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Exploring reasons why Australian senior secondary students do not enrol in higher-level mathematics courses

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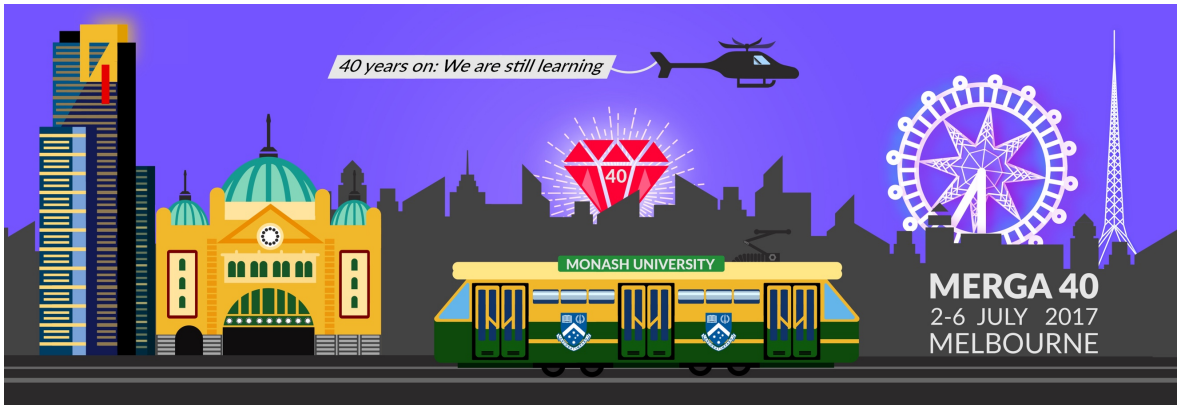

40 years on: We are still learning!

Proceedings of the 40th Annual Conference of the Mathematics Education Research Group of Australasia

Edited by Ann Downton, Sharyn Livy, & Jennifer Hall

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Preface

This publication is a record of the proceedings of the celebratory 40th conference of the Mathematics Education Research Group of Australasia (MERGA), which, like the inaugural MERGA conference, was held at Monash University in Clayton, Melbourne. The proceedings are made available to conference delegates on a USB and are also published on the MERGA website at www.merga.edu.au.

The theme of this 40th anniversary conference was *40 years on: We are still learning!* This theme was chosen to acknowledge the significant contributions of Australasian researchers over the past 40 years, was inspired by a group of currently active researchers who attended both MERGA1 and MERGA40, and is linked to the Monash University motto, *Ancora Imparo* (We are still learning). The theme also highlights the impact and importance of our collective research for enabling new learning, innovation, and critique of mathematics education for those in our region and beyond.

MERGA40 conference participants presented research papers, symposia, round table discussions, and short communications that covered a broad range of topics relevant to mathematics education across all countries, with a particular focus on the Australasian region. The MERGA40 conference also included a series of nine workshops focused on research-related issues and 15 Research Interest Area (RIA) discussion groups aligned with chapter themes in the most recent four-yearly review of mathematics education research in Australasia (Makar et al., 2016). All workshops and RIA discussion groups were led by MERGA members who are acknowledged in the proceedings and conference program. We thank these members for their important contribution, leadership, and generosity.

In accordance with established MERGA procedures, all research papers were blind peer-reviewed by panels of mathematics education researchers with appropriate expertise in the field. Papers were accepted for presentation only, or for both presentation and publication in the conference proceedings. Only those research papers accepted for presentation and publication are published in full in these proceedings. Symposia papers and the abstracts of all short communications and round tables were also peer-reviewed. The published proceedings include the keynote papers; the Beth Southwell Practical Implications Award paper; symposia papers; abstracts for round tables, short communications, and research papers accepted for presentation; and the titles of all workshops and Research Interest Area discussion groups.

We acknowledge, with gratitude, the efforts of the MERGA40 review panel chairs, reviewers, and the Monash editorial team, in reading and providing constructive feedback to presenters in a short timeframe. Ensuring that the published papers are of a high academic quality is an important responsibility of the MERGA community. We thank the proceedings editors, Ann Downton, Sharyn Livy, and Jennifer Hall, for their hard work and care in preparing these proceedings for publication.

Ann Gervasoni and Helen Forgasz
(Co-Conveners of the MERGA40 conference on behalf of the MERGA40 Monash organising committee)

Reference

Makar, K., Dole, S., Visnovska, J., Goos, M., Bennison, A., & Fry, K. (Eds.). (2016). *Research in mathematics education in Australasia 2012–2015*. Singapore: Springer.

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Contents

RESEARCH REPORTS

SHORT COMMUNICATION ABSTRACTS

Exploring Reasons Why Australian Senior Secondary Students Do Not Enrol in Higher-Level Mathematics Courses

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In this research paper, I present the reasons why senior secondary students elect not to enrol in a higher mathematics course. All Year 11 and Year 12 mathematics students within Western Australian secondary schools were invited to participate in an online survey comprised chiefly of qualitative items. The key reasons espoused by students include an expressed dissatisfaction with mathematics, the opinion that there are other more viable courses of study to pursue, and that the Australian Tertiary Admissions Ranking (ATAR) can be maximised by taking a lower mathematics course. In addition, student testimony suggests that there are few incentives offered for undertaking a higher mathematics course.

Mathematics has been heralded as a critically important subject for students to undertake (McPhan, Morony, Pegg, Cooksey, & Lynch, 2008; Office of the Chief Scientist [OCS], 2014; Sullivan, 2011). This importance has been argued largely on the basis of students learning key interdisciplinary knowledge such as science, technology, and engineering (Ker, 2013), and to use this knowledge base to add intellectual value to new technologies, drive innovation and research capacities, and to help Australia compete globally (Australian Academy of Science [AAS], 2006). Furthermore, failure to produce a workforce with sufficient training in mathematics is considered a national concern for the economy of Australia and for keeping Australia as a competitor in the technological world (AAS, 2006; Hine et al., 2016; Maltas & Prescott, 2014; Rubinstein, 2009).

The importance of mathematics is also highlighted within tertiary study, where researchers suggest that university success depends on the level of mathematics studied at secondary school (Nicholas, Poladin, Mack, & Wilson, 2015; Rylands & Coady, 2009). More specifically, findings from various studies indicate that students who undertake higher-level mathematics courses at a secondary level tend to outperform their counterparts who undertake a lower-level mathematics course (Anderson, Joyce, & Hine, in press; Kajander & Lovric, 2005; Sadler & Tai, 2007). Despite this acknowledged importance, the number of students enrolling in higher-level and intermediate secondary school mathematics in Australia is declining (Barrington & Evans, 2014; Kennedy, Lyons, & Quinn, 2014; Wilson & Mack, 2014).

While most Australian universities have dispensed with subject prerequisites for degree programs (Maltas & Prescott, 2014; Nicholas et al., 2015), the phenomenon of declining enrolments is also experienced within tertiary mathematics courses (Brown, 2009; OCS, 2012). At the same time, there has been a reported increase in first-year university students lacking the appropriate mathematical background to complete courses in various disciplines (Poladian & Nicholas, 2013; Rylands & Coady, 2009; Wilson et al., 2013). Studies conducted in New South Wales and South Australia have identified why Australian students enrol in higher-level mathematics courses (Mathematical Association of New South Wales, 2014; McPhan et al., 2008), but there are few reasons proffered as to why capable students do not enrol in these courses. More recently, some researchers in Queensland have identified that capable students do not enrol in senior calculus mathematics courses due to a limited understanding of the relevance of mathematics (Easey & Gleeson, 2016) or the removal of Mathematics C (an advanced mathematics

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course in Queensland) from university prerequisite lists (Jennings, 2014, 2013). Additionally, there is no research available that seeks to explain the declining student enrolments in a Western Australian context.

Research Aims and Significance

The aim of this research is to explore the perceptions of Year 11 and Year 12 Australian Tertiary Admissions Ranking (ATAR) mathematics students in Western Australian schools as to why they believe that senior secondary students do not enrol in a higher-level mathematics course. The ATAR is a percentile score that denotes an Australian student's academic ranking relative to his or her peers upon completion of secondary education. This score is used to predict a student's suitability for particular university courses and, ultimately, for university entrance. The research itself builds on the findings of a previous study (Hine, 2016) in which I investigated the perceptions of Heads of Learning Area: Mathematics (HOLAMs) as to why they felt that capable senior secondary students do not enrol in the two highest mathematics courses. HOLAMS indicated perceptions of student awareness that two mathematics courses are not needed for university entrance, there are other viable and less rigorous courses of study available, and students can maximise their ATAR score without completing those mathematics courses.

It is hoped that findings from this research project may be of particular interest to secondary and tertiary mathematics educators in Western Australia, and more broadly to mathematics educators across Australia. The overarching guiding question to be explored is: What are the factors that influence Year 11 and Year 12 ATAR students' decisions not to enrol in higher-level mathematics courses in Western Australian secondary schools? This research is a predominantly qualitative study designed to give a snapshot (Rose, 1991) of the students' perceptions regarding this phenomenon.

Methodology

This study was interpretive in nature, and relied principally on qualitative research methods to gather and analyse data about why Year 11 and Year 12 ATAR mathematics students feel that senior secondary students do not enrol in higher-level mathematics courses. All Year 11 and Year 12 ATAR mathematics students in Western Australian secondary schools were invited to participate in the study. Participants registered their perceptions through the completion of a single anonymous, online survey comprising 12 five-point, Likert scale items (Q3) and two open qualitative questions (Q4 and Q5). The survey items were developed from the findings of a previous study (Hine, 2016) as well as from current literature (Barrington & Evans, 2014; Kennedy, Lyons, & Quinn, 2014; Wilson & Mack, 2014). The 12 Likert scale items required participants to the extent to which they felt that senior secondary students did not enrol in a higher mathematics course (1 = Strongly Disagree, 2 = Disagree, 3 = Undecided, 4 = Agree, 5 = Strongly Agree). The two open-ended questions asked participants to elaborate on their responses to the Likert scale items and to make any further comments regarding why they felt that senior secondary students did not enrol in a higher mathematics course. Additional demographic information of participants was obtained through a series of closed questions regarding gender, year level, the mathematics courses currently enrolled in (e.g., Applications, Methods, Specialist), type of school (e.g., secondary 7-12), gender composition of school (e.g., co-educational), and location of school (metropolitan or regional).

Participants

In Western Australia, there are 168 secondary schools (36 Catholic, 52 Independent, and 80 Government) offering Australian Tertiary Admissions Ranking (ATAR) mathematics courses to Year 11 and 12 students. These courses are Mathematics Applications, Mathematics Methods, and Mathematics Specialist (School Curriculum and Standards Authority, 2016). All Year 11 and Year 12 students enrolled in these purposively sampled schools were invited to participate in the research, and a total of 1,351 students from 26 schools gave their consent to participate. The demographic information of the participants is provided in Tables 1, 2, and 3.

Table 1
Summary of Participants' Demographic Data (by Gender and Year Level)

Gender	Year 11	Year 12	Total
Male	278	212	490
Female	455	406	861

Table 2
Summary of Participants' Demographic Data (by School Location and Composition)

School composition	Metropolitan	Regional	Total
Coeducational	737	113	850
Single Gender	501	0	501

Table 3
Summary of Participants' Demographic Data (by Mathematics Course and Gender)

Course(s)	Male	Female	Total
Applications	264	554	818
Applications and Methods	7	9	16
Methods	109	288	397
Methods and Specialist	58	62	120

Data Analysis

Qualitative data from the 1,351 completed surveys were explored using a content analysis process. According to Berg (2007), content analysis is "a careful, detailed systematic examination and interpretation of a particular body of material in an effort to identify patterns, themes, biases and meaning" (p. 303). After the two open-ended questions had been examined for themes, patterns, and shared perspectives, I analysed the data according to a framework offered by Miles and Huberman (1994), which comprises the steps: data collection, data reduction, data display, and conclusion drawing/verification. The themes drawn from the qualitative data are displayed in Table 5. For responses to the Likert scale items, descriptive statistics (weighted mean) were used to analyse collected data.

Findings

For the Likert scale items, the number of participants registering a scale rating (i.e., 1 - 5) and the weighted mean for each question item has been included. Within Table 4, a higher weighted mean represents stronger agreement with the question item, while a lower weighted mean represents stronger disagreement. In descending order, the five question items "Other courses are more viable/more attractive", "Dissatisfaction with mathematics", "Maximise ATAR without higher maths", "Higher mathematics not scaled", and "Not needed for university entrance" registered the highest weighted means. At the same time, question items "Not offered at our school", "Gender-related issues", and a "Lack of qualified staff" received the lowest weighted means.

Table 4
Responses to Likert-Scale Question Items

Question item	1	2	3	4	5	Weighted mean
Other courses more viable/attractive	38	112	262	549	383	3.83
Dissatisfaction with mathematics	99	213	467	413	152	3.22
Maximise ATAR without higher maths	94	228	489	404	128	3.18
Higher mathematics not scaled	200	250	315	278	301	3.17
Not needed for university entrance	160	303	322	377	185	3.09
Compulsory subject selections	324	305	366	243	101	2.62
Friends doing the same courses	343	373	355	220	52	2.45
Dislike the teachers	415	328	318	187	95	2.42
Timetabling constraints	485	360	308	138	43	2.17
Lack of qualified staff	707	262	201	100	67	1.92
Gender-related issues	863	228	170	41	39	1.63
Not offered at our school	1098	92	95	26	27	1.34

Table 5
Summary of Extended Answer Questions (Responses to Questions 4 and 5)

Key Themes	Question 4	Question 5	Total
Dissatisfaction with mathematics	215	558	773
Other courses are more viable/more attractive	108	282	390
Higher mathematics courses are not scaled sufficiently	102	60	162
Not needed for university entrance	60	73	133
ATAR can be maximised taking a lower maths course	76	55	131
Not needed for future life or career	33	72	105
Dissatisfaction with higher mathematics teachers	52	46	98

For Questions 4 and 5, the most commonly proffered qualitative responses included a dissatisfaction with mathematics, a decision to enrol in more attractive or viable courses, and a perception that mathematics is insufficiently scaled as a Year 12 course (see Table

5). These qualitative responses (which have been summarised in Table 5 with other responses) will now be explored.

Dissatisfaction with Mathematics

Participants asserted that the chief reason that secondary students did not enrol in a higher mathematics was due to a dissatisfaction with mathematics. Such dissatisfaction was registered via a variety of associated themes, including a perceived discrepancy between the complexity and workload of Applications and Methods courses, an acknowledged mismatch between effort and reward, a lack of confidence to study a higher mathematics, and an expressed lack of interest or enjoyment in the subject. The most frequently expressed theme by participants was the perceived discrepancy between Mathematics Applications and Methods courses, particularly in terms of overall workload and complexity of content (Q4: 139/215, Q5: 395/558). For instance, one participant reflected on this perceived discrepancy between courses:

> I was previously enrolled in Methods, however I found it extremely hard. I had never received such low scores in maths. Now being in Applications, I have noticed that the topics studied are completely unrelated to Methods. It's not necessarily that Methods students are learning a harder level of math, they are learning a completely different topic which is harder to understand. I didn't see how what we learnt applied to real life like the topics we learnt in Applications do. I think there needs to be a bit of consistency in the topics. I also found Methods stressful as we went through the topics very fast.

From those participants asserting that students' dissatisfaction with mathematics stemmed from a perceived discrepancy between Applications and Methods courses, many proposed that an "in-between" course needs to be developed and offered to students. According to those participants, such a course would contain a considerable amount of content common to both Methods and Applications courses, and pitched at a level of difficulty in between those courses.

Other Courses are Viable/More Attractive

The second most common assertion participants made was that secondary students tend to enrol in those courses of study that appear to be more viable or more attractive than a higher mathematics course. In particular, participant responses regarding "course viability" or "course attractiveness" were further classified into the following associated themes: Students chose a "lower" mathematics course in order to excel at it, observed that lower courses were less stressful to undertake, rationalised that undertaking a lower mathematics course translated into less time studying mathematics and more time to allocate to other ATAR courses, and decided to broaden the variety of ATAR courses studied. The most commonly occurring theme was that students felt that undertaking a lower mathematics course required them to devote less time to mathematics study and to set aside more time to successfully complete other ATAR courses (Q4: 43/108, Q5: 123/282). To illustrate, a participant stated:

> I feel as though I prefer to do really well in Applications than have to struggle through Methods with only satisfactory results. It also means I can put more effort into other subjects as I am not having to spend hours and hours of my time doing maths each week.

Another participant advanced this statement, rationalising how taking a lower mathematics course translated into increased time for other courses and a higher ATAR overall:

> I think that people don't choose higher maths because the[se subjects] are subjects that require an increased amount of time and effort. You have to weigh up whether or not doing very well in Applications is going to be better for your ATAR than just doing average in Methods. I know for me, I would love to take a higher level maths; however, I wouldn't have time with my other subjects to do as well, and higher maths [subjects] generally don't get scaled enough. So overall it would be detrimental to my ATAR.

A further concession made by many participants was that on top of the perceived extra effort and workload associated with higher mathematics courses, taking a lower mathematics course would not only increase their ATAR score but improve their chances of being accepted into their desired university degree course.

Higher Mathematics Courses are not Scaled Sufficiently

Several participants (Q4: 102, Q5: 60) intimated that the reason that students do not enrol in a harder mathematics course was due to insufficient scaling or incentives. For example, one participant reinforced some previous key findings by arguing "Higher mathematics courses are not scaled enough. The difference between Applications and Methods in hardness is not compensated by scaling. People are better off doing Applications in terms of time spent on the subject and difficulty". Other participants felt that by completing the Mathematics Applications course instead of Mathematics Methods, their mathematics result would be impacted greater by scaling measures. To illustrate, a participant hypothesised:

> If I dropped down to Maths Applications due to the impractical scaling of the two maths subjects (Methods and Applications) I could achieve a better ATAR by getting much higher results which are only scaled down a small amount instead of getting mid-range results which scale up by a small amount. This is seen by many students [who] I know drop down in both the current Year 12 cohort and the Year 11 cohort, this is not rational as harder maths courses are not rewarded per se for their extra effort.

There were some participants who drew attention to the 10% bonus marks offered by the School Curriculum and Standards Authority (SCSA) to Year 12 students completing Mathematics Methods or Mathematics Specialist courses from 2017 onwards. One participant stated:

> Especially for this year, Methods and Specialist will not be given the 10% additional bonus if it is in your top score. Those harder subjects are not scaled much so the same amount of effort required a 65 in Methods could get a 90 in Applications, allows the people who do easier maths to get a higher ATAR…please explain how that is fair at all?

All participants who voiced concerns over insufficient scaling or incentivisation of higher mathematics courses based their reasoning upon a perceived difference in difficultly between courses (e.g., Methods and Applications), a drastically different scaling method to be used for easier or more difficult courses, the maximisation of the ATAR by taking the easier mathematics course, and the incentive offered to students from 2017 onwards. Irrespective of reason, all participants expressed that scaling procedures influenced their decision not to enrol in a higher mathematics course.

Conclusion

The purpose of this research paper was to outline reasons why Year 11 and Year 12 ATAR mathematics students in Western Australia do not enrol in higher-level mathematics courses. I identified three key findings via Likert-scale items (Table 4) and open questions (Table 5) for further consideration. First, students indicated dissatisfaction with the

perceived discrepancy in difficulty of Methods and Applications courses currently offered in Western Australian schools. Aside from the apparent "jump" in content complexity between these courses, students feel that the time and effort spent on undertaking a more difficult course (i.e., Methods) is unrewarded. At the same time, students suggested that the creation of a mathematics course whose level of difficulty lay in between Methods and Applications would assist in reducing the current discrepancy and consequently encourage more students to enrol in it.

Second, students feel that undertaking an easier mathematics course will allow additional time to focus on other ATAR courses. The themes associated with this finding suggest that students are interested in adopting a balanced approach to their studies where they can apportion a similar amount of time and effort to mathematics as their other ATAR courses for maximal reward. Additionally, there appears to be an expressed need by students to feel confident in the mathematics course they take; this confidence is brought about by choosing a course where the content can be mastered and the level of stress associated with such mastery is not atypically high compared with other ATAR courses.

Third, students believe that there is an insufficient reward offered for taking a higher mathematics course. For the most part, students nominated that the scaling procedures or a lack of incentivisation deterred them from enrolling in a more difficult course. Interestingly, at the time of data collection, neither the Year 11 nor Year 12 students involved in the study had any foreknowledge of how the scaling process in Western Australia had worked for previous Mathematics Applications, Mathematics Methods, and Mathematics Specialist student cohorts; they would become the first and second cohorts, respectively. Some Year 12 students lamented that in 2017 – when they had completed secondary schooling – they would miss out on the incentive offered by the Tertiary Institutions Service Centre (TISC) to students completing Mathematics Methods and/or Mathematics Specialist courses. Students completing either the Methods course or both Methods and Specialist courses will receive a 10 percent bonus of their final scaled score in those courses (TISC, 2016).

This study builds on the previous research conducted in Western Australia regarding student enrolments in senior secondary mathematics courses (Hine, 2016), in that it sought to engage the student voice. The findings outlined illustrate various tensions regarding students' decisions not to enrol in a higher-level mathematics course. These tensions appeared to focus more on the students' short-term goals (e.g., achieving a higher ATAR in an easier course for reduced effort and stress) rather than on the mastery of mathematical concepts required for a career or for further study. Based on these findings, future research efforts could be directed at asking the Year 11 and Year 12 participants the extent to which they feel their choice of secondary mathematics course prepared them adequately for the future (i.e., a longer-term goal). Other efforts could focus on a replica study in the next few years, especially once the bonus marks system for Methods and Specialist has been introduced.

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