Gender Issues In Tertiary Mathematics Education

Helen J. Forgasz
La Trobe University

Fewer females than males opt to study mathematics at the tertiary level, particularly at postgraduate levels. Factors influencing students' decisions to pursue tertiary studies have been identified. Less is known about the factors associated with studying mathematics in particular. Reported here are results from the first phase of a three year study aiming to uncover relevant contributing factors. Enrolment data for 1995 were gathered from La Trobe University (Bundoora campus) and several students taking undergraduate mathematics courses that year were interviewed. While the results are not generalisable, interesting gender-related trends were apparent. The implications of the findings are discussed.

Introduction

More Australian females than males now complete secondary school (Ministerial Council on Education, Employment, Training and Youth Affairs, and Curriculum Corporation, 1994) and women comprise at least 50% of the tertiary intake (Ministerial Advisory Committee on Women and Girls [MACWAG], 1990; Powles, 1986). Yet 'traditional' gender divisions in tertiary course and subject enrolments and in postgraduate studies are still evident. Indeed, Graetz (1991) suggested that gender divisions in higher education were more marked than at school levels. Overall, proportionally more males than females are enrolled in engineering courses and in the physical sciences (Lumley, 1992; MACWAG, 1990). Moses (1990) identified the 'maleness' of disciplines and the lack of female role models as gender-specific barriers to postgraduate participation.

Social, cultural and affective factors have been implicated in students' beliefs about tertiary studies (including mathematics), their decisions to enrol in tertiary courses, and their achievements. Carpenter and Fleishman (1987) found that attitudes towards higher education in Australia were related to academic achievement, school type attended and gender. Encouragement by parents, peers and teachers, was important for attitude formation. Social background factors, followed by ability, were the most important determinants of tertiary attainment reported by Graetz (1991). The academic achievements of females were "much more constrained by social origins" (p.7) than males'. Wilson and Boldizar (1990) found that gender differences in high school aspirations, more than mathematics achievement and the income potential of courses, accounted for gender-segregation in US college enrolments. School attended, but not school type, Hunter (1987) suggested, was related to the gender divisions in New Zealand tertiary course enrolments. At Monash University in 1992, Lumley (1992) found attendance at single-sex schools was not related to the patterns of mathematics and science-based subject enrolments of first year females from private school backgrounds.

The literature suggests that tertiary students' mathematics course decisions can be influenced by a range of background and affective factors. The pedagogical approach adopted by tertiary teachers has also been implicated (eg. Rogers, 1990). At the school level, classroom learning environment factors can affect students' attitudes and beliefs about mathematics and about themselves as learners of the subject (Forgasz, 1995). The research design of the present study incorporated many of these previously identified variables. The study set out to explore the extent to which these and other factors might influence Australian students' decisions to pursue tertiary-level mathematics courses. Reported here are the findings from the first phase of this three year project.

The Study

Identifying variables that might be related to students' decision-making about pursuing tertiary mathematics courses was the main aim of this first phase of the three year study. The findings would serve to inform the design of a large scale survey instrument to be

administered in subsequent phases of the project. Variables for which gender differences were found in the pilot study are discussed in this paper.

Methods

Semi-structured interviews with a representative sample of students enrolled in mathematics courses at La Trobe University in 1995 were the main data source. Questions asked covered a range of factors derived from the literature:

* *Affective factors* eg., Did you enjoy mathematics at school? How good are you at mathematics?
* *Socio-cultural factors.* eg., Why are you studying mathematics? Did you receive encouragement and/or advice to do so?, and
* *Learning environment factors* eg., How would you compare the teaching of mathematics at school and at university? Do you feel comfortable in your university mathematics 'classroom'?

Demographic and other background information about the interviewees (e.g., age, school attended at grade 12, language background, parents' educational levels) were gathered prior to the commencement of the interview.

In order to gauge the representativeness of the sample interviewed, enrolment data were gathered from the university as a whole and from the School of Mathematics in particular.

The sample

Seventy students were randomly selected from the class lists of all undergraduate mathematics subjects offered by the School of Mathematics in 1995 and sent invitations to participate in the interviews. Male and female students were invited in proportion to their numbers in the various courses. A response rate of 30%-40% was anticipated. However, only seven students agreed to be interviewed. A successful personal approach for volunteers at tutorial and lecture sessions followed. In all, twenty three students (16M, 7F) were interviewed. Of these, 12 (9M, 3F) were mature-aged (at least 21 years of age at the commencement of their current undergraduate degrees). In Table 1 is shown the break-up, by year of study and gender, of the 23 interviewees.

Table 1: Interviewees by year of study and gender

	1st year	2nd year	3rd year	4th year (Hons)
Males	4	6	4	2
Females	3	3	1	-

Results and Discussion

Representativeness of the sample

In 1995 15,886 students were enrolled at La Trobe University (Bundoora campus), 64% were female. However, there were more males than females enrolled in mathematics courses. For example, there were 135 (62%) males and 82 (38%) females enrolled in the core first year subject, Maths 1A (NB. this subject does not involve the majority of students studying engineering). This ratio of males to females (about 2:1) was approximately the same for all core second and third year mathematics subjects with the exception of 3rd year Pure Mathematics in which the ratio was reversed: 20 females (62%) and 12 males (38%). At 3rd year, the cohort was less than 50% of the first year enrolment numbers. At the Honours level (4th year) there were 10 students; 7 were male.

The ratio of males to females among the interviewees was also approximately 2:1. That is, the gender composition of the sample was fairly representative of the entire cohort enrolled in mathematics. These enrolment figures also showed that as students progressed

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through the year levels, the drop-out rate for males and females was similar. The major contributor to the gender difference in mathematics course enrolments at La Trobe University would appear to result from the subject choices made by first year students.

Gender differences

The small sample size precludes any generalisations being drawn from the findings. However, the gender differences apparent in the trends that were found are reported below. They invite further investigation.

The factors that seemed to have the most noticeable differences by gender included: school attended, grade 12 mathematics background, and parents' educational levels. Students' perceptions of aspects of the tertiary learning environment showed that gender-stereotyped attitudes are still evident.

School background: The schools attended for grade 12 studies are shown separately for males on Figure 1 and for females on Figure 2.

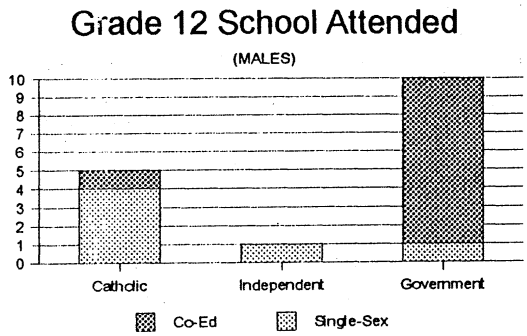

Figure 1 School type attended by males when in grade 12

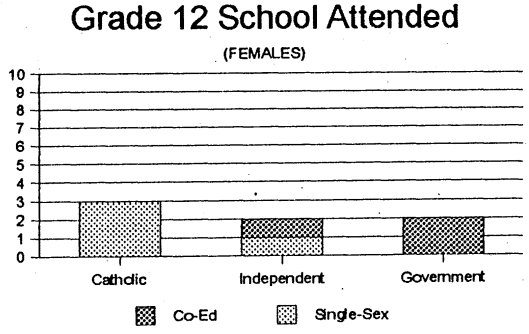

Figure 2 School type attended by females when in grade 12

Figures 1 and 2 indicate that a larger proportion of males (10/16 = 63%) than females (2/10 = 20%) had attended government schools. With one exception, the government schools attended were co-educational. With two exceptions the non-government schools were single-sex. It should be noted that about 62% of all students in Australia in 1993 were enrolled in the government sector (Ministerial Council on Education, Employment, Training and Youth Affairs, 1994). The trends revealed by Figures 1 and 2 suggest that:

* females attending government co-educational secondary schools seem less likely than their male counterparts to study mathematics at the tertiary level
* females at single-sex non-government schools may be more likely than their female counterparts in the government co-education sector to pursue tertiary mathematics courses

Grade 12 mathematics background: The Victorian Certificate of Education [VCE] (or equivalent) mathematical backgrounds of the interviewees by gender are shown in Figure 3.

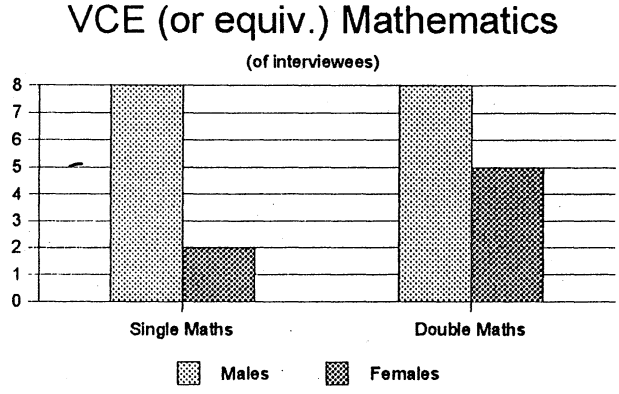

Figure 3 VCE (or equivalent) mathematics background of interviewees

It can be seen from Figure 3 that a larger proportion of the females (5/7 = 71%) than of the males (8/16 = 50%) had taken double mathematics in grade 12. The data suggest that females taking tertiary mathematics have broader and stronger mathematical backgrounds than their male counterparts. In part, this may support frequently reported findings that females are less confident about their mathematical abilities than are males (see Leder, 1992). It may be that some females who are capable of studying tertiary mathematics are not choosing to do so. On the other hand, some males who are enrolled in these courses may well have been better advised to consider alternatives.

Parents' educational levels: The educational levels of the interviewees' parents are shown in Table 2.

Table 2: Parents' educational levels (percentages shown in brackets)

		Tertiary	Gr 12	Secondary	Primary	Unknown
Males (16+1*)	Mother	6 * (35)	-	8 (47)	1 (6)	2* (12)
	Father	8 (50)	1(6)	4(2 5)	2 (13)	1 (6)
Females (7)	Mother	1 (14)	3 (43)	3 (43)	-	-
	Father	5 (71)	1 (14)	1 (14)	-	-

* One male's natural mother was tertiary-educated. The educational level of his step-mother (with whom he'd lived since a toddler) was unknown

The data in Table 2 indicate that the educational backgrounds of the males' parents were more disparate than the females' parents, particularly at the lower end. While all of the females' parents had completed primary school, several of the males' parents had not. For both the males and the females, a higher proportion of fathers than mothers had completed tertiary education. While a higher proportion of the females' than of the males' fathers were tertiary qualified, the pattern was reversed for the mothers. From the data it might be inferred that:

* parents hold higher expectations for their sons than for their daughters with respect to mathematics and other science-related careers.
* compared with males, females gain less support from less educated fathers to pursue studies in mathematics-related fields.

These inferences would not be inconsistent with some of the findings on parents' aspirations for their children reported by Kelly (1986). For example, Kelly found that parents rated "the jobs of engineer, electrician and draughtsman... much more suitable for boys than for girls" (p.98). Although fewer fathers than mothers completed the questionnaires, and while those who did were more likely to be working class and to have daughters, they "expressed much more sexist ideas than the mothers who replied" (p.102).

The tertiary mathematics learning environment - lecturers and fellow students:

The students were asked whether they felt that any groups of students were treated differently in the School of Mathematics, and whether they had personally experienced or observed any discrimination. Many students believed that all students were treated fairly. A greater proportion of female than male students commented that female students might experience some discrimination. Karen, for example, believed that some lecturers held prejudiced views.

> ... some tutors and lecturers will pay more attention to the women and some don't think women can do maths so then they actually pay, they are

> more reluctant to help you and there is also, and some of them are racist, arrogant. They don't give much time to some students. But I think, yes, the maths department here they seem to have a fairly good balance of people whereby if you strike one who is a bit funny towards you, you can find one who is the opposite way.

She also commented on the effects of a female lecturer on male students with sexist attitudes:

> ... apart from some female tutors, this semester, second semester of second year, is the first time we have had a female lecturer. And yes I think that affects some of the guys' attitudes because they can see that she does a good job and perhaps even better than some of the other male lecturers... I think there are a lot of entrenched beliefs that women cannot do maths as well as men... I mean I enjoy seeing a woman teacher at university and having women teachers because, I guess there is a bit of a difference.

Jan had strong feelings about her personal experiences of the overt sexism of one of her lecturers:

> Like first semester I had a tutor who was a male chauvinist pig, he was rude but I could not handle him. If you asked him a question he would respond to the male partner who you were working with. ... [T]hat made learning really difficult... his belief is that women should not be in maths at all.... [that] women are not capable of maths and don't have the learning capability to keep up with the work later on.

While not having experienced discrimination personally, Jack was prepared to concede that females (and overseas students) might be disadvantaged:

> Well I can't really [perceive disadvantage] from my perspective, you know what I mean. If I was female or from another country it would be much more easy for me to be aware of such things.

Phil said that he had heard that females had experienced discrimination:

> I have heard that some of the male teachers are a little uncomfortable around some of the female students but again I have not seen that and the women that are studying it do quite enjoy it so, no I don't know...Um one of the comments was that women should not be studying mathematics but if they are they will get the help. But they [the females] got the impression that the teachers felt that they should not be studying.

Some male students exhibited stereotyped views of females' mathematical abilities. When asked to explain why fewer females than males studied the most demanding mathematics courses at grade 12, three males believed that genetic factors were involved. Colin, for example, said:

> Just genetics. Males and females are different. I am sure there are subjects that more females do. I am not talking about sewing and cooking, I am not being so blind as that but there are just subjects that appeal to males more than they appeal to females and visa versa, there are subjects that appeal to females more than males.

It should be noted that the students generally spoke very highly of the teaching program in the School of Mathematics and praised the support and assistance provided by the majority of lecturers and tutors. The examples discussed above, however, suggest that some of the females interviewed may have experienced gender-based discrimination. The females' perceptions of the sexist attitudes of some male lecturers were supported by a few male students. It would appear that it is not only some lecturers, but also some male students, who hold ill-informed, gender-stereotyped views that the genetic make-up of females 'naturally' inclines them away from mathematics and towards the humanities. At present, it seems that females who persist with mathematics at the tertiary level have to be highly motivated and prepared to face and overcome the obstacles and adversity they may face.

Final Words

Several gender issues pertinent to tertiary mathematics education emerged from the analysis of the data gathered from undergraduate students enrolled in mathematics courses at La Trobe University in 1995. The factors identified were: school attended, grade 12 mathematics backgrounds, parental educational levels, and the beliefs and attitudes of academic staff and students. Further investigation is needed to determine whether the trends discussed here extend to larger cohorts of students whose personal and educational background profiles may differ and to other tertiary institutions. The influence of female role models within an apparently 'masculine culture' is also worth examining in more depth.

Much more needs to be known about the factors implicated in students' decisions to pursue tertiary mathematics. There are longer-term benefits to the nation to be gained from identifying and addressing gender inequities in mathematics and related fields. As well as the variables identified in the relevant literature, the factors discussed in this paper have been incorporated into a survey instrument to be administered to students at three Victorian universities during 1996 and 1997.

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