DECLINING ENROLMENTS IN SENIOR SECONDARY MATHEMATICS COURSES: STAFF AND STUDENT PERCEPTIONS

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ABSTRACT

Within this paper the author presents a comparison of results from two research projects investigating the issue of declining student enrolments in senior secondary mathematics classes. For one project, 50 Heads of Learning Area: Mathematics (HOLAMs) within Western Australian secondary schools outlined why they believe capable students were not enrolling in the two higher-level mathematics courses of study. The second project reports on the perceptions of Year 11 and Year 12 students in Western Australian schools (n=1351) as to why they believe capable students elect not to enroll in a higher mathematics course. For both projects, participants were invited to participate in a single, anonymous, online survey comprised chiefly of qualitative items. Key findings from the 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 Australian Tertiary Admissions Ranking (ATAR) score without completing these mathematics courses. The key findings espoused by Year 11 and Year 12 students included 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 suggested that there are few incentives offered for undertaking a higher mathematics course, and that such courses are not needed for university entrance nor later life. The findings reported in this paper have significance for shaping educational policy in Western Australian schools and more widely across Australia.

INTRODUCTION

Australian secondary schools have experienced a steady decline of student participation in higher-level mathematics courses since the 1990s (Ainley et al. 2008; Kennedy et al., 2014). In more recent times, similar declines in advanced and intermediate levels of secondary mathematics have been reported (Barrington, 2006; Forgasz, 2005), as well as in tertiary mathematics courses (Brown, 2009; Office of the Chief Scientist [OCS], 2012). Commentators have also outlined how declining enrolments at a secondary school level are accompanied by increasing numbers of students opting for lower levels of study in mathematics and the 'softer' sciences (Dow & Harrington, 2013; Kennedy et al., 2014). Furthermore, Australian students are opting out of advanced mathematics and science courses when they have the option to do so – and especially girls (Kirkham, Chapman & Wildy, 2019; Watt, 2016). In New South Wales (NSW), Poladian and Nicholas (2013) highlighted that the proportion of students taking calculus-based courses had reduced from 61% of the students studying mathematics in 1992 to 35% in 2012. Wilson and Mack (2014) also discovered in NSW participation rates in a mathematics-science combination declined between 2001 and 2013. Specifically, these authors outlined that much of this decline is due both to shifts in proportions of students undertaking mathematics courses and to an increase in the proportion of students taking no mathematics at Higher School Certificate (HSC) level. Additionally, the proportion of students undertaking no mathematics for the HSC across all cohorts has tripled (Wilson & Mack, 2014). Despite these findings, the national trend of declining enrolments in higher-level mathematics courses appears to have been reversed in Queensland due to a 'bonus points' system offered to students (Jennings, 2014; Maltas & Prescott, 2014). From the period 2010 to 2015, enrolments in the Mathematics C course have increased for Year 11 students (25%) and Year 12 students (22%) (Queensland Curriculum Assessment Authority [QCAA], 2010; 2015).

Researchers have predominantly investigated the issue of declining student participation in mathematics from an adult perspective. For instance, several scholars have expressed concern that shortages of suitably qualified mathematics teachers may contribute to declining student enrolments in higher-level mathematics courses (Chinnappan et al., 2007; Harris & Jensz, 2006). Research

conducted with 1084 mathematics teachers in NSW (approximately 18% of all mathematics teachers in that state) outlined that 51% of respondents believed that mathematically able students in their schools selected senior mathematics courses below their academic ability (Mathematics Association of New South Wales [MANSW], 2014). The most frequently elicited teacher perceptions for this phenomenon included: a desire by students to maximise their Australian Tertiary Admissions Ranking [ATAR] and HSC results, the level of difficulty and time demands of 2-unit mathematics, the attraction of other HSC courses, and an overall lack of interest, motivation and confidence in mathematics (MANSW, 2014). Other researchers have examined the issue with a focus on the non-mandatory prescription of post-Year 10 mathematics courses in states and territories. To illustrate, Nicholas et al. (2015) reported that in NSW, "the requirement for students to study at least one mathematics or science subject was removed in 2001" (p. 38). According to Wilson et al. (2013), this change in educational policy and the increase in alternative subject choices are key factors contributing to the decreasing mathematics enrolments in that state. In addition to NSW, mathematics is not a requirement in Victoria and Western Australia; it is required in South Australia, Queensland and the Northern Territory (Wilson & Mack, 2014). At the same time, the admissions policies at many Australian universities do not require subject prerequisites for entry into degree programs (Maltas & Prescott, 2014; Nicholas et al., 2015). Prospective university students are typically advised of a certain level of secondary mathematics considered to be assumed knowledge for a degree, but ultimately most are offered a place on the basis of their ATAR score (Nicholas et al., 2015). In some cases, students are counselled to undertake university bridging courses to make up for any mathematics they have not learned at secondary school (Chubb et al., 2015; Poladian & Nicholas, 2013).

In more recent years, the attention of researchers has begun to focus on eliciting students' perceptions on declining mathematics enrolments. For example, Murray (2011) interviewed students in NSW who provided various reasons for the declining trend, comprising the perception that students are unaware of the importance of mathematics, and that mathematics is boring, not useful, not well taught, and difficult. Additionally, students offered solutions to reverse the trend, which included: Making mathematics more enjoyable and relevant, ensuring that students understand mathematics in earlier years, and drawing students' awareness to the importance of mathematics. Another solution suggested by student participants was that mathematics needs to be made compulsory for the final years of schooling, with these participants arguing that 'optional' senior mathematics significantly affects student motivation and effort in earlier school years. McPhan et al. (2008) determined key influences why students in South Australia and NSW do not enroll in higher-level mathematics courses. These findings were presented broadly as school influences, sources of advice influences, and individual influences (McPhan et al., 2008). More specifically, these authors found that the associated heavy workload, greater appeal of less demanding courses, and perception of difficulty of higher-level mathematics courses influenced students' decisions to not enroll in those courses (McPhan et al., 2008). Kirkham, Chapman and Wildy (2019) interviewed a small cohort of Year 10 students identified by their teachers as capable of succeeding in an advanced Year 11 mathematics course. When discussing factors they considered in choosing their Year 11 mathematics courses, students' most frequently cited responses included: intrinsic value, utility value, generalised mathematics self-efficacy and sociocultural influences.

In light of the current literature, the purpose of this paper is to present a comparison of results from two research projects investigating the issue of declining student enrolments in senior secondary mathematics classes. One project investigated Western Australian HOLAMs' perceptions as to why capable students do not enroll in the two higher-level mathematics courses (Hine, 2018). The other project explored the perceptions of Year 11 and Year 12 Australian Tertiary Admissions Ranking (ATAR) mathematics students in Western Australian schools as to why they believe senior secondary students do not enroll in a higher-level mathematics course (Hine, 2019).

RESEARCH DESIGN

Both studies were interpretive in nature, and relied principally on qualitative research methods to gather and analyse data about why HOLAMs and Year 11 and Year 12 ATAR mathematics students believe senior secondary students do not enroll in higher-level mathematics courses. All HOLAMs, and in the following year, all Year 11 and Year 12 ATAR mathematics students in Western Australian secondary schools, were invited to participate in the studies. HOLAMs (n = 50) and student participants (n = 1351) registered their perceptions through the completion of a single anonymous online survey comprising twelve five-point, Likert scale items (Q3) and two open qualitative questions

(Q4 & Q5). The HOLAMs were also asked a closed question, which was for them to indicate whether they believed student enrolments were increasing, remaining constant, or decreasing. The student survey items were developed from the findings of the HOLAMs' survey (see Hine, 2018) as well as from current literature (Barrington & Evans, 2014; Kennedy, Lyons, & Quinn, 2014; Wilson & Mack, 2014). The Likert scale items required participants to indicate (across 12 items) the extent to which they believed senior secondary students did not enroll 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 (i) elaborate on their responses to the Likert scale items, and (ii) to make any further comments regarding why they believed senior secondary students did not enroll 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 (students only), number of years teaching mathematics (HOLAMs only), school enrolment (HOLAMs only), type of school (e.g. secondary 7-12), gender composition of school (e.g. co-educational), and location of school (metropolitan, regional). For this demographic information on HOLAMs and students, respectively, see Hine (2018; 2019).

Data analysis
The qualitative data collected from staff and student surveys were analysed using a content analysis process (Berg, 2007) and according to a framework offered by Miles and Huberman (1994) which comprises the following steps: data collection, data reduction, data display, and conclusion drawing/verification. Within each of these steps the researcher executed the following operations: coding, memoing, and developing propositions. Codes developed by the researcher were attached to data gathered via online surveys, and were selected from those data based on their meaning. In particular, the codes applied to the secondary students' surveys were developed *a priori* and in light of findings from the HOLAMs' surveys. Memoing was then used to synthesise coded data so that they formed a recognisable cluster of information anchored in one general concept, e.g. *Dissatisfaction with Mathematics*. Additionally, memoing helped to capture the ongoing, salient thoughts of the researcher as the coding process proceeded. Finally, the researcher generated propositions about connected sets of statements regarding students' perceptions, reflected on the findings, and drew conclusions about the study. The themes drawn from qualitative data are displayed in Table 5.

RESULTS
Closed Question - HOLAMs
In response to the closed question, 49 of 50 HOLAMs indicated that student enrolments had either remained constant (22) or decreased (27). One HOLAM expressed that student enrolments had increased. These responses are summarised in Table 1.

Table 1: HOLAMs' Perceptions on Student Enrolment Trends

	Catholic	Independent	Government
Increased	1	0	0
Decreased	11	5	11
Remained Constant	11	5	6

Likert Scale Items (HOLAMs & Students)
For the Likert scale items, a higher weighted mean represents stronger agreement, while a lower mean represents stronger disagreement (1 = Strongly Disagree, 3= Neither Agree Nor Disagree, 5 = Strongly Agree). Notably, four of the five top-ranked statements (i.e. those with the strongest agreement) for HOLAMs also featured for the students. The exception in this regard was the item *Dissatisfaction with Mathematics*, which had a weighted mean of 2.22 (ranked 7th of 9) for HOLAMs compared with the students' much higher weighted mean (3.22) and overall ranking (2nd of 12). Also, the items *Not Offered at our School* and *Lack of Qualified Staff* ranked in the bottom three for each participant group. The HOLAMs' and students' responses to the Likert scale question items are presented in Tables 2 and 3, respectively.

Table 2: HOLAMs' Responses to Likert Scale Question Items

Item	1	2	3	4	5	Weighted Mean
Not needed for university entrance	1	5	2	19	23	4.16
Maximise ATAR without 2 maths	0	4	9	18	19	4.04
Other courses more viable/attractive	3	2	14	21	10	3.66
Scaling issues	7	2	6	21	9	3.16
Gender-related issues	14	15	12	6	3	2.58
Timetabling constraints	17	9	5	14	5	2.30
Dissatisfaction with mathematics	16	16	10	7	1	2.22
Lack of qualified staff	32	4	8	4	2	1.80
Not offered at our school	34	4	5	4	3	1.76
Compulsory subject selections	16	5	9	5	0	1.46

Table 3: Students' responses to Likert scale Question Items (Question 3)

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

Extended Answer Questions (HOLAMs)

For the extended answer questions, the most common responses given by HOLAMs were that: mathematics is not required for university entrance (25/50), there are less rigorous/more attractive courses to take instead (23/50), and the ATAR can be maximised without enrolling in two higher mathematics courses (22/50). The HOLAMs' responses are displayed in Table 4, and a variety of participants' verbatim quotations can be accessed from Hine (2018).

Table 4: Summary of Extended Answer Questions (HOLAMs' Responses)

Key Themes	Catholic	Independent	Government
Not required for university entrance	10	5	10
Less rigorous/more viable courses to take instead	9	5	9
Maximise ATAR without 2 maths enrolment	9	6	7
Not needed for students' careers	4	5	11
Scaling does not incentivise higher maths	7	6	4
Timetabling and budgetary constraints	4	3	7
Compulsory courses hinder 2 maths enrolment	9	0	0

Extended Answer Questions (Students)
For the extended answer questions, the most commonly proffered responses by students included a dissatisfaction with mathematics (773/1351), a decision to enroll in more attractive or viable courses (390/1351), and a perception that mathematics is insufficiently scaled as a Year 12 course (162/1351). A summary of students' responses to the extended answer questions is tabulated in Table 5, and a variety of verbatim quotations is available at Hine (2019).

Table 5: Summary of Extended Answer Questions (Students' Responses)

Key Themes	Q4	Q5	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

From the first-level theme *Dissatisfaction with Mathematics*, a variety of second-level themes were developed, including: the courses are too challenging, 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. For the first-level theme *Other Courses are More Attractive/More Viable*, participant responses regarding 'course viability' or 'course attractiveness' were further classified into the following second-level themes: Students choosing a 'lower' mathematics course in order to excel at it; observing that 'lower' courses were less stressful to undertake; rationalising that undertaking a lower mathematics course translated into less time studying mathematics and more time to allocate to other ATAR courses, and deciding to broaden the variety of ATAR courses studied.

DISCUSSION
Presented in this paper are findings from two separate research projects which shared a similar aim: to explore reasons why capable senior secondary students in Western Australia elect not to enroll in a higher-level mathematics course. To commence, a vast majority of HOLAMs expressed that since they had commenced teaching mathematics, enrolments in higher-level courses had either decreased (27 of 50) or remained constant (22 of 50). This finding supports the work of other researchers within Australia who have reported on declining student participation at a senior secondary level (Barrington, 2006; Forgasz, 2005; Poladian & Nicholas, 2013; Wilson & Mack, 2014). Data gathered from both participant groupings (HOLAMs & students) yielded consistency across a number of key findings generated from Likert-scale and extended response items. These findings predominantly comprised

internal factors (maximing ATAR with a lower mathematics course; course attractiveness/viability) and external factors (e.g. university pre-requisites; scaling procedures). However, the importance placed on attitudinal factors (e.g. dissatisfaction with mathematics) appeared to differ notably across both groupings.

Internal factors accounting for students' non-participation in higher level mathematics courses were described as students opting for a more attractive or viable course, and taking a lower mathematics course to maximise their ATAR. Furthermore, many students perceived two of the three mathematics courses offered in Western Australia (viz. Mathematics Methods & Specialist Mathematics) are too challenging to undertake, a finding provided in greater detail in Hine (2019). At the same time, students suggested that the creation of a mathematics course whose level of difficulty lay in between Mathematics Methods and Mathematics Applications courses would encourage more students to enroll in it. 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. Other themes developed from participant testimony suggest that students wish to broaden the variety of courses studied in senior secondary school, and will tend to enroll in lower mathematics courses in order to excel at it and undertake a less stressful study schedule. Also, while these comments echo those of researchers in other Australian states (e.g. MANSW, 2014; McPhan et al., 2008), this finding needs to be carefully balanced according to whether students are taking a course which is below their academic ability.

External factors were described by HOLAMs and students as higher-level mathematics courses being insufficiently rewarded (e.g. scaling procedures), or not required for university entrance. At the time of collecting data from students, neither the Year 11 nor Year 12 students had any foreknowledge of how the scaling process in Western Australia had worked for previous cohorts of Mathematics Applications, Mathematics Methods and Mathematics Specialist students - they would become the first and second cohorts, respectively. Currently, students completing either the Methods course or both Methods and Specialist courses receive a 10 per cent bonus of their final scaled score in those courses (Tertiary Institutions Service Centre [TISC], 2016). Nevertheless, participants' collective lamentations of scaling procedures call to mind claims made by several authors about a 'bonus points' system in Queensland contributing to increased enrolments in higher-level senior secondary courses (Jennings, 2014; Maltas & Prescott, 2014). At the same time these claims underscore students' desire to maximise their school-based results (MANSW, 2014; McPhan et al., 2008). HOLAMs and students stated that a higher-level mathematics course was not needed for university entrance, with HOLAMs emphasising the removal or pre-requisite courses from university degrees – a finding which aligns with earlier scholarship (Maltas & Prescott, 2014; Nicholas et al., 2015). While there are no mathematics prerequisites listed for undergraduate degrees at any of the five Western Australian universities – only assumed knowledge – the University of Sydney introduced mathematics course prerequisites for some courses in 2019 to "help students thrive in their science, technology, engineering and mathematics related degrees and prepare them to tackle future career challenges" (University of Sydney, 2016). Independent of any local or national changes afoot, many HOLAMs stated unequivocally that the re-introduction of degree prerequisites would see increasing student enrolments in higher mathematics courses (see Hine, 2018). Notably, while HOLAMs expressed that reintroducing mathematics prerequisites would lead to increased secondary school enrolments (top ranked statement, Table 4), student responses on this same item did not rank as prominently (fourth-ranked statement, Table 5).

The main discrepancy found when comparing HOLAMs' and students' perceptions was the importance each participant group placed upon attitudinal factors (e.g. dissatisfaction with mathematics). According to collected data (see Tables 2-5), this finding featured much more prominently for students than for HOLAMs. Students' attitudinal indications provided insight into an expressed lack of interest or enjoyment in the subject, as well as a frequently cited acknowledgment that the higher-level courses appearing too challenging to study. Frequently interwoven within such statements were links to the previously cited finding of an insufficient reward for a considerable amount of study effort put forth. Such indications align with the findings of Hogden et al. (2010), researchers in the United Kingdom, who suggested that students' attainment and attitudes are strongly inter-related. In particular, researchers within and outside of Australia have provided insight into these attitudes, in that students find mathematics difficult (Brown et al. 2008; MANSW, 2014; McPhan et al., 2008), uninteresting (MANSW, 2014; Murray, 2011) and unenjoyable (Brown et al.,

2008). With the future of mathematics education in mind, these and other researchers (e.g. Smith, 2017) have expressed concern about such negative attitudes towards the subject.

CONCLUSION

In conclusion, a comparison of findings from similar projects suggests that HOLAMs and senior secondary students in Western Australia hold common perceptions as to why capable students do not enroll in higher-level mathematics courses. The common perceptions held have been described by participants as internal (e.g. maximing ATAR with a lower mathematics course; course attractiveness/viability) or external (e.g. university pre-requisites; scaling procedures). However, students placed considerably greater emphasis on attitudinal factors (e.g. dissatisfaction with mathematics) than the HOLAM participants. Dissatisfaction with mathematics encompassed a number of themes, including: the courses are too challenging, a recognised 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. It is hoped that the findings presented within this paper, together with a growing evidence base, will provide the impetus for educational leaders, policymakers, curriculum consultants and teachers in Australia to attract greater numbers of senior secondary students undertaking mathematics courses.

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