International Journal of Mathematical Education in Science and Technology

ISSN: 0020-739X (Print) 1464-5211 (Online) Journal homepage: https://www.tandfonline.com/loi/tmes20

Prior decisions and experiences about mathematics of students in bridging courses

Sue Gordon & Jackie Nicholas

To cite this article: Sue Gordon & Jackie Nicholas (2013) Prior decisions and experiences about mathematics of students in bridging courses, International Journal of Mathematical Education in Science and Technology, 44:7, 1081-1091, DOI: 10.1080/0020739X.2013.823249

To link to this article: https://doi.org/10.1080/0020739X.2013.823249

International Journal of Mathematical Education in Science and Technology, 2013
Vol. 44, No. 7, 1081–1091, http://dx.doi.org/10.1080/0020739X.2013.823249

Taylor & Francis
Taylor & Francis Group

Prior decisions and experiences about mathematics of students in bridging courses

Sue Gordon* and Jackie Nicholas

Mathematics Learning Centre, The University of Sydney, NSW 2006, Sydney, Australia

(*Received 2 March 2013*)

We report on the survey responses of 51 students attending mathematics bridging courses at a major Australian university, investigating what mathematics, if any, these students had studied in the senior years of schooling and what factors affected their decisions about the level of mathematics chosen. Quantitative findings are augmented by qualitative responses to open-ended questions in the survey as well as excerpts from follow-up emails. The findings show that the major reasons for students taking lower levels of mathematics in senior year(s), or dropping mathematics, include finding enough time for non-mathematics subjects, confidence in mathematical capability, advice and maximizing potential ranking for university admission.

Keywords: mathematics education; mathematics choices in senior secondary school; mathematics bridging courses

1. Introduction

This project was motivated by the question: Why do students end up in mathematics bridging courses? That is, why are these students inadequately prepared for the mathematics they will need in their tertiary study? To investigate this issue, we surveyed over 100 students who enrolled in the 2012 mathematics bridging courses run by our university – a major, research intensive university in Sydney, Australia. In this paper, we focus on responses of 51 students who left school in 2009 or later.

Research findings show a need for school programmes that enable students from varied backgrounds and educational experiences to participate and engage in mathematics and science at school.[1,2] Nevertheless, Anderson [3] postulates that in developed countries, such as Norway, students do not study sufficient mathematics at secondary school despite the availability of relatively well-paid jobs in fields that demand mathematics and surmises that students see mathematics as hard, boring and irrelevant. In England, Noyes [4] explored possible factors that might contribute to the drop in attitude to mathematics among 11-year olds, finding that students' experiences of their classes and teaching were the significant factors. The decline in the interest of students in studying mathematics and other science or technology subjects at school, observed in many countries, is of particular concern in countries like Australia where the economy relies on the availability of sufficient highly skilled people.[5]

Students in senior secondary school in Australia have options to study mathematics at levels appropriate for tertiary degree programmes such as Engineering, Science,

*Corresponding author. Email: sue.gordon@sydney.edu.au

Economics or Pharmacy, that is, advanced or intermediate levels, or at an elementary level. While advanced or intermediate levels include the study of calculus to differing extents, the elementary mathematics levels do not include any study of calculus and are not appropriate for the tertiary study of mathematics. Barrington [6] notes that while the absolute number of students studying mathematics is growing in Australia, the proportion of Year 12 students studying mathematics at the advanced or intermediate level is decreasing, while the proportion of students studying mathematics at the elementary level is increasing – an alarming trend.

To investigate why capable students in Australia are not choosing to take higher-level mathematics in the senior years of schooling, McPhan et al. [7] surveyed mathematics teachers and career professionals. Their findings indicate that influential and interacting factors include interest in mathematics, perceptions about mathematical ability, perceived difficulty of mathematics, perceived usefulness of mathematics and advice from mathematics teachers or others. In a large study with Australian middle school students, Martin et al. [8] investigated factors predicting 'switching on' and 'switching off' in mathematics: finding that at the student level, future intent and disengagement in mathematics were significantly affected by mathematical self-efficacy, valuing and enjoyment.

In New South Wales (NSW), Australia, the factors affecting students' choices about mathematics in senior years are further complicated by university entry requirements. Students are admitted to university on the basis of the Australian Tertiary Admission Rank (ATAR).[9] The ATAR is a rank that allows the comparison of students who have completed different combinations of subjects for the Higher School Certificate (HSC) – the qualification students receive at the end of Year 12. The subjects for the HSC are scaled in ways that ensure that they will be fairly compared and will contribute equably to the final ATAR. For each subject, this scaling takes into account the achievements of the cohort being examined so that students are 'compensated' for tackling more challenging topics. Questions about the level of mathematics a student could study and the impact on the ATAR are therefore complex.

There are four mainstream mathematics courses in senior secondary school in NSW: the elementary level – with no calculus – is called General Mathematics, the intermediate level is called HSC Mathematics (or 2-Unit) and the advanced levels are Mathematics Extension 1 (or 3-Unit), which includes and 'extends' HSC Mathematics, and Mathematics Extension 2, which includes Mathematics Extension 1.

While requirements for a prior study in mathematics for entry to a science degree differ among Australian universities,[10] at our university there are no prerequisites for admission into science. This means that the students who have achieved the requisite ATAR for entry but have only studied mathematics at the elementary level are not barred from science degree programmes even if they wish to major in mathematics. Instead of prerequisites in mathematics, all Junior Mathematics subjects at the university have 'assumed knowledge' in mathematics, that is, knowledge that students are assumed to have studied and understood and which may not be revised in lectures.

The assumed knowledge for almost all degrees in the Faculty of Science at our university is at least HSC Mathematics, that is, intermediate mathematics. Science students who intend majoring in mathematics, computer science or physics, as well as all Engineering students require a good understanding of HSC Mathematics Extension 1 (advanced mathematics). The entry into Agriculture, Architecture and Pharmacy has an assumed knowledge of HSC Mathematics as do some in Economics. Except for specialist courses, Mathematics Extension 2 is not required.

As do many Australian universities, our university provides mathematics bridging courses to help ameliorate students' difficulties with mathematics. These are short preparatory courses that enable a prospective student to study some of the prerequisite or 'assumed knowledge' before commencing their tertiary study.[11]

In previous research we investigated students' conceptions and views about their mathematics bridging courses [12,13] as well as the perceptions of bridging course teachers.[14] Our project now probes the reasons for bridging students' choices about studying mathematics in school as identified by the students themselves.

2. Method

2.1. Context of survey

Two different mathematics bridging courses are offered at our university annually. The 2-Unit course introduces differential calculus together with revision of the necessary algebra and coordinate geometry, while the Extension 1 course is for the students who have completed HSC Mathematics and wish to enrol in a university subject, which has an assumed knowledge of Extension 1 Mathematics. The 2-Unit and Extension 1 bridging courses run concurrently in February and include 24 hours of class teaching held over 12 days. These bridging courses are open to all and are fee paying.

2.2. Data collection

All students enrolled for the mathematics bridging courses in 2012 at our university were sent an email inviting them to take part in an online survey. A link to the participant information statement providing full information about the project was included in the email in accordance with our institutional ethics approval. 109 of the 380 students enrolled in the mathematics bridging courses completed the survey using *SurveyMonkey*. The last question of the survey asked students if they would be willing to provide further information via email about their choices in studying mathematics. Sixteen students took part in this second round.

The survey asked for some (optional) demographic information including age, the year the student left school and gender. All other questions were compulsory and followed different paths according to answers given. For example, the following question led to different paths depending on whether the student answered 'Yes' or 'No': *did you study mathematics for your HSC or equivalent?*

Our survey questions and choice of fixed responses drew on the findings of McPhan et al. [7] and were tailored according to the results of our previous open-ended questions about students' experiences of mathematics bridging courses and the challenges faced by bridging course students and their teachers.[12–14] In addition, a number of survey questions were open ended allowing students to enter more detailed information. One such question was *what influenced your decision to study the level of mathematics that you did for the HSC or equivalent?* The responses to these open-ended questions together with the email interviews of the 16 second round participants add rich qualitative information to the quantitative reports developed from the data.

We report on the responses of 51 of the 56 students who left school at the end of 2009 or later, and either completed HSC mathematics at a level not appropriate for their university studies (38 students) or did not study mathematics for the HSC at all (13 students). The remaining five students did not fully complete the survey. Short excerpts from the surveys

or follow-up emails are quoted in the findings under pseudonyms; in the latter case (emails), these pseudonyms were chosen by the students themselves, for example, 'â'.

The study is limited in that the sample was small and the participants elected whether to respond or not – perhaps skewing the results. Further, these bridging course students may not be representatives of those enrolled for similar bridging courses at other universities.

2.3. Research questions

(1) For the students who completed some unit of mathematics for the HSC, what were the influences on their decisions about the level of mathematics studied?
(2) For the students who did not study mathematics for the HSC, what were the factors that impacted on their decisions not to study any mathematics?
(3) Whose advice was influential for these students and when was it sought?

3. Results

3.1. Background information

Out of the 51 students, 32 (63%) were enrolled in the 2-Unit mathematics bridging course, with 19 (37%) studying the Extension 1 mathematics bridging course. Among all the students, 63% (32) were female and most (78%, 40 students) had been to school in Metropolitan Sydney.

Among all, 94% (48) of the students affirmed that they were enrolled (or were about to enrol) in a degree at university. Many of these degrees related to or included science such as Bachelor of Science, Bachelor of Computer Science and Technology and Bachelor of Medical Science. Others were enrolled in diverse degrees such as Engineering degrees or Bachelor of Economics or Bachelor of Education.

We now consider the reports of 38 students who completed a mathematics unit for their HSC. The reports of the remaining 13 students will be reported in Section 3.3.

3.2. Reports of students who completed mathematics for their HSC

The 38 students can be further divided into two groups. Group 1 are 26 students who began and completed studying mathematics at the level of their HSC examination, while Group 2 (12 students) began their HSC studying mathematics at one level but dropped to a lower level before their HSC examination.

Group 1. Out of the 26 students, 14 (54%) completed elementary level mathematics (General Mathematics) for their final year in secondary school, while the remaining 12 students (46%) completed intermediate level mathematics (HSC Mathematics). Among all the students, 13 (50%) were enrolled in the higher (Extension 1) mathematics bridging course, while 13 (50%) of them were enrolled in the 2-Unit mathematics bridging course.

All 26 students recorded responses to the question: *what influenced your decision to study the level of mathematics that you did for the HSC or equivalent? Please tick all the relevant influences*. Figure 1 shows the categories and frequencies of responses.

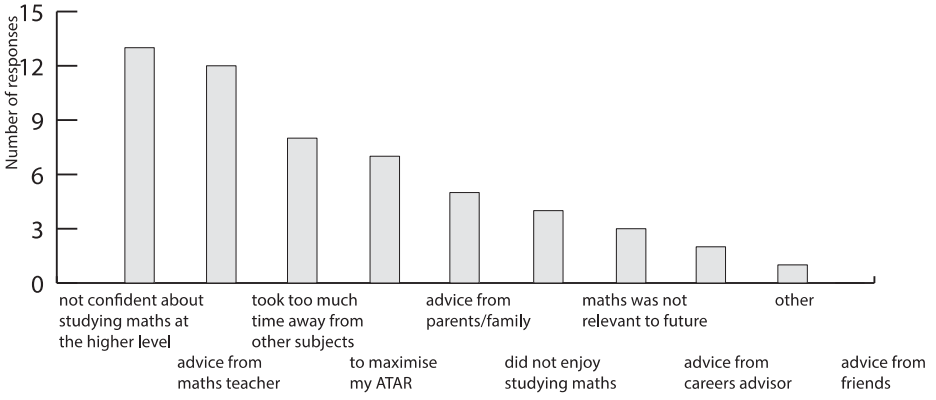

Figure 1. Responses of students who completed a mathematics unit for the HSC.

The four categories with the highest frequency selected were the following:

• Not confident about studying mathematics at the higher level –	13 (50%)
• Advice from my mathematics teacher –	12 (46%)
• Took too much time away from my other subjects –	8 (31%)
• To maximize my ATAR (overall HSC ranking) –	7 (27%)

More light is shed on these findings by students' qualitative responses to the open-ended survey question asking for the most important influences on their decision about what level of mathematics to study for the HSC. Added insights were elicited from the students who consented to be interviewed by email.

Casey, who completed HSC Mathematics (intermediate level), reported:

> Maths has always been an interest of mine and [I] have usually been proficient throughout my schooling years. Taking 2 unit maths [HSC Mathematics] was a choice that brought the personal requirements I set myself for mathematics as it was challenging but doable. I had large amounts of doubt establishing the same balance with Extension 1 and believed that this was enough.

John studied General Mathematics (elementary) in the HSC as he did not see himself 'getting a high mark in 2-Unit mathematics' (HSC Mathematics). John, like many of the students in this group, sought advice from his mathematics teachers.

> Furthermore, I had been told from math teachers that generally speaking, those who do general mathematics tend to get a higher ATAR than those who do 2 Unit mathematics, and the scaling for General Mathematics is decent. My main priority was to get into the degree I wanted, and to deal with the assumed knowledge later.

Kate had completed HSC Mathematics and was enrolled for the Extension 1 bridging course. She reported that one of the influences on her decision not to study Extension 1 (advanced mathematics) for the HSC was that 'math was a pretty time consuming subject' with 'a lot of homework, etc'. When asked to expand on this, she said: 'I also thought I'd do better in other subjects if I put in as much effort'.

The responses quoted here indicate how students weighed up their strategies in choosing what level of mathematics to attempt for the HSC.

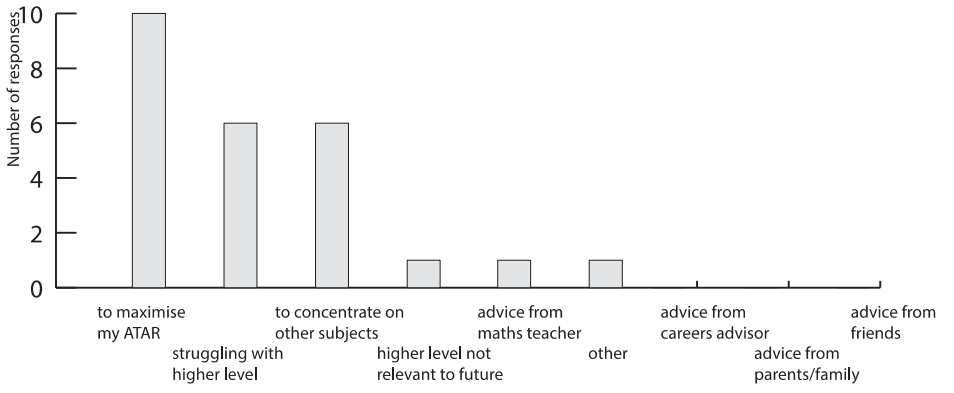

Figure 2. Influences on students' decisions to drop a higher level of maths before completing their HSC studies in a lower level of mathematics.

Group 2. We now discuss the decisions of the 12 students who began studying mathematics for their HSC at a higher level than they eventually completed. Out of the 12 students, 6 of them (50%) were enrolled in the higher (Extension 1) mathematics bridging course, while 6 (50%) of them were enrolled in the 2-Unit mathematics bridging course.

All the 12 participants recorded responses to the question: *what influenced your decision to drop the higher level of math when you did?* Figure 2 shows these responses.

The highest categories selected were the following:

• To maximize my ATAR	10 (83%)
• Struggling with the high level (of mathematics)	6 (50%)
• To concentrate on other subjects'	6 (50%)

For the 10 (out of 12) students who reported that they had dropped the higher level of mathematics to 'maximize my ATAR', explanations in an open-ended survey question and in 2 email interviews expand on this response and clarify its relationship with other categories.

A General Mathematics student, Harry, reported that 'HSC Mathematics was the only subject I was struggling with and it was taking a lot of my time' and that 'I wanted to spend equal time on my other subjects to maximize my ATAR'. In accord, Kadin, an HSC Mathematics student acknowledged:

> I dropped the higher level maths [Extension 1] solely in order to maximise my ATAR. I found the amount of time that I was required to put into the course was not reflective of my marks and . . . I also felt it was important to diversify my subjects as I was unsure of my results and future opportunities after school.

Jed believed that he 'would perform very poorly in mathematics and wanted to avoid subjects I thought I was weak in'. He admitted that his decision not to continue to study Extension 1 Mathematics might have been different: 'had I had a better understanding of scaling'. James testified that the scaling for General Mathematics, as he understood it, was instrumental in his decision to drop HSC Mathematics:

> The scaling for general mathematics allows intelligent students with an aptitude for maths to completely blitz the system, thus coming out with a final score far in excess of what they would practically have achieved doing the course appropriate to their skill level. Thus instead of doing 2-Unit . . . I elected to do General instead, and redirect time that could have been spent on maths to other academic pursuits.

A student who adopted the pseudonym 'â' felt that dropping down from HSC Mathematics to General Mathematics just months before the HSC examinations was not really his decision. He described his experience at school as 'bitter' and that his 'hand was forced' into dropping down to General Mathematics after the trial examinations.

> I was not doing well at senior maths and was advised that if my marks did not match the next lowest persons scores in the class then my mark will pull down the elite class members and was asked to drop my maths class as I would pull down their ATAR score (if that makes any sense to you). It is very hard to explain the maths politics of the school.

The comments of these students illustrate the importance of the ATAR in their minds and how it is reflected in students' (voluntary or forced) decisions to drop to lower levels of mathematics. Interestingly, in contrast to the previous group, only one student responded that advice from the mathematics teacher influenced this decision.

3.3. Students who did not complete any HSC mathematics course

We turn now to the responses of 13 bridging course students who did not complete any mathematics unit for the HSC. These students either started studying mathematics in Year 11 and then dropped it at some point before the HSC examinations (eight students), or made the decision not to study mathematics at all for their HSC (five students). Six of the eight students, who started studying mathematics in Year 11, were initially studying the unit HSC Mathematics. We will consider these students together due to the small numbers. Any differences between the groups will be pointed out. All students were enrolled in the 2-Unit bridging course.

The students in this group were asked one of the following questions as appropriate:

- What influenced your decision to drop mathematics when you did? or
- What influenced your decision not to study mathematics for the HSC or equivalent?

In both the cases, the students were asked to check all relevant influences.

Out of the 13 students, 10 of them (77%) reported that 'to concentrate on my other subjects' was an influence on their decision either to drop mathematics or not to study mathematics at all. This was an influence for all eight students who dropped mathematics before their HSC. Out of the 13 students, 10 (77%) reported that a desire to 'maximize my ATAR' was a factor in their decisions, namely 7 of the 8 students who subsequently dropped mathematics and 3 (of the 5) students who did not study mathematics at all. Out of the 13 students, 3 (46%) from each group, reported that they 'did not like studying maths' and this was an influence. Four students out of the eight who subsequently dropped mathematics reported that 'struggling/not doing well with mathematics' was a factor in their decisions.

The qualitative responses of the eight students who started studying mathematics, but then dropped it altogether, mirrored those of the students who dropped to a lower level of mathematics (Group 2). A common perception was that mathematics involved 'heaps

more homework' compared to other subjects, and dropping mathematics was an effective strategy to maximize the ATAR. As Drew, an HSC Mathematics student, summed up:

> The amount of time I spent studying maths, for only modest results in my tests, was limiting the amount of time I spent on other subjects which I performed well in. As such, I thought it advisable to drop maths and devote more time to the subjects which were likely to improve my ATAR.

Although only two of the eight students who dropped mathematics were studying General Mathematics, both the students reported that this decision was motivated by the poor scaling of General Mathematics. Lucy explained further:

> I spoke at length with my General Math teacher and he told me that it was a low scaling subject, and unless you performed extremely well it wouldn't scale very much. I was wary of not receiving this high mark . . . When I spoke to my English and History teachers, it became apparent that Extension 2 English and History extension both scale well, and while they were harder, doing well could scale significantly.

For the five students who had chosen not to study mathematics, the following comment by Sharon exemplifies the path taken.

> I chose only subjects that interested me – despite being quite good at maths I did not enjoy the subject at all. – At the time I had no idea what I wanted to do at university but I was leaning towards a language-based degree and I assumed I wouldn't need maths. – I did know that, if needed, I could take a bridging course if I did need maths.

For these students, it appears that studying mathematics could be without the rewards of personal interest and perceived relevance to future life.

3.4. Whose advice was influential and when was it sought?

Twenty-three of the recent school leavers (45%, $n = 51$) reported that advice from others was an influence. Twenty of these sought advice when making their subject selection for the HSC with 19 reporting that the advice they received was an influence on their decision to study mathematics at the level that they ultimately completed and one deciding not to study mathematics at all.

Out of the 23 students, 14 (61%) who sought advice reported that the advice of their mathematics teachers was considered important and usually heeded, although, with hindsight, not all students endorsed decisions taken on this basis. Lindsay commented: 'My maths teacher's opinion was to study the lower level although in hindsight I believe this was the wrong decision'.

Of the remaining nine students, five sought advice from parents or family, two from careers advisors and two from friends. Qualitative reports shed light on how this counselling played out. Ashley reported: 'I didn't want to do any Maths but my parents insisted I did the minimum, saying it was important knowledge for tertiary education, especially as I had no idea of a career pathway'. Mason commented:

> At the time I was planning a career not involving Maths but changed my mind in year 12. Also, my two best friends disliked Maths and were not taking it at HSC level so I was heavily influenced by them – perhaps too much so!

The reports indicate for the most part students sought and accepted advice from those with experience.

4. Discussion

Research into students' subject choices has focussed on the views of students and teachers at school.[7,8] In contrast, our study, while small, builds on our research into the perceptions and views of students in mathematics bridging courses on the cusp of their tertiary study,[12,13] and asks students to reflect back on the choices that led them to the necessity of studying these bridging courses. The students' accounts portray an array of complex issues that influenced their choices. Student confidence and evaluating the time demands of mathematics compared to other subjects were two important factors that emerged from the survey responses. Since the student's ATAR – overall HSC ranking – often does determine whether or not that student is offered a place at a university and can enrol in the degree of choice, it is not surprising that students considered seriously the impact of their choices in mathematics on their rankings. Students weighed up the ATAR 'value' versus effort of studying mathematics at higher levels for their HSC and in many cases found that the equation did not balance.

While not asked explicitly about their understanding of the relative scaling of the levels of mathematics, some participants' responses showed that they realized that General Mathematics scaled relatively poorly unless the student performed very well. This knowledge motivated some to drop mathematics altogether in favour of higher scaling subjects but also encouraged an able mathematics student to choose General Mathematics in order to 'blitz the system'. A few respondents revealed possible misunderstandings about the scaling.

The findings also indicate a focus on grades for HSC rather than long-term goals. In some cases, students did not yet know their career paths but the comment by John, quoted earlier, rings true for many of our participants. His priority was: 'to get into the degree I wanted, and to deal with the assumed knowledge later'.

John's comment exposes the tension between gaining access to the degree of choice and being adequately prepared in mathematics for successful completion of that degree. By focusing on relatively short-term goals and adopting such strategies, students may be 'mortgaging their future' (2010 seminar given by Professor J. Ramagge to the Institute for Innovation in Science and Mathematics Education, The University of Sydney; unreferenced). The under-preparedness in mathematics of students entering higher education is a major difficulty in their success and engagement with mathematics at university.[1]

The study raises questions as to what messages universities send out about mathematics preparedness for tertiary study including students' understandings of 'assumed knowledge' – a topic of our ongoing research. We also question whether students and even their mathematics teachers have realistic expectations about mathematics bridging courses. Do some assume that the bridging course will be a panacea or will short circuit the hard work of studying more challenging levels of mathematics at school? One experienced teacher of mathematics bridging courses observed [14,p.42] that some students at school: 'expect there to be an easier path ... if something is difficult you just drop back to an easier level – instead of working harder to learn something new that is initially confusing'.

Evidence shows the strong influence that individual teachers have on student engagement and achievement in mathematics and science.[4] Our findings augment this by showing

that mathematics teachers are influential in advising students on their options. However, like their students, teachers are mindful of the ATAR procedures. Further, the advice students receive is not always consistent with the intent of this scaling to encourage able students to study more demanding options, nor is the advice always given or interpreted correctly. Particularly worrying was John's comment that he had been told by mathematics teachers 'that generally speaking, those who do general mathematics tend to get a higher ATAR than those who do 2-Unit mathematics . . .'.

5. Conclusion

The results of this study may be directly applicable only to the local context: that of bridging course students enrolled at research-intensive university in NSW, Australia. Nevertheless, the research highlights the complexity of students' decision-making about studying mathematics at school and indicates that students act to maximize their perceived prospects for university entry according to the system they find themselves in. Our findings suggest that students find the higher levels of high school mathematics hard and time consuming. Further, university entry procedures that do not seem to reward this effort may inadvertently discourage students from studying appropriate levels of mathematics – to the detriment of their university careers. Perhaps the time has come to acknowledge that mathematics is a difficult subject and arguably more time consuming than other subjects that carry similar weight for university admission and make changes accordingly.

References

[1] Brown G. Review of education in mathematics, data science and quantitative disciplines: report to the Group of Eight universities. Canberra (Australia): Group of Eight; 2009.
[2] Panizzon D, Westwell M. Participation, engagement and achievement in mathematics and science education. South Australia: Future SACE Mathematics and Science Innovation Program; 2007.
[3] Anderson E. Why you should choose math in high school. Ubiquity. 2006; 2006(March):Article 4. Available from: http://ubiquity.acm.org/article.cfm?id=1125361.
[4] Noyes A. It matters which class you are in: student-centred teaching and the enjoyment of learning mathematics. Res Math Educ. 2012;14(3):273–2907.
[5] Chubb I. Mathematics, engineering & science in the national interest: report from the Office of the Chief Scientist. Canberra (Australia): Department of Industry, Innovation, Science, Research and Tertiary Education; 2012. Available from: http://www.chiefscientist.gov.au/2012/05/mes-report/.
[6] Barrington F. 2011 Year 12 mathematics student numbers. Melbourne (Australia): Australian Mathematical Sciences Institute, University of Melbourne; 2012. Available from: http://www.amsi.org.au/publications/amsi-publications/929-2011-year-12-mathematics-student-numbers.
[7] McPhan G, Morony W, Pegg J, Cooksey R, Lynch T. Maths? why not?: final report prepared for the department of education. Canberra (Australia): DEEWR; 2008.
[8] Martin A, Anderson J, Bobis J, Way J, Vellar R. Switching on and switching off in mathematics: an ecological study of future intent and disengagement amongst middle school students. J Educ Psychol. 2012;104(1):1–18.
[9] University Admissions Centre. The Australian tertiary admission rank (ATAR). 2012. http://www.uac.edu.au/undergraduate/atar/.
[10] Belward S, Matthews K, Rylands L, Coady C, Adams P, Simbag V. A study of the Australian tertiary sector's portrayed view of the relevance of quantitative skills in science. In: Clark J, Kissane B, Mousley J, Spencer T, Thornton S, editors. Mathematics: traditions and (new) practices. Adelaide: MERGA; 2011. p. 107–114.
[11] MacGillivray, H. Learning support and students studying mathematics and statistics. Int J Math Educ Sci Technol. 2009;40(4):455–472.

[12] Gordon S, Nicholas J. Challenges and responses: lessons from students in mathematics bridging courses. In: Hannah J, Thomas M, editors. Proceedings of Volcanic Delta 2011: the Eighth Southern Hemisphere Conference on the Teaching and Learning of Undergraduate Mathematics and Statistics; 2011 Nov 27–Dec 2; Christchurch (New Zealand); University of Canterbury); 2011. p. 111–119.

[13] Gordon S, Nicholas J. Students' conceptions of mathematics bridging courses. J Furth High Educ. 2013;37(1):109–125.

[14] Gordon S, Nicholas J. Teachers' reflections on the challenges of teaching mathematics bridging courses. In: Sharma MD, editor. Proceedings of the 16th UniServe Science Annual Conference; 2010 Sep 29–Oct 1; Sydney (Australia): University of Sydney; 2010.