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This research paper examines the perspective of the Heads of Learning Area: Mathematics (HOLAMs) within all Western Australian secondary schools as to why they felt capable students were not enrolling in the two higher-level mathematics courses of study. All HOLAMs were invited to participate in a single, anonymous online survey comprising predominantly qualitative items. Key findings indicate 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.

A recent nationwide report has revealed that over the past two decades, Australian secondary schools have experienced a steady decline of students enrolling in higher-level mathematics courses (Kennedy, Lyons, & Quinn, 2014). Previous reports have noted a similar decline in enrolments in advanced and intermediate levels of secondary mathematics (Barrington, 2006; Forgasz, 2005) and tertiary mathematics (Brown, 2009; Office of the Chief Scientist, 2012). Moreover, Ainley, Kos and Nicholas (2008) discovered that from 2004 to 2007 – and after remaining consistent from 1994 to 2003 – enrolments in the highest mathematics courses in both New South Wales and Victoria had decreased respectively (22.5% to 19%; 12.5% to 9.8%). 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). Findings from the *Maths? Why Not?* research project (DEEWR, 2008) indicated key influences why Australian students enrol in higher-level mathematics courses. These findings were presented as school influences, sources of advice influences, and individual influences (DEEWR, 2008). Although this research outlined reasons why certain secondary students enrol in higher-level mathematics courses, no reasons were offered as to why other capable students do not enrol in these courses. In a similar vein, research findings from the past decade have only pointed to declining enrolments in higher-level mathematics, without investigating the reasons for this trend. Additionally, there is no research available that seeks to explain the declining student enrolments in a Western Australian context.

Research Aims and Significance

The purpose of this project is to investigate the perceptions of Heads of Learning Area: Mathematics (HOLAMs) in Western Australian secondary schools regarding declining student enrolments in higher-level mathematics courses. HOLAMs were purposively selected as participants suitably qualified to respond to the types of questions asked which required both experience as mathematics educators and knowledge of enrolment trends within their schools and the larger educational system. For instance, within secondary schools HOLAMs are those personnel privy to conversations (with students, parents, colleagues) and decisions regarding Year 11 and Year 12 course enrolments. In Year 12, the

two higher-level mathematics courses which can be studied concurrently are 3C3D Mathematics (3C3D MAT) and 3C3D Specialist Mathematics (3C3D MAS). By agreeing to participate in the research, HOLAMs help provide a deeper and richer understanding of the factors influencing secondary student enrolments in higher-level mathematics. The significance of this study rests upon the belief that higher-level mathematics courses are valuable courses for students to enrol in. According to Sullivan (2011, p. 3) there is broad consensus "among policy makers, curriculum planners, school administrations and business and industry leaders that mathematics is an important element of the school curriculum". Furthermore, within an Australian context Science, Technology, Engineering and Mathematics (STEM) and STEM-related careers are frequently heralded as critical to economic growth and global competitiveness (DEEWR, 2008; Office of the Chief Scientist, 2014). It is argued that for students to succeed in STEM and other disciplines at university (e.g pharmacy, economics) an appropriate level of mathematics is undertaken in the senior years of secondary school (Nicholas et al., 2015). It is hoped that findings from this research project may be of particular interest to mathematics educators within the three education sectors in Western Australia, namely: Government, Catholic and Independent sectors. The overarching guiding question to be explored is: What are the factors that contribute to HOLAMs perceptions of the declining student enrolments in higher-level mathematics courses in Western Australian secondary schools? This research is a predominantly qualitative study designed to give a snapshot (Rose, 1991, p. 194) of the HOLAMs' perceptions regarding this phenomenon.

Methodology

Method

This study was interpretive in nature, and relied predominantly on qualitative research methods to gather and analyse data about how HOLAMs perceived capable students not enrolling in two higher-level mathematics courses (i.e. both 3C3D MAT and 3C3D MAS). For this study these two higher-level mathematics courses will be referred to as *the two maths*. Participants registered perceptions through the completion of a single anonymous, online survey comprising one closed and two open qualitative questions, and ten five-point, Likert scale items. The closed question asked whether participants felt the number of students taking the two maths had increased, decreased, or remained constant. The Likert scale items required participants to indicate (across 10 items) the extent to which they felt capable students do not choose to study the two maths (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 students' reasons not to study the two maths. Additional demographic information of participants was obtained through a series of closed questions regarding gender, number of years teaching mathematics, school size (by student enrolment), type of school (e.g. secondary 7-12), gender composition of school (e.g. co-educational), and location of school (metropolitan, regional).

Participants

In Western Australia there are 168 secondary schools (36 Catholic, 52 Independent, 80 Government) offering higher-level, Australian Tertiary Admissions Ranking (ATAR) mathematics courses to Year 11 and 12 students. The ATAR is a percentile score which

denotes a student's academic ranking relative to his or her peers upon completion of secondary education. The HOLAMs of these purposively sampled schools were invited to participate in the research, and a total of 50 HOLAMs gave their consent to participate (23 Catholic, 10 Independent, 17 Government). The demographic information of the 50 participants is tabulated in Tables 1 and 2.

Data Analysis

Qualitative data from the 50 completed surveys were explored using a content analysis process. According to Berg (2007, p. 303), 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". After the two open-ended questions had been examined for themes, patterns and shared perspectives, the researcher 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 (mean, standard deviation) were used to analyse collected data.

Table 1
Summary of Participants' Demographic Data (By System & Gender)

System	Descriptor	Male	Female
Catholic	Number of teachers	14	9
	Mean teaching experience (years)	25.8	20.2
	Mean school size (students)	1070	1084
Independent	Number of teachers	8	2
	Mean teaching experience (years)	22.6	23
	Mean school size (students)	856	650
Government	Number of teachers	10	7
	Mean teaching experience (years)	25.6	20.4
	Mean school size (students)	859	1040

Table 2
Summary of Participants' Demographic Data (By System & Location)

System	School Type & Composition	Metropolitan	Regional
Catholic	Composite	3	0
	Secondary	18	2
	Coeducational	17	2
	Single Sex	4	0
Independent	Composite	3	0

	Secondary	4	3
	Coeducational	7	3
	Single Sex	3	0
Government	Coeducational	7	3

Note: In Western Australia all Government schools are coeducational institutions.

Presentation of Findings

In response to the closed question, 49 of 50 HOLAMs indicated that student enrolments had either remained constant (22) or decreased (27). One HOLAM felt that student enrolments had increased. These responses are summarised in Table 3.

Table 3
HOLAMs' Perceptions on Student Enrolment Trends

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

For the Likert scale items, the means ($\bar{x}$) and standard deviations (σ) of HOLAMs' responses according to system have been included in Table 4. Within this table, a higher mean represents stronger agreement, while a lower mean represents stronger disagreement. Key themes generated from an analysis of the extended answer responses are displayed in Table 5, with the numbers indicating how many HOLAMs from each system proffered that response.

Table 4
Responses to Likert scale Question Items

Item	$\bar{x}$ (C)	σ (C)	$\bar{x}$ (I)	σ (I)	$\bar{x}$ (G)	σ (G)
Dissatisfaction with mathematics	2.22	1.06	2.00	0.63	2.35	1.33
Not needed for university entrance	4.09	1.26	4.50	0.50	4.06	1.11
Maximise ATAR without 2 maths	3.78	0.98	4.30	0.64	4.24	0.94
Other courses more viable/attractive	3.22	1.10	4.10	0.70	4.00	0.84
Gender-related issues	2.17	1.23	2.60	0.92	2.53	1.19
Timetabling constraints	2.61	1.34	2.00	1.00	3.00	1.64
Compulsory subject selections	3.43	1.50	2.00	1.10	2.41	1.24
Not offered at our school	1.48	1.17	1.50	0.81	2.29	1.40
Lack of qualified staff	1.65	1.24	1.90	1.14	1.94	1.16

Scaling issues	3.09	1.21	3.70	0.87	3.82	1.20

Note: C = Catholic, I = Independent, G = Government.

The means for Likert scale responses highlighted similar perceptions for HOLAMs working in Catholic, Independent and Government schools. For instance, the four items 'Not needed for university entrance', 'Maximise ATAR without 2 maths enrolment', 'Compulsory subject selections' and 'Other courses more viable/attractive' consistently scored the highest means across each system. Equally, the items 'Lack of qualified staff' and 'Not offered at our school' consistently received the lowest means. In addition, the most commonly proffered qualitative responses indicate that the two maths are not needed for university entrance, capable students elect to take more attractive or more viable courses, and students' preference to maximise an ATAR without enrolling in the two maths. These qualitative responses will now be explored.

Table 5
Summary of Extended Answer Questions

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

Not Required for University Entrance

Half of the participants asserted that the chief reason capable students do not enrol in the two maths is because these courses of study are not required for university entrance. One Government school HOLAM illustrated this claim, stating "It seems that pre-requisites for study in some tertiary courses have been lowered over the years, and kids are asking themselves 'Why bother with the harder mathematics, when I can get in with the easier courses?'" From the Independent system, another HOLAM claimed

> The universities have not set pre-requisites for their courses and have relied on the bridging courses so [students] have adopted the attitude that they would do subjects they would enjoy, maximise their ATAR and then look at what is needed at university.

In a similar vein to this participant, another Government school HOLAM attributed declining mathematics enrolments directly to universities, who, made "the decision to abandon university course pre-requisites and focus only on an ATAR score to enter university degree courses…Moreover, universities offer fee-for-service bridging courses which makes them money - clearly not interested in addressing the problem, only on profits!"

One Catholic school HOLAM recalled how his past students had relayed how "they were studying engineering at university and did not [study] Specialist [Mathematics] at school, and struggled in their first year". As a possible solution to the problem of declining enrolments, one HOLAM suggested that universities ensure all degree courses have prescribed school prerequisites (and a letter grade) to enable tertiary entry. This suggestion to reintroduce tertiary course pre-requisites was echoed by a majority of those participants who regarded the withdrawal of pre-requisites as the factor deterring capable students from studying the two maths.

Other Courses Less Rigorous or More Viable

Just under half of the HOLAMs (23 of 50) described how Year 11 and Year 12 students select less academically rigorous courses instead of enrolling in the two maths. Some HOLAMs justified this choice by claiming that students have broad study interests which are demonstrated in their selection of ATAR courses. One Independent school HOLAM asserted students "appear to be more interested in subjects like Languages, Physical Education Studies, and Psychology". Furthermore, this selection appears predominantly to include five ATAR courses in Year 12 and one non-ATAR course. For instance, one Government school HOLAM stated that

> Many students prefer to study only 5 ATAR courses in Year 12 and prefer to select a non-ATAR or general course as their sixth course, as a break from rigorous academic study. Leisure-type courses such as Outdoor Education, Art and Physical Education. Studies are selected by students to give some balance to the Maths/Science courses they select.

On the related topic, HOLAMs at Independent and Catholic schools tended to describe how students completed fewer ATAR courses in Year 12 than they did in Year 11. To illustrate, one HOLAM explained at his school:

> Students are not required to complete six subjects in Year 12. In 2015 we had 140 students achieve an ATAR, however, fewer than 10 completed 6 subjects. The great majority choose to study 5 subjects, giving them a whole line off which become study periods. Students at our school feel that they would be at a disadvantage if they gave up these study periods to study 6 subjects. Specialist Mathematics doesn't fit into most students' loads if they do 5 subjects. Most years our Specialist numbers drop significantly from Year 11 to 12 as students drop from 6 subjects to 5.

A HOLAM in a Catholic school supported this notion, asserting "At our school prior to this year students study 7 subjects in Year 11 then drop to 6 subjects in Year 12. The subject they may drop off is 3C3D MAS". Speaking specifically about the Specialist Mathematics courses, this HOLAM noted that because they are "so jammed packed with content that students feel they can't get a handle on things before being forced to move on with the next topic". At the same time, other HOLAMs drew attention to the significant commitment required to study the 2 maths. To illustrate, one Government school HOLAM offered that students

> know a big commitment of time is required to study 2 mathematics courses and to complete them successfully. The distractions of social media and other commitments in their lives, such as part-time work, sport, music, and a social life mean they simply cannot or are not prepared to commit the out-of-school-hours' time necessary to be successful in 2 higher-level mathematics courses.

Similar assertions about students not committing to the two maths were voiced by a majority of HOLAMs across all systems. Other concerns raised included students becoming increasingly worried about not graduating, not achieving their desired ATAR, and not being accepted into the university they want to attend.

Maximising ATAR Without Two Mathematics

Twenty-two HOLAMs agreed that students decide not to enrol in the two maths in order to maximise their ATAR. Overall, capable Year 12 students elect to study only one mathematics course (e.g. 3C3D MAT) or an easier course to achieve a better ATAR for less effort. From the Catholic system, one HOLAMs offered her opinion: "I think today's students focus very much on achieving the numerical ATAR score rather the benefit from studying mathematics at school". Another HOLAM (Catholic system) drew attention to the decision-making process students encounter when choosing ATAR courses:

> The perception here is the workload required for a mark comparable to other 'less rigorous' subjects is significantly more in MAS. The students making these choices are highly intelligent students for whom maximising their ATAR while addressing any prerequisites is their prime concern. They are very adept at 'playing the system' to appease their preferred outcomes.

A third HOLAM (Catholic system) offered insight into the behaviours of female and males students *vis-a-vis* higher level mathematics. This person commented:

> Many girls do not select maths at the higher level even though they are well capable as either they do not see it as a requirement for their desired pathway or more the case seems to be that they may not do exceptionally well (e.g. above 80%) so think that they cannot succeed (a mindset that needs to change given many boys who struggle with double maths still attempt it. In my time I have not had girls fail double maths but many boys have!).

Of the 22 HOLAMs who asserted that students wished to maximise their ATARs without studying the two maths, 17 HOLAMs expressed concern that enrolling in Specialist Mathematics was not incentivised by the scaling process (see Table 5). The unanimous recommendation was for the scaling process to adequately reward students who enrolled in harder subjects, particularly Specialist Mathematics. For example, an Independent school HOLAM conjectured:

> If selecting between a Language and Specialist, the students will study the language because of the bonus marks offered. Students will drop Mathematics Specialist in Year 12 after having studied it in Year 11, because they believe it will be too much work and they don't need it as a pre-requisite and/or they will drop it to pick up extra study periods during school time.

If studying Specialist Mathematics translated into a tangible benefit for students, many HOLAMs indicated that this incentive would result in greater student numbers enrolling in the two Maths. However, without an incentive the general view is that enrolments into higher level mathematics will remain constant or continue to decrease.

Conclusion

This research investigated the perceptions of HOLAMs in Western Australian secondary schools regarding declining student enrolments in higher-level mathematics courses. Participant responses indicated that while the number of Western Australian secondary students enrolling in the two maths has either decreased or remained constant, there are several reasons to account for the low enrolment in these courses. According to a significant number of HOLAMs in Catholic, Independent and Government schools, the chief reasons comprise: higher level mathematics courses are not required for university entrance, students enrol in more viable and less rigorous courses, and the ATAR can be maximised without

studying the two maths. While this study generated data from all three educational sectors within Western Australia, it is possible that certain findings particular to each system could be interrogated further. For instance, within the Catholic system the Likert scale item 'Compulsory subject selections' registered a mean of 3.43. At the same time more than one-third (9 of 23) of Catholic HOLAMs attested that compulsory Year 11 and 12 subject selections (i.e. English and Religion & Life) hinder enrolments into the two maths. Following their proffered testimony, HOLAMs across all systems recommended that to increase higher-level mathematics enrolments, students be adequately rewarded for undertaking a difficult course of study. Such a reward could be similar to the 'bonus marks' students currently receive for studying a foreign language, or through the scaling process used in calculating an ATAR. In addition, HOLAMs believe that if universities set the two maths as pre-requisites for various tertiary courses (e.g., engineering) the secondary enrolments in higher-level mathematics will rise accordingly. While tensions exist with universities wanting to attract a broad range of students into courses requiring higher-level mathematics, the re-establishment of mathematics prerequisites for certain courses may prepare secondary students more adequately for tertiary study. Future research efforts focussed on enrolments in the two maths could broaden the participant base by including the voice of Year 11 and Year 12 students, as well as seeking input from additional mathematics teaching staff.

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