HOW INCLUSIVE IS YEAR 12 MATHEMATICS?

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This paper draws from a longitudinal study of student achievement in Melbourne's northern suburbs. It examines Year 12 students' attitudes to mathematics, their experience of the mathematics classroom, their views of teachers and their expectations of success. Despite a differentiated Year 12 mathematics curriculum, there is evidence of inequity in students' experience of mathematics. Perceptions of mathematics classrooms and mathematics teachers, and expectations of success, vary according to subject, gender and social background. Implications for pedagogical and curriculum reform are discussed.

Introduction

Mathematics is not a level playing field. Achievement gaps based on socioeconomic status (SES) are evident in early primary school and increase in magnitude throughout the school journey. Recent achievement data show this to be the case nationally (ACARA, 2009) and within the Northern Metropolitan Region (NMR), which is one of the poorest regions in Victoria. In 2007 the NMR's literacy and numeracy achievement levels were among the lowest in the state (Department of Education and Early Childhood Development (DEECD), 2009). The region also had the lowest VCE study scores in Victoria and the lowest rate of transfer to university (Helme, Teese & Lamb, 2009).

Helme, Teese & Lamb (2009) reported that, within the region, there were marked social gaps in Year 7 achievement and subsequent achievement in Year 9. Most low achievers from poorer backgrounds did not improve their position relative to the average student during lower secondary education. For example, in mathematics 80 per cent of low achievers from the lowest SES band remained low achievers. The higher the social level of students, the greater the chance of the weakest learners improving—in addition to the lesser likelihood of low achievement in the first place.

In recognition of low student achievement levels, the NMR embarked on a major school improvement campaign in 2008, whose key initiative is the *Achievement Improvement Zones* (AiZ) project. The AiZ aims to improve literacy and numeracy levels across all schools in the region, focusing on leadership development, professional

learning in numeracy and literacy, ongoing coaching and training and support from the region, department and education experts (DEECD, 2009).

This paper draws from a broader longitudinal study funded by DEECD that is evaluating the impact of strategies to lift achievement within the NMR, the Raising Achievement in Public Schools (RAPS) project. The project is synthesising data from a range of sources: NAPLAN data, student and teacher surveys and teacher interviews. Years 3, 5, 7 and 9 NAPLAN data will be monitored for a period of five years, with a focus on social differences in achievement as students progress from one stage to the next.

Teacher surveys have been conducted in a sample of 10 primary and 10 secondary schools in the region to obtain a teacher perspective on the challenges of lifting student achievement and the strategies needed to achieve progress. Focus groups with teachers and leadership teams were undertaken in 2011 and a second wave of interviews is planned for 2013 to allow teachers to reflect on progress. Surveys have been completed with students in Years 3, 5, 7, 9, and 12 in the 20 sample schools to obtain a student perspective on learning and achievement. The focus of this paper is on students' experiences of mathematics in Year 12 and asks how inclusive it is.

Background and research questions

In Victoria, almost all young people complete school within the framework of the Victorian Certificate of Education (VCE). Mathematics in the VCE is optional, and is designed to accommodate a broad range of student skills, interests and abilities through the provision of a set of subjects that forms a hierarchy of difficulty. Further Mathematics is the least difficult and Specialist Mathematics is the most advanced, with Mathematical Methods occupying an intermediate position. Students enrolled in Specialist Mathematics must also be concurrently enrolled in Mathematical Methods. Students enrolled in the Victorian Certificate of Applied Learning (VCAL), a non-academic alternative to VCE, can undertake a VCE mathematics study or a VCAL numeracy skills unit, which is a more practical subject with a vocational emphasis.

Gender differences are characteristic of enrolment patterns in Year 12 mathematics. Enrolment rates derived from VCAA (2010) figures indicate that participation in Further Mathematics is much the same for males and females, but that girls are less likely than boys to select Mathematical Methods (26.0% compared with 37.4%) and even less likely to enrol in Specialist Mathematics, where the enrolment rate of boys is more than double that of girls (13% compared with 6.2%).

Social differences in VCE mathematics participation are also evident. Helme and Lamb (2007) examined 2005 enrolment data and found that enrolment levels in Further Mathematics were relatively similar in all SES quintiles, but in Mathematical Methods and Specialist Mathematics enrolment levels were substantially higher in higher SES quintiles. Yeoh and Lancaster (2010) also found a social gradient in the distribution of enrolments in Mathematical Methods and Specialist Mathematics, but not in Further Mathematics. Social differences also characterise mathematics enrolment in the NMR. Enrolment rates in Mathematical Methods are almost twice as high in the highest SES quintile as in the lowest, and for Specialist Mathematics this ratio exceeds 2:1 (Helme, Teese & Lamb, 2009).

Outcomes in Year 12 mathematics also demonstrate a social pattern. Yeoh and Lancaster (2010) found a social gradient in study scores in all three mathematics studies. Helme, Teese and Lamb (2009) found that Further Mathematics students in the highest SES quintile in NMR were more than twice as likely than their counterparts in the lowest SES quintile to achieve a study score above the defined average of 30. Similar patterns were evident in Mathematical Methods. For example, more than half the Mathematical Methods students in the lowest quintile of SES achieved scores below 24 (53 per cent), compared with 18 per cent of those in the highest SES quintile.

There is also evidence of inequality in students' experience of Year 12 mathematics (Teese, 2000). Teese, Lamb, Helme & Houghton (2006) found substantial differences in students' views of mathematics between different schools and between different mathematics subjects. Mathematical Methods students were more satisfied with teachers, the classroom environment and the subject itself than Further Mathematics students. Furthermore, girls perceived mathematics as less interesting, more difficult and less relevant to the real world than boys did.

These findings warrant further investigation. If mathematics is inclusive, as it claims to be, there should be broadly similar levels of satisfaction across the different study options. One would also hope that quality of classroom experience would be much the same, regardless of individual characteristics such as gender and socioeconomic status. This study set out to explore whether or not this is the case.

Methodology

The data for this paper were derived from a survey of Year 12 students in ten secondary schools in the NMR. The ten schools were selected on the basis of their intake-adjusted performance on a range of indicators such as attendance, academic achievement and post-school transitions. The sample comprised five schools with above expected performance, one school with expected performance and four schools with below expected performance. The schools were diverse in terms of size and the socioeconomic background of students.

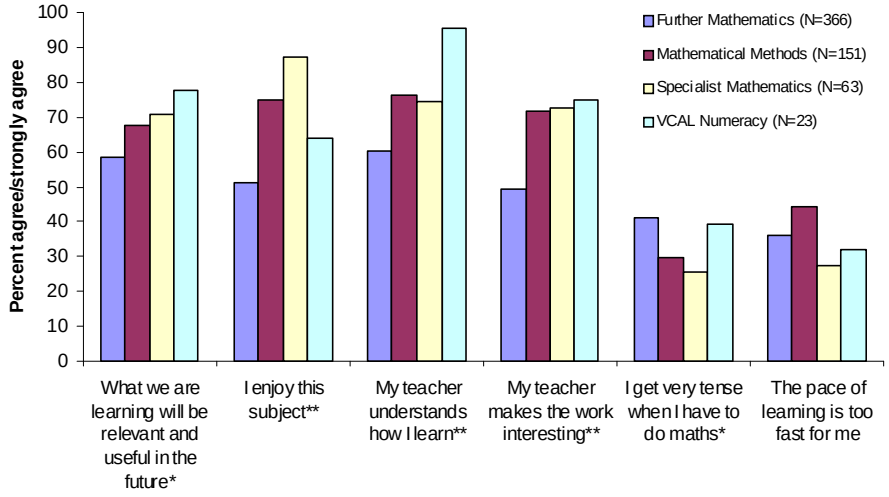
The Year 12 surveys were completed by consenting students during the last two weeks of Term three, 2010. Of a total enrolment of 1107 Year 12 students in the ten schools, 841 completed the survey, giving an overall completion rate of 76 per cent. 603 students nominated a mathematics subject that they were currently enrolled in and responded to a set of questions about that subject. These questions canvassed their views of subject content and difficulty, quality of teaching, quality of classroom experience and their expectations of success. Students were also invited to contribute their ideas on how to improve mathematics and the way it is taught in their school.

Students were also asked to nominate, for each parent separately, their highest level of school completed and their highest post-school qualification, in order to establish a measure of SES. These data were combined into a single scale showing the qualification level of the parent with the highest qualification level. Students were then grouped into five categories according to parental qualifications. In the discussion that follows two contrasting socioeconomic groups were used: students with a parent who had obtained university qualifications and students for whom neither parent went beyond Year 11.

Results and Discussion

Is quality of classroom experience independent of the type of maths studied?

Figure 1 shows students' views of their current mathematics study, and indicates significant differences between subjects in students' perceptions of their classroom experience. VCAL numeracy students are more likely than other students to agree that their teacher understands how they learn and to view the subject as relevant to their future plans, suggesting a good match between subject content and pedagogy and the learning needs of students. Conversely, Further Mathematics students are the least likely of all students to agree that they enjoy the subject, that their teacher makes the work interesting or that their teacher understands how they learn.



Note: Levels of significance based on Chi-square tests: *p<0.5, **p<0.01

Figure 1. Students' views of current mathematics study, by subject.

Can we conclude that there is a mismatch in Further Mathematics between curriculum content and teaching approaches, on the one hand, and the needs of learners, on the other? Is the relatively low level of student satisfaction in this study a reflection that Further Mathematics enrols many academically-weaker students who struggle to engage with mathematics and may have been pressured into taking "at least some maths"? They are certainly the least likely to endorse its connection with future life and career. If Further Maths is the path of least resistance for students who dislike mathematics, this places particular pressure both on the design of the study and on the nature of the teaching approaches that are required to engage students in successful learning.

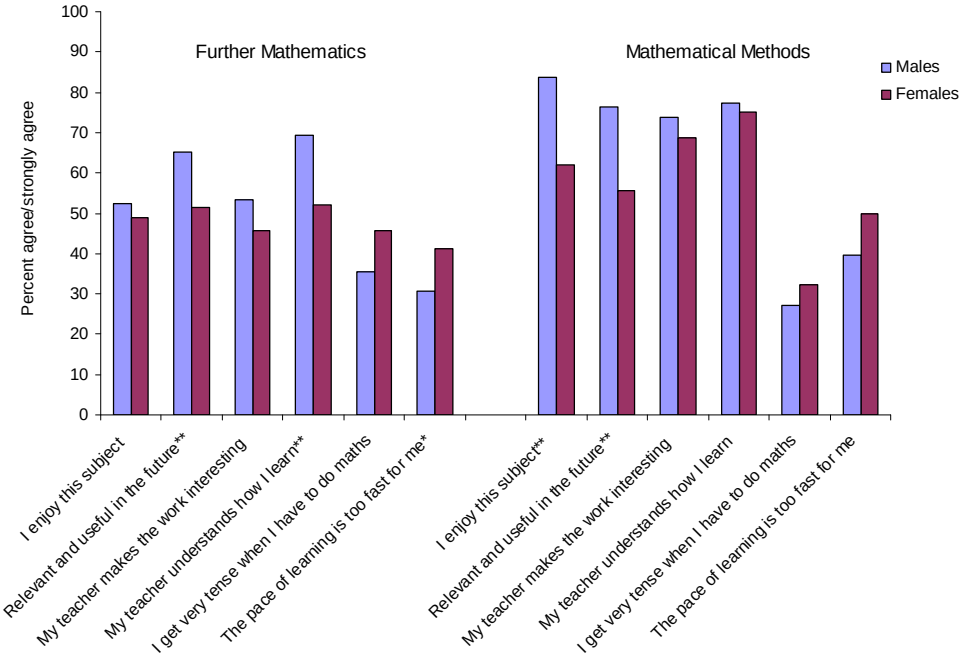
The more academic options of Specialist Mathematics and Mathematical Methods are relatively strongly endorsed in terms of enjoyment and interest, suggesting a better match between the content and pedagogy of these subjects and the needs of their clientele.

Is quality of classroom experience independent of gender?

Figure 2 shows gender differences in students' mathematics classroom experience, for Further Mathematics and Mathematical Methods (numbers in Specialist Mathematics

and VCAL Numeracy were too small for further analysis). Gender differences in favour of boys were evident for all items, but the magnitude of the differences varied.

Girls in both subjects were significantly less likely than boys to perceive mathematics as relevant and useful for the future. Female Further Mathematics students were significantly less likely than their male counterparts to agree that their teacher understands how they learn, and significantly more likely to report that the pace of learning is too fast. Female Mathematical Methods students were significantly less likely than their male counterparts to agree that they enjoy the subject. While gender differences in mathematics anxiety were not significant, the trend suggested here is consistent with the findings of previous studies (e.g., OECD, 2004).



Note: Levels of significance based on Chi-square tests: *p<0.5, **p<0.01

Figure 2. Students' views of current mathematics study, by gender.

Is quality of classroom experience independent of social background?

Figure 3 displays quality of classroom experience in Further Mathematics and Mathematical Methods (Specialist Mathematics and VCAL Numeracy were excluded from the analysis due to small numbers).

While none of the differences was statistically significant, the data suggest some notable disparities between children of contrasting social backgrounds. In both subjects, the pace of learning appeared to be a greater problem for students from a less educated background, and in Mathematical Methods there were consistent differences in favour of children of university educated parents. These findings are consistent with Teese's (2000) view of the influence of family educational, economic and cultural capital on access to Mathematical Methods: the further up the hierarchy of cognitive demands, the greater the call made by the curriculum on cultural resources and the narrower the social base from which these are available.

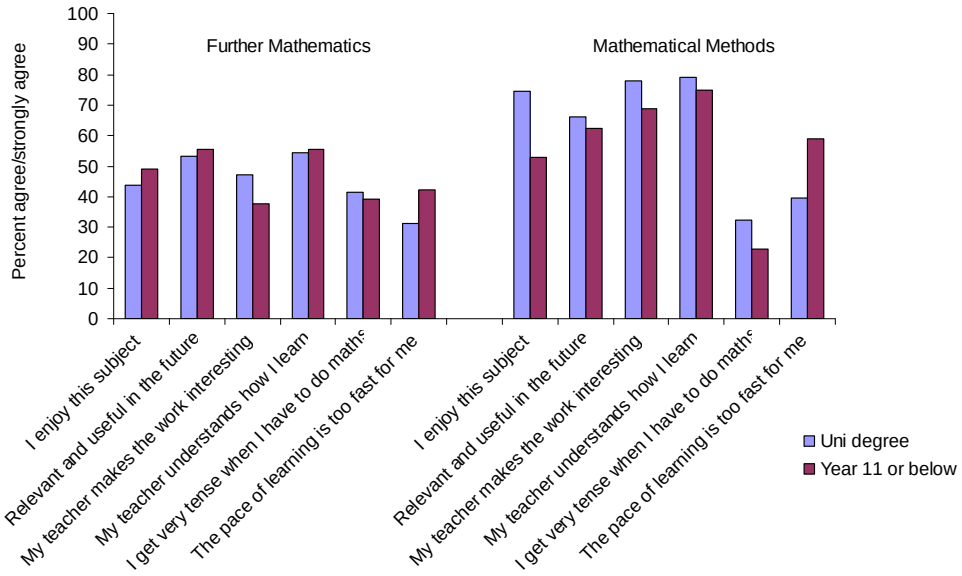


Figure 3. Students' views of current mathematics study, by social background.

Are expectations of success equitably distributed?

As Figure 4 indicates, expectations of success varied among subjects. (VCAL was excluded from the analysis due to small numbers.) Further Mathematics students were the least confident of success, perhaps not surprising, given that many students taking this option have a history of low achievement, while Specialist Mathematics students were the most confident, with Mathematical Methods students occupying an intermediate position. In Further Mathematics there was no notable gender difference in students' expectations of success, but this was not the case for Mathematical Methods and Specialist Mathematics. Male Mathematical Methods students were more than three times more likely than their female counterparts to expect to do very well (29% compared with 9%). The corresponding percentages for Specialist Mathematics were 62% and 40%.

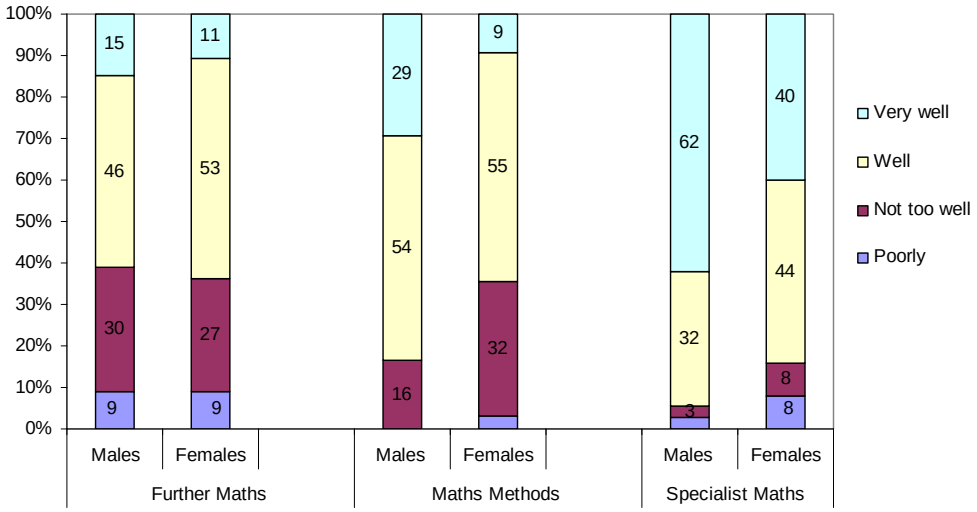


Figure 4. Students' expectations of success, by subject and gender

Given that girls take Methods less frequently than boys, one might expect that those who enrol in the subject have at least as much confidence as their male peers. But they do not, which suggests that there is still some way to go to improving gender equity, quite apart from the persistent gap in enrolment rates.

When data for all mathematics subjects were combined, students from more highly educated homes were more likely than students from less well educated homes to expect to do very well (25% compared with 14%). The compounding effect of being a boy from a well educated home background pushed this expectation to 33%, while that for a girl from a less well educated home reduced this expectation to only 10%.

These findings are consistent with the view that children of more highly educated parents have stronger social and cultural ties with the values and practices of senior secondary schooling, and therefore feel more confident of success. Conversely, children from families where there is no experience of completion of secondary education or of further education are more likely to struggle to adapt to the demands of the VCE (Teese, 2000; Teese, Lamb, & Helme, 2009).

Improving mathematics and the way it is taught

Students were asked to complete an open-ended item asking them to make suggestions for improving mathematics and the way it is taught. The findings of this aspect of the analysis will be reported separately as space does not permit a detailed discussion here. Suffice to say that the most frequently mentioned suggestion for improvement concerned quality of teaching. Students asked for teachers who could speak and explain more clearly, and adapt their explanations to individual needs. They also called for teaching methods that were less dependent on textbooks and were more interactive.

Other feedback included better teaching at earlier year-levels, more thorough preparation for Year 12, and a slower pace of teaching in Year 12. Students also asked for more enjoyable coursework and course content that has stronger links to real life situations. Students in all subjects expressed a desire for more “hands on” mathematics.

Student feedback suggests that some schools need to review curriculum, pedagogy and teacher allocation practices in earlier years. It also highlights the difficulties schools face in finding mathematics teachers who have the appropriate expertise. This is a particular issue in low SES schools in the region, which are more vulnerable to shortages of qualified mathematics teachers and high teacher turnover (Helme, Teese & Lamb, 2009).

These findings reveal a mismatch between what students say they need and what they get. While students appear to have a good understanding of their needs as learners, these often clash with externally imposed demands and constraints. Teachers must complete the coursework in the time available and prepare their students for final examinations. They cannot slow the pace, diverge from the set curriculum or amend the content to suit students’ needs and interests. This issue has been previously identified in low SES schools, where the need to accommodate student diversity is the greatest (Helme, Lamb, & Teese, 2009; Teese, Lamb, & Helme, 2009).

Conclusion

Despite a differentiated Year 12 curriculum, students undertaking different Year 12 Mathematics subjects in the NMR do not enjoy the same quality of experience. Perceptions of mathematics classrooms, mathematics teachers and expectation of success vary according to the mathematics subject students are enrolled in.

This study also shows that children of tertiary educated parents are more connected to mathematics and more confident of success, and therefore better placed to achieve good results and enter tertiary education. These students are also more likely to attend larger schools that do not experience the serious staffing issues confronted by smaller, poorer schools in the NMR. It is noteworthy that four of the ten schools in this study are no longer able to offer Specialist Mathematics classes.

Despite decades of research in gender differences and strategies for making mathematics content and pedagogy more responsive to the needs of girls, this study reveals there is still more to be done.

Student feedback obtained in this study provides some signposts for action, which include more engaging pedagogy, better ways of preparing students for VCE and a stronger emphasis on addressing individual learning needs.

Inequities in the experiences and outcomes of Year 12 mathematics students cannot, however, be overcome simply by teachers in low SES schools continuing to struggle to adapt to the demands of the VCE. School systems must also heed student feedback, reinvigorate the curriculum and provide enough trained teachers to ensure that all students have the opportunity to engage deeply with mathematics. What better time than now to review curriculum and pedagogy, in the current context of the development of the Australian mathematics curriculum? Otherwise, too many students will remain marginalised from mathematics and the rewards conferred by curriculum and pedagogy will continue to be inequitably distributed.

Acknowledgements

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