2019

Reasons why I didn't enrol in a higher-level mathematics course: Listening to the voice of Australian senior secondary students

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This article was originally published as:
Hine, G. (2019). Reasons why I didn't enrol in a higher-level mathematics course: Listening to the voice of Australian senior secondary students. *Research in Mathematics Education, Early View (Online First)*.

Original article available here:
https://www.tandfonline.com/doi/full/10.1080/14794802.2019.1599998

This is an Author's Original Manuscript of an article published by Taylor & Francis Group in *Research in Mathematics Education* on 3 May 2019**,** available online**:** https://www.tandfonline.com/doi/full/10.1080/14794802.2019.1599998

Hine, G. (2019). Reasons why I didn't enrol in a higher-level mathematics course: Listening to the voice of Australian senior secondary students. *Research in Mathematics Education, Online First*. doi: 10.1080/14794802.2019.1599998

Title Page

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Reasons why I didn't enrol in a higher-level mathematics course: Listening to the voice of Australian senior secondary students.

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Abstract

This research project investigated the reasons why senior secondary school students elect not to enrol in a higher mathematics course. All Year 11 and Year 12 mathematics students within Western Australian schools (aged 17-18 years) were invited to participate in a single, anonymous, online survey comprised predominantly of qualitative items. Participant responses (n = 1351) indicate that students are dissatisfied with mathematics, there are other more viable courses of study to undertake, and that the Australian Tertiary Admissions Ranking (ATAR) score can be maximised by taking a lower mathematics course. Additional testimony suggests that there are few incentives offered to students undertaking a higher mathematics course, and that such courses are not needed for university entrance nor in later life. In light of these findings, a discussion synthesises student-led suggestions with current literature which could lead to higher future enrolments in secondary mathematics courses.

Keywords

Secondary mathematics enrolments, senior secondary mathematics, senior secondary student participation

Funding Details:

There was no funding for this research project.

Disclosure Statement:

There is no financial interest or benefit that has arisen from the direct application of this research.

Reasons why I didn't enrol in a higher-level mathematics course: Listening to the voice of Australian senior secondary students.

This research project investigated the reasons why senior secondary school students elect not to enrol in a higher mathematics course. All Year 11 and Year 12 mathematics students within Western Australian schools (aged 17-18 years) were invited to participate in a single, anonymous, online survey comprised predominantly of qualitative items. In line with a symbolic interactionist theoretical perspective, participant responses (n = 1351) were analysed to determine the meaning students conferred upon decisions to enrol in mathematics courses. In particular, responses indicated that students are dissatisfied with mathematics, there are other more viable courses of study to undertake, and that the Australian Tertiary Admissions Ranking (ATAR) score can be maximised by taking a lower mathematics course. Additional testimony suggests that there are few incentives offered to students undertaking a higher mathematics course, and that such courses are not needed for university entrance nor in later life. In light of these findings, a discussion synthesises student-led suggestions with current literature which could lead to higher future enrolments in secondary mathematics courses.

Keywords: Secondary mathematics enrolments, senior secondary mathematics, senior secondary student participation

Introduction

A growing body of international evidence suggests that student enrolments in mathematics courses in the final years of secondary school is declining or remaining persistently low (Arnoux et al., 2009; Brown et al., 2008; Edwards & Smith, 2008; Hogden et al., 2010; Smith, 2017; Watt, 2016). In addition, the number of university students majoring in mathematics at an undergraduate level is also falling in various countries (Arnoux et al., 2009; Brown, 2009; Holton et al., 2009; Office of the Chief Scientist (OCS), 2012). While mathematics is repeatedly proclaimed as a critically important subject for students to undertake (McPhan et al., 2008; OCS, 2014; Sullivan, 2011), the number of students enrolling in higher-level and intermediate secondary school mathematics in Australia is also declining (Barrington & Evans, 2014; Kennedy, Lyons, & Quinn, 2014; Wilson & Mack, 2014). Due to this declining participation at secondary school and university level – which is comparable with other nations – the Australian Industry Group (2015, p. 5) has commented that “the pipeline of STEM skills to the workforce remains perilous”. Scholars have noted that a majority of Australian universities have dispensed with subject prerequisites for undergraduate degree programs (Jennings, 2014; Maltas & Prescott, 2014; Nicholas et al., 2015). At the same time, there has been a documented increase in Australian 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).

The issue of declining enrolments in senior secondary mathematics has generated international scholarly interest for some time. Nearly a decade ago, researchers in the United Kingdom investigated reasons why students chose to discontinue with mathematics at age 16 (Brown et al., 2008). According to testimony from over 1500 students across 17 schools, the chief reasons included the perceived difficulty and lack of confidence in mathematics, as well as a perceived dislike and boredom with the subject, and a lack of relevance overall. Brown et al. (2008, p. 15) concluded that the main factor deterring students is the “perceived difficulty of the subject, based either on previous experience as learners or on sources informing future expectations, with older students (including siblings) and teachers being two of the most important”. Shortly after the work of Brown et al. (2008), Hogden et al. (2010) examined the provision for mathematics education for 16-18/19 year-old (pre-university level) learners in 24 countries, including Australia and those countries comprising the United Kingdom. For each country, these researchers identified the policy for mathematics education and the structure of the provision for this education. Additionally, the mathematical content, level of mathematics education available, and participation rates for each country were outlined and compared. While acknowledging that England, Wales, Ireland and Scotland were four of six countries surveyed not requiring compulsory participation in mathematics at age 16, Hogden et al. (2010) highlighted that these countries

> …recorded lower levels of participation in upper secondary mathematics education than any other country surveyed. They are the only countries in the survey in which 20% or fewer of upper secondary students study mathematics…Levels of participation are slightly higher in Scotland, but still below the level recorded in the majority of the 24 countries (p. 5)

Several factors influencing participation levels included the non-requirement of mathematics for entry into many higher education courses (or that students do not intend to enter higher education), and the subsequent strategic behaviour of students opting out of advanced mathematics.

Almost a decade after the work done by Brown et al. (2008), Smith (2017) reviewed the status of post-16 mathematics in England. Among the factors investigated were those encouraging or discouraging individual students to participate in mathematics. Smith (2017) noted that while there had “been an increase in the proportion of students in England at academic age 16 studying mathematics, reaching 47 per cent in 2015/16 (including students resitting GCSE mathematics)” (p. 30), participation rates in AS/A level mathematics within state schools remain low. To further increase these rates, Smith recommended that current efforts with pre- and post-16 year-olds be continued and improved. Specific recommendations included addressing students’ entrenched cultural negative attitudes towards mathematics, investigating carefully how participation rates act as a function of gender – particularly in higher level courses, providing all students with appropriate counselling regarding their selection of mathematics courses, and supporting teachers’ professional development in experience and training.

Within Australia, researchers in New South Wales (MANSW, 2014; McPhan et al., 2008), South Australia (McPhan et al., 2008) and Queensland (Easey & Gleeson, 2016; Jennings, 2013; 2014) have identified reasons why Australian secondary students do not enrol in higher-level mathematics courses. However, there is no recent research published on the same phenomenon in a Western Australian context.

The importance of mathematics

The importance of undertaking mathematics study has been argued largely on the basis of students learning key interdisciplinary knowledge for other courses including science, technology and engineering (Ker, 2013). Concomitant to learning mathematics is for students 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, the failure to produce a workforce with sufficient training in mathematics is considered a national concern for the economy of Australia and for keeping the country as a competitor in the technological world (AAS, 2006; Author et al., 2016; Maltas & Prescott, 2014; Rubinstein, 2009). The importance of mathematics is also highlighted within a range of tertiary degrees, where researchers suggest that university success depends on the level of mathematics studied at secondary school (Author et al., 2015; Nicholas et al., 2015; Rylands & Coady, 2009). Moreover, findings from various studies indicate that students who undertake higher-level mathematics courses at a secondary level tend to outperform their counterparts who undertook a lower-level mathematics course (Anderton et al., 2017; Author et al., 2015; Kajander & Lovric, 2005; Joyce et al., 2017; Sadler & Tai, 2007).

Declining mathematics enrolments at secondary level: An Australian perspective

Since the 1990s, Australian secondary schools have experienced a steady decline of student participation in higher-level mathematics courses (Ainley et al. 2008; Kennedy et al., 2014). During this time period several reports have communicated similar declines in advanced and intermediate levels of secondary mathematics (Barrington, 2006; Forgasz, 2005), as well as in tertiary mathematics courses (Brown, 2009; OCS, 2012). More recently, Poladian and Nicholas (2013) highlighted that in New South Wales the proportion of students taking calculus-based courses had reduced from 61% of the students studying mathematics in 1992 to 35% in 2012. In New South Wales, Wilson and Mack (2014) reported declining participation rates in a mathematics-science combination 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). According to Watt (2016), Australian students - especially girls - are opting out of advanced mathematics and science courses when they perceive a real choice to do so. However, 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%) (QCAA, 2010; 2015).

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). Other 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 New South Wales (approximately 18% of all mathematics teachers in NSW) outlined that 51% of respondents felt that mathematically able students in their school are selecting a senior mathematics course below their academic ability (MANSW, 2014). The most frequently proffered teacher perceptions for this phenomenon included: a desire by students to maximise their 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).

Compared with other developed countries, Australia does not prescribe mandatory requirements for senior secondary courses, with the exception of English (Wilson & Mack, 2014). While national curricula and assessment programs now mandate uniform mathematics and science courses to Year 10, undertaking mathematics in senior secondary school is not required in some Australian states and territories (Nicholas et al., 2015). For instance, in New South Wales, "the requirement for students to study at least one mathematics or science subject was removed in 2001" (Nicholas et al., 2015, 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 New South Wales, 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 into undertaking university bridging courses to make up for any mathematics they have not learned at secondary school (Chubb et al., 2015; Poladian & Nicholas, 2013).

The student voice

Several years ago Murray (2011) examined the issue of declining participation in post-compulsory secondary school mathematics within New South Wales. Interviewed students 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. In light of these comments, students also offered solutions 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. An additional solution suggested was that mathematics needs to be made compulsory for the final years of schooling; students argued that 'optional' senior mathematics significantly affects student motivation and effort in earlier school years. Findings from the *Maths? Why Not?* research project (McPhan et al., 2008) indicated key influences why students in South Australia and New South Wales 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). While numerous researchers have investigated declining student enrolments in senior secondary mathematics, few have sought the student perspective on this phenomenon. Moreover, there are few published studies available which comment on student enrolments in mathematics within Western Australia.

Research Aim

The aim of this research was 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 senior secondary students do not enroll in a higher-level mathematics course. The ATAR is a percentile score which 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. In Western Australia, Year 12 students can take as many as six (but no fewer than four) subjects that can be counted towards the Tertiary Entrance Aggregate (TEA). Since 2008, the TEA has been calculated by adding any student's best four scaled subject scores, plus a 10 per cent bonus of a student's best Language Other Than English (LOTE) scaled score. The calculated TEA is then converted to an Australian Tertiary Admissions Ranking (ATAR), which can range from 0 to 99.95 (in increments of 0.05) and reports the ranking position of any student relative to all other students. According to the Tertiary Institutions Service Centre (TISC), the ATAR takes into account the number of students who sit the Western Australian Certificate of Education (WACE) examinations in any year, as well as the number of people of Year 12 school-leaving age in the total population (TISC, 2016).

The research itself builds on the findings of a previous study (Author, 2016) which investigated the perceptions of Heads of Learning Area: Mathematics (HOLAMs) as to why they felt capable senior secondary students do not enroll 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 immediate interest to secondary and tertiary mathematics educators within Western Australia, across Australia, and even on an international scale. Various literature reviewed in an earlier section has indicated that declining enrolments in secondary mathematics is a problem experienced internationally (Arnoux et al., 2009; Brown et al., 2008; Edwards & Smith, 2008; Watt, 2016). For this research, the overarching guiding question to be explored was: What are the factors that influence Year 11 and Year 12 ATAR students' decisions not to enroll in higher-level mathematics courses in Western Australian secondary schools? This research was a predominantly qualitative study designed to give a "snapshot" (Rose, 1991, p. 194) of the students' perceptions regarding this phenomenon.

Theoretical Perspective

The theoretical perspective that informed the methodological character of this study was symbolic interactionism. The origins of symbolic interactionism can be traced back to the work of social behaviourists including Dewey, Cooley, Parks, and Mead. Following these preliminary efforts, Blumer (1969) officially coined the term 'symbolic interactionism', and contributed substantially to the advancement of this behavioural theory. In articulating his view of symbolic interactionism, Blumer established that human beings account for meaning in two basic ways:

> First, meaning may be seen as intrinsically attached to an object, event, or phenomenon. Second, meaning may be understood as a 'psychical accretion' imposed on objects, events, and the like by people. (Berg, 2007, p. 10)

To further explain how meanings are devised and attributed to objects, events and phenomena, Blumer enunciated three interactionist assumptions. First, human beings act toward things on the basis of the meanings that these things have for them. Second, the meaning of such things is derived from, and arises out of, the social interaction that one has with one's fellows. Third, these meanings are handled in, and modified through, an interpretive process used by the person in dealing with the things encountered. In essence, the central tenet underpinning symbolic interactionism is that objects, phenomena, situations, and people do not in themselves possess meaning. Rather, meaning is conferred on these elements by and through human interaction (Berg). For this study, the researcher sought to uncover the meanings Year 11 and Year 12 students conferred upon the mathematical courses they (and other students) chose or chose not to enrol into.

Symbolic interactionism deals directly with issues such as language, communication, interrelationships, and community (Blumer, 1969). This theoretical perspective stipulates that human behaviour depends on learning rather than biological instinct, and "people communicate what they learn through symbols, the most common system of symbols being language" (Berg, 2007, p. 10). According to Bogdan and Biklen (1992), human behaviour is an ongoing and negotiated interpretation of objects, events and situations. The central task of symbolic interactionists as researchers, then, is to capture the essence of this process for interpreting or attaching meaning to various symbols.

Consistent with the symbolic interactionist paradigm, this study of Year 11 and Year 12 students' perceptions of enrolments in mathematics courses is taken largely from the perspective of those individuals being studied—Year 11 and Year 12 students participating in senior secondary mathematics courses. Morrison (2002) suggested that symbolic interactionism is "an unfolding process in which individuals interpret their environment and act upon it on the basis of that interpretation" (p. 18). Based on this suggestion, the researcher sought to collect data from students in their ultimate or penultimate year of formal education (i.e. Year 11 or Year 12) using a "snapshot" (Rose) approach. The subsequent analysis and presentation of these data aimed to capture the essence of how meaning had been assigned by participants to their socially constructed phenomena and situations, namely, their perceptions as to why senior secondary students choose not enroll in higher-level mathematics courses. Much of the research in symbolic interactionism involves studying 'natural' conversations between people, as well as textual analysis of relevant, written material, "by which an intention of communication is attributed by the researcher" (Wiseman, 1993, p. 135). Such approaches are indicative of the data collection method employed within this study, which was qualitative survey research

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 senior secondary students do not enroll 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 (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 survey items were developed from the findings of a previous study (Author, 2016) 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 felt 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 felt 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 (Male, Female), year level (Year 11, Year 12), 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, regional). The survey items have been included in the appendices as Appendix 1.

Method

Participants

In Western Australia there were 151 secondary schools (33 Catholic, 49 Independent, 61 Government) offering Australian Tertiary Admissions Ranking (ATAR) mathematics courses to Year 11 and 12 students (aged 17-18 years) in 2016 (SCSA, 2016a; 2016b). These courses are Mathematics Applications, Mathematics Methods, and Mathematics Specialist (SCSA, 2018) (see Appendix 2 for the structure & content of these courses). All Year 11 and Year 12 students enrolled in these purposively sampled schools were invited to participate in the research, and a total of 1351 students from 26 schools gave their consent to participate. While the number of schools participating in the study is precise (26/151 = 17%), the number of potential student participants is markedly more difficult to calculate. According to an annual report of candidates sitting for a specific number of ATAR course examinations in 2016, there may have been as many as 28 000 Year 11 and Year 12 students who could have participated in the study in that year (SCSA, 2016c). The demographic information of the participants (see Tables 1, 2, 3) indicate that data represent a cross-section of Western Australian secondary students with regard to gender, school location (metropolitan & regional) and composition (co-educational & single gender), educational sector (Catholic, Government & Independent) and mathematics course(s) undertaken (Applications, Methods & Specialist). Despite the heterogeneity provided by this cross section, there appears to be some overrepresentation in the total number of responses from single-gender schools and in particular from female students.

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

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

Data analysis

The researcher explored qualitative data collected from the 1351 completed surveys 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. Within each of these components the researchers executed the following operations: coding, memoing, and developing propositions. Miles and Huberman (1994, p. 56) described codes as "tags or labels for assigning units of meaning to the descriptive or inferential information compiled during a study". 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 were developed in light of findings from a previous study by Author (2016) which focussed on HOLAMs' perceptions of why senior secondary students elect not to take the two highest mathematics courses. 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. For responses to the Likert scale items, descriptive statistics (e.g. 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 3)

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

For survey questions 4 and 5, the most commonly proffered qualitative responses included a dissatisfaction with mathematics, a decision to enroll 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.

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

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

Dissatisfaction with mathematics

A majority of participants asserted that the chief reason secondary students did not enroll in a higher mathematics course was due to a dissatisfaction with mathematics (773 of 1341). Such dissatisfaction was registered via a variety of associated responses, which were developed further into sub-themes, 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. Findings for some of these sub-themes are articulated below.

The courses are too challenging

Of the 773 participants who expressed dissatisfaction with mathematics, 332 explicitly stated that they felt the higher mathematics courses are too challenging. One participant regarded the challenging aspects of such courses as the amount of content and the pace at which this content is delivered:

> I think that many students do not pick higher maths subjects because there is too much content and since we have to move through all of the content so quickly, it is hard to get a full grasp of every single concept before moving on. This results in it being very difficult, especially in exams when a lot of content needs to be remembered.

Another participant's response aligned with this statement, articulating that the higher mathematics courses necessitate a "heavy time commitment and study requirements involved and the level of difficulty". Other participants drew attention to a perceived 'jump' in complexity of the content from the Year 10 course to senior secondary courses. Herein, three such responses are offered:

> I tried Mathematics Methods, found it incredibly hard, [and it] was way too hard jumping from Year 10 to Methods.

> Because Year 11 is such a change from Year 10, the course content is much harder. However, having studied Methods through Year 11 and into [Year] 12, I must say once you've learnt the Year 11 topics, Year 12 is much easier.

> Higher courses are very difficult compared to the level of math being taught in the lower years, even though they are meant to be an 'introduction' into the next year. Students also find it difficult as the method of teaching in Year 11 and [Year] 12 is different to Year 10 which can make students want to drop maths.

Within this sub-theme of 'Too challenging', many claims were represented with other sub-themes which are presented below, and across other themes.

Discrepancies in complexity and workload

The second most frequently expressed response under the theme *Dissatisfaction with Mathematics* was the perceived discrepancy between Mathematics Applications and Methods courses, particularly in terms of overall workload and complexity of content (199 of 773). 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.

Another participant agreed with this discrepancy, and hypothesised a potential solution:

> I believe the reason students in Year 11 and 12 choose Applications over Methods is due to the extreme/severe jump in content difficulty. I myself, along with many other students I have spoken to, feel the Methods [course] is simply too hard to achieve substantial marks and comprehend [the] content, while Applications is slightly too easy. Although we have been achieving what looks like commendable marks, scaling in WACE exams at the end of the year will ruin this. I believe there need to be a course in between Applications and Methods that finds middle ground in content and difficulty that can challenge people, like myself, but not swamp [them] in impossibility.

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.

Mismatch between effort and reward

The third most common participant response from the theme *Dissatisfaction with Mathematics* (120 of 773) suggested a perceived mismatch between the amount of effort expended studying higher-level mathematics courses and the reward received. Participant responses were typically supported with assertions of: needing more time to study mathematics instead of other courses, mathematics not being needed for university entrance, there are harder concepts to learn, no incentive is offered for taking a higher-level course (e.g. scaling), and a lower ATAR or grade is received overall. An example of each of these assertions has been included below as a verbatim participant statement. Also, these assertions were all 'stand-alone' themes generated through an analysis of data (see Table 5).

> I feel that it's mainly due to the fact that a lot of effort can be put in without the desired effect – unless you are passionate about/relatively gifted at higher mathematics, it is considered by many to be time better spent elsewhere.
>
> The workload versus what you get out of [a higher mathematics course] is not worth it; [I am] also told it's not needed at university.
>
> The fact that Methods and Spec[ialist] are so much harder requires more time for study, taking away study time for other subjects that in fact also need our attention since the top 4 [courses] make up our ATAR.
>
> Maths Methods is not being scaled enough. For the effort and time put in as well as the difficulty level, students aren't receiving what they should.
>
> The majority of my friends who could have done Methods (but ended up choosing

> Applications) did so because they felt that they could get a higher ATAR score by doing extremely well in the course they perceived to be easier, rather than ending up somewhere in the middle of the results for the course they thought would be harder.
>
> Because the time and effort and the work put in is not rewarded in scores, exams etc.

Other courses are more viable/more attractive

The second most common assertion participants made was that secondary students tend to enroll in those courses of study which appear to be more viable or more attractive than a higher mathematics course (390 of 1341). In particular, participant responses regarding ‘course viability’ or ‘course attractiveness’ were further classified into the following associated sub-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 sub-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 (159 of 390). 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 that in addition to 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

A number of participants (162 of 1341) intimated that the reason students do not enroll 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 (sic) 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 & 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. Herein, 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 & 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, these participants expressed that scaling procedures influenced their decision not to enroll in a higher mathematics course.

Discussion

The purpose of this research paper was to outline reasons why Year 11 and Year 12 ATAR mathematics students in Western Australia do not enroll in higher-level mathematics courses. An analysis of student participants' testimony identified three key findings via Likert-scale items (Table 4) and open questions (Table 5) for further consideration. In line with a symbolic interactionist theoretical perspective, these findings were analysed to uncover meanings students attributed to mathematical courses and ultimately, their decisions to enroll in such courses. Given the social nature of the teaching and learning enterprise, as well as the decision-making process concerning enrolments into senior secondary courses, students' attributed meanings were viewed as the result of numerous human interactions (e.g. parents, peers, teachers, siblings, careers counsellors, university admissions staff) across a number of years.

First, students indicated a dissatisfaction with mathematics which was characterised by various factors revealing students' short- term goals and attitudes towards mathematics. Short-term goals included students' perceived discrepancy of the complexity and workload between Applications and Methods courses, and an acknowledged mismatch between effort and reward of undertaking a more difficult course. 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 this perceived discrepancy and consequently encourage more students to enroll in it. 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. Furthermore, such indications align with the findings of Hogden et al. (2010), who suggested that students' attainment and attitudes are strongly inter-related. In particular, researchers within and outside of Australia have provided insight into such 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.

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. This finding is connected to students' perceived dissatisfaction with mathematics; for the most part, less demanding mathematics courses have greater appeal for senior secondary students. Such appeal has been documented by other researchers within Australia (MANSW, 2014, McPhan, 2008) and the United

Kingdom (Hogden et al., 2010). Additionally, there appears to be an expressed need by students to feel confident in the mathematics course they take – a need found by Brown et al. (2008), Author (2016), Hogden et al. (2010) and MANSW (2014). Such 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. According to several commentators, this finding needs to be carefully balanced according to whether students are taking a course which is below their academic ability (Author, 2016; MANSW, 2014). Moreover, careful consideration must be given by schools to counsel students carefully to participate in mathematics courses which they will need in the future (smith, 2017).

Third, students believe that there is an insufficient reward offered for taking a higher mathematics course. For the most part, students nominated that the current 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 have completed secondary schooling - they would have missed 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 per cent bonus of their final scaled score in those courses (TISC, 2016). Such student claims 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 (Author, 2016; MANSW, 2014). Such a desire echoes the suggestion made by Hogden et al. (2010) that, in the United Kingdom, low participation rates can be attributed to the role of the GSCE Mathematics (or Ordinary Grade in Scotland) plays as an endpoint for students.

Conclusion

This study builds on the previous research conducted in Western Australia regarding student enrolments in senior secondary mathematics courses (Author, 2016), in that it sought to engage the student voice. More broadly, the findings of this study add to the existing literature base at national and international levels regarding the phenomenon of declining enrolments in higher-level mathematics courses. Consistent with a symbolic interactionist perspective, the findings outlined illustrate various tensions students have conferred upon mathematical courses and ultimately, their decisions not to enrol in these courses. These conferred 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 Western Australia over the next few years, especially now that the bonus marks system for Methods and Specialist courses has been introduced. While it was not the intention of the researcher to interrogate how enrolment selections are made as a function of gender, it might be of interest to schools and educational authorities alike to discern any differences in this regard. Also, while the present study engaged only Year 11 and Year 12 ATAR students it would be interesting to canvass the opinions of those senior secondary students taking non-ATAR mathematics courses as to why they have not enrolled in an ATAR mathematics course.

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Funding Details

There was no funding for this research project.

Disclosure Statement

There is no financial interest or benefit that has arisen from the direct application of this research.

Appendix 1: Survey Items

1. After having read the Information Sheet, do you give your informed consent to participate in this research project? Yes No

2. Please indicate:

(a) your gender: Male Female

(b) what year level you are in: Year 11 Year 12

(c) the mathematics courses you are currently studying Mathematics Applications Mathematics Methods Mathematics Specialist

(d) the type of school you attend: K - 12 4 - 12 5 - 12 7 - 12

(e) the gender composition of your school: Coeducational All Boys All Girls

(f) the location of your school: Metropolitan Country

3. Respond to the following items by indicating a number 1, 2, 3, 4, or 5 that represents your opinion (1 = completely disagree, 2 = slightly disagree, 3 = neutral, 4 = slightly agree, 5 = completely agree).

From your experience as a mathematics student why do you feel that Year 11 and Year 12 students do not choose to study higher-level mathematics courses?

(a)	Dissatisfaction with mathematics	1	2	3	4	5
(b)	Not needed for university entrance	1	2	3	4	5
(c)	ATAR can be maximised by studying 1 mathematics course	1	2	3	4	5
(d)	Other courses of study are more attractive	1	2	3	4	5
(e)	Gender-related issues	1	2	3	4	5
(f)	Timetabling constraints	1	2	3	4	5
(g)	Compulsory subject selections	1	2	3	4	5
(h)	Not offered at our school	1	2	3	4	5
(i)	Lack of qualified staff	1	2	3	4	5
(j)	Higher mathematics courses are not scaled enough	1	2	3	4	5
(k)	Their friends are doing the same course(s) as them	1	2	3	4	5

(l) They do not like the teachers who take higher mathematics courses 1 2 3 4 5
(m) They have been advised not to take these courses 1 2 3 4 5

4. Can you elaborate on any of the items from Question 3? Please include your responses below.

5. Are there other reasons you feel Year 11 and Year 12 students do not choose to study higher-level mathematics courses?

Appendix 2: Summary of ATAR Mathematics Courses (Western Australia)

Year 11 Mathematics Applications	**Year 12 Mathematics Applications**
Unit 1 Topic 1.1 Consumer arithmetic (20 hours) Topic 1.2 Algebra and matrices (15 hours) Topic 1.3 Shape and measurement (20 hours) **Unit 2** Topic 2.1 Univariate data analysis and the statistical investigation process (25 hours) Topic 2.2 Applications of trigonometry (10 hours) Topic 2.3 Linear equations and their graphs (20 hours)	**Unit 3** Topic 3.1 Bivariate data analysis (20 hours) Topic 3.2 Growth and decay in sequences (15 hours) Topic 3.3 Graphs and networks (20 hours) **Unit 4** Topic 4.1 Time series analysis (15 hours) Topic 4.2 Loans, investments and annuities (20 hours) Topic 4.3 Networks and decision mathematics (20 hours)

Year 11 Mathematics Methods	**Year 12 Mathematics Methods**
Unit 1 Topic 1.1 Functions and their graphs (22 hours) Topic 1.2 Trigonometric functions (15 hours) Topic 1.3 Counting and probability (18 hours) **Unit 2** Topic 2.1 Exponential functions (10 hours) Topic 2.2 Arithmetic and geometric sequences and series (15 hours) Topic 2.3 Introduction to differential calculus (30 hours)	**Unit 3** Topic 3.1 Further differentiation and applications (20 hours) Topic 3.2 Integrals (20 hours) Discrete random variables and networks (15 hours) **Unit 4** Topic 4.1 The logarithmic function (18 hours) Topic 4.2 Continuous random variables and the normal distribution (15 hours) Topic 4.3 Interval estimates for proportions (22 hours)

Year 11 Mathematics Specialist	**Year 12 Mathematics Specialist**
Unit 1 Topic 1.1 Combinatorics (11 hours) Topic 1.2 Vectors in the plane (22 hours) Topic 1.3 Geometry (22 hours) **Unit 2** Topic 2.1 Trigonometry (16 hours) Topic 2.2 Matrices (19 hours) Topic 2.3 Real and complex numbers (20 hours)	**Unit 3** Topic 3.1 Complex numbers (18 hours) Topic 3.2 Functions and sketching graphs (16 hours) Topic 3.3 Vectors in three dimensions (21 hours) **Unit 4** Topic 4.1 Integration and application of integration (20 hours) Topic 4.2 Rates of change and differential equations (20 hours)

	Topic 4.3 Statistical inference (15 hours)