Student Experiences of VCE Further Mathematics

Sue Helme
University of Melbourne
<sueh@unimelb.edu.au>

Stephen Lamb
University of Melbourne
<lamb@unimelb.edu.au>

This paper examines student experiences in VCE Further Mathematics. In a survey conducted in 2006, 866 year 12 graduates who had studied Further Mathematics the previous year were asked about their experiences of Further Mathematics classes and their views on the subject and the teacher. The students who did Further Mathematics as their only mathematics subject were less confident about doing well, had a less positive view of the classroom as a learning environment and more negative attitudes towards their mathematics teachers, compared to students who studied both Further Mathematics and Mathematical Methods. The practice of allowing Mathematical Methods students also to study Further Mathematics may contribute to higher results in Further Mathematics for these students, but it may inhibit the capacity for teachers and schools to cater properly to the needs of those for whom the subject was initially designed.

This paper comes from a broader ARC-funded project examining the extent to which young people from different family backgrounds access different "locations" within the Victorian Certificate of Education (VCE) curriculum. It explores the quality of their instructional experiences, their academic outcomes, and the post-school destinations connected with the places they occupied in the curriculum. The broad objective of the project is to make the curriculum more transparent with respect to underlying social patterns and processes.

The formal role of the VCE is to prepare young people for a successful transition to further study and work. In this context, the VCE needs to be both equitable in the range of learning opportunities it provides, and effective in the range of valued destinations to which it leads.

Some subject areas in the VCE are organised to accommodate a broad range of student skills and abilities. Mathematics is designed to do this through provision of a hierarchical set of subjects designed around different skill levels. The mathematics subject Further Mathematics was designed to,

> provide access to worthwhile and challenging mathematical learning in a way which takes into account the needs and aspirations of a wide range of students. It is also designed to promote students' awareness of the importance of mathematics in everyday life in a technological society, and confidence in making effective use of mathematical ideas, techniques and processes. (Victorian Curriculum and Assessment Authority (VCAA), 2005, p. 1)

It is meant to be widely accessible, providing general preparation for employment or further study, in particular where data analysis is important. According to the Victorian Parliamentary Enquiry into the Promotion of Mathematics and Science Education (2006),

> it is suited to students who require some mathematical literacy in their further study or work but not high level applications of pure mathematics or high level conceptual mathematics… it is the easiest of the VCE Unit 3 and 4 mathematics subjects (p. 54).

Further Mathematics has consistently been the most popular Unit 3 and 4 mathematics subject, and is gaining in popularity. According to the Victorian Parliamentary Enquiry (2006) enrolments in Further Mathematics have increased from 37% of the Year 12 cohort

in 2000 to 47% in 2004. This is in contrast to enrolments in Mathematical Methods (stable at about 37%) and Specialist Mathematics (13%). The number of students who sat for the Further Mathematics examinations was 21,815 in 2005, a slight increase over 2004 (21,216) (VCAA, 2006).

Participation rates in Further Mathematics are much the same for males and females (see Table 1, which shows participation rates in 2005). This is in contrast to Mathematical Methods, where there is a large gender gap in participation favouring boys, particularly in lower SES bands. The social composition of Further Mathematics is also much more democratic. In contrast to Mathematical Methods, enrolment levels in Further Mathematics are high amongst all groups, but peak in the middle social bands. They are lowest amongst students in the highest quintile of SES. The high overall levels of enrolment in Further Mathematics reflect a range of different orientations to the subject, and contribute to a flattening of the social trend, since students from a wide range of social backgrounds take the subject, either as their only mathematics subject or in conjunction with Mathematical Methods.

Table 1
Participation in VCE Mathematics, by SES and Gender: Year 12 Students, 2005

	Further Mathematics		**Mathematical Methods**		**Specialist Mathematics**	
SES quintile	Males	Females	Males	Females	Males	Females
Lowest	44.4	44.9	34.2	23.5	11.7	6.0
Lower middle	45.2	46.1	35.7	23.9	12.7	5.8
Middle	47.1	46.9	36.5	26.3	12.5	5.7
Upper middle	46.0	45.1	41.6	32.0	16.7	8.7
Highest	40.7	39.0	52.1	44.5	21.0	13.8
Total	44.6	44.5	40.3	29.7	15.1	7.9

Source: Unpublished VCAA data

Lamb and Helme (2007) have reported a pattern in some schools of high rates of enrolment in Further Mathematics associated with high rates of enrolment in Mathematical Methods. In about a fifth of secondary schools in Victoria, 21% or more Further Mathematics students were enrolled in Mathematical Methods. The authors also found that schools in which many Further Mathematics students also studied Mathematical Methods tended to have higher than predicted achievement for Further Mathematics. The strategy of combining Further Mathematics and Mathematical Methods leads to significantly higher achievement levels in Further Mathematics. The results show that the strategy of combining Mathematical Methods and Further Mathematics gives some schools a competitive advantage in VCE scores (and also possibly in terms of ENTER scores). The practice may have benefits for the students in the schools that employ the strategy, however, it may make it more difficult for students in schools where the practice does not occur to achieve the same levels of success.

Further Mathematics is designed for a diverse range of abilities, and particularly for students who do not want to be exposed to the rigorous and challenging intellectual demands of Mathematical Methods or Specialist Mathematics. The growing tendency for students to combine Further Mathematics and Mathematical Methods suggest that Further

Mathematics has been open to use by able and high achieving mathematics students seeking a competitive advantage in the race for VCE results, a situation that may further depress the opportunity for success of students genuinely wanting to continue to learn mathematics at an appropriate level.

This paper examines the impact of these practices on students' classroom experience of mathematics, and investigates a number of questions.

- Do Further Mathematics students who also do Mathematical Methods experience their Further Mathematics classroom in a different way to students who just do Further Mathematics?
- Do Further Mathematics students who also do Mathematical Methods experience their Further Mathematics teacher in a different way to students who just do Further Mathematics?
- Do any differences in student experiences of Further Mathematics classes help explain the performance differences discussed above?

Methodology

The data for this study were derived from a sample of students surveyed as part of a larger study of the VCE curriculum in a group of selected Victorian secondary schools. The aim of the larger study is to look at student experiences in schools that vary in terms of effectiveness, measured on the basis of VCE results. Schools that were selected were those where VCE results (measured as an aggregate as well as across eight key learning areas) were either (a) well above what could be predicted based on SES intake, General Achievement Test (GAT) scores, location, size, resource levels, and sector, (b) about the level that would be expected given those characteristics, and (c) well below expected performance levels based on student intake characteristics. The schools represent a range of SES, GAT achievement, and regional characteristics. For the present paper, 23 of the original schools are represented.

Year 12 VCE graduates from these schools were surveyed in April 2006, the year after they completed VCE. The survey included questions on their experiences of mathematics in VCE. It was done in conjunction with the annual *On Track* data collection. *On Track* is an annual telephone survey of Year 12 completers conducted in March-April in the following year.

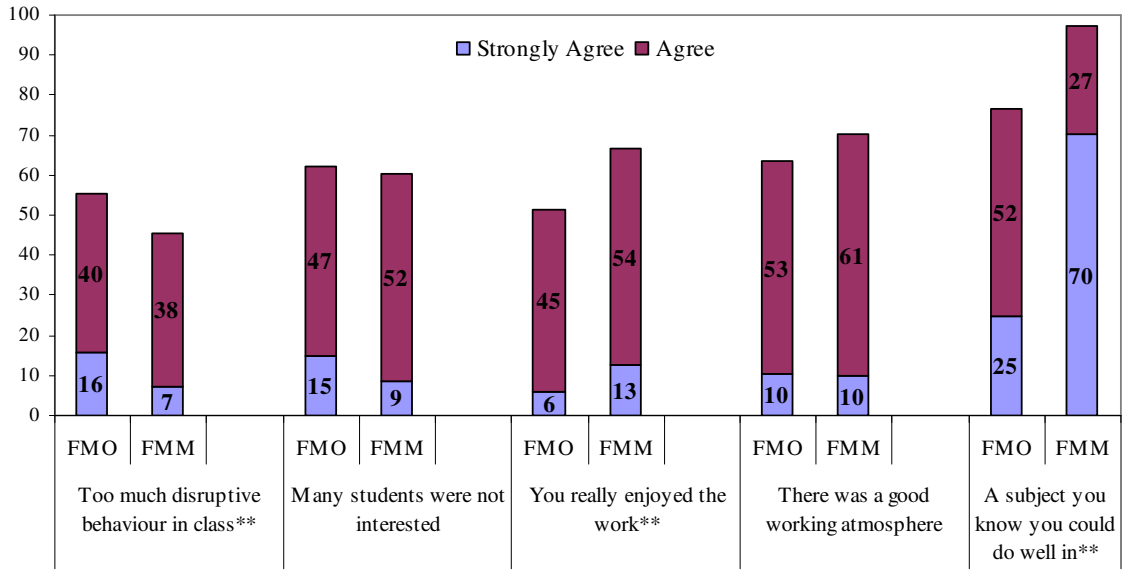
Data were obtained from 1368 Year 12 students who confirmed in the survey that they had studied Further Mathematics and/or Mathematical Methods during VCE. A sample of 866 of the respondents indicated that they had studied Further Mathematics and 659 confirmed that they had studied Mathematical Methods, whereas 157 reported that they had enrolled in both subjects. It was possible, on this basis, to distinguish between Further Mathematics only students (FMO) and those who had completed both Further Mathematics and Mathematical Methods (FMM). The samples represented 65.7% and 66.8% respectively of the total enrolments in these subjects across the schools. The response rates compare favourably with the overall response rate for *On Track*, which in 2006 was 66.5% of all Year 12 or equivalent completers (Teese, Nicholas, Polesel, & Mason, 2007).

Two sorts of analyses are presented. The first is a set of descriptive results presenting information on student views on Further Mathematics including on classroom climate, attitudes towards the subject, and enjoyment, and views on their Further Mathematics teacher and his or her qualities and methods. The second is a set of results from a

regression analysis using Hierarchical Linear Modelling (HLM) to model both student-level and school-level influences on student experiences of Further Mathematics. Student-level factors included gender, GAT scores, and mathematics subject combination (Further Maths Only or Further Mathematics and Methods). School-level factors included mean SES of the student body at the school, school size (measured as the number of Year 12 enrolments in 2005), and the percentage of Further Mathematics students also studying Mathematical Methods in each school.

Student Views of the Mathematics Classroom

Student responses to a range of items on their experiences of mathematics are shown in Figure 1. It compares the perceptions of students who did Further Mathematics as their only mathematics subject (FMO) with the perceptions of those who also did Mathematical Methods (FMM).



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

Figure 1. Student views of mathematics and mathematics classrooms.

Figure 1 reports significant differences in the perceptions of the two groups of students. The most striking aspect of the results is the difference between the two groups in their perceptions of how well they expected to do. Students who combined Further Mathematics with Methods were significantly more likely to report that they knew that they could do well in Further Mathematics (70% strongly agreed, compared with only 25% of FMO students). Indeed, almost all of the FMM students (97%) agreed or strongly agreed that it was a subject they expected to do well in. These findings confirm the strategic value to these students of combining the study of Mathematical Methods and Further Mathematics.

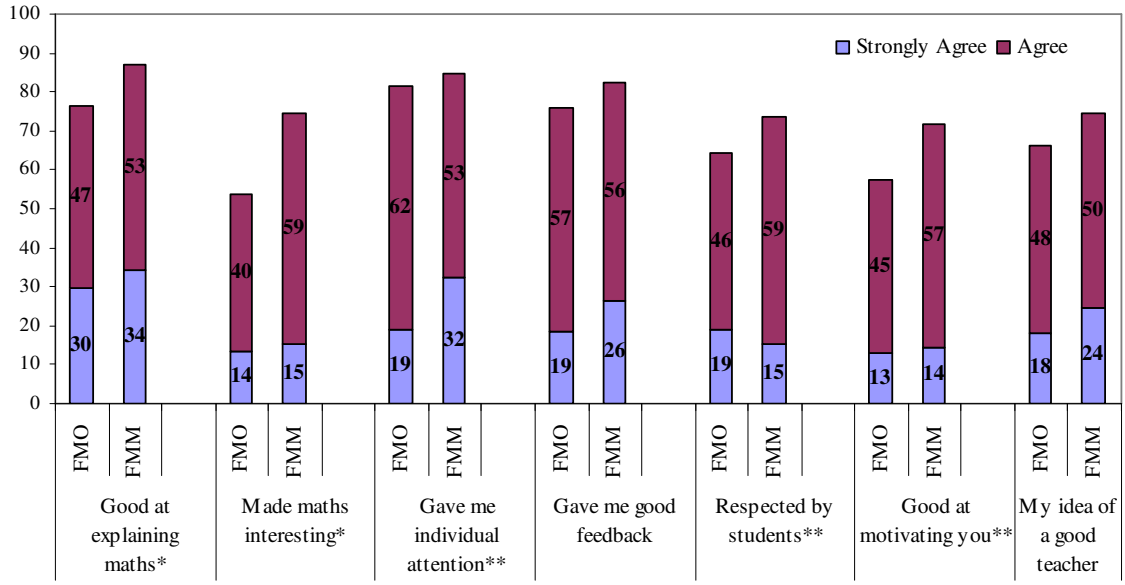
In addition to their perceived advantages over their peers in terms of preparation and confidence the FMM students were significantly more likely to report that they really enjoyed the work.

The other item for which there was a significant difference between the two groups was in relation to student perceptions of classroom behaviour. FMO students were significantly more likely to report that there was too much disruptive behaviour in their classes.

Although statistically significant differences were not evident for the remaining two items, the trend in responses was consistent with the results reported above, that is, FMM students appeared to experience the mathematics classroom in a more positive way than FMO students.

Student Views of their Further Mathematics Teacher

Figure 2 examines student views of their Further Mathematics teacher, in relation to several dimensions of perceived teacher expertise. Similarly to Figure 1, it compares the responses of FMO students with the responses of FMM students.



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

Figure 2. Student views of their Further Mathematics Teacher.

There were some strong and significant differences between the two types of students with regard to their perceptions of their mathematics teacher. Students who did both subjects were significantly more likely to report that their maths teacher made the subject interesting. They were also more likely to report that their teacher gave them individual attention when they needed it and was good at motivating them to do their best. Their teacher was also significantly more likely to be reported as good at explaining things clearly, and to be well respected. Results for the remaining two items – "gave you good feedback on your work during the year" and "was your idea of a good teacher" – although not statistically significant using Chi-square, were consistent with the trends for the other items.

Clearly, students who did both subjects had a much more favourable view of their Further Mathematics teacher, compared to those who did Further Mathematics only.

The results indicate that the FMM students experience Further Mathematics differently from the FMO students. They have a more positive experience of their Further Mathematics classroom and perceive their Further Mathematics teacher as responding more to their needs.

A Closer Examination of the Differences

There are a number of student-level and school-level factors that could account for the differences in perceptions, separately from whether or not students were enrolled for both Further Mathematics and Mathematical Methods. At the student level, these include academic aptitude (as measured by GAT), gender, and SES. For example, differences in confidence between FMO students and FMM students may simply be due to FMM students being more academically able, or comprising a higher proportion of male students.

Similarly, school level factors such as size, average socioeconomic status or the proportion of Further Mathematics Students also doing Mathematical Methods may influence student perceptions.

Regression analysis using Hierarchical Linear Modelling was conducted to model both student-level and school-level factors that may influence student experiences and dispositions. The results of the analysis are shown in Table 2.

Student-level Effects

1. GAT. The higher students' GAT scores, the more likely they were to express confidence in their ability to do well in Further Mathematics. Moreover, after controlling for other factors, the higher the GAT the more likely students were to perceive their teacher as good at explaining maths ($p<0.01$).

2. Mathematics Subject Combination. In this analysis, the control group was the FMM students. There were two significant differences between the FMO group and the FMM group, independent of other factors. First, FMO students were significantly less likely to express confidence in their ability to do well ($p<0.001$) and, second, to report that their teacher made mathematics interesting ($p<0.001$), all else equal.

3. Gender. Gender was a significant factor on two items only. Female students were significantly more likely to perceive their Further Mathematics teacher as well respected ($p<0.01$) and as good at motivating them ($p<0.1$). Interestingly, there were no significant differences between male and female students in their confidence in doing well and their enjoyment of the subject.

School-level Effects

1. Socioeconomic status. The mean SES level of a school tends to have a negative relationship with student perceptions, independent of all other factors. That is, the higher the SES of the school, the less that students report enjoying the work. The patterns may reflect a higher propensity for weaker mathematics students in middle class settings to continue in a subject area that they do not enjoy, responding to school policies to include a mathematics subject in Year 12, parental pressure to do mathematics, and/or the desire to keep their options open for further study.

Table 2
Variation among Students and Schools in Perceptions of Further Mathematics and Further Mathematics Teachers

	Student-level			*School-level*			*School effects*	
	GAT	Further Maths Only	Female	SES	School size	% Maths Methods	Without school-level controls	With school-level controls
Views on Further Maths								
It is a subject you knew you could do well in	0.009***	-0.121***	-0.041	-0.000	-0.060	0.008***	13.3	7.1
There was too much disruptive behaviour in your class	-0.005	0.022	-0.014	-0.000	-0.045	-0.006**	17.1	14.7
You really enjoyed the work	-0.003	-0.091	0.040	-0.002***	0.135	0.003	24.2	21.9
There was a good working atmosphere	0.000	-0.005	0.014	0.000	0.119**	0.005***	12.5	8.7
Many of your fellow students were not interested	0.002	-0.012	-0.020	-0.000	-0.152**	-0.009***	19.4	10.7
Views on Further Maths teacher								
Was good at explaining maths	0.007**	-0.014	0.031	-0.001*	0.254**	0.005	34.9	31.7
Made maths interesting	-0.005	-0.069***	0.039	-0.001	0.227**	0.005*	23.5	18.8
Gave you individual attention	0.001	-0.026	-0.010	-0.000	0.078	0.004**	12.5	8.7
Gave you good feedback	-0.000	-0.022	-0.026	-0.000	0.150**	0.003	16.0	12.5
Was well respected by students	0.000	-0.018	0.060**	-0.001*	0.176*	0.003	24.3	22.2
Was good at motivating you	-0.002	-0.029*	0.041*	-0.001	0.218**	0.007**	27.3	22.6
Was your idea of a good teacher	0.004	-0.011	0.025	-0.001	0.182	0.006*	27.8	25.7

Note: * p<0.1, ** p<0.05, *** p<0.01

2. *School size.* The smaller the size of the VCE cohort, the more likely are students to report negative views of Further Mathematics and their Further Mathematics teachers, independent of all other factors. These findings may reflect the differences between smaller and larger schools in the size of their mathematics department, in that larger schools have greater numbers of qualified and experienced teachers from which to draw in staffing their VCE mathematics classes. These results parallel the relationship between school size and achievement in mathematics, whereby the smaller the school, the lower the performance in mathematics (Lamb & Helme, 2007).

3. *Proportion of FMM students.* Independent of all else, the strongest effects on students' views of mathematics and mathematics teachers is the proportion of students in Further Mathematics classes who are also doing Mathematical Methods. As this proportion increases, there is a significant increase in the proportions of Further Mathematics students who view the subject as one they could do well in, a significant decrease in the proportion of students who view classrooms as one in which there is too much disruptive behaviour, a significant increase in the proportion who consider their classroom to have a good working atmosphere, and a significant decrease in the proportion who claim that many students are not interested. Thus in the schools where there are larger numbers of Mathematical Methods students also doing Further Mathematics, students are more confident about doing well, feel they are learning in a good working atmosphere, and sense that other students are well motivated. These findings extend to their views of teachers, who are more likely to be perceived as making mathematics interesting, providing the individual attention they need, motivating them to do well, and conforming to their idea of a good teacher.

4. *School effects.* The data in the last two columns of Table 2 indicate that school level factors can account for much of the variation in students' views of Further Mathematics and Further Mathematics teachers. The second last column presents the amount of variance in the student view that can be explained by between-school differences, before taking account of the school-level factors. The final column presents the amount of between-school variance after controlling for the school-level factors. On certain items, there is a substantial reduction in the amount of school level variation after controlling for school-level factors. For example, between-school differences accounted for about 13.3% of the variation in responses to the item that Further Mathematics is "a subject you knew you could do well in". The school-level factors accounted for almost 50% of the between-school effects, reducing the unexplained variance to 7.1%. The school-level factors identified in this study (SES, size and proportion of FMM students) account for a large proportion of the school effect and can reduce the amount of school-level variance by up to half. This is the case for several items, including students' confidence in doing well, their claims of a good working atmosphere, and their reports of receiving the individual attention they needed.

Conclusions

This paper demonstrates that the students who do Further Mathematics as their only mathematics subject have a different experience of Further Mathematics than do students who combine Further Mathematics and Mathematical Methods. Further Mathematics-only students are less confident about their ability to do well, have a poorer experience of the mathematics classroom, and have more negative views of their mathematics teachers.

Further Mathematics was originally designed to cater to less-skilled mathematics students. The practice of allowing Mathematical Methods students to also study Further Mathematics may contribute to higher results in Further Mathematics for these students, but this may inhibit the capacity for teachers and schools to cater properly to the needs of those for whom the subject was initially designed.

Those in the mathematics education community with an interest in equity need to question the strategies that are being used to provide some students with an unfair advantage both within schools and across the school system, at the expense of the "traditional" Further Mathematics student. The recent decision to allow students to undertake all three mathematics subjects in the VCE without penalty will only exacerbate this problem, further expanding the gap between the "winners" and the "losers".

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