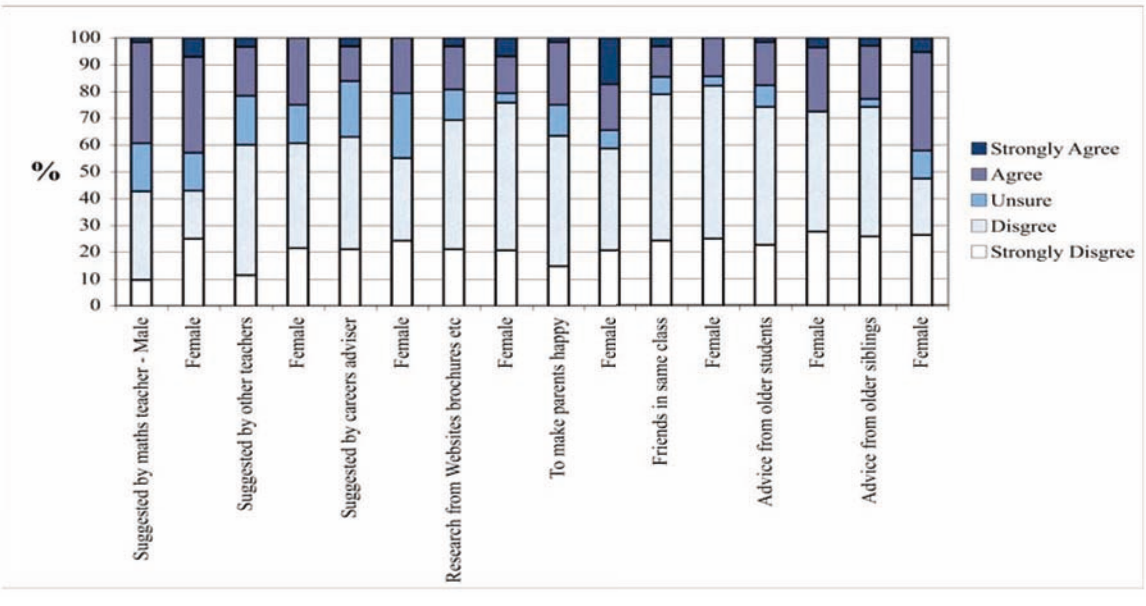

Figure 5.5 Gender Breakdown of Students' Responses to Advisory Influences on their Choice of Mathematics Courses

From a consideration of the student responses in the 'strongly agree' and 'agree' categories presented above, individual and post-secondary considerations accounted for the major influences on students' decisions. Summarizing the most important of these influences, students indicated that positive junior school experiences and confidence in their mathematical ability support their decisions concerning the choice of mathematics course. In addition, the importance of mathematics in the decision process is reinforced through its career and personal relevance beyond secondary school.

The Survey also included two opportunities for students to provide extended comments about the advantages and disadvantages of doing higher-level mathematics courses (Questions 38 and 39) and the content of these comments provided further insight into students' thinking. The comments were analysed for common themes and Table 5.1 provides a breakdown of student responses for each question.

Table 5.1 Students' Views of the Advantages and Disadvantage in Doing Higher-level Mathematics

Question 38: Advantages of Doing Higher-level Mathematics		Question 39: Disadvantages of Doing Higher-level Mathematics	
Theme	%	Theme	%
Greater understanding and knowledge acquired	29.1	Workload and time required	36.1
Career relevance	27.3	Difficulty of the subject	32.4
UAI and university course requirements	19.1	Grades obtained	4.5
Keeps options open	6.4	Previous preparation and support available	3.6
Support associated with higher-level mathematics	2.7	Lack of relevance	3.6
Nil response; not doing higher-level mathematics	15.4	Nil response; not doing higher-level mathematics	19.8

The comments summarized in Table 5.1 reinforced the post-secondary importance of mathematics in leading to further study and as a basis for a specific career. Students also recognized the value of the knowledge and problem-solving skills acquired through doing a 'hard subject' and that the benefits come at a price in terms of effort and time allocation.

5.3 Student Focus Groups

The focus group discussions provided students with the opportunity to discuss openly their reasons for choosing particular mathematics courses. These comments were categorised according to the general coding grid and the discussion which follows is based on its categories (see Appendix H). A total of 330 comments were coded and Table 5.2 provides a summary of the categories referred to during the sessions with the five most frequently discussed highlighted.

Table 5.2 General Coding and Percentages for Comments from Student Focus Groups

General Category	Specific Category	Percentage of comments
Curriculum & Methodology	Structure	4.2
	Image of mathematics	14.8
	Difficulty & competition	0.9
	Pedagogy	0.6
	Rigour & student preparation	0.3
Subject Usefulness	Career relevance	2.1
	Relevance for learning & life	15.5
Tertiary Entrance	Needed	1.8
	Maximizing UAI/TER	0.6
	Internal university requirement	0.9
Early School Experiences	Teaching & learning in junior school	0.6
School Factors	Timetable options	1.2
Student Factors	Aspirations & priorities	13.3
	Attitudes towards school	9.7
	Self-concept	1.5
	Cohort quality	0.9
Advice & Encouragement	Careers counsellors	0.6
	Mathematics teachers	4.5
	Other staff	2.7
	Parents & siblings	9.4
	Peers	3.6
	Reporting	0.3
	Organisations & community	4.8
	Resources	2.4
Assessment & Reporting	Formal testing	1.2
	Assignments & projects	0.6
	Internal assessment	0.6

Two of the specific categories reinforced priorities previously identified by students in their surveys. The first of these concerned the *Relevance for learning in life* from the Subject Usefulness general category and this was perceived by students to be the most important post-secondary influence on their choice of mathematics course. Typical comments which qualified the notion of relevance included:

> I also chose maths because of physics; I was told that if I did Studies Maths it would help me with physics, so I also chose that because of physics.
> [Annabelle]

> I'd like to keep my options open in case something different catches my interest and needs maths … in case half way through my life I want to change careers …
> [Angus]

> … it as a sort of fall back thing in case you find out it's a good thing I did that anyway.
> [Phillip]

> I think maths does help because maybe it doesn't connect in the environment but it connects in here (*points to head*). I think it does have connections but it's not so much with the world maybe it is something with the world but you probably can't really acknowledge it but I think it's somewhere in the head, in the brain.
> [Daniel]

> … you do want to get your subjects that you need like your maths is important, in some high jobs you need that.
> [Rowena]

> … he's got a mate who's an optometrist and his wife's an optometrist and they just rake in the dough and it seemed like the way to go.
> [Nathan]

> … in maths, you're always doing the same thing, even though you've got different problems and stuff but you're just always working with numbers and … when I do a career, I want to have something new everyday rather than the same thing.
> [Natalie]

> … it's a good course to do because it can branch out to a lot of things.
> [Todd]

These comments provided some insight into students' notion of relevance suggesting that learning needs, back-up plans, keeping options open and career aspirations figure prominently.

The second area identified by students as a priority in the survey was that associated with *Parents and siblings* from the Advice and Encouragement general category. Students had indicated, generally, that parents were happy with choices made and their comments provided confirmation of this. The comments also provided an insight into the diversity of parental expectations and the extent of support provided as students make decisions about their choice of mathematics course and careers. In most cases, students recognised that parents wanted what was best for them although in some cases, the support was interpreted as an additional pressure, and the impact ranged from mild to overt. Typical comments included:

> I talk to my parents about University courses and stuff and things like that and they're very open to what I want to do, so they'll help me in my choice as opposed to they'll give me a choice and expect me to follow along and that is really useful because that gives me a very a broad view on what I want to do and I know that I'll have my parents to help me with it if I need it.
> [Phillip]

> I really don't have a choice in what I do because my parents are very well, they're Asian, so they like to tell me what to do … I'm quite stubborn they keep telling me but I just disregard it because there's the old Asian thing which is wearing off a bit now. They want their kids to become doctors, and then if they fail the U maths they go down to pharmacy, or if they don't fail they'll go into dentistry but it's usually doctor.
> [Lucy]

> I consult with my parents with career options and stuff like that and school work and they usually back me up and they encourage me to do what I want to do.
> [Daniel]

> … my mum said to try and she thought I had the knowledge for something bigger, so she said she would like me to do it, which means she was pressuring me into doing it. So um yeah I also did that for my mum because I knew that she would like me to.
> [Annabelle]

> … parents play a major role because you tell them what you want to do and they assist you in what subjects would be good for it.
> [Cassandra]
>
> They kind of want me always to do, they're always pressuring me that I have to do University rather than TAFE, because they know I can do it if I try and they think it's just a waste of like brain power if I do TAFE, knowing that I can do University.
> [Natalie]
>
> My parents don't really mind what I do so it's kind of up to me to choose what I want to do, but they help me with what area of psychology I want to do, like clinical psychology is a lot harder, so I wanted to do forensic psychology.
> [Rowena]

The three other important areas to emerge during discussions were the Curriculum/methodology specific category of *Image of Mathematics* (14.8% of comments), and the Student Factors specific categories of *Aspirations and priorities* (13.3% of comments), and *Attitudes towards school* (9.7% of comments). Some representative comments are provided below from these categories. They present an insight into students' thinking by revealing that they have clearly established personal criteria which inform their decision-making and learning needs. In addition, students' views of themselves and post-secondary options are well defined, as are the strategies they intend to employ to negotiate their respective pathways.

> I don't like maths because it seems too rigid and guarded by a set of rules; there's no basis for thinking, thinking outside the box …
> [Angus]
>
> From what I've been told by Year 12's, Year 12 can be easier if you don't do maths or physics.
> [Richard]
>
> Because at the start I wanted to do maths applications but the (the teacher) kind of talked me into it and I still wasn't sure and then it was kind of like (the teacher) said you're not going to be able to do all this study in your further subjects and so it was pressure a bit; but then I just didn't enjoy it because I didn't really want to do it to start off with.
> [Joanne]
>
> The thing that irks me about maths is my cousin is studying maths in Uni and she's saying stuff we've just learnt she's saying she's never used in real life and that annoys me. The stuff we learn we can't actually apply to real life situations.
> [Phillip]
>
> I want to do both robotics and psychology so I'm trying to figure out a way I can link them.
> [Angus]
>
> For me science was something I was good at and when I was picking my subjects I wanted to have at least three subjects of science and maths and

English. I was thinking which ones did I think would be more important for me in my education and ended up sacrificing physics for biology because it was something I was more interested in – microbiology and pathogens and stuff like that; so I tool two units of biology and got rid of the two units of physics. I had one unit left over and I didn't want to pick up anything like Art of something, so I picked up three lot of maths because it was better than two lots.
[Nathan]

The day when you choose your subjects, yeah there's someone there that tells you. They had all the hard subjects picked out for me and I said I didn't want to do any of them.
[Sarah]

I'm worried if specialist maths is too hard and I'll fail and I won't get into the course I want in University and then I'll have to choose something else that I don't want to be as much. I don't want to do that. It's important.
[Rowena]

I didn't really enjoy maths up to Year 10 and then did Extension Maths and got a bit more interesting and followed on.
[Adam]

It makes me kind of enjoy maths a little bit more knowing that I chose it …
[Joanne]

I'm intending to go onto Year 12 maths, probably Maths Studies and Methods. I don't think I'll go specialist because as much as I want to try maths in Year 12, I don't want to get over my head.
[Phillip]

I've got mates in Year 12 and they've said if you want a stress free Year 12 don't do maths. They said it's annoying.
[Angus]

5.4 Teacher Focus Groups

Teachers responded to two questions during the focus group session. The first of these related to why capable students are not selecting higher levels of mathematics, and the second concerned motivational aspects associated with helping students to excel in mathematics and/or choose higher-level mathematics courses. Their comments were also coded according to the general coding grid used throughout the analysis and Table 5.3 provides a summary of the categories covered during the session.

Table 5.3 General Coding and Percentages for Comments from Teacher Focus Group

General Category	Specific Category	Percentage of comments	
		Question 1	Question 2
Curriculum/Methodology	Image of mathematics	8.6	3.3
	Difficulty & competition	8.6	-
	Pedagogy	-	6.7
	Rigour & student preparation	5.3	6.7
Subject Usefulness	Career relevance	3.4	-
	Relevance for learning & life	10.3	3.3
Tertiary Entrance	Maximizing UAI/TER	5.2	-
	Internal university prerequisite	3.4	-
Early School Experience	Teaching & learning in primary school	3.4	3.3
	Teaching & learning in junior school	1.7	-
School Factors	Timetable options	3.4	-
	Class organization	6.9	26.7
	Reputation	1.7	3.3
	Location	1.7	-
	Resources	-	3.3
Student Factors	Aspirations & priorities	10.3	3.3
	Attitudes to school	13.8	3.3
	Engagement with school	-	3.3
	Cohort quality	5.2	3.3
	Part-time work	-	3.3
Advice & Encouragement	Maths teachers	-	3.3
	Peers	1.7	-
Teacher Factors	Attitudes to the	-	6.7
	profession/teaching	3.4	10
	Preparation & training	-	3.3
	Teacher workload	1.7	-

When coded, the comments of the teachers encompassed a number of the general categories with three categories in particular highlighting important issues for this group. Within the Curriculum/Methodology category, there was recognition that the image of mathematics is undergoing a change in the light of a shift in the student culture – from one which was predictable and measured, to one which is subject to a diverse range of competitive social pressures that are not conducive to sustaining the effort in a difficult course, such as, higher-level mathematics. The cultural shift is summarized in the following teacher comments:

> … students have all these extra pressures compared to what they did 10, 20 years ago. You used to go school, come home and do your homework, watch a bit of TV and go to bed. Then you might have training one afternoon a week or gone outside and played with your brothers and sisters or the friends who lived up the road but a lot of kids aren't coming home till very late at night; families don't eat dinner together not everyone is home at the same time the culture has really changed but we have not changed or looked at other ways where it's still possible to get understanding in mathematics but in a different way of delivering it perhaps that's where we need to look so students can still have their sport have their part time work have their social life and not be disadvantaged because they have not done their homework three nights in a row because they all just catch up with it on Sunday afternoon when they have the time.

> I think part of it is the shifting culture over the last few years and the culture that these students have grown up with is instant gratification with like they have instant messaging, text messaging, everything is instant that's what they have grown up with now ... If you are doing the high levels of maths, there is sequential learning you need to be on the ball, you need to do your work one day so the next day you are ready to go to keep up with it and, because of the whole nature of the change of culture there is a lot more pressures on students like they have social pressures, they have to keep up with their friends, they've got materialistic pressures so they need to go to work so they can have their phone so that they can buy the things that they need to buy to keep up with the other students so … they take the easy option.

In addition to the shifting culture, another important issue raised in the comments above was the notion that the way mathematics is taught needs to be responsive to the shift. As well as recognizing the social pressures students currently face, teachers' comments also revealed some generalized perceptions of how students function when faced with the option of doing higher-level mathematics.

Essentially, the time and effort commitment does not encourage otherwise capable students to take up higher-level courses. Rather than try to sustain the challenge of a rigorous course with associated peer pressure and class disruptions resulting from commitments in other subjects, students would rather take an easier option or take on one of the many – often glamorous, VET courses which are now available for students as part of the broad range of subjects on offer. The VET courses also have the added advantage of providing easy access to a career and an earning capacity which reinforce the notion that a mathematics course can be done later. The idea that you can do an easy option for the maximum return is mirrored in students' approach to tertiary entrance scores. Teachers see many students doing the minimum, both in terms of course difficulty and necessary units, to obtain the most rewarding Year 12 score. On the positive side, however, teachers see that the development of productive relationships with students can overcome many of the hurdles of the more rigorous courses. Some representative comments which contributed to such a view of students included:

> … they think if there is no need to do it why do it there are other things to do.. It seems to me that they are not prepared to commit the time. It's just not there...their social life and the other things they want.. The other thing is there has been a big growth in the VET courses as that has been a means to a career path setting them up to do hospitality and all those retail courses and they are not only being taken by the students of lower ability but also by students who have high ability. They get given this as a career path through the HSC then they can go on to TAFE and then to University. These paths have given students the idea that if they want to do maths they can do it later …

> …they don't have time to put that therefore they are choosing what looks better on their HSC so they do General Maths and get a higher mark that looks good and requires a lot less effort from the higher achieving kids that's one thing I've found and there are a lot of kids are dropping in Year 12 from 2 unit, maths to General because they know they can get 95 without too much work whereas to get 95 at 2 unit requires a lot more effort from them …

> … the pressure within the school to compete with other schools to keep our top kids so we can get our results up higher. That pressure of us competing against the independent schools causes us to change our focus away from academic

> excellence. We are now pushing areas we succeeded in last year, drama and things like that. Our top kids are selecting that as "my letdown subject… I don't have to think too hard in that one". Our top kids are deciding I won't do that then they are dragged out of class for variations of routine and they miss maths classes and start going poor in maths and they think "I may as well drop it now" so all of the top kids are being dragged down and all of a sudden their results have plummeted
>
> …Why do students choose higher levels? ... They have obviously experienced earlier successes … developed positive relationships with their teachers, probably need to look at developing these positive relationships with these kids …

5.5 Summary

From the students' surveys and focus group discussions, individual and post-secondary considerations accounted for most of the influences on their decisions. The most important of these included the increased levels of knowledge and understanding that studying mathematics brings, and the notions that positive junior school experiences and acquiring confidence in their ability will support their choices. In addition, the importance of mathematics was reinforced through its career and personal relevance beyond secondary school. Nevertheless, students also recognise that mathematics is a hard subject and that the knowledge and skills acquired come at a price in terms of effort and time allocation. Students' comments concerning parental advice provided some clarification of this issue. Generally, students recognised that parents wanted what was best for them, and that support could be directive or based on discourse.

In their focus group discussions, teachers' comments 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 to maintain the effort required to undertake a 'hard' course, such as higher-level mathematics. In responding to this, 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 managing the change in student culture.

SECTION 6

A COMPARISON OF TEACHER AND CAREER PROFESSIONAL DATA

6.1 Introduction

The survey data from teachers and career professionals was described in Section 3 and Section 4 respectively and a number of important themes emerged from the responses and extended comments. A summary of the key findings from these two groups is restated here as background to this section which provides the results of an analysis of the survey questions which were answered by both teachers and career professionals. The analysis was carried out in order to identify significant item effects and interactions.

Based on the number of survey responses in the ‘extremely influential’ and ‘very influential’ categories, teachers perceived that four influences from the Individual group of influences had the greatest impact on students’ decision making. These were: self-perception of ability; interest and liking for higher-level mathematics; the perceived difficulty of higher-level mathematics; and, students’ previous achievement in mathematics. Three other groupings of influences were identified and these were:

1. The greater appeal of less demanding subjects; the perceived usefulness of higher-level mathematics.
2. Parental aspirations and expectations; the advice of students’ mathematics teachers; students’ experience of junior mathematics; students’ understanding of career paths.
3. The advice of parents; the advice of friends in the same Year; the perception of teachers and teaching to be encountered; how tertiary entrance scores are calculated.

Teachers did not generally consider that the number of students undertaking higher-level mathematics had increased over the past five years and they did not consider that current teaching practices were particularly influential in encouraging students to enrol in higher-level mathematics.

Based on the number of survey responses in the ‘extremely influential’ and ‘very influential’ categories, career professionals perceived that five influences from the Individual group and one from the Sources of Advice group had the greatest impact on students’ decision making. These were: self-perception of ability; interest and liking for higher-level mathematics; students’ previous achievement in mathematics; the perceived difficulty of higher-level mathematics; students’ perceptions of the usefulness of higher-level mathematics; and mathematics teachers as a source of advice. Two other groupings of influences were identified and these were:

1. Students’ experience of junior mathematics; students’ understanding of career paths associated with higher-level mathematics; parental aspirations and expectations; the advice of parents and other adults.
2. The perception of teachers and the teaching to be encountered; the way tertiary entrance scores are calculated; the involvement of mathematics teachers; the advice of friends in the same Year.

Career professionals in rural and regional areas noted declines in the number of students undertaking higher-level mathematics over the past five years. Rural and regional career professionals also identified that current teaching practices were more likely to be influential in encouraging students to enrol in higher-level mathematics than did the metropolitan group.

For the analysis, items were grouped by groups of influences, as per the structure of each survey: school factors, sources of advice, individual factors, and other factors. Analyses dealt with each item group in turn. Each group of influences was analysed using a 2 (survey group: math teachers/career professionals) by 2 (location: rural & regional/metropolitan) by group of items MANOVA design, where groups of items defined the repeated measures or within subjects factor and survey group and location defined the between-groups factors.

Interpretation focused only on the multivariate tests of the repeated measures effects (items main effect; survey group by items interaction; location by items interaction; and survey group by location by items interaction) as these concerned differences between and among the items themselves. The between groups effects (survey group and location main effects and the survey group by location interaction) were not considered meaningful to the analysis because of averaging effects. None of the repeated measures analyses showed a significant 3-way interaction between survey group, location and items. The two variables comprising enrolment trends were analysed separately using univariate Survey Group by Location factorial between-groups ANOVAs.

6.2 An Analysis of the Perceptions of Teachers and Career Professionals

6.2.1 School Influences

Table 6.1 displays the outcomes for the multivariate tests of effects related to School Items. The table shows three significant effects related to School Items: the School Items main effect, the Survey Group by School Items interaction and the Location by School Items interaction. The 3-way interaction was not significant.

Table 6.1 Multivariate Tests

Effect	Wilks' Lambda	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
School Items	*.279*	*255.602(a)*	*5.000*	*494.000*	*.000*	*.721*
School Items * Survey Group	*.945*	*5.743(a)*	*5.000*	*494.000*	*.000*	*.055*
School Items * Location	*.974*	*2.646(a)*	*5.000*	*494.000*	*.023*	*.026*
School Items * Survey Group * Location	.994	.615(a)	5.000	494.000	.688	.006

Main Effect of School Items

The dominant significant effect was the main effect ($p < .001$), accounting for 72.1% of the variance in item scores. Table 6.2 shows the means for the School Items main effect. Basically, this effect shows how the six School items differ, overall, from each other. Using the 95% confidence intervals, we can draw inferences as to which items are significantly different from which other items; items will differ if their confidence intervals do not overlap. Thus, the 'Greater Appeal of Less Demanding Subjects' and 'Experience of Junior Secondary Mathematics' items were perceived as significantly more influential on students' decision making than the remaining four items, but did not differ in level of influence from each other. The 'Taking the Course in a Composite Class' item was significantly less influential than any other item. The remaining three items did not significantly differ in their level of influence. Note that the significant interactions may impose some qualifications on these overall item trends.

Table 6.2 School Items Main Effect Means

School Items	Mean	Std. Error	95% Confidence Interval Lower Bound	Upper Bound
Timetable Restrictions	1.071	.058	.957	1.185
Availability of Courses	1.195	.064	1.069	1.321
Composite Class	.827	.065	.698	.956
Less Demanding Subjects	2.632	.053	2.528	2.735
Experience of Junior Secondary Maths	2.840	.048	2.746	2.935
Quality of Teaching Resources	1.346	.055	1.238	1.453

Interaction of Survey Group and School Items

Table 6.1 showed that the Survey Group by School Items interaction was significant ($p < .001$) and explained 5.5% of the variance in item scores. Table 6.3 reports the means for this interaction along with 95% confidence intervals around each mean. The overlap or non-overlap of selected confidence intervals can be used to draw some inferences about item differences between the two survey groups.

Table 6.3 Survey Group by School Items Interaction Means

Survey Group	School Items	Mean	Std. Error	95% Confidence Interval Lower Bound	Upper Bound
Teachers	Timetable Restrictions	1.219	.054	1.112	1.325
	Availability of Courses	1.201	.060	1.084	1.319
	Composite Class	.952	.061	.832	1.072
	Less Demanding Subjects	2.863	.049	2.766	2.959
	Experience of Junior Secondary Maths	2.751	.045	2.663	2.839
	Quality Teaching Resources	1.421	.051	1.321	1.521
Career Professionals	Timetable Restrictions	.924	.103	.722	1.125
	Availability of Courses	1.189	.114	.966	1.413
	Composite Class	.702	.116	.474	.929
	Less Demanding Subjects	2.401	.093	2.218	2.584
	Experience of Junior Secondary Maths	2.929	.085	2.762	3.096
	Quality Teaching Resources	1.271	.097	1.080	1.461

Figure 6.1 plots the interaction, so the trends become visually obvious. In this Figure, and others which follow, data points are connected to assist with the visual tracking of the separate Survey Group means.

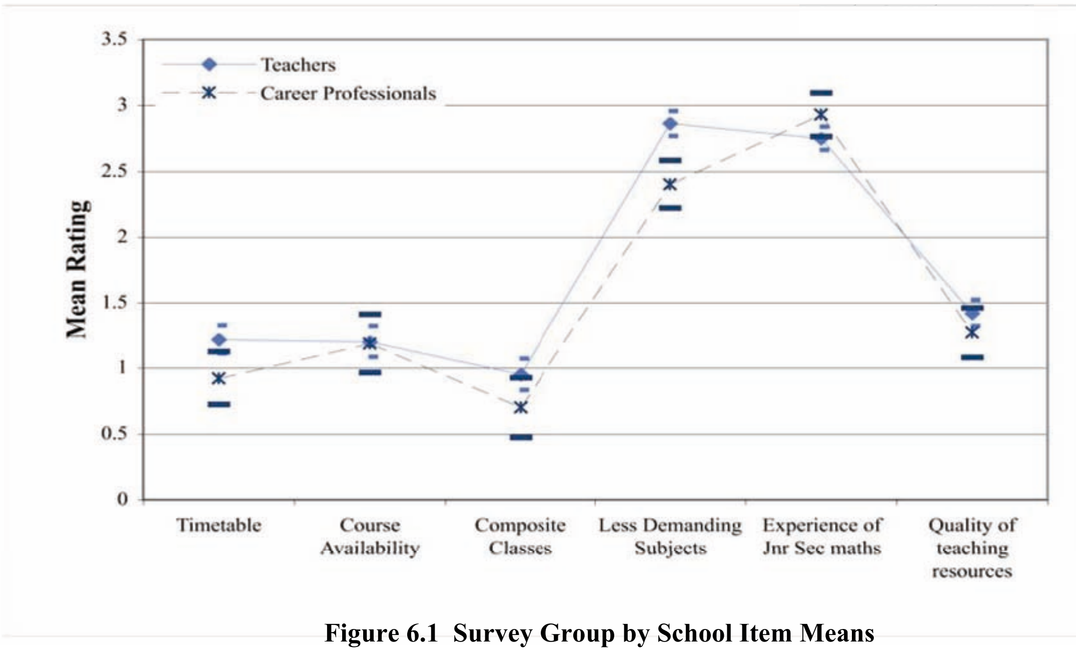

Figure 6.1 Survey Group by School Item Means

From Figure 6.1, it was clear that the only School Items where meaningful survey group differences appeared to exist were: 'Timetable Restrictions', 'Taking the Course in a Composite Class' and 'The Appeal of Less Demanding Subjects'. However, of these visual differences between the two survey groups, only that for 'The Appeal of Less Demanding Subjects' can be considered significant. The remaining two items were close (their confidence intervals just barely overlap) but cannot be considered to be significantly different between the two survey groups. Thus, Mathematics Teachers perceived that students' decision making was significantly more strongly influenced by 'The Appeal of Less Demanding Subjects' compared to Career Professionals, but only marginally more strongly influenced by the 'Timetable Restrictions' and 'Taking the Course as Composite Class' items.

Interaction of Location and School Items

Table 6.1 also showed that the Location by School Items interaction was significant ($p = .023$) and explained 2.6 % of the variance in item scores. Table 6.4 reports the means for this interaction along with 95% confidence intervals around each mean. The overlap or non-overlap of selected confidence intervals can be used to draw some inferences about item differences between the two locations.

Table 6.4 Location by School Items Interaction Means

Location	School Items	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Regional/ rural	Timetable Restrictions	1.097	.094	.912	1.282
	Availability of Courses	1.216	.104	1.011	1.421
	Composite Class	1.045	.106	.836	1.254
	Less Demanding Subjects	2.662	.085	2.494	2.830
	Experience of Junior Secondary Maths	2.837	.078	2.684	2.991
	Quality Teaching Resources	1.382	.089	1.207	1.556
Metropolitan	Timetable Restrictions	1.045	.068	.912	1.178
	Availability of Courses	1.174	.075	1.027	1.322
	Composite Class	.609	.076	.458	.759
	Less Demanding Subjects	2.601	.061	2.481	2.722
	Experience of Junior Secondary Maths	2.843	.056	2.733	2.953
	Quality Teaching Resources	1.310	.064	1.185	1.436

Figure 6.2 plots the interaction, so the trends become visually obvious. From Figure 6.2, it was clear that the only School Item where a meaningful location difference appeared to exist was 'Taking the Course as a Composite Class' and this difference may be considered significant. Thus, respondents in regional and rural areas perceived that students' decision making was significantly more strongly influenced by the 'Taking the Course as a Composite Class' item compared to respondents from metropolitan locations.

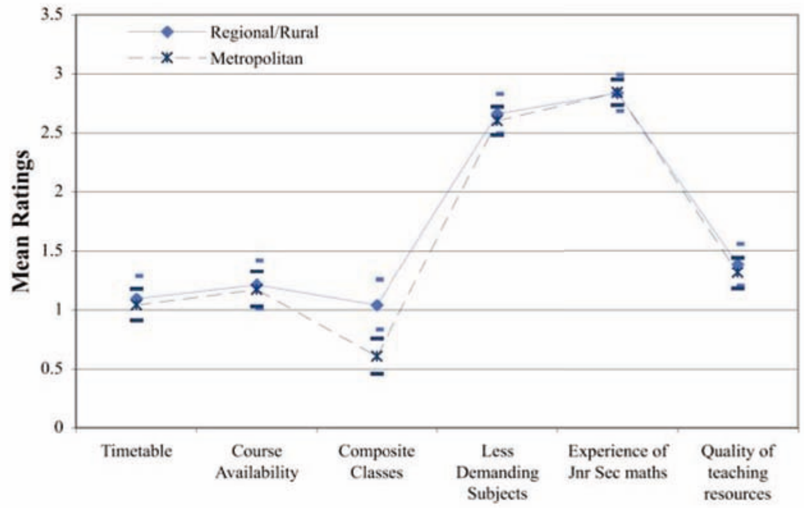

Figure 6.2 Location by School Item Means

Summary

From the analysis of survey responses to the six school-related questions, two influences were identified as impacting significantly on students' decision making. These were the greater appeal of less demanding subjects and students' experience of junior secondary mathematics. Although there were a number of meaningful differences in the responses of teachers and career professionals to the questions about school influences, only one was found to be significant and that related to the appeal of less demanding subjects, where teachers perceived it to be more influential than did career professionals. One significant difference was identified in responses when the location was considered and this related to the likelihood of taking higher-level courses in a composite class and/or by distance education. Regional and rural respondents perceived this to be more influential on students' decision making than did metropolitan respondents.

6.2.2 Sources of Advice

Table 6.5 displays the outcomes for the multivariate tests of effects related to Sources of Advice. The Table shows three significant effects related to Sources of Advice: the Sources of Advice main effect, the Survey Group by Sources of Advice interaction and the Location by Sources of Advice interaction. The 3-way interaction was not significant.

Table 6.5 Multivariate Tests

Effect	Wilks' Lambda	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Sources of Advice	*.566*	*61.004*	*6.000*	*477.000*	*.000*	*.434*
Sources of Advice * Survey Group	*.967*	*2.693*	*6.000*	*477.000*	*.014*	*.033*
Sources of Advice * Location	*.974*	*2.149*	*6.000*	*477.000*	*.047*	*.026*
Sources of Advice * Survey Group * Location	.990	.779	6.000	477.000	.587	.010

Main Effect of School Items

The dominant significant effect was the main effect ($p < .001$), accounting for 43.4% of the variance in item scores. Table 6.6 shows the means for the Sources of Advice main effect. This effect shows how the seven Source of Advice differ, overall, from each other. Using the 95% confidence intervals, we can conclude that 'Mathematics Teachers' were perceived as significantly more influential on students' decision making than the remaining six items. 'Other Teachers' were perceived as significantly less influential on students' decision making than each of the other sources of advice. 'Parents and Other Adults' were perceived as significantly more influential on students' decision making than either 'Older Students and Friends/Siblings', 'Career Advisers' or 'Job Guides'. 'Friends in the Year Level' was significantly more influential on students' decision making than 'Job Guides'. Note that the significant interactions may impose some qualifications on these overall item trends.

Table 6.6 Sources of Advice Main Effect Means

Source of Advice	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Career Advisers	2.456	.048	2.361	2.550
Job Guides	2.349	.046	2.258	2.440
Maths Teachers	2.956	.044	2.869	3.042
Other Teachers	2.107	.045	2.017	2.196
Friends in Year Level	2.580	.046	2.489	2.671
Older Students, Friends, Siblings	2.441	.045	2.353	2.528
Parents, Other Adults	2.728	.040	2.650	2.807

Interaction of Survey Group and Sources of Advice

Table 6.5 showed that the Survey Group by Sources of Advice interaction was significant ($p = .014$) and explained 3.3% of the variance in item scores. Table 6.7 reports the means for this interaction along with 95% confidence intervals around each mean. The overlap or non-overlap of selected confidence intervals can be used to draw some inferences about item differences between the two survey groups.

Table 6.7 Survey Group x Sources of Advice Interaction Means

Survey Group	Source of Advice	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Teachers	Career Advisers	2.361	.046	2.272	2.451
	Job Guides	2.250	.044	2.164	2.336
	Maths Teachers	2.782	.042	2.700	2.864
	Other Teachers	2.088	.043	2.003	2.172
	Friends in Year Level	2.578	.044	2.492	2.665
	Older Students, Friends	2.462	.042	2.379	2.545
	Parents and Other Adults	2.618	.038	2.544	2.693
Career Professionals	Career Advisers	2.550	.085	2.384	2.717
	Job Guides	2.448	.082	2.287	2.608
	Maths Teachers	3.129	.078	2.976	3.281
	Other Teachers	2.126	.080	1.969	2.283
	Friends in Year Level	2.581	.082	2.421	2.742
	Older Students, Friends	2.419	.079	2.264	2.573
	Parents and Other Adults	2.838	.070	2.699	2.976

Figure 6.3 plots the interaction, so the trends become visually obvious. From Figure 6.3, it was clear that the only Sources of Advice where meaningful survey group differences appeared to exist were: ‘Careers Advisers’, ‘Job Guides’, ‘Mathematics Teachers’ and ‘Parents and Other Adults’. However, of these visual differences between the two survey groups, only those for ‘Mathematics Teachers’ and ‘Parents and Other Adults’ can be considered significant. The remaining three sources of advice (‘Other Teachers’, ‘Friends in the Year Level’ and ‘Older Students, Friends, Siblings’) cannot be considered to be significantly different between the two survey groups. Thus, Career professionals perceived that students’ decision making was significantly more strongly influenced by ‘Mathematics Teachers’ and ‘Parents and Other Adults’ compared to Math Teachers, but only marginally more strongly influenced by ‘Careers Advisers’ and ‘Job Guides’.

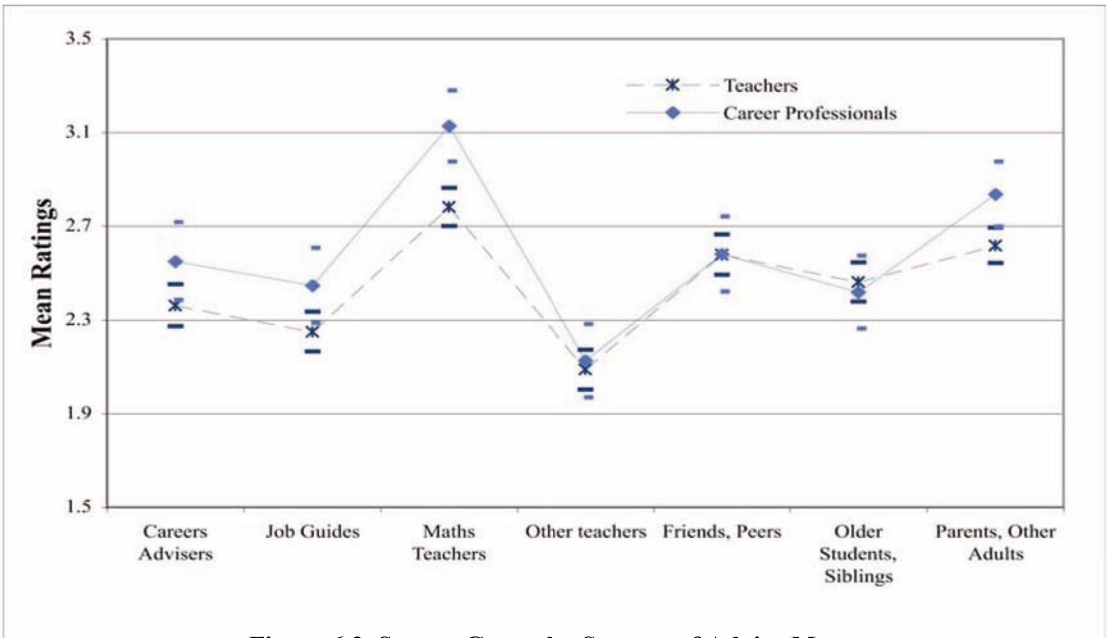

Figure 6.3 Survey Group by Sources of Advice Means

Interaction of Location and Sources of Advice

Table 6.5 also showed that the Location by Sources of Advice interaction was just significant (p = .047) and explained 2.6 % of the variance in item scores. Table 6.8 reports the means for this interaction along with 95% confidence intervals around each mean. The overlap or non-overlap of selected confidence intervals can be used to draw some inferences about item differences between the two locations.

Table 6.8 Location by Sources of Advice Interaction Means

Location	Source of Advice	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Regional/ rural	Career Advisers	2.490	.078	2.337	2.643
	Job Guides	2.417	.075	2.269	2.565
	Maths Teachers	2.942	.071	2.801	3.082
	Other Teachers	2.212	.074	2.067	2.357
	Friends in Year Level	2.588	.075	2.440	2.736
	Older Students, Friends	2.432	.072	2.290	2.575
	Parents and Other Adults	2.663	.065	2.536	2.791
Metropolitan	Career Advisers	2.422	.056	2.311	2.532
	Job Guides	2.281	.054	2.174	2.387
	Maths Teachers	2.969	.052	2.868	3.071
	Other Teachers	2.001	.053	1.897	2.106
	Friends in Year Level	2.572	.054	2.465	2.678
	Older Students, Friends	2.449	.052	2.346	2.552
	Parents and Other Adults	2.793	.047	2.701	2.885

Figure 6.4 plots the interaction, so the trends become visually obvious. From Figure 6.4, it was clear that the only Sources of Advice where a meaningful location differences appeared to exist were ‘Careers Advisers’, ‘Job Guides’, ‘Other Teachers’ and ‘Parents and Other Adults’. None of these differences may be considered significant, but those for ‘Parents and Other Adults’ and ‘Other Teachers’ may be considered as marginal. The remaining three differences are not significant. Thus, respondents in regional and rural areas perceived that students’ decision making was marginally more strongly influenced by ‘Other Teachers’ but marginally less strongly influenced by ‘Parents and Other Adults’ compared to respondents from metropolitan locations.

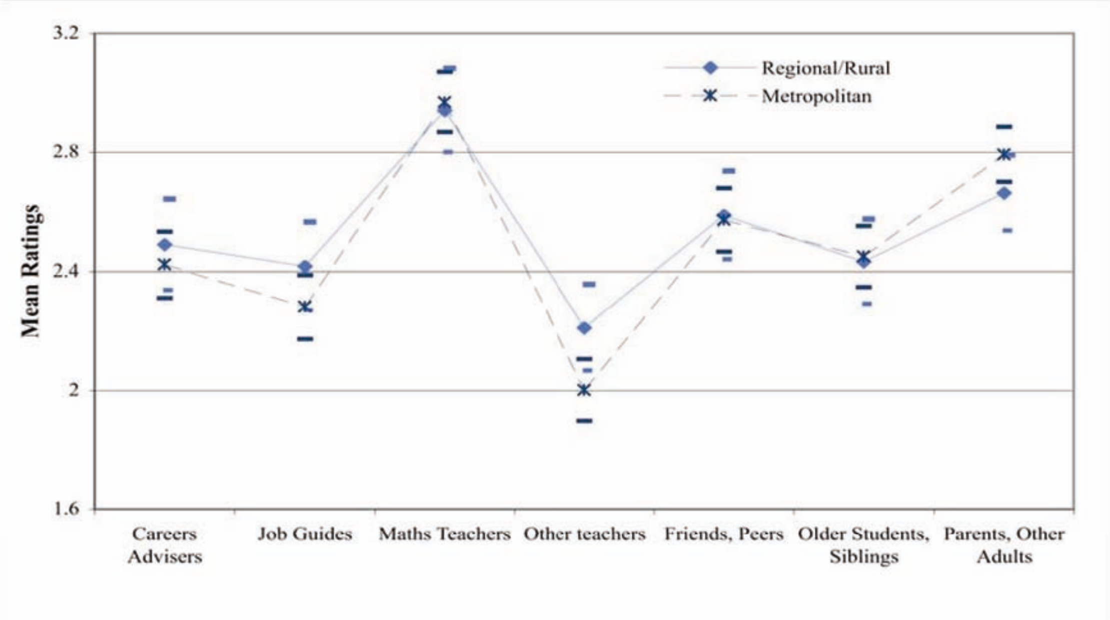

Figure 6.4 Location by Sources of Advice Means

Summary

From the analysis of survey responses to the seven sources of advice-related questions, two influences were identified as being significant for students' decision making. The first of these was identified as the advice of mathematics teachers which was perceived to be more influential than all other influences. The second related to the advice of other teachers which was perceived to be significantly less influential than all other sources of advice. Although there were a number of meaningful differences in the responses of teachers and career professionals to the questions about sources of advice, two were found to be significant. These related to the advice of students' mathematics teachers, and parents and other adults, where career professionals perceived these two sources to be more influential than did teachers. Differences in responses were marginal when the location was considered. Two such differences were identified and respondents in regional and rural locations perceived the advice of other teachers to be marginally more influential, and the advice of parents and other adults to be marginally less influential, than did metropolitan respondents.

6.2.3 Individual Influences

Table 6.9 displays the outcomes for the multivariate tests of effects related to Individual Factors. The table shows two significant effects related to Individual Factors: the Individual Factors main effect and the Location by Individual Factors interaction. The Survey Group by Individual Factors interaction and the 3-way interaction were not significant.

Table 6.9 Multivariate Tests

Effect	Wilks' Lambda	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Individual Factors	*.731*	*36.103*	*5.000*	*490.000*	*.000*	*.269*
Individual Factors * Survey Group	.992	.794	5.000	490.000	.554	.008
Individual Factors * Location	*.973*	*2.679*	*5.000*	*490.000*	*.021*	*.027*
Individual Factors * Survey Group * Location	.985	1.467	5.000	490.000	.199	.015

Main Effect of Individual Factors

The dominant significant effect was the main effect ($p < .001$), accounting for 26.9% of the variance in item scores. Table 6.10 shows the means for the Individual Factors main effect. This effect shows how the six Individual Factors differ, overall, from each other. Using the 95% confidence intervals, we can conclude that 'Perceived Ability at Maths' was perceived as significantly more influential on students' decision making than either 'Usefulness of Maths' or 'Perceptions of Teachers', but not significantly different from either 'Interest in Maths' or 'Perceived Difficulty of Maths'. 'Perceptions of Teachers' was perceived as significantly less influential on students' decision making than any of the other Individual Factors. 'Usefulness of Maths' was perceived as significantly less influential on students' decision making than either 'Previous Maths Achievement' or 'Perceived Difficulty of Maths'. Note that the significant interactions may impose some qualifications on these overall item trends.

Table 6.10 Individual Factors Main Effect Means

Individual Factors	Mean	Std. Error	95% Confidence Interval Lower Bound	Upper Bound
Perceived Ability at Maths	3.278	.036	3.207	3.350
Interest in Maths	3.169	.036	3.097	3.240
Perceived Difficulty of Maths	3.276	.040	3.198	3.355
Previous Maths Achievement	3.223	.038	3.147	3.298
Usefulness of Maths	3.041	.043	2.956	3.125
Perceptions of Teachers	2.609	.048	2.514	2.704

Interaction of Location and Individual Factors:

Table 6.9 also showed that the Location by Individual Factors interaction was just significant ($p = .021$) and explained 2.7 % of the variance in item scores. Table 6.11 reports the means for this interaction along with 95% confidence intervals around each mean.

Table 6.11 Location by Individual Factors Interaction Means

Location	Individual Factors	Mean	Std. Error	95% Confidence Interval Lower Bound	Upper Bound
Regional/ rural	Perceived Ability at Maths	3.370	.059	3.254	3.486
	Interest in Maths	3.188	.059	3.073	3.304
	Perceived Difficulty of Maths	3.396	.065	3.269	3.523
	Previous Maths Achievement	3.282	.062	3.160	3.404
	Usefulness of Maths	3.029	.070	2.892	3.166
	Perceptions of Teachers	2.624	.079	2.470	2.778
Metropolitan	Perceived Ability at Maths	3.186	.043	3.102	3.270
	Interest in Maths	3.149	.042	3.066	3.233
	Perceived Difficulty of Maths	3.157	.047	3.065	3.249
	Previous Maths Achievement	3.163	.045	3.075	3.252
	Usefulness of Maths	3.052	.050	2.953	3.151
	Perceptions of Teachers	2.594	.057	2.482	2.706

Figure 6.5 plots the interaction, so the trends become visually obvious. From Figure 6.5, it was clear that the Individual Factors where a meaningful location differences appeared to exist were ‘Perceived Ability at Maths’, ‘Difficulty of Maths’ and ‘Previous Maths Achievement’. Using the 95% confidence intervals, the differences between locations with respect to ‘Perceived Difficulty of Maths’ may be considered significant, but those for ‘Perceived Ability at Maths’ and ‘Previous Maths Achievement’ must be considered marginal at best. The remaining three differences are not significant. Thus, respondents in regional and rural areas perceived that students’ decision making was significantly more strongly influenced by ‘Perceived Difficulty of Maths’ and marginally more strongly influenced by ‘Perceived Ability at Maths’ and ‘Previous Maths Achievement’ compared to respondents from metropolitan locations.

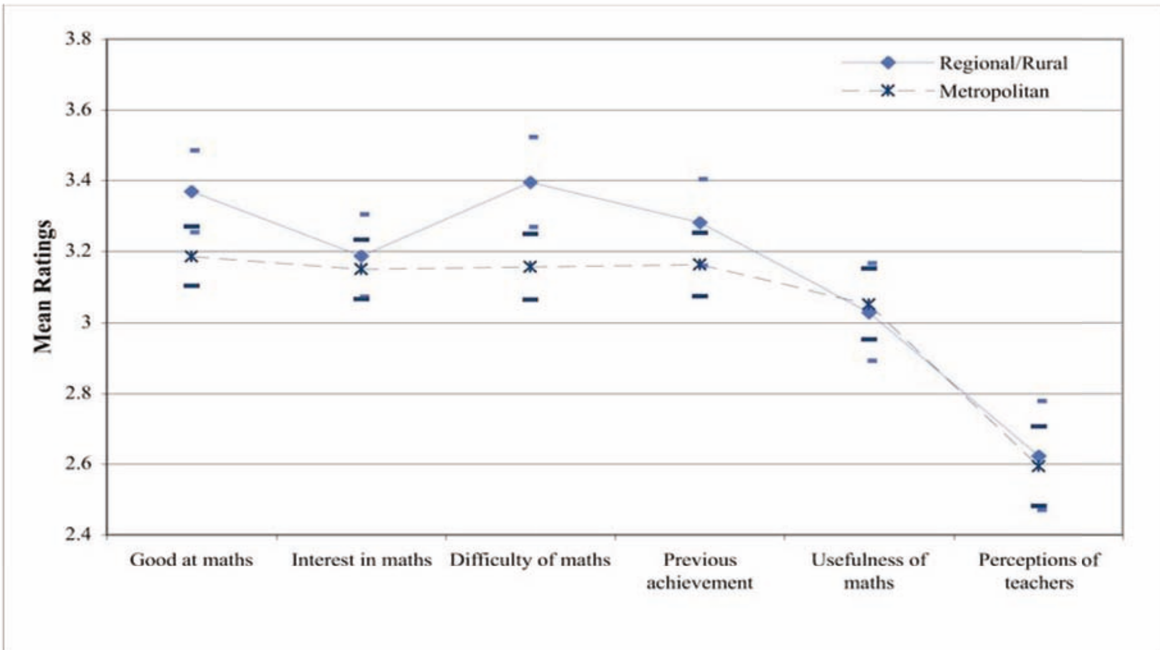

Figure 6.5 Location by Individual Influences Means

Summary

From the analysis of survey responses to the six individual-related questions, two influences were identified as being significant for students' decision making. The first of these was identified as students' perception of their ability in mathematics. This was more influential than the usefulness of mathematics or perceptions of the teachers and teaching that students thought they would be encountering. The second related to the perceptions of teachers which was perceived to be significantly less influential than all other individual influences. There were no significant differences identified for the two survey groups on this set of influences. One significant difference was identified in responses when the location was considered and this related to the perceived difficulty of higher-level courses. Regional and rural respondents perceived this to be more influential on students' decision making than did metropolitan respondents. Regional and rural respondents perceived two other influences as marginally significant and these were perceived ability at mathematics and previous achievement in mathematics.

6.2.4 Other Influences

Table 6.12 displays the outcomes for the multivariate tests of effects related to Other Influences. The table shows two significant effects related to Other Influences: the Other Influences main effect and the Survey Group by Other Influences interaction. The Location by Other Influences interaction and the 3-way interaction were not significant.

Table 6.12 Multivariate Tests

Effect	Wilks' Lambda	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Other Influences	*.387*	*127.783*	*6.000*	*484.000*	*.000*	*.613*
Other Influences * Survey Group	*.973*	*2.229*	*6.000*	*484.000*	*.039*	*.027*
Other Influences * Location	.982	1.476	6.000	484.000	.184	.018
Other Influences * Survey Group * Location	.991	.734	6.000	484.000	.622	.009

Main Effect of Other Influences

The dominant significant effect was the main effect ($p < .001$), accounting for 61.3% of the variance in item scores. Table 6.13 shows the means for the Other Influences main effect. This effect shows how the seven Other Influences differ, overall, from each other. Using the 95% confidence intervals, we can conclude that 'Parental Aspirations and Expectations' and 'Understanding of Career Paths' were perceived as significantly more influential on students' decision making than any of the remaining five Other Influences. 'Gender of Student' was perceived as significantly less influential on students' decision making than any of the Other Influences. 'Student SES' and 'Knowledge of Pay and Conditions of Maths Jobs' were perceived as significantly less influential on students' decision making than all Other Influences except for 'Gender of Student'. 'Involvement of Maths Teachers' was significantly more strongly influential on students' decision making than all Other Influences except for 'Parental Aspirations and Expectations' and 'Understanding of Career Paths'. 'How Tertiary Entrance Scores are Calculated' was significantly more strongly influential on students' decision making than all Other Influences except for 'Parental Aspirations and Expectations', 'Involvement of Maths Teachers' and 'Understanding of Career Paths'. Note that the significant interactions may impose some qualifications on these overall item trends.

Table 6.13 Other Influences Main Effect Means

Other Influences	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Gender	1.410	.053	1.305	1.515
Student SES	1.946	.055	1.838	2.054
Parental Aspirations and Expectations	2.825	.040	2.747	2.904
Involvement of Maths Teachers	2.561	.044	2.475	2.646
Understanding of Career Paths	2.822	.044	2.735	2.908
Knowledge of Conditions of Maths Jobs	1.935	.053	1.830	2.039
How Tertiary scores are Calculated	2.628	.055	2.520	2.736

Interaction of Survey Group and Other Influences

Table 6.12 showed that the Survey Group by Other Influences interaction was significant ($p = .039$) and explained 2.7% of the variance in item scores. Table 6.14 reports the means for this interaction along with 95% confidence intervals around each mean.

Table 6.14 Survey Group by Other Influences Interaction Means

Survey Group	Other Influences	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Teachers	Gender	1.408	.050	1.310	1.506
	Student SES	1.995	.051	1.894	2.095
	Parental Aspirations and Expectations	2.771	.037	2.697	2.844
	Involvement of Maths Teachers	2.527	.041	2.447	2.606
	Understanding of Career Paths	2.697	.041	2.616	2.778
	Knowledge of Conditions of Maths Jobs	1.966	.050	1.868	2.063
	How Tertiary scores are Calculated	2.518	.051	2.417	2.619
Career Professionals	Gender	1.412	.094	1.226	1.597
	Student SES	1.897	.097	1.706	2.088
	Parental Aspirations and Expectations	2.880	.070	2.742	3.019
	Involvement of Maths Teachers	2.595	.077	2.444	2.746
	Understanding of Career Paths	2.947	.078	2.793	3.100
	Knowledge of Conditions of Maths Jobs	1.903	.094	1.719	2.088
	How Tertiary scores are Calculated	2.738	.097	2.547	2.929

Figure 6.6 plots the interaction, so the trends become visually obvious. From Figure 6.6, it was clear that the only Other Influences where meaningful survey group differences appeared to exist were: ‘Understanding of Career Paths’ and ‘How Tertiary Entrance Scores are Calculated’. However, of these visual differences between the two survey groups, only that for ‘Understanding of Career Paths’ can be considered significant; the ‘How Tertiary Entrance Scores are Calculated’ difference can be considered as marginally significant. The remaining five Other Influences cannot be considered to be significantly different between the two survey groups. Thus, career professionals perceived that students’ decision making was significantly more strongly influenced by ‘Understanding of Career Paths’ compared with teachers, but only marginally more strongly influenced by ‘How Tertiary Entrance Scores are Calculated’.

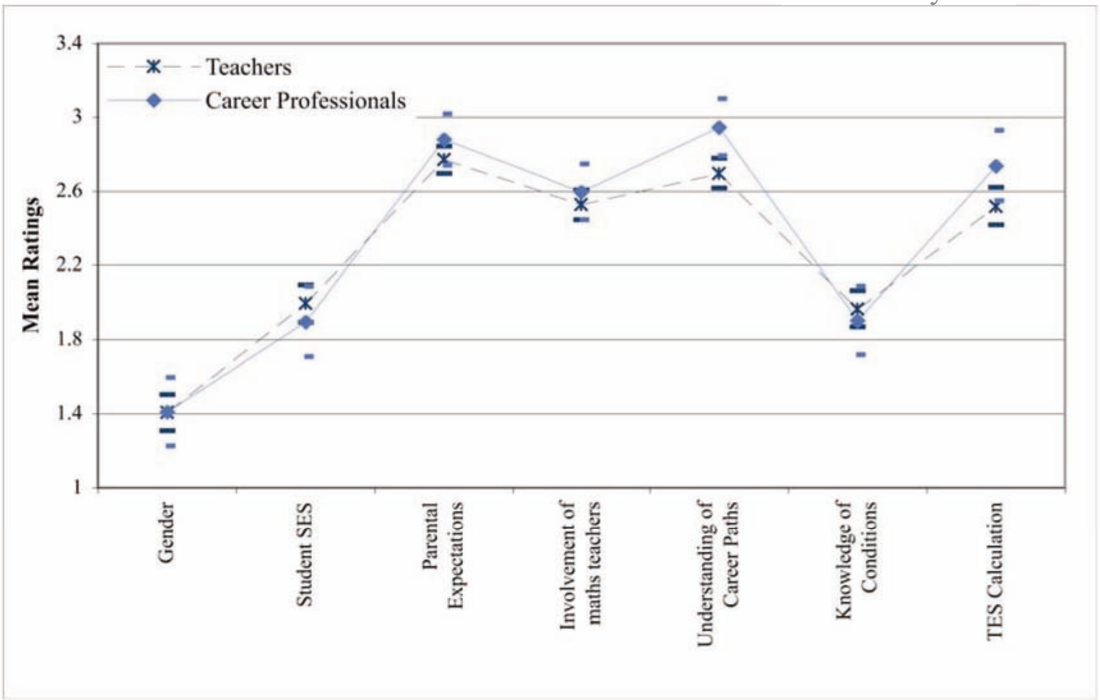

Figure 6.6 Survey Group by Other Influences Means

Summary

From the analysis of survey responses to the seven other-related questions, two influences were identified as impacting significantly on students' decision making. These were parental aspirations and expectations, and students' understanding of career paths associated with higher-level mathematics. There were two meaningful differences in the responses of teachers and career professionals to the questions about other influences. One was found to be significant and that related to career professionals' perception that students' decision making was more strongly influenced by their understanding of career paths associated with higher-level mathematics compared with teachers. The other influence concerned the way tertiary entrance scores are calculated, where career professionals perceived it to be a marginally stronger influence compared with teachers. There were no significant differences identified for the location of respondent on this set of influences.

6.3 Enrolment Trends related to Higher-Level Mathematics

Table 6.15 displays the outcomes for the univariate tests of effects related to the proportion of students taking higher-level mathematics over the past five years. The table shows one significant effect: the Survey Group main effect. The Location main effect and the Location by Survey Group interaction were non-significant.

Table 6.15 Univariate Tests

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Survey Group	***15.258***	***1***	***15.258***	***17.269***	***.000***	***.036***
Location	1.000	1	1.000	1.132	.288	.002
Survey Group * Location	.369	1	.369	.417	.519	.001
Error	411.725	466	.884			
Corrected Total	432.555	469				

Main Effect of Survey Groups

The only significant effect was the Survey Groups main effect (p < .001), accounting for 9.8% of the variance in item scores. From this analysis, we can conclude that Career Professionals (mean = 1.664; s.e. = .096) rated the 'Proportion of Students' item significantly higher than did Mathematics Teachers (mean = 1.214; s.e. = .051).

Table 6.16 displays the outcomes for the univariate tests of effects related to the extent to which teaching practices encourage students to take higher-level mathematics. The table shows one significant effect: the Survey Group main effect. The Location main effect and the Location by Survey Group interaction were non-significant.

Table 6.16 Univariate Tests

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Survey Group	*8.536*	*1*	*8.536*	*11.343*	*.001*	*.022*
Location	.397	1	.397	.528	.468	.001
Survey Group * Location	.004	1	.004	.006	.939	.000
Error	374.015	497	.753			
Corrected Total	383.605	500				

Main Effect of Survey Groups

The only significant effect was the Survey Groups main effect (p = .001), accounting for 2.2% of the variance in item scores. From this analysis, we can conclude that Career Professionals (mean = 2.064; s.e. = .085) rated the 'Teaching Practice Encouragement' item significantly higher than did Math Teachers (mean = 1.740; s.e. = .045).

6.4 Summary

Table 6.17 summarises the most significant items from the four groups of perceived influences contained in the teacher and career professional surveys. The School, Sources of Advice, and Other items in the Table were perceived to be more significantly influential on students' decision-making than the other influences in their respective item groups.

Table 6.17 Summary of the most Significant Influences

Group of influences	Influence	Main effect mean
School	• Students' experience of junior secondary mathematics	2.840
	• The greater appeal of less demanding subjects	2.632
Sources of Advice	• The advice of mathematics teachers	2.956
Individual	• Students' perception of how good they are at mathematics	3.278
Other	• Parental expectations and aspirations	2.825
	• Students' understanding of career paths associated with higher-level mathematics	2.822

The inclusion of students' experience of junior secondary mathematics is in line with the findings of a number of studies that have highlighted the strong associations early school achievements and interest in mathematics have with later participation in science and mathematics courses (e.g., Ainley, Jones, & Navaratnam, 2000; Kooh & Ainley, 2005; Lyons, 2006). This association provides the opportunity to investigate further specific aspects of teaching and learning that contribute to positive achievement and high levels of interest. These would include teacher pedagogy, classroom environment and the nature of feedback provided to students.

For students who do not choose mathematics courses, subject appeal has been identified as a major aspect influencing their decision (e.g., Brinkworth & Truran, 1998). The qualitative comments provided by students during focus group discussions also highlighted the issue of appeal in their comments about avoiding higher-level courses in the interests of completing "stress free" senior years at school. This decision-making influence provides the opportunity to investigate further specific aspects of subjects offered within the curriculum that are perceived to be less demanding. These aspects would include workload, contribution to tertiary entrance scores and the range of courses available, not only within mathematics, but across all discipline areas, inclusive of vocational courses.

The place of mathematics teachers' advice as the dominant source of advice has not been reported as widely as that of parents (e.g., DEST, 2006; Lyons, 2006). There are, however, some messages to be found in the idea that youth identity development is a neglected aspect of mathematics education (Schreiner & Sjoberg, 2007) and therefore teachers could have a role in the development of cultural and social capital as do parents (Lyons, 2006). This lack of information about the how teachers develop an appropriate world view for students of mathematics provides the opportunity to investigate further specific aspects of their advice that promote the intrinsic benefits of studying higher-level mathematics courses (i.e., to make it interesting, important and meaningful). These aspects would include teacher beliefs, pedagogy and professional development, the classroom environment generated by teachers, teacher's capacity to counsel students about the uses and applications of mathematics in post-secondary options, and the nature of assessment and feedback provided to students the throughout secondary years of schooling.

The role of parents' expectations and aspirations has been well documented for both mathematics and science (e.g., Marks et al., 2000; Marks et al., 2001; DEST, 2006; Lyons, 2006; Lyons, Cooksey, Panizzon, Parnell & Pegg, 2006) and is also supported by the qualitative comments provided by students in the focus group sessions. A key aspiration identified in the SiMERR National Survey (Lyons et al., 2006) was the importance parents placed on completion of a degree by their children. This aspiration warrants more detailed investigation in the context of students' transition to tertiary education. In particular, the aspects which facilitate – or diminish, the uptake of students into mathematics related courses.

Improving information and awareness about careers has been identified in a number of studies (e.g., Brinkworth & Truran, 1998; Crann, 2006; DEST, 2006) and by teachers in the SiMERR National Survey (Lyons, et al., 2006). Teachers across the discipline areas of science, ICT and mathematics, for example, identified the opportunity to visit educational sites related to their subject as having the highest level of student learning need. Addressing this need has the potential to develop students' beliefs about mathematics, mathematicians, users of mathematics, and possible career options.

In the Individual group of items, students' perception of their ability was significantly more influential than the two items of perceived usefulness of mathematics, and the perception of the teachers and the teaching to be encountered in higher-level mathematics courses. Perceptions of ability were not more significant than the group of items which included subject difficulty, previous achievement, and subject interest. This lack of clear significance amongst such a group of items is a theme which is supported by findings from a number of sources. Whilst achievement within the top two quartiles in external tests for numeracy and literacy can be a predictor of enrolments in higher-level mathematics course (e.g., Lamb & Bell, 1998; Fullarton &

Ainley, 2000; Fullerton et al., 2003), there has been an emerging focus on the idea that measures of achievement can also contribute to students' sense of competence and disposition towards further study (e.g., Ainley & Jones, 1990; Ainley, Jones & Navaratnam, 1990; OECD, 2004; Thomas & Fleming, 2004, Khoo & Ainley, 2005).

In the 2003 PISA study, for example (OECD 2004), an attempt was made to identify aspects of such a 'disposition' and ten student characteristics were investigated that can provide schools with a basis for enhancing engagement in learning. Coupling this approach with the idea that engagement during the middle years of schooling can be a key predictor of subsequent participation (Khoo & Ainley, 2005), provides an opportunity to investigate further student engagement in mathematics across the secondary years of schooling, and aspects of teaching and learning practice which contribute to positive beliefs about performance and ability.

There were two items perceived as significantly less influential than any of the other items in their respective groups. These were the advice of other teachers, and students' perceptions of teachers and teaching to be encountered.

The interaction between survey group and the groups of items highlighted four points of interest. The first of these related to the appeal of less demanding subjects, where teachers perceived it to be a more significant influence than did career professionals. This finding is in line with the qualitative comments provided by teachers that highlight the consequences, within their subject area, of the culture of competition between academic and social demands experienced by students. The issue of competition provides an opportunity to investigate in additional detail specific attributes which attract students to subjects they perceive to be less demanding.

The other three points of interest related to items from the Sources of Advice and Other groupings. When compared with teachers, career professionals perceived that students' decision making was more strongly influenced by the advice of students' mathematics teachers, by parents and other adults, by students' understanding of career paths associated with higher-level mathematics, and by the way tertiary entrance scores were calculated.

The interaction between location and the groups of influences highlighted three items that regional and rural respondents perceived to be more significant influences on students' decision-making than did 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. It is of interest that regional and rural respondents perceived the advice of parents and other adults to be marginally less of an influence than did metropolitan respondents. Possible differences in advisory influences between rural and metropolitan contexts warrants further investigation and would serve to build on findings from the SiMERR National Survey (Lyons et al., 2006) related to parental aspirations, and the extent to which teachers in some schools are required to teach outside their areas of expertise. Regional and rural respondents perceived two other influences as marginally significant and these were perceived ability at mathematics and previous achievement in mathematics.

SECTION 7

RECOMMENDATIONS

7.1 Introduction

The Maths? Why Not? Survey drew on the perceptions of teachers and career professionals concerning influences on students' decision-making to undertake higher-level mathematics courses. The data also included student survey responses and comments gained during focus group discussion. The responses from these three groups highlighted a range of influences extending throughout the years of schooling and beyond. These influences included student preparation during primary and secondary schooling, teacher pedagogy, subject difficulty, conflict between stated and actual tertiary requirements, sources of advice, previous achievement, and students' self-perceptions of ability. Both teachers and career professionals perceived this last influence as having the most impact on students' choices.

A summary was provided at the end of each of the sections detailing the responses for each group and this section draws on that material for the recommendations that follow. As part of the consultation process for the preparation of this Draft Report, the project Advisory Committee met to consider the outcomes of the survey and to formulate a framework for making recommendations. As a result of that process, five broad themes were identified that provide a holistic approach for schools, education authorities and universities to respond to the issue of declining enrolments in higher-level mathematics courses. The recommendations are presented separately under those themes, namely:

1. Mathematics teaching and learning
2. Career awareness programs
3. The secondary-tertiary transition
4. Further research to obtain a more comprehensive picture of influences
5. Further research to investigate identified influences more deeply
6. Enrolments in mathematics courses

Underpinning these recommendations should be an awareness of the issues that are of particular relevance for rural, regional and remote school communities, and of differences within groups (e.g., gender, ethnicity).

7.1.2 Mathematics teaching and learning

As a subject, students regarded mathematics as important, both in the concepts that need to be consolidated and as a means for facilitating transitions throughout secondary schooling and to their post-secondary options. They were also realistic in their appraisal of the effort and workloads associated with higher-level courses. The following recommendations are designed to ensure that students are sufficiently informed to make decisions about subject choices which link with their career aspirations.

1. That educational authorities actively support the teaching of mathematics in the primary and junior secondary years to ensure that it is directed towards maximising the pool of students for whom higher-level mathematics in the senior years at school is a viable and attractive pathway. School systems need to foster a culture of sustainable professional development within schools that enables mathematics teachers to act on the student-related influences identified in the findings of this report by:

- implementing pedagogical strategies that engage students;
- focusing on conceptual understandings at all levels and at key stages in learning; and
- having access to intervention programs that address students' particular learning needs.

2. That educational authorities have in place mechanisms that identify students, or which enable students to self-identify, as in need of support programs in mathematics. These students should be provided with opportunities to consolidate their understandings of important aspects of mathematics at critical development points in their learning (e.g., through 'second chance' programs).

3. That the Commonwealth and/or other research funding bodies initiate further research be undertaken into the range of mathematics-specific issues that emerged as possible influences on students' engagement and decision making in the Maths? Why Not? Project, namely:

   - The conceptual obstacles experienced by students in the middle years of schooling, with a view to developing strategies to overcome them;
   - The role of formative and summative assessment in early secondary mathematics and the effects of each on students' self-efficacy;
   - The links between student-teacher relationships and performance in mathematics;
   - Problematic components of curriculum and teaching that were identified (e.g., lack of rigour, shallow treatment of important ideas, irrelevance of content, lack of opportunities for creativity);
   - The extent to which teachers develop for students a 'world view' of mathematics and mathematicians.

4. That Federal, State and Territory governments, in consultation with education authorities, school systems and other stakeholder groups, collaborate to develop and implements a range of incentives that:

   - encourage mathematics graduates into primary and secondary mathematics teaching; and
   - address the retention of degree-qualified mathematics teachers in primary and secondary teaching.

7.1.3 Career awareness programs

From the background information that students provided in their survey, a point of interest related to the percentage of students who indicated that the primary and early secondary years of schooling represented a time when they first started thinking seriously about future careers. The focus on careers at such times has implications for current approaches to career education that target students in their later years of secondary education. In addition, the comments from teachers to career professionals provided advice indicating a need to be more informed when it came to offering appropriate advice to students. This advice was repeated in the comments from career professionals to teachers. Overall, there was a perceived need for more comprehensive career education programs that begin earlier than at present and the following recommendations relate to that need.

5. That professional associations involving teachers of mathematics and career professionals work together to develop, trial and implement career awareness programs in the junior secondary and upper primary years of schooling. These learning units should provide information about the potential and value of mathematics-rich careers, and also highlight links between careers and students' evolving understanding of mathematical concepts.

6. That education authorities, tertiary institutions, and other stakeholder groups form partnerships to work together to support the development of school cultures that promote mathematics-rich careers through the provision of programs that include:

    - The regular production of career-related resources, including, a book of mathematics related career advertisements, 'bullseye' type career posters, and career organization newsletters;
    - Clear advice to mathematics teachers, careers advisers and parents about the importance of mathematics in choosing and successfully pursuing a career;
    - Support for mathematics teachers and careers advisers about what mathematics students can do in terms of career options and pathways; and
    - Encouragement for schools to inform parents about career options and desirable pre-requisites related to mathematics for their children.

7.1.4 The secondary-tertiary transition

These recommendations relate to influences associated with the secondary tertiary transition, namely, the calculation of university entrance scores, and the identification of the mathematical background required for particular university subjects and courses.

7. That tertiary admission authorities, in consultation with State and Territory educational authorities, review their procedures to ensure that the calculation of tertiary entrance scores incorporates positive incentives to recognise those students who take advanced (and to a lesser extent intermediate) mathematics subjects in Years 11 and 12.

8. That Federal, State and Territory governments, in consultation with industry, develop a program of post-secondary scholarships and/or cadetships for studying and completing mathematics-rich courses at university (i.e., those that depend on successful completion of higher-level mathematics courses at school).

9. That tertiary institutions develop realistic minimum and desirable levels of mathematical background required for the study of tertiary mathematics subjects. These levels should be clearly and unambiguously identified in all promotional material as "pre-requisite knowledge," "assumed knowledge" or similar.

10. That the Commonwealth and/or other research funding bodies initiate further research into the reasons and motivations which contribute to students' decision to enrol in mathematics-rich courses.

7.1.5 Further research to obtain a more comprehensive picture of influences

A number of limitations have been identified in the collection of data during the time that information was gathered for this project. In particular, it is desirable that all relevant stakeholders have the opportunity to respond to ensure that both the range of influences and their relative impacts that have been identified in this study are confirmed and/or developed. The following recommendations are designed to supplement the existing information to create a comprehensive national picture.

11. That the Commonwealth and/or other research funding bodies support an evaluation of the Maths? Why Not? methodology for application to a fully representative sample of Australian students and parents/caregivers to identify students' beliefs and perspectives concerning the influences on their subject, course and career choices. The study should address the gaps in our understanding of 'Generation Y' in relation to these matters, as well as clarify issues for particular subjects (e.g., the uptake into science and mathematics). There should be a broad scope of students studied (e.g., Years 5 – 12 and into the tertiary years) to gain a comprehensive picture of:

    - The meaning students attach to terms, such as, 'usefulness,' 'relevance,' ' less demanding subjects' and 'difficulty' when used in the context of choosing mathematics subjects in the senior years;
    - The characteristics of earlier learning experiences which contribute to positive achievement and high levels of interest in mathematics, and which have the potential to influence decision-making (e.g., curriculum, pedagogy, teaching, encouragement, feedback, performance); and
    - The factors which contribute to students regarding mathematics as being applicable to their lives and aspirations.

12. That the Commonwealth and/or other research funding bodies initiate further research into the extent of career professionals' knowledge and practice concerning the nature and usefulness of higher-level mathematics, and counselling about possible career paths.

13. That the Commonwealth and/or other research funding bodies initiate further research that:

    - Identifies the current benefits and rewards to students of undertaking higher-level mathematics;
    - Identifies potential benefits and rewards (associated with other subjects) that may be transferable to mathematics;
    - Investigates the relatively low rating that careers professionals' attribute to their advice;
    - Investigates the relative importance of the influences identified in the project that apply to the pre-secondary context, and the efficacy of introducing career programs into the primary years of schooling;
    - Analyses the PISA and TIMSS data concerning enrolments in countries that are more successful than Australia in terms of students studying advanced mathematics, and concerning attitudinal characteristics of students;
    - Determines whether or not there are critical times during schooling when students make formative decisions about subject choices and careers.

7.1.6 Further research to investigate identified influences more deeply

A number of important influences were identified in the responses of the various groups that warrant additional qualification. Ascertaining the exact meaning associated with particular words and statements would help to inform effective advice, and teaching and learning strategies. The following recommendations are designed to probe more deeply those influences.

14. That the Commonwealth and/or other research funding bodies initiate further research that investigates aspects of effective advice which are:

    - Characteristic of careers advisers (e.g., is the advice subject-specific or motivational; advisory or mandatory; informative or influential); and
    - Common to the range of other advisory influences highlighted in the Maths? Why Not? Project (e.g., are there important social constructs inherent in the advice?).

15. That further research be undertaken into the nature of advice offered by careers professionals – is it/should it be subject-specific or motivational; advisory or mandatory; informative or influential.

7.1.7 Enrolments in mathematics courses

In the course of preparing the literature review for this project, it was necessary to update existing reported data about student enrolments across courses. During this process it became clear that there were differing approaches to the reporting of student enrolments across subjects and courses on the part of State and Territory curriculum authorities as well as in the research literature. In addition, whilst declines in enrolments were discussed as a cause for concern, this discussion was not put in any ideal context of an optimum or ideal situation. The following recommendations are included to facilitate the use and interpretation of enrolment data and to provide a national focus for contemplating a desirable level of student enrolments in mathematics courses.

16. That State and Territory curriculum authorities adopt a nationally consistent approach to the reporting of student enrolments across subjects.

17. That State and Territory associations consult concerning the setting of desirable levels of student uptake into senior mathematics courses.

Conclusion

The recommendations presented above require a coordinated approach across school systems, education authorities, associations and universities to build on the findings of this project and to explore more deeply critical issues associated with students' engagement in mathematics courses and how they incorporate mathematics into secondary learning needs and post-secondary options. Because of the range and diversity of stakeholders, and the need to implement strategies in a number of areas, there are implications for how such strategies are negotiated, financed, monitored and evaluated. In addition, any actions need to be coordinated on a national level to ensure that the needs arising from regional and/or local differences are addressed in ways which help to inform, and are informed by, holistic strategies. Furthermore, a national approach to investigating student engagement in mathematics courses will ensure that any synergies between adopted strategies and other current research in mathematics education are affirmed.

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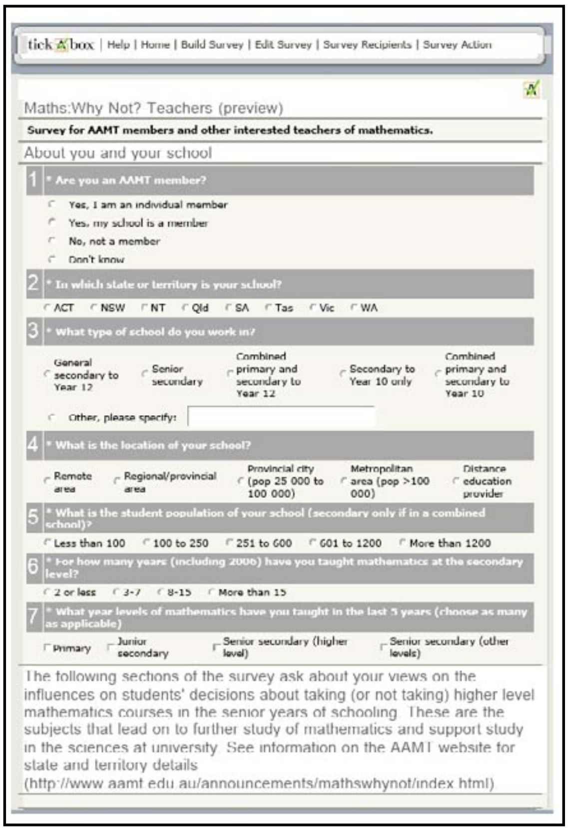
http://www.vcaa.vic.edu.au/vce/statistics/2005/section2/mathsmethodscas05.pdf
http://www.vcaa.vic.edu.au/vce/statistics/2005/section2/mathsspec05.pdf
on 28 February 2006

APPENDICES

Appendix A: Advisory Committee Membership and Affiliations

Ms Kate Castine	Australian Principals Associations Professional Development Council
Ms Anne Curtain	Department of Education, Science and Training
Mr Tom Delahunty	Trinity Grammar School, Kew
Mr Scott Lambert	Department of Education, Science and Training
Dr Terry Lyons	SiMMER National Centre
Ms Donna Miller	Australian Association of Mathematics Teachers Council Nominee
Mr John Shanahan	Australian Association of Mathematics Teachers Council Nominee
Ms Glenys Thompson	Australian Association of Mathematics Teachers Council Nominee
Ms Clare Wynter	Department of Education, Science and Training

Appendix B: Mathematics Teachers, Career Professionals and Student Surveys



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Maths:Why Not? Teachers (preview)

Survey for AAMT members and other interested teachers of mathematics.

About you and your school

1 * Are you an AAMT member?
- Yes, I am an individual member
- Yes, my school is a member
- No, not a member
- Don't know

2 * In which state or territory is your school?
ACT / NSW / NT / Qld / SA / Tas / Vic / WA

3 * What type of school do you work in?
General secondary to Year 12 / Senior secondary / Combined primary and secondary to Year 12 / Secondary to Year 10 only / Combined primary and secondary to Year 10
Other, please specify:

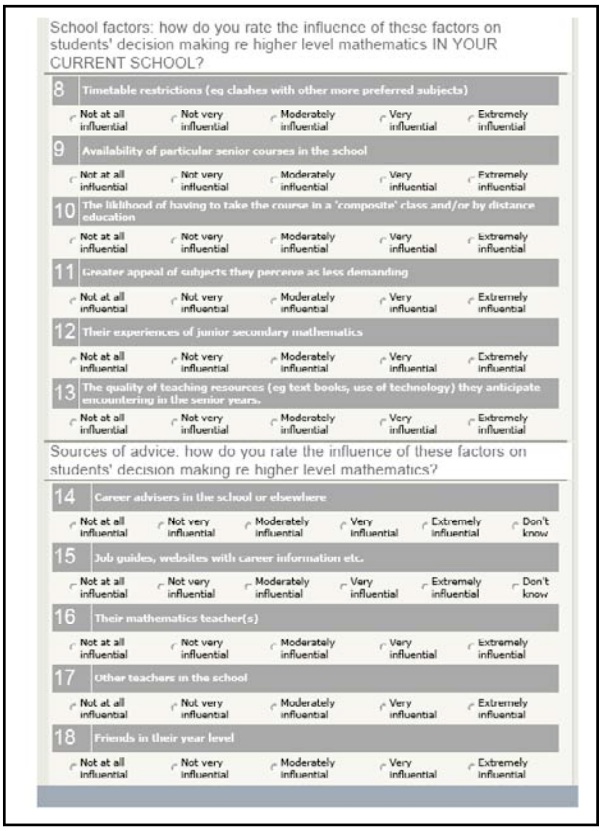
4 * What is the location of your school?
Remote area / Regional/provincial area / Provincial city (pop 25 000 to 100 000) / Metropolitan area (pop >100 000) / Distance education provider

5 * What is the student population of your school (secondary only if in a combined school)?
Less than 100 / 100 to 250 / 251 to 600 / 601 to 1200 / More than 1200

6 * For how many years (including 2006) have you taught mathematics at the secondary level?
2 or less / 3-7 / 8-15 / More than 15

7 * What year levels of mathematics have you taught in the last 5 years (choose as many as applicable)
Primary / Junior secondary / Senior secondary (higher level) / Senior secondary (other levels)

The following sections of the survey ask about your views on the influences on students' decisions about taking (or not taking) higher level mathematics courses in the senior years of schooling. These are the subjects that lead on to further study of mathematics and support study in the sciences at university. See information on the AAMT website for state and territory details (http://www.aamt.edu.au/announcements/mathswhynot/index.html)



School factors: how do you rate the influence of these factors on students' decision making re higher level mathematics IN YOUR CURRENT SCHOOL?

8 Timetable restrictions (eg clashes with other more preferred subjects)
Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

9 Availability of particular senior courses in the school
Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

10 The likelihood of having to take the course in a 'composite' class and/or by distance education
Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

11 Greater appeal of subjects they perceive as less demanding
Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

12 Their experiences of junior secondary mathematics
Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

13 The quality of teaching resources (eg text books, use of technology) they anticipate encountering in the senior years.
Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

Sources of advice: how do you rate the influence of these factors on students' decision making re higher level mathematics?

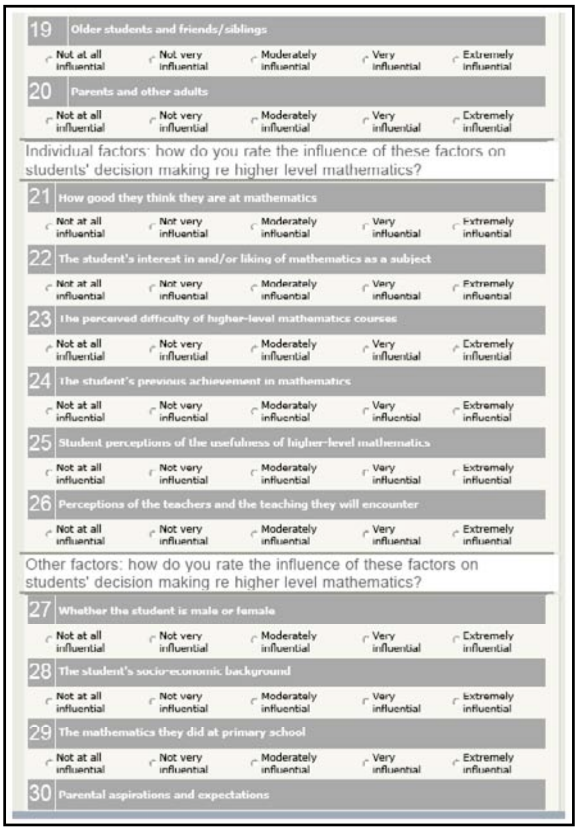
14 Career advisers in the school or elsewhere
Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential / Don't know

15 Job guides, websites with career information etc.
Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential / Don't know

16 Their mathematics teacher(s)
Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

17 Other teachers in the school
Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

18 Friends in their year level
Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential



19 Older students and friends/siblings
Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

20 Parents and other adults
Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

Individual factors: how do you rate the influence of these factors on students' decision making re higher level mathematics?

21 How good they think they are at mathematics
Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

22 The student's interest in and/or liking of mathematics as a subject
Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

23 The perceived difficulty of higher-level mathematics courses
Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

24 The student's previous achievement in mathematics
Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

25 Student perceptions of the usefulness of higher-level mathematics
Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

26 Perceptions of the teachers and the teaching they will encounter
Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

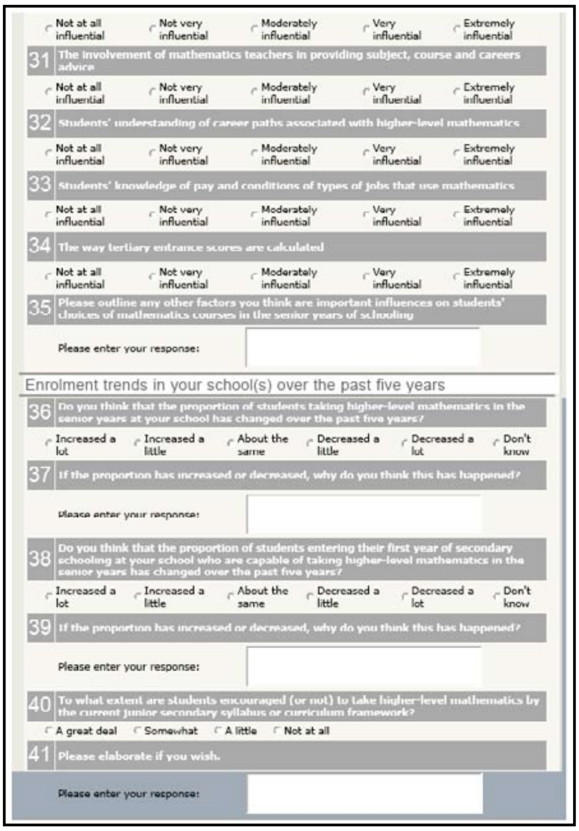
Other factors: how do you rate the influence of these factors on students' decision making re higher level mathematics?

27 Whether the student is male or female
Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

28 The student's socio-economic background
Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

29 The mathematics they did at primary school
Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

30 Parental aspirations and expectations



Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

31 The involvement of mathematics teachers in providing subject, course and careers advice
Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

32 Students' understanding of career paths associated with higher-level mathematics
Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

33 Students' knowledge of pay and conditions of types of jobs that use mathematics
Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

34 The way tertiary entrance scores are calculated
Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

35 Please outline any other factors you think are important influences on students' choices of mathematics courses in the senior years of schooling
Please enter your response:

Enrolment trends in your school(s) over the past five years

36 Do you think that the proportion of students taking higher-level mathematics in the senior years at your school has changed over the past five years?
Increased a lot / Increased a little / About the same / Decreased a little / Decreased a lot / Don't know

37 If the proportion has increased or decreased, why do you think this has happened?
Please enter your response:

38 Do you think that the proportion of students entering their first year of secondary schooling at your school who are capable of taking higher-level mathematics in the senior years has changed over the past five years?
Increased a lot / Increased a little / About the same / Decreased a little / Decreased a lot / Don't know

39 If the proportion has increased or decreased, why do you think this has happened?
Please enter your response:

40 To what extent are students encouraged (or not) to take higher-level mathematics by the current junior secondary syllabus or curriculum framework?
A great deal / Somewhat / A little / Not at all

41 Please elaborate if you wish.
Please enter your response:

tick✓box | Help | Home | Build Survey | Edit Survey | Survey Recipients | Survey Action

Maths:Why Not?- Careers Professionals (preview)

Template of survey for careers professionals

About you and your school

1 * In which state or territory is your school?

ACT / NSW / NT / Qld / SA / Tas / Vic / WA

2 * What type of school do you work in?

General secondary to Year 12 / Senior secondary / Combined primary and secondary to Year 12 / Secondary to Year 10 only / Combined primary and secondary to Year 10

Other, please specify:

3 * What is the location of your school?

Remote area / Regional/provincial area / Provincial city (pop 25 000 to 100 000) / Metropolitan area (pop >100 000) / Distance education provider

4 * What is the student population (secondary only if in a combined school)?

Less than 100 / 100 to 250 / 251 to 600 / 601 to 1200 / More than 1201

The following sections of the survey ask about your views on the influences on students' decisions about taking (or not taking) higher level mathematics courses in the senior years of schooling. These are the subjects that lead on to further study of mathematics and support study in the sciences at university. See accompanying email for details

School factors: how do you rate the influence of these factors on students' decision making re higher level mathematics IN YOUR CURRENT SCHOOL?

5 Timetable restrictions (eg clashes with other more preferred subjects)

Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

6 Availability of particular senior courses in the school

Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

7 The liklihood of having to take the course in a 'composite' class and/or by distance education

Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

8 Greater appeal of subjects they perceive as less demanding

Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

9 Their experiences of junior secondary mathematics

Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

10 The quality of teaching resources (eg text books, use of technology) they anticipate encountering in the senior years.

Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

Sources of advice: how do you rate the influence of these factors on students' decision making re higher level mathematics?

11 Career advisers in the school or elsewhere

Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

12 Job guides, websites with career information etc.

Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

13 Their mathematics teacher(s)

Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

14 Other teachers in the school

Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

15 Friends in their year level

Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

16 Older students and friends/siblings

Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

17 Parents and other adults

Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

Individual factors: how do you rate the influence of these factors on students' decision making re higher level mathematics?

18 How good they think they are at mathematics

Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

19 The student's interest in and/or liking of mathematics as a subject

Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

20 The perceived difficulty of higher-level mathematics courses

Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

21 The student's previous achievement in mathematics

Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

22 Student perceptions of the usefulness of higher-level mathematics

Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

23 Perceptions of the teachers and the teaching they will encounter

Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

Other factors: how do you rate the influence of these factors on students' decision making re higher level mathematics?

24 Whether the student is male or female

Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

25 The student's socio-economic background

Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

26 Parental aspirations and expectations

Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

27 The involvement of mathematics teachers in providing subject, course and careers advice

Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

28 Students' understanding of career paths associated with higher-level mathematics

Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

29 Students' knowledge of pay and conditions of types of jobs that use mathematics

Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

30 The way tertiary entrance scores are calculated

Not at all influential / Not very influential / Moderately influential / Very influential / Extremely influential

31 Please outline any other factors you think are important influences on students' choices of mathematics courses in the senior years of schooling

Please enter your response:

Enrolment trends in your school(s) over the past five years

32 Do you think that the proportion of students taking higher-level mathematics in the senior years at your school has changed over the past five years?

Increased a lot / Increased a little / About the same / Decreased a little / Decreased a lot / Don't know

33 If the proportion has increased or decreased, why do you think this has happened?

Please enter your response:

34 To what extent are students encouraged (or not) to take higher-level mathematics by the current teaching practices in junior secondary mathematics?

A great deal / Somewhat / A little / Not at all

35 Please elaborate if you wish.

Please enter your response:

Strategies to increase student participation in higher-level mathematics

36 Do you think it is important to encourage greater participation in higher level mathematics?

Please enter your response:

37 Please describe any strategies you think would encourage greater student participation in higher-level mathematics courses in the senior years of schooling.

Please enter your response:

(preview)

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Math:Why Not - Students (preview)

Template for survey of students.

About you

1 * I am a
- Girl
- Boy

2 * How old are you?
- 14
- 15
- 16
- 17
- Other, please specify:

3 * I am currently in
- Year 10
- Year 11
- Other, please specify:

4 * What sort of school do you go to?
- General secondary to Year 12
- Senior secondary
- Combined primary and secondary (to Year 12)
- Secondary to Year 10 only
- Combined primary and secondary (to Year 10 only)
- Other, please specify:

5 Where is your school located?
- Remote area
- Regional/provincial area
- Provincial city (pop 25 000 to 100 000)
- Metropolitan area (pop >100 000)

6 How many students in your school (secondary section only if a combined school)?
- Less than 100
- 101 to 250
- 251 to 600
- 601 to 1200
- More than 1200

7 * Can you remember when you first started thinking seriously about what you want to be when you grow up?
- Early primary school
- Upper primary school
- Early secondary
- Not yet thinking seriously about it
- Can't remember

8 What are your top options for the career you want to pursue? (up to three)

Please enter your response:

9 Do you have any other comments about your career choices?

Please enter your response:

About maths and you

10 What I did at primary school was good preparation for high school maths
- Strongly agree
- Agree
- Unsure
- Disagree
- Strongly disagree

11 At the start of high school, how did you rate yourself in maths against the other kids from your primary school?
- Well above average
- Above average
- Average
- Below average
- Well below average

12 How would you now rate yourself in maths now
- A lot better than at the start of high school
- A bit better than at the start of high school
- The same as than at the start of high school
- A bit worse than at the start of high school
- A lot worse than at the start of high school

13 I enjoy maths
- A lot more than other subjects
- A bit more than other subjects
- The same as other subjects
- A bit less than other subjects
- A lot less than other subjects

14 I am well informed about how different maths courses lead to careers
- Strongly agree
- Agree
- Unsure
- Disagree
- Strongly disagree

Your choice of maths for 2007

15 Is Extension 1 Mathematics an option in your school?
- Yes
- No
- Don't know

16 What maths are you going to do in 2007?
- Extension 1
- Mathematics
- General Mathematics

17 My parents are happy with my choice of maths subject
- Strongly agree
- Agree
- Unsure
- Disagree
- Strongly disagree

Influences on your choice of maths subject in 2007

18 I chose my maths subject for 2007 because I have found maths interesting in junior secondary school
- Strongly agree
- Agree
- Unsure
- Disagree
- Strongly disagree

19 I chose my maths subject for 2007 because I like maths
- Strongly agree
- Agree
- Unsure
- Disagree
- Strongly disagree

20 I chose my maths subject for 2007 because I am good at maths
- Strongly agree
- Agree
- Unsure
- Disagree
- Strongly disagree

21 I chose my maths subject for 2007 because I will get the good teachers
- Strongly agree
- Agree
- Unsure
- Disagree
- Strongly disagree

22 I chose my maths subject for 2007 because the one I wanted to do clashed with other subjects or VET courses on the timetable
- Strongly agree
- Agree
- Unsure
- Disagree
- Strongly disagree

23 I chose my maths subject for 2007 because I think I will get good marks
- Strongly agree
- Agree
- Unsure
- Disagree
- Strongly disagree

24 I chose my maths subject for 2007 because it will give me the best score I can get in Year 12
- Strongly agree
- Agree
- Unsure
- Disagree
- Strongly disagree

25 I chose my maths subject for 2007 because I need it for a job or course (Uni or TAFE) I want to do
- Strongly agree
- Agree
- Unsure
- Disagree
- Strongly disagree

26 I chose my maths subject for 2007 because it will be good for me in life
- Strongly agree
- Agree
- Unsure
- Disagree
- Strongly disagree

27 I chose my maths subject for 2007 because it was what my maths teacher suggested
- Strongly agree
- Agree
- Unsure
- Disagree
- Strongly disagree

28 I chose my maths subject for 2007 because other teacher(s) in the school suggested that I do it
- Strongly agree
- Agree
- Unsure
- Disagree
- Strongly disagree

29 I chose my maths subject for 2007 because the school's careers adviser suggested it
- Strongly agree
- Agree
- Unsure
- Disagree
- Strongly disagree

30 I chose my maths subject for 2007 because of the information I got from careers websites, brochures and careers expos etc.
- Strongly agree
- Agree
- Unsure
- Disagree
- Strongly disagree

31 I chose my maths subject for 2007 because it made my parents happy
- Strongly agree
- Agree
- Unsure
- Disagree
- Strongly disagree

32 I chose my maths subject for 2007 because some of my friends will be in the same class
- Strongly agree
- Agree
- Unsure
- Disagree
- Strongly disagree

33 I chose my maths subject for 2007 because older students advised me to
- Strongly agree
- Agree
- Unsure
- Disagree
- Strongly disagree

34 I chose my maths subject for 2007 because my older brother(s)/sister(s) advised me to do it
- Strongly agree
- Agree
- Unsure
- Disagree
- Strongly disagree
- Not relevant - no older siblings

35 I chose my maths subject for 2007 because it doesn't involve having to have lessons 'off-line' (ie before school etc)
- Strongly agree
- Agree
- Unsure
- Disagree
- Strongly disagree

36 I chose my maths subject for 2007 because I need to have time to do my part time job
- Strongly agree
- Agree
- Unsure
- Disagree
- Strongly disagree

Doing maths

37 What is the most important thing you need to do well at maths
- Have ability in maths
- Have a good teacher
- Work hard
- Have friends who are good at maths
- Have parents who help and support you
- Have a maths brain
- Other, please specify:

38 What do you see as the advantages of doing Extension Maths?

Please enter your response:

39 What do you see as the disadvantages of doing Extension Maths?

Please enter your response:

(preview)

Return to survey editor

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Appendix C: The University of New England Human Research Ethics Committee Approval

UNE
THE UNIVERSITY OF NEW ENGLAND

Research Services
Armidale, NSW 2351, Australia
Telephone (02) 6773 2070 Facsimile (02) 6773 3543
http://www.une.edu.au/research-services/index.html

THE UNIVERSITY OF NEW ENGLAND

HUMAN RESEARCH ETHICS COMMITTEE

MEMORANDUM TO:	Prof J Pegg/Mr W Morony/Ms a Curtain/Mr S Lambert/ Ms C Wynter/ Ms D Miller/Mr J Shanahan SiMERR

This is to advise you that the Human Research Ethics Committee has approved the following:

PROJECT TITLE:	Maths? Why not?: Unpacking reasons for students' decisions concerning-higher mathematics in the senior years.
COMMENCEMENT DATE:	28/9/06
COMMITTEE APPROVAL No.:	HE06/154
APPROVAL VALID TO:	28/9/07
COMMENTS:	Nil. Conditions met in full.

The Human Research Ethics Committee may grant approval for up to a maximum of three years. For approval periods greater than 12 months, researchers are required to submit an application for renewal at each twelve-month period. All researchers are required to submit a Final Report at the completion of their project. The Renewal/Final Report Form is available at the following web address: http://rs-nt-10.une.edu.au/Home/V_2_1/ecforms.html

The *NHMRC National Statement on Ethical Conduct in Research Involving Humans* requires that researchers must report immediately to the Human Research Ethics Committee anything that might affect ethical acceptance of the protocol. This includes adverse reactions of participants, proposed changes in the protocol, and any other unforeseen events that might affect the continued ethical acceptability of the project.

In issuing this approval number, it is required that all data and consent forms are stored in a secure location for a minimum period of five years. These documents may be required for compliance audit processes during that time. If the location at which data and documentation are retained is changed within that five year period, the Research Ethics Officer should be advised of the new location.

J Pearson

Fiona Pearson
Secretary

28/9/06

Open to change - Open to challenges - Open to our communities

Appendix D: Approvals to Involve Students in Research for South Australia and New South Wales

Government of South Australia
Department of Education and Children's Services

Office of Strategic Policy & Planning
Education Centre
Level 8/31 Flinders Street Adelaide 5000
South Australia
GPO Box 1152
Adelaide 5001
Tel: 8226 0119
Fax: 8226 0890

DECS CS/06/0116-3.4

10 October 2006

Mr Will Morony
Australian Association of Mathematics Teachers
GPO Box 1729
ADELAIDE SA 5001

Dear Mr Morony

Thank you for your letter requesting approval for your project "*Why is it that capable students are not choosing to take higher-level mathematics in the senior years of schooling*".

Your project has been reviewed by a senior DECS consultant with respect to protection from harm, informed consent, confidentiality and suitability of arrangements. Subsequently, I am pleased to advise you that after careful consideration your project has been **approved**.

Please find below some comments made by the reviewer for your information along with the reviewer's contact details in order for you to clarify any queries or comments made.

"*This is a very useful and worthwhile project. Information from this project will support data that is currently being collated around SSABSA enrolments as part of the Science and Mathematics Strategy.*

It has the potential to influence planning and projects for this strategy. It will be useful to have Australian and South Australian data on these issues to provide a clearer focus for our projects at the local level."

Mr Kym Linke, Policy and Program Officer – Mathematics, DECS. Ph: 8226 0293.

Please supply the department with an electronic copy of the final report, which will be circulated to interested staff and then made available to DECS educators for future reference.

I wish you well with your project.

Lexie Mincham
MANAGER, POLICY AND RESEARCH
INTER-GOVERNMENT RELATIONS

PLANNING AND INNOVATION

NEW SOUTH WALES
DEPARTMENT
OF EDUCATION
AND TRAINING

Early Childhood and Primary Education
Secondary Education
Technical and Further Education
Vocational Education and Training
Higher Education
Adult and Community Education

Mr Will Morony
AAMT Executive Officer
GPO Box 1729
ADELAIDE NSW 5001
AUSTRALIA

Dear Mr Morony SERAP Number **2006074**

I refer to your application to conduct a research project in NSW government schools entitled *Maths? Why Not?* I am pleased to inform you that your application has been approved.

This approval will remain valid until 28/09/2007.

This approval has been amended to cover the following researchers and research assistants to enter schools for the purposes of this research for the periods indicated:

Name	Approval expires
Trevor John Lynch	07/11/2007
John Edward Pegg	30/11/2007

You should include a copy of this letter with the documents you send to schools.

When your study is completed please forward your report marked to General Manager, Planning and Innovation, Department of Education and Training, GPO Box 33, Sydney, NSW 2001.

Yours sincerely

Brian Davies

Dr Brian Davies
Manager, Research and Evaluation
12 December 2006

• Level 6, 35 Bridge Street • GPO Box 33 • Sydney NSW 2001 Australia •
• telephone 02 61 2 9561 8744 • facsimile 02 61 2 9561 8941 • www.det.nsw.edu.au •

Appendix E: Information Sheets and Approval Forms

Appendix E1: Information Sheet for AAMT Teachers and Career Professionals (Survey Participation)

Maths? Why not?

Unpacking reasons for students' decisions concerning higher-level mathematics in the senior years.

Dear Colleague,

We would like to invite you to participate in the *Maths? Why Not?* Project. The purpose of this survey is to address the issue of the reduced number of young people with sufficient levels of mathematical background to meet the skill needs of the future. The Project will research the factors that affect students' choices not to take higher level mathematics in the senior years of schooling and beyond. The project will recommend actions to a range of audiences. The views of teachers, students and parents are absolutely crucial to forming an accurate picture of these issues.

To be involved, you are asked to complete an online survey via the website details given below. Using an online survey instrument is a very efficient way of gathering and electronically collating data.

The survey provides you with a unique opportunity to give your views on the factors that are contributing to the reduced number of students who are choosing to do the higher levels of mathematics in the senior school courses throughout the states and territories of Australia.

It is anticipated that the findings from the survey will be made available to participants and published in the project. Your participation in the survey is voluntary, and you will not be asked to provide your name. You may withdraw from the survey at any time and there is no penalty for non-participation. No school will be identified in any reports and all data will be kept strictly confidential. Further details about the Project can be found on the attached Information Sheet for Participants.

You are asked to follow the link (appropriate web address in here), to access and complete the survey. It should take less than 20 minutes to complete.

If you have any further questions about the survey, please don't hesitate to contact the Executive Officer for the Project, **Trevor Lynch** by email at trevor.lynch@exemail.com.au or by phone (02) 4933 7425.

Yours faithfully

Will Moroney
Executive Officer AAMT and Chief Investigator
Professor John Pegg
Director, SiMERR National Centre, UNE

Information Sheet for Participants

Title: **Maths? Why not?**
Unpacking reasons for students' decisions concerning higher-level mathematics in the senior years

Chief Investigators
Mr Will Morony, Executive Officer AAMT(Chair) (08) 83630288, wmorony@aamt.edu.au Project Coordinator:
Professor John Pegg, Director SiMERR Australia (02) 6773 5070, jpegg@une.edu.au

Advisory Committee Members
DEST Officers
Mr Scott Lambert (Director) scott.lambert@dest.gov.au
Ms Anne Curtain (Assistant Director) anne.curtain@dest.gov.au
Ms Clare Wynter (Assistant Director) clare.wynter@DEST.gov.au
Representatives of AAMT Council
Ms Donna Miller (WA) milld@Curriculum.wa.edu.au
Mr John Shanahan (NT) john.shanahan@nt.gov.au
Ms Glenys Thompson (SA) Thompson.Glenys@saugov.sa.gov.au
Other experts
Ms Kate Castine (SA; Principal and Career Ed expert) castine@bigpond.net.au
Dr Terry Lyons (NSW; Science Ed expert) tlyons@mailhub2.une.edu.au

Executive Officer
Mr Trevor Lynch (Research Assistant) trevor.lynch@exemail.com.au

Research:

Australia has a reduced number of young people with sufficient levels of mathematical background to meet the skill needs of the future. The Project will research the factors that affect students' choices not to take higher level mathematics in the senior years of schooling and beyond. The project will recommend actions to a range of audiences. The views of teachers, students and parents are absolutely crucial to forming an accurate picture of these issues.

Research Methods:

Phase 1:

Surveys will be completed online by teachers, students, parent/caregivers and careers advisers. There are four versions of the survey for the four target groups. These groups are: mathematics teachers who are members of The Australian Association of Mathematics Teachers (AAMT) and their colleagues, students studying mathematics in Year 10 at the secondary level whose achievements in mathematics indicate that they are capable of doing the higher levels in the subject, parents/caregivers of these capable students and career advisers who assist students with their career paths. The surveys should take no more than 20 minutes to complete.

Phase 2:

Further data will be collected through online discussion groups and semi-structured Focus Group Interviews with samples of the populations from Phase I. The interviews will be conducted in cooperating schools. Interviews will be tape-recorded.

Confidentiality

Participation in the project is entirely voluntary. All survey responses will remain anonymous. At no stage will opinions expressed in survey or interviews be identifiable to teachers, principals or the general public. The identity of any school will remain confidential in subsequent reports or publications. All data will be kept in locked filing cabinets or on computer hard drives accessible only by the researchers. All data will be destroyed after five years.

Availability of Research Findings
This project is likely to be completed by February 2007, and a summary of the conclusions will be made available on the SiMERR Australia website, http://simerr.une.edu.au/. The study has the approval of your state/territory DET/ CEC (No. XXX) and the Human Research Ethics Committee of the University of New England (Approval No. HEXX/XX). If you have any further questions or concerns about this study, please don't hesitate to contact the Executive Officer for the Project, **Trevor Lynch**, by email trevor.lynch@exemail.com.au or by phone (02) 4933 7425. Should you have any complaints concerning the manner in which this research is conducted, please contact the Research Ethics Officer at the following address:

Research Services, The University of New England, NSW 2351, Ph. (02) 6773 3449, Fax (02) 6773 3543

Email ethics@.une.edu.au

Thank you for taking the time to read this Information Sheet.

Appendix E2: Letter to School Principals (Survey Participation)

Maths? Why not?

Unpacking reasons for students' decisions concerning higher-level mathematics in the senior years.

Dear

We are writing to seek your permission to invite, students and parents/caregivers from your school to participate in an important education survey to be conducted across Australia. This country hasn't enough young people with sufficient levels of mathematical background to meet the skill needs to maintain and enhance this nation's competitiveness in the global knowledge economy. The Project will research the factors that affect students' choices not to take higher-level mathematics in the senior years of schooling and beyond. The project will recommend actions to a range of audiences. The views of teachers, students and parents are absolutely crucial to forming an accurate picture of these issues.

The project has satisfied the ethics criteria of The University of New England and has approval for access to the South Australian Government DECS' schools:

UNE HECS approval No: HE06/154
DECS approval No: CS/06/0116-3.4

Teacher members of The Australian Association of Mathematics Teachers (AAMT) are being asked to contribute via an online survey. Other stakeholders are to be asked to contribute by a parallel survey also accessible via an internet website. Using an online survey instrument is a very efficient way of gathering and electronically collating data.

Some member(s) of the AAMT at your school have indicated that they are prepared to organise students to do online surveys using school computer facilities. We seek your approval for them to arrange for groups of students to participate in this data gathering process. We would be seeking students who are doing the higher levels of mathematics in Year 11 and Year 12, or who would be capable of doing the higher level had they chosen to do so.

We also hope you/your staff will be able to assist by inviting the parents of these capable mathematics students to complete an online survey from their own computer facilities.

When the online surveys are closed off and the data collated we plan to conduct Focus Group Interviews with teachers, parents and students. Your school's assistance in this phase of the project may also be requested.

It is anticipated that findings from the project will be made available to participating schools and in the project report later this year. Participation in the survey is voluntary and anonymous, and no school will be identified in the report. Further details about the survey can be found on the Information Sheet for Participants.

If you have any questions or require further information please contact the Executive Officer for the project, **Trevor Lynch**, either by email trevor.lynch@exemail.com.au or by phone (02) 49337425.

We appreciate that you have taken the time to read this, and hope that you, your students and parents will be able to contribute to this important research project.

Yours faithfully
Will Morony
Executive Officer – AAMT and Chief Investigator
Professor John Pegg
Director – SiMERR National Centre, UNE and Co-Chief Investigator
2 February 2007

Appendix E3: Information Sheet for Students and Parents/Caregivers (Survey Participation)

Maths? Why not?

Unpacking reasons for students' decisions concerning higher-level mathematics in the senior years.

Dear Parent/Caregiver and Students

We would like to invite you to participate in the *Maths? Why Not?* Project. The purpose of this survey is to address the issue of the reduced number of young people with sufficient levels of mathematical background to meet the skill needs of the future. The Project will research the factors that affect students' choices not to take higher level mathematics in the senior years of schooling and beyond. The project will recommend actions to a range of audiences. The views of teachers, students and parents are absolutely crucial to forming an accurate picture of these issues.

To be involved, parents and students are asked to complete separate but parallel surveys online via the website details given below. Using an online survey instrument is a very efficient way of gathering and electronically collating data.

The survey provides you with a unique opportunity to give your views on the factors that are contributing to the reduced number of students who are choosing to do the higher levels of mathematics in the senior school courses throughout the states and territories of Australia.

It is anticipated that findings from the survey will be made available to participants and published in the project report in the first part of 2007. Your participation in the survey is voluntary, and you will not be asked to provide your name. You may withdraw from the survey at any time and there is no penalty for non-participation. No school will be identified in any reports and all data will be kept strictly confidential. Further details about the survey can be found on the attached Information Sheet for Participants.

We have arranged for students to do the survey using the school computer facilities under the supervision of a teacher volunteer. **Parents** are asked to access their personal computers and follow the link **http://www.tickabox.com.au/servlet/Survey?ts=448935209** to access and complete the survey. It should take less than 20 minutes to complete.

If you have any further questions about the survey, please don't hesitate to contact the Executive Officer for the Project, **Trevor Lynch** by email at trevor.lynch@exemail.com.au or by phone (02) 4933 7425.

Yours faithfully

Will Morony
Executive Officer AAMT and Chief Investigator

Professor John Pegg
Director, SiMERR National Centre, UNE

2 February 2007

Information Sheet for Participants

Maths? Why not? Unpacking reasons for students' decisions concerning higher-level mathematics in the senior years

Chief Investigators
Mr Will Morony, Executive Officer AAMT(Chair) (08) 83630288, wmorony@aamt.edu.au
Project Coordinator:
Professor John Pegg, Director SiMERR Australia (02) 6773 5070, jpegg@une.edu.au

Advisory Committee Members
DEST Officers
Mr Scott Lambert (Director) scott.lambert@dest.gov.au
Ms Anne Curtain (Assistant Director) anne.curtain@dest.gov.au
Ms Clare Wynter (Assistant Director) clare.wynter@dest.gov.au
Representatives of AAMT Council
Ms Donna Miller (WA) milld@Curriculum.wa.edu.au
Mr John Shanahan (NT) john.shanahan@nt.gov.au
Ms Glenys Thompson (SA) Thompson.Glenys@saugov.sa.gov.au

Other experts
Ms Kate Castine (SA; Principal and Career Ed expert) castine@bigpond.net.au
Dr Terry Lyons (NSW; Science Ed expert) tlyons@mailhub2.une.edu.au

Executive Officer
Mr Trevor Lynch (Research Assistant) trevor.lynch@exemail.com.au

Research:
Australia has a reduced number of young people with sufficient levels of mathematical background to meet the skill needs of the future. The Project will research the factors that affect students' choices not to take higher level mathematics in the senior years of schooling and beyond. The project will recommend actions to a range of audiences. The views of teachers, students and parents are absolutely crucial to forming an accurate picture of these issues.

Research Methods:
Phase 1:
Surveys will be completed online by teachers, students, parent/caregivers and careers advisers. There are four versions of the survey for the four target groups. These groups are: mathematics teachers who are members of The Australian Association of Mathematics Teachers (AAMT) and their colleagues, students studying mathematics in Year 11 and 12 at the secondary level whose achievements in mathematics indicate that they are capable of doing the higher levels in the subject, parents/caregivers of these capable students and career advisers who assist students with their career paths. The surveys should take no more than 20 minutes to complete.

Phase 2:
Further data will be collected through online discussion groups and semi-structured Focus Group Interviews with samples of the populations from Phase I. The interviews will be conducted in cooperating schools. Interviews will be tape-recorded.

Confidentiality:
Participation in the project is entirely voluntary. All survey responses will remain anonymous. At no stage will opinions expressed in survey or interviews be identifiable to teachers, principals or the general public. The identity of any school will remain confidential in subsequent reports or publications. All data will be kept in locked filing cabinets or on computer hard drives accessible only by the researchers. All data will be destroyed after five years.

Availability of Research Findings:
This project is likely to be completed early in 2007, and a summary of the conclusions will be made available on the SiMERR Australia website, http://simerr.une.edu.au/. The study has the approval of your state DET (SERAP No. 2006074) and the Human Research Ethics Committee of the University of New England (Approval No. HE 06/154). If you have any further questions or concerns about this study, please don't hesitate to contact the Executive Officer for the Project, **Trevor Lynch**, by email trevor.lynch@exemail.com.au or by phone (02) 4933 7425. Should you have any complaints concerning the manner in which this research is conducted, please contact the Research Ethics Officer at the following address:

Research Services, The University of New England, NSW 2351, Ph. (02) 6773 3449, Fax (02) 6773 3543
Email ethics@.une.edu.au

Thank you for taking the time to read this Information Sheet.

Appendix E4: Student Consent Form (Survey Participation)

Maths? Why not?
Consent Form for Students participating in Survey

Chief Investigators:

Mr Will Morony	Project Coordinator, AAMT GPO Box 1729 Adelaide SA 5001 Tel. (08) 8363 0288
Professor John Pegg	SiMERR National Centre The University of New England, NSW 2351 Tel. (02) 6773 5070

Participant Information

Surname: .... First name: ....

School: ....

Age:.. School Year in 2007: ....

Name(s) of parent(s) or caregiver...

Contact Address and telephone number: ....

....

....

Ph: ....

Please complete the Consent Form over the page

CONSENT

In signing below, I .... (Parent/Caregiver's full name) agree that:

- I have read the information contained in the Information Sheet for Participants and any questions I have asked have been answered to my satisfaction. I agree to .... (full name of my child) participating in this activity, realising that I may withdraw my child at any time. I agree that research data gathered for the study may be published, provided that my child's name is not used.

- I understand the nature of the research sufficiently well to make a free, informed decision on behalf of the person under 18.
- I am satisfied that the circumstances in which the research is being conducted provide for the physical, emotional and psychological safety of my child.

Signature (parent/caregiver): .... Date: ....

Signature (student):.. Date:......................................

Appendix E5: Letter to School Principals (Focus Group Participation)

<Date>

Principal
School
Address
State, pcode

Maths? Why not?

Unpacking reasons for students' decisions concerning higher-level mathematics in the senior years.

Dear Principal

I am writing to seek your permission to invite, teachers students and parents/caregivers from your school to now participate in Focus Group Interviews, the second phase of the *Maths? Why Not?* Project. You will recall that the project is researching the factors that affect students' choices not to take higher-level mathematics in the senior years of schooling and beyond. The project will recommend actions to a range of audiences.

As you will recall, staff, students and parents from your school have already contributed to the project by completing online surveys. The focus group interviews will complement survey data collected during an earlier phase of the study. The purpose of the interviews is for researchers to gather the views of teachers' parents' and students' about some of the issues that emerged from those surveys. Parents and students, along with teachers involved in mathematics make up the three focus groups. It is envisaged that each of these groups would consist of approximately five to eight members, and the focus group interviews would be held at times and dates convenient to the participants and your school. It is anticipated that each interview would take approximately one hour.

One of our research team will be in contact with you soon to ask whether you are willing for your school to host the focus groups, and if so, to discuss the details, negotiate a time and date and any teacher relief that may be required. If you are amenable to the research, I would appreciate it if you could canvass the idea among your mathematics staff and parent groups and perhaps identify possible interview participants.

The Maths? Why Not? Project is funded by the Australian Government, and has the approval of the (state/territory) Department of Education and Training, Approval Number ….. It is anticipated the findings will be made available to participating schools and be published in the report on the project in the first part of 2007. Participation in the project is voluntary, no person or school will be identified in the report.

If you would like to know more about this research, please contact the Executive Officer, **Trevor Lynch** email trevor.lynch@exemail.com.au or phone (02) 4933 7425 or Will Morony on(08) 83630288 or John Pegg on (02) 6773 5070. I appreciate you taking the time to read this, and hope that you and your teachers and parents will be able to contribute to this important research project.

Yours faithfully

Will Morony
AAMT Executive Officer

Professor John Pegg
Director SiMERR National Centre UNE

Appendix E6: Letter to Teachers (Focus Group Participation)

<Date>

Maths? Why not?

Unpacking reasons for students' decisions concerning higher-level mathematics in the senior years.

Dear Teacher or Parent/Caregiver,

I am writing to invite you to participate in a Focus Group Interview, the second phase of the *Maths? Why Not?* Project. You will remember that the project is researching the factors that affect students' choices not to take higher level mathematics in the senior years of schooling and beyond. The project will recommend actions to a range of audiences.

As you will recall, teachers, students and parents from your school have already contributed to the project by completing online surveys. The focus group interviews will complement survey data collected during that earlier phase of the study. The purpose of the interviews is for researchers to gather the views of teachers and parents about some of the issues that emerged from those surveys. It is envisaged that each of these groups would consist of approximately five to eight members, and the focus group interviews would be held at times and dates convenient to the participants and your school. It is anticipated that each interview would take approximately one hour. It will be necessary to record discussions in the focus groups in order to maximise the trustworthiness of the research findings, however all identifying characteristics will be removed when the tapes are transcribed.

One of our research team will be in contact with the principal of the school soon to determine if you are willing to participate, to organise details and negotiate a time and date.

The Maths? Why Not? Project is funded by the Australian Government, and has the approval of the (state/territory) Department of Education and Training, Approval Number ….. It is anticipated that the findings will be made available to participating schools and be published in the report on the project in the first part of 2007. Participation in the project is voluntary, no person or school will be identified in the report.

If you would like to know more about this research, please contact the Executive Officer, **Trevor Lynch** email trevor.lynch@exemail.com.au or phone (02) 4933 7425 or Will Morony on(08) 83630288 or John Pegg on (02) 6773 5070. I appreciate you taking the time to read this, and hope that you will be able to contribute to this important research project.

Yours faithfully

Will Morony
AAMT Executive Officer

Professor John Pegg
Director SiMERR National Centre UNE

Information Sheet for Participants

Title

***Maths? Why not?* Unpacking reasons for students' decisions concerning higher-level mathematics in the senior years**

Chief Investigators
Mr Will Morony, Executive Officer AAMT(Chair) (08) 83630288, wmorony@aamt.edu.au
Project Coordinator:
Professor John Pegg, Director SiMERR Australia (02) 6773 5070, jpegg@une.edu.au

Advisory Committee Members
DEST Officers
Mr Scott Lambert (Director) scott.lambert@dest.gov.au
Ms Anne Curtain (Assistant Director) anne.curtain@dest.gov.au
Ms Clare Wynter (Assistant Director) clare.wynter@DEST.gov.au
Representatives of AAMT Council
Ms Donna Miller (WA) milld@Curriculum.wa.edu.au
Mr John Shanahan (NT) john.shanahan@nt.gov.au
Ms Glenys Thompson (SA) Thompson.Glenys@saugov.sa.gov.au

Other experts
Ms Kate Castine (SA; Principal and Career Ed expert) castine@bigpond.net.au
Dr Terry Lyons (NSW; Science Ed expert) tlyons@mailhub2.une.edu.au

Executive Officer
Mr Trevor Lynch (Research Assistant) trevor.lynch@exemail.com.au

Research:
Australia has a reduced number of young people with sufficient levels of mathematical background to meet the skill needs of the future. The Project will research the factors that affect students' choices not to take higher-level mathematics in the senior years of schooling and beyond. The project will recommend actions to a range of audiences. The views of teachers, students and parents are absolutely crucial to forming an accurate picture of these issues.

Research Methods:
Phase 1:
Surveys will be completed online by teachers, students, parent/caregivers and careers advisers. There are four versions of the survey for the four target groups. These groups are: mathematics teachers who are members of The Australian Association of Mathematics Teachers (AAMT) and their colleagues, students studying mathematics in Year 10 at the secondary level whose achievements in mathematics indicate that they are capable of doing the higher levels in the subject, parents/caregivers of these capable students and career advisers who assist students with their career paths. The surveys should take no more than 20 minutes to complete.
Phase 2:
Further data will be collected through online discussion groups and semi-structured Focus Group Interviews with samples of the populations from Phase I. The interviews will be conducted in cooperating schools. Interviews will be tape-recorded.

Confidentiality:
Participation in the project is entirely voluntary. All survey responses will remain anonymous. At no stage will opinions expressed in survey or interviews be identifiable to teachers, principals or the general public. The identity of any school will remain confidential in subsequent reports or publications. All data will be kept in locked filing cabinets or on computer hard drives accessible only by the researchers. All data will be destroyed after five years.

Availability of Research Findings:
This project is likely to be completed by February 2007, and a summary of the conclusions will be made available on the SiMERR Australia website, http://simerr.une.edu.au/. The study has the approval of your state/territory DET/ CEC (No. XXX) and the Human Research Ethics Committee of the University of New England (Approval No. HEXX/XX). If you have any further questions or concerns about this study, please don't hesitate to contact the Executive Officer for the Project, **Trevor Lynch**, by email trevor.lynch@exemail.com.au or by phone (02) 4933 7425. Should you have any complaints concerning the manner in which this research is conducted, please contact the Research Ethics Officer at the following address:

Research Services, The University of New England, NSW 2351, Ph. (02) 6773 3449, Fax (02) 6773 3543
Email ethics@.une.edu.au

Thank you for taking the time to read this Information Sheet.

Appendix E7: Letter to Students (Focus Group Participation)

Maths? Why not?
Unpacking reasons for students' decisions concerning higher-level mathematics in the senior years.

Dear Student,

I am writing to invite you to participate in a Focus Group Interview, the second phase of the *Maths? Why Not?* Project. You will remember that the project is researching the factors that affect students' choices not to take higher level mathematics in the senior years of schooling and beyond. The project will recommend actions to a range of audiences.

As you will recall, teachers, students and parents from your school have already contributed to the project by completing online surveys. The focus group interviews will add to the survey data collected during that earlier phase of the study. The purpose of the interviews is for researchers to gather the views of students about some of the issues that emerged from those surveys. It is envisaged that each of these groups would consist of approximately five to eight members, and the focus group interviews would be held at times and dates convenient to the participants and your school. It is anticipated that each interview would take approximately one hour. It will be necessary to record discussions in the focus groups in order to maximise the trustworthiness of the research findings, however all identifying characteristics will be removed when the tapes are transcribed.

One of our research team will be in contact with the principal and teachers in your school soon to determine if you are willing to participate, to organise details and negotiate a time and date.

The Maths? Why Not? Project is funded by the Australian Government, and has the approval of the (state/territory) Department of Education and Training, Approval Number ….. It is anticipated that the findings will be made available to participating schools and be published in the report on the project in the first part of 2007. Participation in the project is voluntary, no person or school will be identified in the report.

If you would like to know more about this research, please contact the Executive Officer, **Trevor Lynch** email trevor.lynch@exemail.com.au or phone (02) 4933 7425 or Will Morony on(08) 83630288 or John Pegg on (02) 6773 5070. I appreciate you taking the time to read this, and hope that you will be able to contribute to this important research project.

Yours faithfully

Will Morony
Executive Officer AAMT and Chief Investigator
Professor John Pegg
Director, SiMERR National Centre, UNE

Information Sheet for Participants

Title

***Maths? Why not?* Unpacking reasons for students' decisions concerning higher-level mathematics in the senior years**

Chief Investigators
Mr Will Morony, Executive Officer AAMT(Chair) (08) 83630288, wmorony@aamt.edu.au Project Coordinator:
Professor John Pegg, Director SiMERR Australia (02) 6773 5070, jpegg@une.edu.au

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Mr Scott Lambert (Director) scott.lambert@dest.gov.au
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Ms Clare Wynter (Assistant Director) clare.wynter@DEST.gov.au
Representatives of AAMT Council
Ms Donna Miller (WA) milld@Curriculum.wa.edu.au
Mr John Shanahan (NT) john.shanahan@nt.gov.au
Ms Glenys Thompson (SA) Thompson.Glenys@saugov.sa.gov.au
Other experts
Ms Kate Castine (SA; Principal and Career Ed expert) castine@bigpond.net.au
Dr Terry Lyons (NSW; Science Ed expert) tlyons@mailhub2.une.edu.au

Executive Officer
Mr Trevor Lynch (Research Assistant) trevor.lynch@exemail.com.au

Research:
Australia has a reduced number of young people with sufficient levels of mathematical background to meet the skill needs of the future. The Project will research the factors that affect students' choices not to take higher-level mathematics in the senior years of schooling and beyond. The project will recommend actions to a range of audiences. The views of teachers, students and parents are absolutely crucial to forming an accurate picture of these issues.

Research Methods:
Phase 1:
Surveys will be completed online by teachers, students, parent/caregivers and careers advisers. There are four versions of the survey for the four target groups. These groups are: mathematics teachers who are members of The Australian Association of Mathematics Teachers (AAMT) and their colleagues, students studying mathematics in Year 10 at the secondary level whose achievements in mathematics indicate that they are capable of doing the higher levels in the subject, parents/caregivers of these capable students and career advisers who assist students with their career paths. The surveys should take no more than 20 minutes to complete.

Phase 2:
Further data will be collected through online discussion groups and semi-structured Focus Group Interviews with samples of the populations from Phase I. The interviews will be conducted in cooperating schools. Interviews will be tape-recorded.

Confidentiality:
Participation in the project is entirely voluntary. All survey responses will remain anonymous. At no stage will opinions expressed in survey or interviews be identifiable to teachers, principals or the general public. The identity of any school will remain confidential in subsequent reports or publications. All data will be

kept in locked filing cabinets or on computer hard drives accessible only by the researchers. All data will be destroyed after five years.

Availability of Research Findings:
This project is likely to be completed by February 2007, and a summary of the conclusions will be made available on the SiMERR Australia website, http://simerr.une.edu.au/. The study has the approval of your state/territory DET/ CEC (No. XXX) and the Human Research Ethics Committee of the University of New England (Approval No. HEXX/XX). If you have any further questions or concerns about this study, please don't hesitate to contact the Executive Officer for the Project, **Trevor Lynch**, by email trevor.lynch@exemail.com.au or by phone (02) 4933 7425. Should you have any complaints concerning the manner in which this research is conducted, please contact the Research Ethics Officer at the following address:

Research Services, The University of New England, NSW 2351, Ph. (02) 6773 3449, Fax (02) 6773 3543
Email ethics@.une.edu.au

Thank you for taking the time to read this Information Sheet.

Appendix E8: Teacher Consent Form (Focus Group Participation)

PARTICIPANT COPY

Maths? Why not? **Consent Form for Teachers (or Parents/Caregivers)**

participating in Focus Group Interviews

I (name) ________________________have read the information contained in the Information Sheet for Participants and any questions I have asked have been answered to my satisfaction. I agree to participate in a focus group interview, realising that I may withdraw at any time. I understand that the interview will be tape recorded. I agree that research data gathered for the study may be published provided my name is not used. I am 18 years of age or older.

Signed ....
Date ....

RESEARCHER COPY

Maths? Why not? **Consent Form for Teachers (or Parents/Caregivers)**

participating in Focus Group Interviews

I (name) ________________________have read the information contained in the Information Sheet for Participants and any questions I have asked have been answered to my satisfaction. I agree to participate in a focus group interview, realising that I may withdraw at any time. I understand that the interview will be tape recorded. I agree that research data gathered for the study may be published provided my name is not used. I am 18 years of age or older.

Signed ....
Date ....

Appendix E9: Student Consent Form (Focus Group Participation)

PARTICIPANT COPY

Maths? Why not?

Consent Form for Students participating in Focus Group Interviews

Chief Investigators:

Mr Will Morony — Project Coordinator, AAMT
GPO Box 1729 Adelaide SA 5001
Tel. (08) 8363 0288

Professor John Pegg — SiMERR National Centre
The University of New England, NSW 2351
Tel. (02) 6773 5070

Participant Information

Surname: .... First name: ....

School: ....

Age:.. School Year in 2006: ....

Name(s) of parent(s) or caregiver..

Contact Address and telephone number: ....

....

....

Ph: ....

Please complete the Consent Form over the page

CONSENT

In signing below, I .... (Parent/Caregiver's full name) agree that:

- I have read the information contained in the Information Sheet for Participants and any questions I have asked have been answered to my satisfaction. I agree to .... (full name of my child) participating in this activity, realising that I may withdraw my child at any time. I agree that research data gathered for the study may be published, provided that my child's name is not used.

- I understand the nature of the research sufficiently well to make a free, informed decision on behalf of the person under 18.
- I am satisfied that the circumstances in which the research is being conducted provide for the physical, emotional and psychological safety of my child.
- As a parent/caregiver, I would like to participate in the Parent Forum. Please contact me at a later date regarding the times and venues for these forums.

Signature (parent/caregiver): .... Date: ....

Signature (student):... Date: ....

RESEARCHER COPY

Maths? Why not?

Consent Form for Students participating in Focus Group Interviews

Chief Investigators:

Mr Will Morony	Project Coordinator, AAMT GPO Box 1729 Adelaide SA 5001 Tel. (08) 8363 0288
Professor John Pegg	SiMERR National Centre The University of New England, NSW 2351 Tel. (02) 6773 5070

Participant Information

Surname: .... First name: ....

School: ....

Age:... School Year in 2006: ....

Name(s) of parent(s) or caregiver..

Contact Address and telephone number: ....

....

....

Ph:...

Please complete the Consent Form over the page

CONSENT

In signing below, I .... (Parent/Caregiver's full name) agree that:

- I have read the information contained in the Information Sheet for Participants and any questions I have asked have been answered to my satisfaction. I agree to .... (full name of my child) participating in this activity, realising that I may withdraw my child at any time. I agree that research data gathered for the study may be published, provided that my child's name is not used.

- I understand the nature of the research sufficiently well to make a free, informed decision on behalf of the person under 18.
- I am satisfied that the circumstances in which the research is being conducted provide for the physical, emotional and psychological safety of my child.
- As a parent/caregiver, I would like to participate in the Parent Forum. Please contact me at a later date regarding the times and venues for these forums.

Signature (parent/caregiver): .... Date: ....

Signature (student):.. Date: ....

Appendix F: Material About Parent Surveys Provided to Volunteer Teachers

Maths? Why not?

Unpacking reasons for students' decisions concerning higher-level mathematics in the senior years.

Dear Parent/Caregiver and Students

We would like to invite you to participate in the *Maths? Why Not?* Project. The purpose of this survey is to address the issue of the reduced number of young people with sufficient levels of mathematical background to meet the skill needs of the future. The Project will research the factors that affect students' choices not to take higher level mathematics in the senior years of schooling and beyond. The project will recommend actions to a range of audiences. The views of teachers, students and parents are absolutely crucial to forming an accurate picture of these issues.

To be involved, parents and students are asked to complete separate but parallel surveys online via the website details given below. Using an online survey instrument is a very efficient way of gathering and electronically collating data.

The survey provides you with a unique opportunity to give your views on the factors that are contributing to the reduced number of students who are choosing to do the higher levels of mathematics in the senior school courses throughout the states and territories of Australia.

It is anticipated that findings from the survey will be made available to participants and published in the project report in 2007. Your participation in the survey is voluntary, and you will not be asked to provide your name. You may withdraw from the survey at any time and there is no penalty for non-participation. No school will be identified in any reports and all data will be kept strictly confidential. Further details about the survey can be found on the attached Information Sheet for Participants.

We have arranged for students to do the survey using the school computer facilities under the supervision of a teacher volunteer. **Parents** are asked to access their personal computers and follow the link **http://www.tickabox.com.au/servlet/Survey?ts=298434818** to access and complete the survey. It should take less than 20 minutes to complete.

If you have any further questions about the survey, please don't hesitate to contact the Executive Officer for the Project, **Trevor Lynch** by email at trevor.lynch@exemail.com.au or by phone (02) 4933 7425.

Yours faithfully

Will Morony
Executive Officer AAMT and Chief Investigator

Professor John Pegg
Director, SiMERR National Centre, UNE
2 February 2007

Information Sheet for Participants

Maths? Why not? Unpacking reasons for students' decisions concerning higher-level mathematics in the senior years

Chief Investigators

Mr Will Morony, Executive Officer AAMT(Chair) (08) 83630288, wmorony@aamt.edu.au
Project Coordinator:
Professor John Pegg, Director SiMERR Australia (02) 6773 5070, jpegg@une.edu.au

Advisory Committee Members

DEST Officers
Mr Scott Lambert (Director) scott.lambert@dest.gov.au
Ms Anne Curtain (Assistant Director) anne.curtain@dest.gov.au
Ms Clare Wynter (Assistant Director) clare.wynter@dest.gov.au
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Other experts

Ms Kate Castine (SA; Principal and Career Ed expert) castine@bigpond.net.au
Dr Terry Lyons (NSW; Science Ed expert) tlyons@mailhub2.une.edu.au

Executive Officer

Mr Trevor Lynch (Research Assistant) trevor.lynch@exemail.com.au

Research:

Australia has a reduced number of young people with sufficient levels of mathematical background to meet the skill needs of the future. The Project will research the factors that affect students' choices not to take higher level mathematics in the senior years of schooling and beyond. The project will recommend actions to a range of audiences. The views of teachers, students and parents are absolutely crucial to forming an accurate picture of these issues.

Research Methods:

Phase 1:
Surveys will be completed online by teachers, students, parent/caregivers and careers advisers. There are four versions of the survey for the four target groups. These groups are: mathematics teachers who are members of The Australian Association of Mathematics Teachers (AAMT) and their colleagues, students studying in Year 11 and 12 at the secondary level whose achievements in mathematics indicate that they are capable of doing the higher levels in the subject, parents/caregivers of these capable students and career advisers who assist students with their career paths. The surveys should take no more than 20 minutes to complete.

Phase 2:
Further data will be collected through online discussion groups and semi-structured Focus Group Interviews with samples of the populations from Phase I. The interviews will be conducted in cooperating schools. Interviews will be tape-recorded.

Confidentiality:

Participation in the project is entirely voluntary. All survey responses will remain anonymous. At no stage will opinions expressed in survey or interviews be identifiable to teachers, principals or the general public. The identity of any school will remain confidential in subsequent reports or publications. All data will be kept in locked filing cabinets or on computer hard drives accessible only by the researchers. All data will be destroyed after five years.

Availability of Research Findings:
This project is likely to be completed early in 2007, and a summary of the conclusions will be made available on the SiMERR Australia website, http://simerr.une.edu.au/. The study has the approval of your state DECS (No. CS/06/0116-3.4) and the Human Research Ethics Committee of the University of New England (Approval No. HE 06/154). If you have any further questions or concerns about this study, please don't hesitate to contact the Executive Officer for the Project, **Trevor Lynch**, by email trevor.lynch@exemail.com.au or by phone (02) 4933 7425. Should you have any complaints concerning the manner in which this research is conducted, please contact the Research Ethics Officer at the following address:

Research Services, The University of New England, NSW 2351, Ph. (02) 6773 3449, Fax (02) 6773 3543
Email ethics@.une.edu.au

Thank you for taking the time to read this Information Sheet.

Appendix G: Parent Surveys

tick box | Help | Home | Build Survey | Edit Survey | Survey Recipients | Survey Action

Math:Why Not - Parents (preview)

Parents' survey

About your child and their school

1 * Your child is a

Girl · Boy

2 * How old are they?

14 · 15 · 16 · 17

Other, please specify:

3 * They are currently in

Year 10 · Year 11

Other, please specify:

4 * What sort of school do they go to?

- General secondary to Year 12
- Senior secondary
- Combined primary and secondary (to Year 12)
- Secondary to Year 10 only
- Combined primary and secondary (to Year 10 only)
- Other, please specify:

5 Where is the school located?

- Remote area
- Regional/provincial area
- Provincial city (pop 25 000 to 100 000)
- Metropolitan area (pop >100 000)

About your child and maths

6 What they did at primary school was good preparation for high school maths

Strongly agree · Agree · Unsure · Disagree · Strongly disagree

7 Can you remember when your child first started thinking seriously about what they want to be when they grow up?

Early primary school · Upper primary school · Early secondary · Not yet thinking seriously about it · Can't remember

8 My child enjoys maths

A lot more than other subjects · A bit more than other subjects · The same as other subjects · A bit less than other subjects · A lot less than other subjects

9 My child is pretty good at maths

Strongly agree · Agree · Unsure · Disagree · Strongly disagree

10 My child is well informed about how different maths courses lead to careers

Strongly agree · Agree · Unsure · Disagree · Strongly disagree

Influences on your child's choice of maths subject in 2007

11 My child has chosen their maths course for senior secondary school because they have found maths interesting in junior secondary school

Strongly agree · Agree · Unsure · Disagree · Strongly disagree

12 My child has chosen their maths course for senior secondary school because they like maths

Strongly agree · Agree · Unsure · Disagree · Strongly disagree

13 My child has chosen their maths course for senior secondary school because they are good at maths

Strongly agree · Agree · Unsure · Disagree · Strongly disagree

14 My child has chosen their maths course for senior secondary school because they will get the good teachers

Strongly agree · Agree · Unsure · Disagree · Strongly disagree

15 My child has chosen their maths course for senior secondary school because the one they wanted to do clashed with other subjects on the timetable

Strongly agree · Agree · Unsure · Disagree · Strongly disagree

16 My child has chosen their maths course for senior secondary school because they think they will get good marks

Strongly agree · Agree · Unsure · Disagree · Strongly disagree

17 My child has chosen their maths course for senior secondary school because it will give them the best score they can get in Year 12

Strongly agree · Agree · Unsure · Disagree · Strongly disagree

18 My child has chosen their maths course for senior secondary school because they need it for a job or course (Uni or TAFE)

Strongly agree · Agree · Unsure · Disagree · Strongly disagree

19 My child has chosen their maths course for senior secondary school because they think it will be good for them in life

Strongly agree · Agree · Unsure · Disagree · Strongly disagree

20 My child has chosen their maths course for senior secondary school because it was what their maths teacher suggested

Strongly agree · Agree · Unsure · Disagree · Strongly disagree

21 My child has chosen their maths course for senior secondary school because other teacher(s) in the school suggested they do it

Strongly agree · Agree · Unsure · Disagree · Strongly disagree

22 My child has chosen their maths course for senior secondary school because the school's careers adviser suggested it

Strongly agree · Agree · Unsure · Disagree · Strongly disagree

23 My child has chosen their maths course for senior secondary school because of the information they got from careers websites, brochures, careers expos etc.

Strongly agree · Agree · Unsure · Disagree · Strongly disagree

24 My child has chosen their maths course for senior secondary school because of my/our influence

Strongly agree · Agree · Unsure · Disagree · Strongly disagree

25 My child has chosen their maths course for senior secondary school because of the influence of their friends

Strongly agree · Agree · Unsure · Disagree · Strongly disagree

26 My child has chosen their maths course for senior secondary school because older students advised them to

Strongly agree · Agree · Unsure · Disagree · Strongly disagree

27 My child has chosen their maths course for senior secondary school because their older brother(s)/sister(s) advised them to do it

Strongly agree · Agree · Unsure · Disagree · Strongly disagree · Not relevant - no older siblings

28 My child has chosen their maths course for senior secondary school because it doesn't involve having to have lessons 'off-line' (ie before school etc)

Strongly agree · Agree · Unsure · Disagree · Strongly disagree · Not relevant

Your views about maths and career choices

29 It is important to me that my child does the highest level maths they can

Strongly agree · Agree · Unsure · Disagree · Strongly disagree

30 It is important that my child do the subjects that will give them the highes score at the end of Year 12

Strongly agree · Agree · Unsure · Disagree · Strongly disagree

31 It is important to me that my child has a good idea of their directions beyond school

Strongly agree · Agree · Unsure · Disagree · Strongly disagree

32 It is important to me that I am able to influence what subjects my child does at school and beyond

Strongly agree · Agree · Unsure · Disagree · Strongly disagree

33 It is important to me that my child is happy with their choice of subjects

Strongly agree · Agree · Unsure · Disagree · Strongly disagree

34 What would you see as the advantages of your child doing Extension Maths at school?

Please enter your response:

35 What would you see as the disadvantages of your child doing Extension Maths at school?

Please enter your response:

36 Do you have any other comments about how to help students to become more aware of career choices?

Please enter your response:

37 New question

- Remote area
- Regional/provincial area
- Provincial city (pop 25 000 to 100 000)
- Metropolitan area (pop >100 000)
- Other, please specify:

(preview)

Return to survey editor

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Appendix H: General Coding Framework

General Category	Specific category	Explanatory Notes	Code
Curriculum/Methodology	Structure	Courses offered; topics/strands covered; sequencing; enrichment/ext.	110/1
	Image of maths	Capacity for creativity, self-expression; meeting learning needs; motivational; status; maths is for the brainy; abstract; fun	120/1
	Difficulty & competition	Maths is hard; other subjects are easier/more attractive/softer options	130/1
	Pedagogy	Mode of teacher delivery; student focus	140/1
	Rigour & Student preparation for HM	Depth of treatment of prerequisite topics needed for higher maths; falling standards; acquired knowledge/skills/understandings	150/1
Subject Usefulness	Career relevance	Required for a specific career	210/1
	Relevance of Mathematics for learning or life	Does maths reflect post-school needs; view of maths/mathematicians; keeping options open for career pathways; maths is important; personal relevance	220/1
Tertiary Entrance	Needed	As a "stepping stone" to further study;	310/1
	Maximise UAI/TER	A specific TER needed; how maths/"easier" subjects are rewarded	320/1
	Internal University prerequisite	Individual university department requirements	330/1
Early School Experiences	Teaching & Learning in Primary School	The quality of experiences K-6	410/1
	Teaching & Learning in Junior School	The quality of experiences 7-10	420/1
School Factors	Timetable options	Capacity to timetable all subject combinations	510/1
	Class organisation	Distance/correspondence; composite classes; combined schools; Running small or large classes; streaming; mixed ability; middle schooling; acceleration	520/1
	Reputation	Perception that the school is a good school	530/1
	System	Government; Catholic; Independent (Selective, single sex etc …)	540/1
	Location	Rural; Metropolitan	550/1
	Time	Amount required to do maths well	560/1
	Resources	Money, infrastructure, technology required to support & resource quality teaching/learning	570/1
	Professional Development	Support for subject specific requirements	580/1
	Cocurricular offerings	Capacity of a school to provide a comprehensive program	590/1

General Category	Specific category	Explanatory Notes	Code
Student Factors	Aspirations & priorities	Clear focus for post-secondary options; capacity for decision making	610/1
	Cultural	Ethnicity	620/1
	Attitudes to school	View of learning/ teachers; application; workload; interest level/boredom	630/1
	Engagement with school	The extent to which students are involved	640/1
	Self-concept	View of achievement/resilience/support	650/1
	Cohort quality	Level of acquired knowledge/understanding/skills; "bright" vs "dumb"; undertaking what they are capable of	660/1
	Part time work	Effect that part time work plays	670/1
	Gender	Where being male or female has an effect	680/1
Advice & Encouragement	Careers Counsellors	Quality/basis of advice offered; access to counsellor	710/1
	Maths Teachers	Quality/basis of advice offered	720/1
	Other Staff	Quality/basis of advice offered	730/1
	Parents/siblings	Aspirations of parents or the community	740/1
	Peers	Impact of peers before selection/once chosen	750/1
	Reporting	Formal & Informal feedback/support students & parents receive throughout schooling; repeating; celebrating successes	760/1
	Organisations & community	School information sessions; TAFE/Unis/users of maths; promotion by outside groups, including television/media	770/1
	Resources	Printed material available	780/1
External factors	Socioeconomic	High or low	810/1
	Cultural	LBOTE /demographics/community expectations etc	820/1
	Parental background	Education level; occupation	830/1
Teacher Factors	Aspirations	Career goals	910/1
	Cultural	Ethnicity	920/1
	Attitudes to profession & teaching	Valuing maths; accountability; passion; results; collegiality; quality teaching	930/1
	Self-concept	Level of school/colleague support; view of teachers; leadership	940/1
	Preparation & training	Capacity to teach at the desired level; pursuit of PD; knowledge of senior courses; pre-service factors; teaching maths but not trained to teach it	950/1
	Staff stability	Turnover of teachers	960/1
	Teacher workload	Amount of work teachers have to do	970/1
Assessment/Reporting	Formal testing	The role of traditional pen and paper tests	1010/1
	Common testing	Meets student needs; informative	1020/1
	Experience gained role for the future	Students who have done lots of tests already are well prepared	1030/1
	Assignments, projects & Alternative Tasks	Purpose and usefulness; flexible	1040/1
	Extension work	Purpose and usefulness	1050/1
	Outcomes	Value of an outcomes approach	1060/1
	Quantitative Feedback (Mark/position etc)	Holistic/summative appraisal; value of numbers/comments or both	1070/1
	External Assessment	The preparation/value of public exams	1080/1
	Internal Assessment	Quality; purpose (for learning); reflecting syllabus; variety	1090/1

- Code ending in "0" means a negative response reason why students not doing higher levels
- Code ending in "1" means positive response