AN EXPLORATION OF GENDER DIFFERENCES IN SUBJECT CHOICE AND BELIEFS AMONG YEAR 12 STUDENTS

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This paper explores gender differences within data collected in a study of the factors influencing Year 12 students to study or not to study mathematics. In particular, differences in subject choice, beliefs about mathematics, mathematicians and users of mathematics, and reasons for studying or not studying mathematics are examined. While the results of analysis generally confirm the trend towards a reduction or elimination of gender differences at this level, some differences persist. Possible reasons for this are conjectured.

INTRODUCTION

Decreasing participation rates in mathematics as a subject of study at Year 12 have been of considerable concern to mathematics educators because they signal the very real possibility that too few people are becoming mathematically and technologically literate. As a result of such concern, a number of studies have been carried out to investigate the reasons why more and more students are opting out of mathematics e.g. Jones (1988), Ainley, Jones & Navaratnam (1990), Dick & Rallis (1991), Hamlett (1991), Brinkworth & Truran (1998).

Participation rates in Year 12 subjects in South Australia are fairly indicative of the trend. An examination of the enrolments in Year 12 South Australian Certificate of Education (SACE) mathematics subjects between 1992 and 1996 shows that the total number of students enrolled in mathematics dropped from 70% of the total SACE enrolments in 1992 to 50% of total enrolments in 1996 (SSABSA, 1992; SSABSA, 1996). Furthermore, of those students enrolled in mathematics subjects, the percentage of students enrolled in 'advanced' mathematics, which leads to mathematics, 'hard' science and engineering courses at university level, dropped from 16% to 13·5%. Thus not only are less students overall doing mathematics, but less are undertaking it at an 'advanced' level.

Enrolments according to gender present a mixed picture. Over the same period, the percentage of females enrolling in Year 12 SACE mathematics actually increased marginally from 44% to 46%, but there was a small but steady drift of female students away from advanced mathematics. Of particular concern is that the number of males doing advanced mathematics continues to be more than double that of females. This situation has persisted for more than a decade both in other states of Australia (Dekkers, de Laeter, & Malone, 1986; Watt, 1996) and overseas (Pallas & Alexander, 1983; Revak, 1995). Inevitably, since less females are taking advanced mathematics courses, they continue to be under-represented in the mathematics and science professions. More generally, by opting out of mathematics, they are limiting their educational opportunities, occupational choices and career paths.

Why has the pattern of reduced participation rates for female students continued? In order to investigate this, gender differences were explored within data collected in a survey of the influences on Year 12 students' reasons for studying or not studying mathematics (Brinkworth & Truran, 1998). A review of research was undertaken about relevant variables associated with gender differentiated participation in mathematics as a basis for interpreting the results of the survey data. The following summary of representative findings is based on the categorisation of variables adopted by Leder (1992) and Forgasz (1994).

Basis for career choice: Males attach significantly greater importance to the *money to be earned* in making a career choice than females (Dick & Rallis, 1991) and are more influenced to choose mathematics because of its importance as a *credential* for a future career (Russell, 1984). For females, it is more likely to be *interest and enjoyment* of the subject which is

the basis for choosing it (Quality Assurance Directorate, 1994), although females are more likely to see mathematics as irrelevant to their interests and of little use to them in their future careers (Barnes & Coupland, 1990). Often this is because they are not given information about the possibility of careers in mathematics (Schwartz & Hansen, 1992).

Gender and learning style: The learning style preferred by female students is based on *cooperation* rather than competition, which is favoured by males (Schwartz & Hansen, 1992; Forgasz, 1994). Females more greatly value the importance of mutual support and the sharing of information which is a feature of cooperative learning.

Attributions of success and failure: According to the review of literature by Kloosterman (1993), males are more likely than females to attribute success to ability and failure to either bad luck or lack of effort, while females are more likely to attribute success to effort and failure to lack of ability. Thus females feel that they have to work harder to have their efforts and accomplishments recognised.

Mathematics as a subject of study: It is commonly believed by students that mathematics is a fragmented set of facts, formulas and procedures to be memorised (Southwell & Khamis, 1994). While Barnes (1995) reported that females tend to view the subject as cold, impersonal and lacking in imagination and creativity, leading many to dislike it and opt out early, Crawford et al (1994) found no gender differences among students' beliefs about mathematics: all tend to see it as rigid, barren and meaningless, and the learning of it mechanical and boring.

Risk-taking and assessment: Leder & Taylor (1995) found that females tend to be more cautious and less prepared to take risks in tests than males, while Forgasz & Leder (1991) observed that they make greater use of the "I don't know" option when this is available on multiple choice items: this may be a measure of their confidence in doing mathematics.

Mathematics as a stereotyped domain: The belief that "mathematics is a male domain" has a number of negative effects on females (Forgasz, 1994), resulting in lowered expectations and performance, and opting out of mathematics, although it has been argued by some researchers that as well as opting out of mathematics, females self-select into other subjects for positive reasons (Tobias, 1990), particularly English, which is seen as a female domain (Forgasz & Leder, 1996).

Socialisers and subject choice: Teachers can inspire or encourage students to choose to study mathematics or not, and in the process tend to favour male students (Rodgers & Mahan, 1989; Walkerdine, 1989). Parents too can influence students' subject choices in mathematics (Eccles & Jacobs, 1986), tending to favour male over female offspring (Schwartz & Hansen, 1992. Pressure from friends and peers can also be influential. Being seen as good at mathematics can carry a social stigma, so that some students, especially females, prefer underachievement to ostracism from the peer group (Forgasz, 1994).

METHOD

A survey was undertaken of students from Year 12 classes in 10 South Australian secondary schools and provided data from a sample broadly representative of the whole Year 12 cohort, including schools which were large/small, urban/rural, state/independent /Catholic, and boys only/girls only/mixed. Of the 392 students surveyed, 70 (10 male, 60 female) were no longer studying mathematics, and of the students continuing with mathematics (169 male, 222 female), 78 were enrolled in 'advanced' mathematics courses.

Students were asked about their current study of mathematics, their level of achievement in mathematics and their expectations for future work and study, and then to indicate their level of agreement/disagreement with a number of sets of statements of "opinion" about

mathematics, mathematicians and users of mathematics. In the case of mathematics, students responded to 33 statements on a four-point Likert-type scale (Strongly Agree = 1; Agree = 2; Disagree = 3; Strongly Disagree = 4), while in the other two cases, which used the same set of 13 statements, students also had the option of "Don't Know". Those who were currently studying some form of mathematics were asked to judge the level of influence on a three-point Likert-type scale (Strong influence = 1; Some influence = 2; Little or no influence = 3) of 16 possible reasons for choosing to study mathematics, while those who were not doing so judged influences on 16 loosely matched possible reasons for choosing *not* to study mathematics. Finally students were asked to identify some of the characteristics of their most recent mathematics classes and their familiarity with a number of mathematical techniques.

Gender differences were investigated with the aid of an SPSS package by means of cross-tabulations, using χ^2 to test for significance.

RESULTS & DISCUSSION

Student Destination

In a result which is consistent with typical Year 12 enrolment patterns, 41% of males but only 20% of females indicated that they expected to study any mathematics course (beyond Year 12) apart from statistics. Otherwise there were no gender differences apparent among students regarding their future study plans, despite 70% of both males and females agreeing that "careers are available for people who graduate from a university with a major in mathematics".

Beliefs about Mathematics

There was surprising unanimity of response from males and females to the 33 statements of 'opinions' about mathematics: only 6 yielded significant differences (see Table 1 below).

Male and female students appear to have largely similar beliefs about mathematics as a subject of study (Table 1). For example, no gender differences were found in students' shared perceptions that to succeed in mathematics requires working through exercises but not memorising textbooks and notes, and this was true of most other statements. In fact where there were differences, they were mainly focussed on beliefs about people who study mathematics and jobs which require mathematics. In all cases, females were more likely to disagree with the given statements.

There was no strong evidence that males attach greater significance to *money to be earned* than females when considering mathematics-related careers. Both males and females differed widely in their beliefs about whether jobs for those with mathematics qualifications earned higher incomes and whether mathematicians or users of mathematics earn large salaries (Table 1), although it was noted that they tend to believe that mathematicians are better paid than users of mathematics. Apart from males being more strongly agreed than females that users of mathematics earn a large salary (Table 2), there were no other gender differences on this issue.

There was some evidence that males doing mathematics are more influenced by the importance of mathematics as a *credential* for further study. They rated needing mathematics for further study as a reason for studying mathematics more highly than females (Table 3). While males were also more convinced that there are more jobs for people with mathematics qualifications (Table 1), suggesting that their choice is career-related, they did not rate mathematical job opportunities (Table 3) any differently from females as a reason for choosing to study mathematics. This may indicate that some students are studying

Table 1
Students' Opinions about Mathematics (excerpt)

Statements (in survey order)	Level of agreement	sig. diffs	mean
M2 It is important to discuss mathematics with others			2.05
M5. To succeed in mathematics requires hard work studying at home.			1.95
M6. There are more jobs for people with mathematics qualifications.	m>f	*	2.63
M8. People who study mathematics are uncultured.	m>f	**	3.28
M10. Jobs for those with mathematics qualifications produce higher incomes.			2.71
M11. People who study mathematics are conventional.	m>f	**	2.81
M13. To succeed in mathematics requires memorising textbooks and notes.			2.95
M16. There's not enough room for creativity in Year 12 Mathematics.			2.33
M19. Mathematics is useful for understanding literature.	m>f	*	3.35
M21. People who study mathematics are dull.	m>f	*	3.15
M22. To succeed in mathematics requires good luck.			3.25
M24. Jobs for those with mathematics qualifications are more interesting.	m>f	**	3.10
M26. You can either do mathematics or you can't.			2.62
M29. To succeed in mathematics requires lots of natural ability.			2.45

Significant gender differences: * $p < 0.01$, ** $p < 0.001$

mathematics for other reasons such as gaining a high TER score. That is, the "further study" for which Year 12 is a credential may not involve mathematics at all.

That females consider jobs with mathematics qualifications *less interesting* than other jobs is confirmed by the data. While both male and female students generally felt that mathematical jobs were less interesting (Table 1), females were significantly more convinced of this than males. Furthermore, both groups gave a low rating to mathematical jobs being more interesting as a reason for choosing to study mathematics (Table 3), with females rating this reason even lower than the males.

There were no significant gender differences found in students' high level of agreement that it is important to discuss mathematics with others to clarify thinking in the classroom (Table 1). This could be considered evidence that mathematics teachers are encouraging more discussion in class or simply that students feel the need for it. Either way, it could lend support to the view that it is not just female students who prefer a *cooperative, discursive style of learning*, although other data collected in the survey indicates that despite some positive features most students are still being exposed to traditional teaching methods in Year 12 which encourage individual and competitive learning.

Contrary to the findings of previous research, no significant gender differences were apparent in students' *attributions of success and failure*. Both male and female students agreed that success in mathematics requires both hard work *and not* good luck, although they were divided in their belief that natural ability is required (Table 1). They were also divided over the statement "you can either do mathematics or you can't". Thus it appears that for these students neither luck, hard work nor ability are gender-linked to success.

Students appear to see Mathematics and English (or other creative, language-rich subjects) as separate kinds of activities, but there is no strong evidence here that they are *gender-stereotyped*. Both males and females disagreed that mathematics is useful for understanding literature (Table 1), with females being more emphatic about this than males. It might be argued that this result arises because females prefer literature over mathematics, are better

at it and thus do not associate as strongly with mathematics. Yet there were no gender differences (or unanimity) regarding the appeal of language-rich subjects as an influence on choosing not to study mathematics (Table 4). Nor were there gender differences in choosing not to study mathematics being influenced by the perception that "mathematics doesn't provide enough creativity/self-expression" (Table 4): both males and females ranked this as the second most influential reason to give up mathematics. Furthermore, there were no gender differences on the issue of whether students believe that there is enough creativity in Year 12 mathematics (Table 1), an issue about which all students were divided in their opinion. Choosing to study creative, language-rich subjects rather than mathematics does not appear to be strongly related to gender according to these students.

There appears to be no strong evidence that *peer pressure* has an influential role in subject choice through labelling or stigmatising those who study mathematics (Table 1). Both males and females disagreed that those who study mathematics are uncultured and dull, although females disagreed more strongly. It seems that females are more tolerant than males of students doing mathematics and thus probably less likely to shun them because of it. However, females are less likely than males to agree that mathematics students are conventional. In other words doing mathematics may be considered a slightly offbeat thing for females, but not enough for them to be labelled in a negative way.

Beliefs about Mathematicians and Users of Mathematics

There were no significant gender differences in students' beliefs about mathematicians: all students seem to have a similar image of what mathematicians are like, possibly the result of their lack of direct contact with any of these people. However, gender differences did surface among students' opinions of users of mathematics, of which teachers are the closest role models for students (see Table 2 below). While students' views were divided, females were more inclined than males to agree that users communicate results to the community, but less inclined to accept that users assess the work of other professionals. Why this is so is not clear, but it is interesting to note these are among the four statements about users of mathematics with the highest "Don't Know" responses, with varying proportions of male and female students expressing an opinion. The gender differences may be more apparent than real.

While the frequency of "Don't Know" responses to opinions about mathematicians and users of mathematics indicates that many students have a very limited view of such people, the finding that significantly more females than males gave "Don't Know" responses to most statements in these categories may suggest that females are less willing to offer an opinion when they are unsure. This mirrors the differential test-taking behaviour of males and females found in other studies, and may be an effect of using a multiple choice format in the questionnaire, where "Don't Know" is given as an option.

Table 2

Students' Opinions about Users of Mathematics (excerpt)

Users of mathematics spend a significant amount of their working time				Don't know
DIVIDED OPINIONS	U8 assessing the work of other professionals	*	2·32	28·4%
	U1 communicating results the community	‡	2·50	34·1%
	U10 earning a large salary	*	2·74	29.7%

Significant gender differences: * = m > f, $p < 0{\cdot}01$; ‡ = m < f, $p < 0{\cdot}001$

Reasons for Studying or Not Studying Mathematics

As noted earlier, while both males and females rate the requirement to have mathematics for later study quite highly, males appear to view it more strongly as a *credential* for further study (Table 3).

Table 3
Students' Reasons for Choosing to Study Mathematics (excerpt)

Statements (in decreasing order of influence)	mean	mode	sig diff
S16 Mathematics is required for the course I want to pursue	1.97	1	p<.01;m>f
S4 I took notice of advice from my parents	2.16	2	
S10 I took notice of advice from my mathematics teacher	2.17	2	
S8 There are more job opportunities for those with maths qualifications	2.20	3	
S7 I have had inspiring mathematics teachers	2.37	3	
S6 Jobs for those with maths qualifications are more interesting	2.53	3	p<.001;m>f
S14 I wanted to understand the nature of the universe	2.72	3	p<.001;m>f
S1 My friends are studying mathematics	2.77	3	p<.001;m>f

Males and females were not however significantly different in their ratings of the influence of taking advice from mathematics or class teachers, parents, careers advisers and school counsellors to choose to study or not to study mathematics. For those who were studying mathematics (Table 3), advice from *parents* and *mathematics teachers* was more highly valued than advice from other sources, while for those who were not studying mathematics (Table 4 below), the influence of parental advice was ranked even lower. Thus overall, these *socialisers* provide only moderate to low influence on students' subject choice, and generally have less influence on the decision to opt out than to continue with the subject.

There is little evidence that *friends* have much influence on students' subject choice (Tables 3 and 4). Both males and females ranked the influence of friends on their choice to study or not to study mathematics last behind all listed options, with males more influenced than females. 81% of students doing mathematics indicated that having friends doing mathematics had little or no influence on their decision to study it at Year 12, while 90% of those not doing mathematics stated that friends had little or no influence on them giving it up.

Wanting to understand the nature of the universe as a reason to choose to study mathematics (Table 3) and blaming mathematics for the problems of the world as a reason not to (Table 4) both produced significant gender differences, but in each case since at least 80% of both male and female students rated these reasons as having little or no influence on their decision, it is not possible to draw conclusions with any confidence.

Table 4
Students' Reasons for Choosing to Not Study Mathematics (excerpt)

Statements (in decreasing order of influence)	mean	mode	sig diff
D15 Maths doesn't provide enough room forcreativity/self-expression	1.83	1	
D11 The teaching in language-rich subjects is much better	2.23	3	
D13 I took notice of advice from my mathematics teacher	2.54	3	
D3 I took notice of advice from my parents	2.67	3	
D6 Mathematics is to blame for many of the world's problems	2.81	3	p<.001;m>f
D16 My friends are not studying mathematics	2.89	3	

CONCLUSION

Analysis of survey data has yielded comparatively few gender differences among paricipants' beliefs and reasons to study or not study mathematics at Year 12. The apparent lack of differences in these data among variables such as learning style, attributions of

success and failure, mathematics as a male domain and socialisers such as teachers, parents and the peer group, contrary to previous research findings, suggests that there may be greater gender equity in mathematics classrooms than used to be the case. This is to be applauded.

However, gender differences still exist. Where they have been identified through this analysis, they tend to relate to beliefs about jobs for those with mathematics qualifications, the qualities of people who study or use mathematics, self-confidence and mathematics as a credential for further study. The relevant issue is whether these beliefs are instrumental in influencing gender differential participation in mathematics: is the under-representation of females in advanced mathematics at Year 12 (and beyond) the result of such beliefs? If so, then there is need for a greater effort to promote mathematics to those who have the potential to succeed in and benefit from it, for example, by building confidence, providing positive role models and making available better information about careers and career paths. Given the limitations of the study, though, the causal factors may lie elsewhere as well.

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