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STUDENT PARTICIPATION IN MATHEMATICS COURSES IN AUSTRALIAN SECONDARY SCHOOLS

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Participation in advanced levels of mathematics in secondary school is of interest to those involved in educational policy and practice as well as those involved in research. This paper uses multilevel analyses (including a trichotomous outcome variable) of longitudinal data from a nationally representative sample of Australian schools to investigate the influence of a number of factors on participation in mathematics (advanced, general, or none) in the final year of secondary school. The results suggest that the major influences on mathematics participation are gender and prior mathematics achievement. Both influences are substantial and independent of each other. Building a strong foundation in mathematics is likely to be an effective way of enhancing participation in advanced mathematics in the final year of school. However, although that may result in higher overall levels of participation in advanced mathematics, it is unlikely to alter the balance between boys and girls. Nor is the wider use of single sex schooling.

The impact of school and school type on differences in student achievement and on variations in course enrolments has become a focus of popular and professional concern. This is particularly the case in curriculum areas that are seen to have a major influence upon the educational and career options available to young people. Mathematics attracts particular attention because of its crucial role in entry to further studies in the scientific, technical, and engineering fields. Those concerned with promoting rigorous and intellectually demanding studies in secondary school see participation in advanced studies in mathematics as important, as do those who see under-representation of disadvantaged groups in advanced mathematics as reflecting unequal earlier opportunities and

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exacerbating later differences in outcomes. The development of mathematical competence by a broad range of students in earlier years of schooling is relevant to both of these concerns.

The considerable literature on participation in mathematics encompasses student-level influences (such as gender, earlier school achievement and social background) and school-level influences (such as school type, coeducational status and curriculum policy). Much of the literature is based on trends and patterns in aggregate statistics so that, in an area where so many influences are inter-related, it is difficult to derive conclusions of an 'other things equal' type. Research relating to student-level and school-level factors is available.

At the student level, an extensive body of literature has examined gender differences in participation in mathematics (and the physical sciences) in a number of countries. This has consistently shown substantial differences in favour of males (Ainley, Jones & Navaratnam, 1990; Ainley et al, 1994; Bosker & Dekkers, 1994; Elwood 1995; Gill & Gaffney, 1996; Hyde, Fenema & Lamon, 1990; Oakes, 1990). Part of the concern regarding the under-representation of girls in advanced mathematics courses in senior secondary school and equivalent grade levels arises because of perceived consequences for career development. Even though the average gender gap in mathematics achievement appears to have narrowed in recent years in many countries (Daly & Shuttleworth, 1997; Lokan, Greenwood & Ford, 1996) participation remains an issue of concern.

In Australia, girls in the final year of secondary school participate in advanced mathematics at less than half the rate of boys (Ainley et al, 1990; Dekkers, DeLaeter & Malone, 1991). In response, governments have introduced numerous schemes to encourage females to continue the study of mathematics into the senior years of secondary school (Australian Education Council, 1991; Commonwealth Schools Commission, 1987). Explanations for gender differences have often invoked ideas related to occupational interests (Care & Naylor, 1984), social influences in school and outside (Kelly, 1988; Leder & Forgasz, 1992), opportunities in the earlier years of school (Oakes, 1990), and the nature of school curricula (Willis, 1989).

The search for explanations of the low participation rates of girls in mathematics sometimes invokes contextual and interaction effects. Lamb (1996) has argued that gender differences are dependent on socioeconomic background and school policies that shape access to the curriculum. He found differences in the patterns of mathematics participation by girls in four schools that could be related to the educational policies of the schools. He concluded that future research needs to focus less on whether girls as a group are disadvantaged in mathematics and more on which groups of girls and in which school settings.

Socioeconomic background has been identified as associated with participation in mathematics. Students from upper socioeconomic backgrounds study a greater amount of mathematics and more advanced forms of mathematics (Ainley et al, 1994; Teese, 1994). Explanations for this are far from clear. On the one hand, advanced mathematics subjects are seen as prestigious in the sense that they provide access to professional preparation, and it would be expected that students from high socioeconomic, and culturally enriched, backgrounds would participate to a greater extent than other students (Teese, 1989). On the other hand, it is also recognized that the orientation of those courses to applied science and engineering careers provides an appeal for working class males (Teese, 1989). Such an argument suggests that there may be interaction effects involving gender and social background contributing to a more complex picture than is sometimes painted.

Finally, at the individual level, high levels of earlier school achievement have been found to be strongly associated with participation in advanced mathematics (and physical sciences) in senior secondary school in Australia (Ainley et al, 1990, 1994). In a longitudinal study conducted in 22 schools in one state, it was found the type of mathematics course in which students enrolled in senior secondary school was strongly related to achievement on a mathematics test completed in Grade 9 (Ainley, 1995). In fact, the association between type of mathematics course and earlier mathematics achievement was a little stronger for females than for males. This corresponds with the observation by other writers that female students who study advanced mathematics are a more select group than their male counterparts (Gill, 1995). This could be because males are more strongly encouraged to enrol in advanced mathematics courses than females of similar mathematics ability. However, it should also be noted that despite this strong overall relationship, approximately 20% of students choosing advanced mathematics scored below the mean in the Year 9 test. There are other factors at work.

A number of writers have suggested that the association between earlier mathematics achievement and enrolment in advanced mathematics is strong because mathematics is seen as a difficult subject to be chosen only by students who perceive themselves to be competent. This suggests that a sense of efficacy developed in earlier years could be an important influence on subsequent choice of mathematics courses. Kelly (1988) observes that the role of perceived competence in career and subject choice is stronger for males than females.

A further interpretation of the selectivity of participation in mathematics invokes processes of channelling which take place in schools rather than the exercise of choice by students (Dauber, Alexander & Entwisle, 1996; Oakes 1990; Spade, Columba & Vanfossen , 1997). Gill and Gaffney (1996) indicate that these processes may involve teachers sponsoring able students and encouraging them to enrol in advanced mathematics. Certainly students of lower mathematics achievement are discouraged from attempting advanced studies. Either because students study in areas in which they feel capable, or because of the different advice (or even prescriptions) given to students (e.g., to maximize their subsequent choices of study and career), it is found that participation in advanced mathematics is higher among high achieving students.

Two of the major school-level factors reported in the literature are school type (Government, Catholic, or Independent) and coeducational status (single-sex or coeducational). These are factors that appear on the surface to be associated with participation in mathematics but which seem to be reduced when analyses take account of the effects of student intake (Daly & Shuttleworth, 1997; LePore & Warren, 1996).

In the context of the present paper, type of school refers to school governance or the school system to which the school belongs. In Australia the three types of school are Government (public), Catholic, and Independent (private non-Catholic). In the final year of secondary school, these three groups of schools enrol 63, 21, and 15% respectively of the student population (ABS, 1996). There is evidence of differences between the types in the extent to which their students participate in advanced mathematics or physical sciences. Generally, it appears that Independent schools have higher levels of participation in advanced mathematics (and the physical sciences) than Government or Catholic schools (Ainley et al, 1994). This has been interpreted as an important part of the culture of non-government schools that is promoted through a number of practices (Teese, 1989). However, given the selectivity of the intake of those schools, there is a need to examine whether the higher levels of participation in advanced mathematics reflect school influences or the nature of the intake to the schools.

Single-sex or coeducational schooling is a vexed question in educational research (Parker & Rennie, 1996; Riordan, 1990). In one study that examined participation in mathematics as well as achievement, and used a method of analysis that controlled for the concomitant effects of other variables, Daly and Shuttleworth (1997) report little evidence of a beneficial effect of single-sex schooling on the mathematics participation of girls. Other studies of single-sex schooling have tended to focus on achievement outcomes, but are not consistent in their conclusions. In the United States, Lee and Bryk (1986) analysed *High*

School and Beyond data and concluded that girls benefited academically and attitudinally from being in single-sex secondary schools. On the other hand, Marsh (1989), using the same data, argued that those differences were not statistically significant. Analyses by the Inner London Educational Authority during the 1980s have been inconclusive although a complex multi-level analysis, incorporating data relating to three pupil cohorts, suggested significant attainment advantages for girls attending single-sex secondary schools (Nuttall et al, 1989). In Northern Ireland where single-sex schooling is widespread, Daly (1996) reported achievement advantages for 16-year-old girls in public examinations but the findings failed to reach significance. Furthermore, Daly's (1995) study of enrolment and achievement differences, among boys and girls taking public examinations in science at age 16, indicated that attendance at single-sex schools did not appear to confer significant advantages. A recent Irish study reported the non-significant impact of single-sex/coeducational secondary school differences on overall achievement in the main public examination taken by school leavers. However, in the case of mathematics results, there was a slightly different pattern with girls appearing to benefit from single-sex schooling (Hannan et al, 1996).

Some writers argue that single-sex schooling, and single-sex teaching, ought to enhance achievement and participation in mathematics among girls because in such an environment they will be less inhibited from demonstrating interest and skill in a non-traditional environment (see Leder & Sampson, 1989). On the other hand, it could be argued that the general culture of a single-sex girls school might not emphasize study in an area that has not been traditional for girls, and that enrolments in non-traditional areas of study might not reach the critical threshold. Gill (1988) suggests that there is little evidence that girls are more inclined to continue studies in mathematics in a single-sex environment. Ainley et al (1990, 1994) suggest that there may be a small effect but that differences could be attributed to other confounding influences such as type of school (most single-sex schools are in the non-government sector) and socioeconomic background (single-sex schools tend to enrol students from higher socioeconomic backgrounds). The discussion of the issue is such that an investigation that controls for other influences and takes account of the multilevel nature of the data is opportune.

There is evidence that school-level factors other than school type and coeducational status can influence participation in mathematics. As noted above, a detailed analysis of four schools in Victoria by Lamb (1996) indicated that school policies regarding access to the curriculum generally, and entry to advanced mathematics in particular, could influence patterns of participation. A study of 22 schools in New South Wales by Ainley (1995) showed that schools differed in the extent to which their students enrolled in advanced mathematics courses, even after allowing for the effects of mathematics achievement in Grade 9. The two schools with the largest positive residuals were both single-sex male schools, but the two single-sex female schools did not stand out as having fewer than the expected numbers of students in advanced mathematics (they were in fact about average on this dimension). The two all-male schools both promoted their programmes as having a technological orientation and had an established tradition of science and technology. Schools that had unusually low percentages of students in advanced mathematics did not strongly promote academic achievement (in two cases promoting an alternative course of study with a vocational emphasis).

In the study reported in this paper, multilevel and multivariate analyses of longitudinal data are used to investigate the influence of a number of factors on participation in mathematics (advanced, general, or none) in the final year of secondary school in Australia. At the level of individual students, it explores the effect of gender, earlier achievement in mathematics, as well as home and ethnic background. At the level of the school, it considers the type of school (Government, Catholic, or Independent), the coeducational status of the school (single-sex or coeducational), and the location of the school. It pays special attention to the effects of coeducational status and type of school.

Since our study is based on data about students in Australia in the early 1990s some comment on context is appropriate. In Australia most young people continue in school to Year 10. Years 11 and 12 are considered to constitute the senior secondary, or postcompulsory, years. Approximately 80% of each cohort continues at school to Year 11 and around 70% to Year 12 (ABS, 1996). The nature and structure of what is studied in those senior years varies between states but typically the equivalent of five or six subjects is studied from a wide selection, and usually subjects studied in Year 12 build on what was covered in Year 11. In recent years, the secondary school curriculum and students' subject choices have received attention from educational researchers and policy-makers. There has been increasing interest in patterns of enrolment in different subjects and the consequences of subject choice for future educational and occupational opportunities.

In 1994, approximately 14% of Grade 12 students studied no mathematics subjects at all and approximately 17% studied more than one mathematics subject. The study of more than one mathematics subject can be taken as an indication of studying 'advanced' mathematics. Mathematics studies can be designated as 'advanced', 'ordinary', or 'fundamental', depending on whether they provide the basis for entry to mathematics or mathematics dependent studies at university. In this paper no distinction is made between 'ordinary' and 'fundamental' mathematics: they are referred to together as general mathematics courses.

METHOD

Sample

The students in the sample were born in 1975 and were sampled in 1989. The sampling process involved a two-stage design: schools were selected with a probability proportional to size from a stratified sampling frame and students were selected at random within schools. In 1992, there were some 2,877 respondents of whom 2,002 had completed the final year of secondary school (Year 12). These 2,002 students are the focus of the analyses in the present paper. They attended 250 schools; hence, there was an average of eight students per school. This is an appropriate degree of clustering for a two-level design (Snijders & Bosker, 1993). Three-quarters of the students were in coeducational secondary schools and almost two-thirds were in government secondary schools.

Data Collection

The students completed tests of literacy and numeracy in 1989 when they were 14 years old. They were contacted subsequently by survey at the end of each year from 1990 onwards. In 1992 they indicated (among other things) their year level in school and the subjects which they had studied in that year. Information was available from other surveys on factors such as gender, socioeconomic and ethnic background, parents' education, type of secondary school attended (Government, Catholic, Independent), the coeducational status of the school, and other information relevant to the experience of schooling.

Variables and Measures

Student-level Variables

Earlier mathematics achievement was measured when the students were 14 years old and in early secondary school in 1989. The modal level of school was Year 9. For this paper the achievement variable is represented in quartile form, with the quartiles being defined in relation to those students who reached Year 12. In the multilevel analyses, the bottom quartile is the omitted category.

Parental education is based on information provided by the student about the highest level of education attained by each parent. For analyses, the highest level of attainment by either parent has been used and has been classified dichotomously as university graduate or non-graduate. In the multilevel analyses, non-graduate is the omitted category.

Ethnic background refers to the country of birth of one of the student's parents. For these analyses it is classified as English-speaking or non-English speaking. In the multilevel analyses, English speaking background is the omitted category.

School-Level Variables

School type refers to the type of secondary school attended and is classified as Government, Catholic, or Independent. In the multilevel analyses, Government is the omitted category.

School location refers to where the school was located. It is classified as metropolitan or non-metropolitan. In the multilevel analyses, metropolitan is the omitted category.

Coeducational status refers to the gender composition of the school. It is classified as all-girls, all-boys, or coeducational. In the multilevel analyses, coeducational is the omitted category.

Analysis

The first analysis reported records the percentages of students participating in each type of mathematics course. This provides descriptive summary data for the sample. However, for a number of reasons a multilevel modelling approach to the data analysis was required. Firstly, students were grouped within schools and to ignore this clustering would ignore correlations induced by clustering, thereby biasing estimates of standard errors in the models. Secondly, since there were associations between several of the predictor variables, a method of analysis was required to establish the effect of each variable on participation in mathematics controlling for other variables in the model. Thirdly, the model included variables specified at the student level and the school level with the meaning of variables depending on the level at which they were specified. Thus, it was necessary to identify the influence of factors at each level. Fourthly, the outcomes of interest were discrete response measures and multilevel logit models were required (Goldstein, 1991; Paterson, 1991).

The methods followed were similar to those used by Daly and Shuttleworth (1997). Categorical (dummy) predictor variables were used. With regard to the dependent variable, participation in advanced mathematics course was first treated as a dichotomous response variable (i.e., participation in these courses was compared with non-participation). A wider analysis was then conducted involving a trichotomous response variable, namely, participation in advanced mathematics courses, participation in general mathematics courses, and non-participation in mathematics courses. In this analysis, the reference category is participation in a general mathematics course for each course variable coefficient.

Logistic regression is commonly used to model dichotomous outcome variables. In the analysis reported in Table 2, a two-level random intercepts model (students at level 1 and schools at level 2) was fitted to the data (see Goldstein, 1991). Participation in advanced mathematics was coded as 1 and non-participation as 0. Y_{ij} denoted the participation value for student i in school j. Following Paterson's (1991) simplified notation, F_{ij} denoted the fixed part of the main effects model.

$$F_{ij} = b_0 + b_{1(gender)} + b_{2(prior\_maths\_ach)} + b_{3(parent\_edn)} + b_{4(ethincity)} + b_{5(school\_type)} + b_{6(coed\ status)} + b_{7(school\_location)}$$

The function p is defined by:

$$p(F) = \exp(F) / (1 + \exp(F))$$

The basic model equation is:

$$Y_{ij} = p(F_{ij} + u_j) + e_{ij}$$

with u_j as the school-level random term and $p(F+u)$ as the probability of the student taking advanced mathematics conditional on the fixed part variables and on the random term. This means that the beta coefficients can be taken as the natural logarithms of the odds of participating in advanced mathematics against non-participation. At level one, fitting binomial variation was adequate. Modelling a trichotomous outcome (see Table 3) represents an extension of the above procedures.

The software used was developed at the University of London Institute of Education by the Multilevel Models Project team led by Professor Harvey Goldstein (Goldstein, 1995; Yang, Goldstein & Rasbash, 1996).

RESULTS

Sample Data: Unadjusted Associations

Table 1 records data reflecting the unadjusted relationship between each of the variables in the model and participation in mathematics. These results are consistent with what is known about patterns of participation in mathematics.

Student-Level Associations. At student level, the strongest relationships involve gender and prior mathematics achievement. Participation in advanced mathematics courses among boys is approximately three times that for girls. At the other end, girls more frequently study no mathematics than do boys, but the difference is not quite so pronounced. For prior mathematics achievement, the effect is even stronger. Participation in advanced mathematics among the top quarter of achievement from age 14 is nearly 20 times that of the bottom quarter of achievement. For no mathematics, the association is not so strong reflecting the possibility that some high achieving students choose not to include mathematics among the subjects that they study in Year 12.

Parental education was associated with mathematics participation (students whose parents were graduates were more likely to enrol in advanced mathematics) but the effect was not as strong as prior achievement or gender. Ethnic background had very little effect.

TABLE 1

SAMPLE DATA SUMMARY: LEVELS OF MATHEMATICS COURSE PARTICIPATION BY AUSTRALIAN YEAR 12 STUDENTS

Variable	Category	Advanced Math	General Math	No Math	No. of Students
Student Gender	Girls	5.7	73.5	20.8	1204
	Boys	17.5	69.5	12.9	798
Prior Math Achievement (Quartiles)	Lowest	1.2	68.0	30.8	487
	Second	6.0	76.4	17.6	517
	Third	10.4	77.4	12.1	461
	Top	23.1	66.5	10.4	537
Parent's Education	Non-graduate	9.3	71.8	19.0	1544
	Graduate	14.4	72.5	13.1	458
Ethnic Background	English speaking	10.4	71.5	18.1	1560
	Non-English speaking	10.6	73.3	16.1	442
School Type	Government	10.7	71.1	18.2	1258
	Catholic	8.9	74.6	16.5	448
	Independent	11.5	71.6	16.9	296
Coeducational Status	All girls	5.2	77.5	17.3	329
	All boys	15.5	76.4	8.0	174
	Coeducational	11.0	70.2	18.8	1499
School Location	Metropolitan	9.6	73.1	17.3	1274
	Non-metropolitan	12.0	69.9	18.1	728

N (students) = 2002; N(schools) = 250.

School-Level Associations. Some variation in mathematics participation in relation to school-level variables can also be observed in Table 1. Participation in advanced mathematics is greater for Independent schools than for either Government or Catholic schools. Indeed, participation in advanced mathematics is higher for Government than for Catholic schools. At the other end of the participation range, the percentage of students with no mathematics is greater for Government schools than for either Catholic or Independent schools. Table 1 also shows a higher level of participation in advanced mathematics in non-metropolitan compared to metropolitan schools. This reflects a strong involvement in mathematics/physical science courses in regional cities (some of which have an industrial base) and towns (Ainley et al, 1994). Differences in mathematics participation by the coeducational status of the school are evident but, of themselves, do not reveal a great deal since they do not show the patterns separately for boys and girls.

Multilevel Analysis with a Dichotomous Outcome Variable

Table 2 records the results for the analysis based on multilevel logit modelling using a dichotomous response variable. This analysis compares participation with non-participation in advanced mathematics. Results for two models are recorded. Model A (the reduced model) includes predictor variables except earlier mathematics achievement. Model B (the full model) includes earlier mathematics achievement as a predictor.

Model A. The results for Model A indicate that after adjustment for other variables in the regression model these data show that girls were significantly less likely than boys to enrol in advanced mathematics. Family educational background was also linked to enrolment. Students with at least one parent who was a university graduate were more likely to enrol in advanced mathematics courses than other students. School location had a statistically significant influence on participation: students from metropolitan schools were more likely to enrol in advanced mathematics than their peers from non-metropolitan schools.

At the individual level, ethnic background was not significantly associated with participation in advanced mathematics and at school level an association was not found with either school type or coeducational status.

Model B. It can be seen from the results for Model B in Table 2 that prior mathematics achievement (at the age of 14 years) has a statistically significant and substantial effect on enrolment in advanced mathematics. Each of the achievement quartiles is significant compared to the reference group (the lowest achieving quartile). The effect of gender is statistically significant and of similar magnitude to the result in Model A. In other words, including earlier school achievement in the model has no effect on the relationship between gender and participation in advanced mathematics.

The results for Model B indicate that family educational background has no effect on participation in advanced mathematics after allowance is made for the effect of early achievement. Family educational background, however, is associated with prior mathematics achievement. Prior achievement is a strong predictor of participation in advanced mathematics and neutralized the influence of family educational background.

TABLE 2

LOGIT MODEL ESTIMATES FOR THE LOG ODDS OF ADVANCED MATHEMATICS COURSE PARTICIPATION: AUSTRALIAN STUDENTS IN THE FINAL YEAR OF SCHOOL

Variable	Category	Model A		Model B	
		Estimate	Standard Error	Estimate	Standard Error
Constant		-3.14	0.591	-0.496	0.733
Prior Math	Lowest	-	-	-	-
Achievement	Second			1.612	0.458
(Quartiles)	Third			2.188	0.466
	Top			3.066	0.433
Student	Girls	-1.248	0.180	-1.304	0.187
Gender	Boys	-	-	-	-
Parent's	Non-graduate	-	-	-	-
Education	Graduate	0.595	0.176	0.244	0.183
Ethnic	English speaking			-	-
Background	Non-English speaking	0.143	0.188	0.183	0.196
School Type	Government	-	-	-	-
	Catholic	-0.068	0.272	-0.130	0.289
	Independent	0.221	0.295	0.009	0.320
Coeducation	All girls	-	-	-	-
al Status	All boys	-0.034	0.406	0.066	0.428
	Coeducational	0.234	0.368	0.272	0.389
School	Metropolitan	-	-	-	-
Location	Non-metropolitan	0.335	0.178	0.261	0.191
RANDOM PART					
Level II	σ^2			0.290	0.147
Level 1	σ^2			1	0

N (students) = 2002; N(schools) = 250.

None of the school-level variables had statistically significant effects on participation in advanced mathematics. There was a tendency for Government schools to enrol a higher proportion of students than Catholic schools, and a smaller proportion of students than Independent schools, in advanced mathematics, but the effects were not statistically significant. Schools in non-metropolitan areas tended to improve the likelihood of participating in advanced mathematics but the effect was not statistically significant after controlling for the influence of earlier achievement. As was found for Model A, no effect of coeducational status of the school was detected after controlling for student-level intake differences and for other school-level variables. Girls' schools did not appear to confer advantages in terms of increased advanced mathematics enrolments. There was no evidence of a significant gender by coeducational status interaction in relation to enrolment in advanced mathematics courses.

Multilevel Analysis with a Trichotomous Outcome Variable

Table 3 records the results of the multilevel analysis using a trichotomous response variable as the outcome. In this variable, participation in a general (i.e., one subject) mathematics course is the reference category so that participation in advanced mathematics (i.e., double mathematics) and in no mathematics is compared to that reference. Consistent with the results reported in Table 2, these data show that girls were significantly more likely than boys to take the general mathematics course rather than the advanced mathematics course. The data in Table 3 also show that girls were more likely than boys to have no mathematics subjects (just on the border of significance) after allowance was made for the effects of other student and school-level factors. Prior achievement in mathematics had a significant effect on participation in advanced mathematics and (negatively) on no mathematics. In each case, the magnitude of the effect was large: more so in the case of advanced mathematics than no mathematics.

The effects of the two home background measures (parental education and ethnic background) were not statistically significant, although there was a greater tendency (almost reaching statistical significance) for students from non-English speaking backgrounds to participate in general mathematics courses than not to participate.

Among school-level variables, there were no effects that reached statistical significance. Coeducational status of the school had no effect on participation, although there was a greater tendency for coeducational schools than all-girls schools to have students who did not take any mathematics studies in Year 12. There was no evidence of a gender by coeducational status interaction effect in relation to participation in advanced mathematics or non-participation in

TABLE 3

LOGIT MODEL ESTIMATES FOR THE LOG ODDS OF GRADE 12 MATHEMATICS COURSE PARTICIPATION

Variable	Category	Advanced Mathematics	General Mathematics	No Mathematics
Constant		-4.496	-	-0.903
		(0.732)		(0.367)
Student Gender	Girls	-1.002		0.301
		(0.186)		(0.151)
	Boys	-	-	-
Prior Math	Lowest	-	-	-
Achievement	Second	1.465		-0.711
(Quartiles)		(0.461)		(0.159)
	Third	1.978		-1.075
		(0.449)		(0.183)
	Top	2.874		-1.021
		(0.437)		(0.189)
Parent's Education	Non-graduate	-	-	-
	Graduate	0.201	-	-0.225
		(0.182)		(0.178)
Ethnic Background	English speaking	-	-	-
	Non-English speaking	0.087	-	-0.293
		(0.196)		(0.171)
School Type	Government	-	-	-
	Catholic	-0.096	-	0.224
		(0.285)		(0.308)
	Independent	0.108	-	0.573
		(0.316)		(0.303)
Coeducational Status	All girls	-	-	-
	All boys	-0.072	-	-0.180
		(0.426)		(0.476)
	Coeducational	0.391	-	0.373
		(0.388)		(0.201)
School Location	Metropolitan	-	-	-
	Non-metropolitan	0.252	-	-0.007
		(0.188)		(0.201)
RANDOM PART				
Level II		0.27		1.125
		(0.142)		(0.188)

N (students) = 2002; N(schools) = 250.
Standard errors are shown in brackets below the value of the estimate of the coefficient.

mathematics. With regard to type of school, there was little difference between Government and Catholic schools in terms of advanced mathematics, but there was a tendency for Catholic schools to have more students who did not take any mathematics. Government schools appeared marginally behind Independent schools in terms of advanced mathematics and in terms of non-participation (just bordering on statistical significance). In other words, in Independent schools there was a bifurcation between advanced mathematics and no mathematics. There was also a tendency (but not significant) for non-metropolitan schools to have some advantage over metropolitan schools in terms of advanced mathematics participation. In this model, as for the dichotomous model, there was evidence of remaining variation between schools.

CONCLUSION

Senior secondary schools aim to provide courses that can accommodate a broad range of students. Those schools also seek to promote successful learning outcomes in courses that provide a sound basis for further learning. For some time, education authorities in Australia have regarded it as desirable to increase, and broaden, participation in mathematics (and particularly advanced mathematics) during the senior years of secondary school. Mathematics is important because it is considered to be a key learning area and it provides a basis for entry to many courses of study in higher education.

Policies that focus on promoting increased participation in mathematics are more likely to be successful if they are based on an understanding of factors that currently influence participation in school mathematics courses. The analyses reported in this paper indicate that the major influences on mathematics participation are gender and prior mathematics achievement. More importantly, the results suggest that the relationship between prior mathematics achievement and mathematics participation is non-linear. The effect of being in the top level of previous mathematics performance on participation in advanced mathematics is substantial, and greater than would be expected on the basis of a linear extrapolation. This influence would seem to operate through a number of pathways. One pathway is that schools guide capable students into mathematics programs through a process of selective recruitment. A second is that students who develop a sense of competence and confidence in mathematics tend to choose studies in that area. Overall, the results suggest that improving levels of mathematics performance in the early secondary years may be the most effective way to raise participation rates in advanced mathematics.

The difference between males and females in mathematics participation is substantial. Boys are three times more likely than girls to enrol in advanced mathematics courses in the final year of secondary school. Moreover, the difference appears to be largely unrelated to earlier mathematics achievement. In this respect, the findings confirm the results of many other studies. They also show that the coeducational status of the school has no influence on participation in advanced mathematics once an allowance is made for the effect of other student and school-level influences. Thus, structural solutions such as extending single-sex schooling would appear to be unlikely to result in any substantial change in the differences between boys and girls in participation rates in mathematics.

Other aspects of student background were not found to have a significant influence, when allowance was made for mathematics performance three years earlier. The apparent influence of socioeconomic background on participation that has been widely reported appears to be an influence that is transmitted through earlier achievement. It should, therefore, be malleable through early intervention. Most of the school-level variables (including whether or not the school is a private school) had no significant influence after allowance was made for prior achievement in mathematics. However, differences remain among schools that were not explicable in terms of the factors investigated in the study. There may be some benefit in exploring these differences in terms of more detailed information about curriculum policy and approaches to teaching mathematics.

The conclusion from these analyses is that building a strong foundation in mathematics is likely to be the most effective way of enhancing participation in advanced mathematics in the final year of school. However, although that may result in higher overall levels of participation, it is unlikely to alter the difference between boys and girls in mathematics participation. Nor is the wider use of single-sex schooling.

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