Year 11 Advanced Mathematics: Hearing from Students who Buck the Trend

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There are concerns about the trends and patterns in enrolments in senior school mathematics. Shortages of suitably qualified teachers and dwindling students' demand for Advanced Mathematics have led some Western Australian schools to collaborate to provide an otherwise unavailable opportunity for their students to study Advanced Mathematics. It is of research interest amidst the downward trends in enrolment to learn about such students, to hear about their experiences and perspectives. This paper reports parts of the initial findings.

In recent years, trends and patterns in enrolments in senior school mathematics[12] have raised many concerns. Numerous studies have highlighted the downward trend in the number of students enrolled in Advanced Mathematics (for e.g., Ainley, Kos & Nicholas, 2008; Chinnappan et al., 2007; Forgasz, 2006). As reported in Barrington (2006), Advanced Mathematics students as a percentage of Year 12 decreased from 14.1% in 1995 to 11.7% in 2004 across Australia. For Western Australia, the decline was from 12.6% in 1995 to 8.4% in 2004. In an update, Barrington reported that the 2004 enrolment of 11.7% had decreased to 10.2% by 2007 (Rubinstein, 2009).

Underpinning the declining numbers are concerns about shortages of suitably qualified mathematics teachers (Harris & Jensz, 2006; Chinnappan et al., 2007) and *possible* changes in students' interests and perceptions of higher-level mathematics (McPhan et al., 2008). In a report prepared for the Australian Council of Deans of Science (Harris & Jensz, 2006, p. 10), of the 621 schools surveyed across Australia, Elementary and Intermediate mathematics were taught by the majority, while Advanced mathematics was offered by just 64% of the schools. Many schools cited insufficient demand from students for not offering Advanced mathematics while some schools indicated a shortage of qualified teachers. According to Thomas, Muchatuta and Wood (2009), some schools in relatively affluent areas of Melbourne had reported that they had problems recruiting qualified teachers; dropping electives and enrichment classes for Year 10 students in spite of student demand and consequently found insufficient student demand to justify offering Advanced Year 12 Mathematics – a possible case of shortage of qualified teachers in earlier years affecting student demand for Advanced Mathematics in *subsequent* years.

Besides shortages of suitably qualified mathematics teachers, there are other factors that contribute to the dwindling student demand for Advanced Mathematics. McPhan et al. (2008) found, among other things, that the perception of difficulty of higher-level mathematics and the associated heavy workload as well as the greater appeal of less demanding subjects influenced students' decision.

At the broader level, the declining numbers raise strategic concerns about Australia's future, in particular, her ability to produce enough young people with sufficient mathematical background to pursue careers deemed crucial to maintaining Australia's place in the technological world (Rubinstein, 2009; Tao, 2008; Australian Academy of

[12] Based on the categories of Elementary, Intermediate and Advanced Mathematics as described by Barrington & Brown (2005).

L. Sparrow, B. Kissane, & C. Hurst (Eds.), *Shaping the future of mathematics education: Proceedings of the 33rd annual conference of the Mathematics Education Research Group of Australasia.* Fremantle: MERGA.

Science, 2006). Should the downward trend continues, the long-term outlook does not bode well for Australia and for mathematics education.

Nevertheless, there are high school students who want to enrol in Advanced Mathematics courses. The decline in enrolment is not uniformly distributed; it appears to be more pronounced in poorer suburbs or regions deemed predominantly lower in socioeconomic status. Increasingly, students from such areas, who wish to enrol, face an additional disadvantage of not being able to do so at the schools they attend.

Clearly, attracting and retaining student interest in mathematics is of strategic important for many reasons (Australian Academy of Science, 2006; Rubinstein, 2009). One way to address the enrolment situation is for a group of schools to collaborate to provide their students with better access than a single school can offer. The current study arose from one attempt to implement such a strategy.

The Study

Five high schools from a region deemed lower in socioeconomic status formed a collaborative partnership to offer Western Australia's Specialist Mathematics[13] 3A/3B to a combined group of students. In collaboration with a university, the classes were held in its regional campus, providing students with additional resources and support.

The initial enrolment was 18, out of the total of about 1000 Year 11 students in the five schools; less than 2% of the combined cohort. Given the broad backdrop of dwindling enrolments and the 'working class' region the schools were in, it was indeed uncommon for students to enrol. It was of strategic importance that more should be known about them.

The study was designed to address the following research questions:

- What are the backgrounds of these students?
- Why did the students enrol in Specialist Mathematics?
- What or who encouraged their interest in mathematics?
- What or who has helped/hindered in their learning of mathematics?
- What would help them stay on the course?
- (For students who discontinued) Why did they discontinue the course? And what might have supported them to continue?

Besides collecting background information about the students, it was hoped that their responses to the other questions would provide a qualitative dimension to an important area of research. While broader-scaled studies such as the one done by McPhan et al. (2008) had looked into various factors affecting students' choice of subjects, this study investigated students who were already enrolled and why some of them discontinued. It aimed to glean insights into students' experience and perspectives by listening more *directly* to what they say, to lend credence to the student's voice to inform *practice* (Rudduck & McIntyre, 2007).

Method: Questionnaire and Interview

The study involved a small number of students. Data was collected through a questionnaire and individual semi-structured interviews. The items in the questionnaire covered students' background, their experience of mathematics in school and some open-

[13] Specialist Mathematics is regarded as Advanced Mathematics under Barrington & Brown (2005)'s categorisation of Senior School Mathematics subjects; previously *Calculus* was taken as Advanced Mathematics in Western Australia

ended items including what had helped them stay the course and, for those students who discontinued, their reasons for discontinuing and what might had helped them stay.

The interviews were semi-structured with a prepared set of questions as a guide. The students were asked: (i) their reasons for doing the course, (ii) what or who had influenced their attitudes towards mathematics, (iii) what have helped them in their learning environment, (iv) about students' perspectives of 'status' of mathematics in Australia, in their school, and amongst their peers, and (v) if they enjoy the course. The interviews were transcribed. The content of the transcribed data was analysed to identify the range of responses and themes. An interpretive inquiry approach is adopted to address the research questions.

Results and Analysis

The cohort of ten students in the targeted class comprised nine boys and a girl. The questionnaire was administered and each of the ten was interviewed individually over a period of two weeks. In addition, attempts were made to contact the eight students who had discontinued from the course. Four of these (two boys and two girls) responded; they were given the questionnaire, and three of them were interviewed while the fourth was not available. Because of the constraints of space, this paper will focus on students' responses to the interview questions (i), (iii) and (iv), as well as parts of the interviews with students who discontinued with the course.

Students' Responses to the Interview Questions (i), (iii) and (iv)

(i) Reasons for enrolling in Specialist Mathematics. It appears that all students who had enrolled in the Specialist Mathematics course had some aspirations to higher education, particularly going to the university and doing courses related to careers they want to pursue. They considered enrolling in Specialist mathematics as something that they either need or would give them more options in University courses. Dennis's[14] response was typical:

> Dennis: I take it because I like maths obviously, and it opens more doors for you to get into Uni. Firstly it highers your TEE score which is always good and also if you can't get into one thing into Uni then you can get into other stuff because you have that basic Maths and even more than basic, you know the foundations, to get into other stuff, so it just opens more courses into Uni.
>
> Jack: Ah, I need it for university, my university degree for Engineering.

Such aspirations are consistent with what McPhan et al. (2008, p. 18) listed as one of the influencing factors "impacting on students' decision to undertake higher-level and further mathematics".

It was fairly obvious that the group as a whole liked mathematics and generally did well in it. One or two students felt that they were not doing very much in their (regular) mathematics classes and were getting good grades without much of an effort. Chris cited the following as one of his reasons for enrolling in Specialist Mathematics:

> Um, a good opportunity. I've always just sat around not doing very much in maths and getting an A, so I thought I'd challenge myself um also need it for when I leave school, want to be an Engineer, I need this to get into Uni.

Another student, Eddy, expressed a similar view:

[14] All students' names are pseudonyms

> I joined it because I found the mathematics that I was doing, or the general mathematics I was doing at school relatively easy and I like to have a challenge so I thought well this might actually challenge me and I might actually learning something new, so I thought "I'll do this then".

While some took it to challenge themselves, others were encouraged or recommended by their teachers to enrol:

> Always been interested in that … maths ... I guess, and wanted a challenge I guess. And my teachers recommended me for it, so I decided to do it.

> Because my teacher came to me and he said "you should do this" and because I've yeah, I've always liked my maths, enjoyed it and I find that was a good choice.

> My teacher last year (i.e. Year 10) started me doing the Year 11 math… she said I could probably do Specialist Maths which would challenge me more instead of getting frustrated with the simple maths. So that's mainly why I sign up for it

(iii) Who or what has helped/hindered in their learning environment? Many of the students responded that they found the email access to the teacher very useful:

> … having constant access to a ... communication with the teacher ... through email has really helped when I get stuck, and stuff like that. Umm ... yeah ... it's very much the only tool I use I guess to learn ... in the environment

They appreciated the constant availability of help, day and night and the speedy response from the teacher, especially when they were stuck with a math problem and did not know what to do. Given that there were only two two-hour lessons per week conducted on Tuesdays and Thursdays at an off-school site, this constant availability of help via the email appears to provide an alternate avenue for students to *access* the teacher. The intensity and the lack of a tutorial or a help session between the lessons proved to be an issue for one of the student (who eventually discontinued with the course). So while some students found the email access to the teacher and her fast response helpful, others did not draw upon this accessibility for one reason or another, preferring face-to-face help sessions.

When asked about what hindered their learning of mathematics, many of the students pointed to their own laziness (often with a laugh):

> Um, yeah, my laziness [laughs], and that's about it. I'm pretty lazy, I needed to put in more work and then I'd succeed a lot better.

> I'm a bit lazy [laughs]. I can be a bit lazy sometimes and just leave my homework to the last minute.

> ... the only thing that could hold me back is my own laziness sometimes but besides that I mean you have the book, you have the teacher, you can email the teacher you can ask the teacher, you can even ask the teachers at your own school, I mean the maths teachers anyway. We have the resources and nothing is really blocking us to our own knowledge, it's just our own laziness or willingness that you could say, yeah.

Other forms of hindrances at the individual level include personality traits or habits like being easily distracted and losing concentration especially when stuck with a (math) problem.

On a broader scale, the school's ethos and the prevailing classroom culture can help or hinder the students' learning. To Chris, being in the senior school made a lot of difference; the classroom environment was crucial:

> … Teachers in senior school are a lot better than middle school. They are a lot more motivated. The fact that in senior school, doing the tertiary subjects it's only the kids that only really want to be there that are doing those subjects, so you don't have the idiots mucking around all lesson. So the

teacher's attention is focused towards those who want to learn rather than those who are misbehaving.

So for Chris, a teacher's focused attention on learning in the classroom environment made a lot of difference to him. In contrast, a classroom with a number of students who were misbehaving and/or unmotivated to learn takes the teacher's focus away from teaching and hinders the other students' learning.

In the following exchange between the interviewer and Ben, the discussion centred around the idea of 'adjusting' the difficulty level of Specialist Mathematics and some other school subjects:

Ben: … you can't drop this course (Specialist Maths) down any more, make it any more simple than it is. Because then it wouldn't be the course it is. And you can't make the school courses harder or more challenging because the majority of people that undertake them fail anyway. Like in my chemistry class there's four people passing. So we don't even do work now, the kids that are passing. Because they're so busy trying to get everyone else to pass. So it's pretty much … the gap is like influenced by what other people want to do, and the amount of work that everyone else wants to put in. So it's pretty bad.

Many would agree with Ben that it would not make much sense to simplify the Specialist Mathematics course further without also changing the nature of the course itself. It is the second point that highlights what might be hindering Ben's learning (albeit in this case it was a chemistry course). He related how the teacher responded to the majority of the students in the class, focusing on 'trying to get everyone else to pass' and somewhat neglecting the four who were passing. A critical mass of uninterested students affects the whole class:

Ben: … Like there's only three of us in the class that do this (Specialist Mathematics course) in my school; so when we have (mathematics) sessions at school, it's just … so much harder to get stuff done …

Ben opined that having a larger number of people doing the same course and wanting the same goals might make the environment more conducive to learning. As it was, with only three of them in his school sharing his interest in mathematics, it was "so much harder to get stuff done."

Ben went on to relate how he felt like he was in a minority group, struggling to learn within the given school context:

Ben: It's not hard. You can still do it. It's not ... you can't cry about it. But it's obviously a disadvantage, if you think about it, being in a public school ... when no one else will work. Can't force them to work. No strict rules or anything like that. Just doesn't help you along I guess …

When 80% of my school are going to go to TAFE or drop out next year. They don't cater much for university kids, at least university-bound kids. Like my year 10 course counsellor said … didn't even let me into these courses or any of the physics and chem and that ... they said "no, you'll struggle, you can't do the TEE subjects". I said "well I'll do the work" and they said "yeah we've heard that before, we don't want to let you in" and then … I finally talked to the principal, had an interview, got into all these courses and now I'm like averaging first, second in the school, and like you know, straight As pretty much so ... it's just they don't get it, I guess.

… Yeah, I don't know if it's like that everywhere, but… it seems… they really don't want to put effort in to get kids to go to uni. Or they'd much rather say "yeah you can just cruise and go to TAFE and we don't really ... we do mind, but ..." yeah… it's all up to you pretty much in a school like that.

The overall ethos in school and the prevailing classroom culture did not make for a conducive learning environment for Ben. Certainly, he felt unsupported in his quest to

want to learn and his aspiration to go to the university. He had to deal with his school's low expectations to avail himself of the opportunities to study the courses that he wanted.

Chris and Ben's views appear to be one aspect of the disciplinary climate discussed in PISA's *Learning for Tomorrow's World* (OECD, 2004, p. 208ff); that the environment in the school and the classroom do help or hinder students' learning very significantly. While Chris and Ben pulled through, one wonders how many did not.

(iv) Students' perspectives of the status of mathematics in Australia. The general perspectives that emerge from the interviews were that mathematics was not well 'recognised' or highly valued by students; that mathematics was a difficult and not a very well-liked subject in school. While the students recognised their own particular personal interest in mathematics, they were also aware that they were the exceptions. Many of their peers did not share their liking for mathematics enough to enrol.

> Chris: A lot of people could do it (Specialist Mathematics). Um … for instance there's one girl who is in half of my subjects at school and she's averaging for the subjects she's in with me, 80-90%, but she didn't do this. So she could, I think that was so she could focus on a third science subject, but one of my friends, he could have done this but he was just like "nah, I can't be bothered" and it was going to involve more homework so he was just like "nah".

The issue of perception of status of mathematics was not just a purely personal one. The overall impression from the community affects the perception, in particular the lived day-to-day experience of the individual student immersed within the ethos of the school and the classroom culture. When asked about the status of mathematics at his school, Ben responded:

> Ben: … Um many people... a lot of people don't like doing it. They think… they blame the maths teachers for them not being able to understand and stuff like that, always making excuses, never want to try and learn maths and that. It's pretty bad.

Ben did not think that mathematics was either highly regarded or valued; many of his peers in his school were not willing to put in the effort to learn. He made a comparison with private schools:

> … our school's only got three kids doing this course but the private schools have all got up to 80 kids doing similar maths levels so that really puts us in a bad spot kind of thing.

Apparently, going by the perceived discrepancy in the number of students doing higher-level mathematics, the status of mathematics would be deemed somewhat higher in the private schools. This comparison with private schools raises many questions, particularly, of access to resources and social equity. These are pertinent questions but they lie outside the confines of this present study.

Interviews with Students who Discontinued with the Course: A Snapshot

The interview questions were: (i) Why did they discontinue the course? (ii) What might have supported them to continue?

The common themes that ran through the interviews of the three students, who discontinued with the course, were the demanding nature of the course, including the amount of work and homework they had to do, and the appeal of less demanding subjects (McPhan et al., 2008). They found the requirements and the expectations disproportionate to the other subjects they were taking; they found it hard to balance the time and effort required to meet the demands of the course along with the other subjects. The 'decider'

was the poor grades they were getting in their class tests. Mia shared her reasons for discontinuing:

> Because ... ah … 'cause I didn't think it (Specialist maths) was going to be that hard and you have to ... I didn't realise that you had to put so much effort into it like … Maths like I am doing so well in maths (2A and B) right now and I'm not even doing any work because it was easy. But I didn't realise how much you have to do in the specialist course ... and it was so much it was like you always constantly be doing the work if you want to even get a like a 'C' in it ... and after I did the test I fail … that I was like well this isn't really cool that I even know if I should be in this anymore.

Travelling to and from the class venue was also mentioned as another reason students cited for tipping their decision to discontinue. Karen alluded to transport as one of the additional reasons she had for discontinuing:

> It's kind of travelling from here to Murdoch all the time. And originally when we signed up for the course there was going to be transport to go up there … and then after that the first lesson, we got told we have to find our own way there. My dad works in the city and my mum works here so they can't get time off so it was really hard for my parents to try and get us up there.

Some alternative arrangements were made but it did not quite work out. She was told then to either take a bus or a taxi. Both options were not viable as her parents did not want her to go on public transport outside of the normal school travel time and taking taxis incur additional financial costs.

On the question of what might have supported them to continue, Mia suggested that a better preparation leading up to the course would have given her a better chance of coping and continuing. She thought the transition from Year 10 Mathematics to Year 11 Specialist Mathematics was "too big for most of us to handle so we didn't really know what we had to do." She suggested that, towards the end of Year 10, students who actually wanted to do Specialist Mathematics could be given some general idea of the topics and even get started on some and that would have made the transition easier or at least less problematic. The idea of preparing Year 10 students was also mooted by a few other students.

Conclusion

The study provided a platform to hear from a group of students who enrolled in an Advanced Mathematics course made possible through their respective schools banding together. The value of hearing from students consists largely in their capacity to alert schools to possible ways of addressing the deficiencies, shortcomings, and/or areas of need (Rudduck & McIntyre, 2007). The initial hearings of the students' voices, as it were, highlighted some things, raised some questions and offered some suggestions.

That the students were able to avail themselves of the opportunity to enrol in the course, continue with it, and found it generally enjoyable suggest that the arrangement was working to some extent. Though the transport problem became an issue for some students, contributing to them leaving the course, the remaining students adapted to the arrangement. If the schools are serious about supporting students, then more logistical support in terms of transporting students to and from the class venue, as well as making provisions for additional help classes are needed.

The question of why some schools are not encouraging and supporting (at least) some of their students to aspire to university education and higher careers must be raised. The experiences and perspectives some of the students spoke of did not reflect an encouraging learning environment. Perhaps there were other more pressing issues affecting the school as a whole. Notwithstanding, it is crucial to engage with this question and clear that more

research is needed to investigate more deeply what the students were telling us about their experiences in school.

In terms of helping the students stay the course, the suggestion offered by Mia was notable – that a better preparation prior to Year 11 might give prospective students a better idea of the demands of the course and thereby better chance of enrolling, continuing and succeeding.

Would schools be alerted to the possible ways of addressing the shortcomings and areas of need, to provide a more supportive and nurturing environment for students who take up Advanced Mathematics? If not, how else can the students buck the trend?

References

Ainley, J., Kos, J., & Nicholas, M. (2008). *Participation in Science, Mathematics and Technology in Australian Education, ACER Research Monograph No 63.* Victoria: Australian Council for Educational Research Ltd.

Australian Academy of Science. (2006). *Mathematics and statistics: Critical skills for Australia's future.* Retrieved on 11 November 2009 at http://www.review.ms.unimel.edu.au/FullReport2006.pdf

Barrington, F. (2006). *Participation in Year 12 Mathematics across Australia 1994-2004.* Melbourne, Australia: ICE-EM Publications in Mathematics No. 2, May 2006, ISBN 978-09775254-6-1.

Barrington, F. & Brown, P. (2005) *Comparison of Year 12 Pre-tertiary mathematics subjects in Australia 2004-2005.* International Centre of Excellence in Mathematics and the Australian Mathematics Sciences Institute. Retrieved 3 November 2008 from http://www.amsi.org.au/images/stories/downloads/pdfs/education/comp_y12_pretertiary_aus_2004-05.pdf

Chinnappan, M., Dinham, S., Herrington, A., & Scott, D. (2007). *Year 12 students and higher mathematics: Emerging issues.* Paper presented at the AARE, Fremantle.

Forgasz, H. (2006). *Australian Year 12 Mathematics Enrolments: Patterns and trends – Past and Present*. Melbourne, Australia: ICE-EM Publications in Mathematics. Retrieved 3 November 2008 from: http://www.ice-em.org.au/images/stories/FileDownloads/1.pdf

Harris, K-L., & Jensz, F. (2006). *The preparation of mathematics teachers in Australia.* Retrieved 3 November 2008 from http://www.cshe.unimelb.edu.au/pdfs/Prep_Math_Teach_Aust.pdf

McPhan, G., Morony, W., Pegg, J., Cooksey, R., & Lynch, T. (2008). *Maths? Why not?* Department of Education, Employment and Workplace Relations, Canberra.

Organisation for Economic Co-operation and Development (OECD) (2004). *Learning for tomorrow's world*. Paris: OECD.

Rudduck, J., & McIntyre, D. (2007). *Improving learning through consulting pupils.* London: Routledge.

Rubinstein, H. (2009). *A National Strategy for Mathematical Sciences in Australia*. Retrieved 5 November, 2009, from http://www.amsi.org.au/images/stories/downloads/pdfs/general-outreach/National_Maths_Strategy.pdf

Tao, T. (2008). *Mathematics in today's world.* Retrieved 22 February 2010 from http://www.the-funneled-web.com/Editorial-080409-Tao-guest.htm

Thomas, J., Muchatuta, M., & Wood, L. (2009). Mathematical sciences in Australia. *International Journal of Mathematical Education in Science and Technology, 40*(1), 17-26.