# Mathematics and Gender: Beliefs they are a Changin'

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In this paper, we present findings from a new instrument, "Who and Mathematics", devised to measure the extent to which mathematics is now stereotyped as a gendered domain. A large sample of Victorian grade 7-10 students participated in the study. Gender trends elicited from the responses to each of the 30 items comprising the instrument are examined and gender differences among the respondents are reported. Many of the results were inconsistent with previous findings in the field. Students' gendered beliefs about mathematics and the relevance of mathematics as an area of study appear to be changing.

## Introduction

Gender differences in mathematics learning have attracted much attention over the past 25 years or so, from researchers, practitioners, and policy makers (see Leder, Forgasz, & Solar, 1996; Forgasz, Leder, & Vale, in press for extensive reviews). During the 1970s and 1980s much emphasis was placed on areas in which females appeared disadvantaged: enrolment in the most advanced mathematics subjects, courses which needed such subjects as pre-requisites, and achieving well-above average scores. Frequently reported findings are summarised in Table 1.

In contrast to the historical emphasis on the perceived disadvantages faced by girls, more recently considerable attention has been placed on the educational disadvantages faced by boys. Views of boys' disadvantage, even in the traditionally male preserves of mathematics and science, are receiving increasing media publicity and coverage (e.g., Colebatch, 2000; Gough, 2000) The impact of gender on performance and participation in mathematics continues to be of concern to the community.

### *Mathematics Learning: Affective Factors*

It is widely accepted that "affective issues play a central role in mathematics learning and instruction" (McLeod, 1992, p. 575). Of the instruments used to assess student attitudes to mathematics, the Fennema-Sherman [F-S] Mathematics Attitudes Scales [MAS] (Fennema & Sherman, 1976) have been used particularly frequently (Walberg & Haertel, 1992).

The MAS consist of "nine, domain specific, Likert-type scales measuring important attitudes related to mathematics learning" (Fennema & Sherman, 1976, p.1). The contents of the subscales can be gauged from their headings: *Confidence in Learning Mathematics; Mother Scale; Father Scale; Mathematics as a Male Domain; Teacher Scale; Attitude toward Success in Mathematics Scale; Usefulness of Mathematics; Mathematics Anxiety Scale; and the Effectance Motivation in Mathematics Scale.* The Likert format makes the scales easy to administer and score. An extensive meta-analysis of mathematics education research studies concerned with affective variables and gender revealed that "mathematics as a male domain" had the largest effect size for gender differences (Hyde, Fennema, Ryan, Hopp, & Frost, 1990). The authors reported that gender differences in perceptions of mathematics as a male domain had declined during the 1980s. Nevertheless, some differences continued to be evident in the most recent of the work they reviewed.

*Arguments for Re-examining the Fennema-Sherman Mathematics as a Male Domain [MD] Scale*

The MAS were published in 1976. The assumptions underpinning the development of the MD were noted by Fennema and Sherman (1976):

> The less a person stereotyped mathematics, the higher the score. This is done to fulfill the purpose of the scale development as it was assumed that the less a female stereotyped mathematics as a male domain, the more apt she would be to study and learn mathematics. (p. 7)

The corollary of this assumption is that low-scoring females believe mathematics to be a male domain and would thus be less likely to study and learn mathematics. Given the prevailing Western societal views of the 1970s, when the scale was developed, it is not surprising that no allowance was made for beliefs that mathematics might be considered a *female* domain. However, low scores on the MD can no longer be interpreted as necessarily reflecting the stereotyping of mathematics as a *male domain.* Recent research studies have indicated that significant numbers of people, both males and females, who reject the notion that mathematics is a male domain do so because they believe that women are higher achievers in mathematics than men. Substantive evidence is presented in Forgasz, Leder, and Gardner (1999). Clearly, the scale is in need of revision.

## Developing a New Scale

We developed two forms of a new survey instrument: *Mathematics as a gendered domain* and *Who and Mathematics*. The aim of both versions of the instrument was to measure the extent to which students stereotype mathematics as a gendered domain; that is, the extent to which they believe that mathematics may be more suited to males, to females, or be regarded as a gender-neutral domain.

An important difference between the two versions was in the response formats used. For the *Mathematics as a gendered domain* scale, a traditional Likert-type scoring format was adopted – students indicated the extent to which they agreed (or disagreed) with each statement presented. A five-point scoring system was used – strongly disagree (SD) to strongly agree (SA). A score of 1 was assigned to the SD response and a score of 5 to SA. This version of the instrument consisted of 48 items. There were three subscales: *Mathematics as a male domain, Mathematics as a female domain,* and *Mathematics as a neutral domain.* The 16 items making up each subscale were presented in a random order.

An innovative response format was adopted for the *Who and Mathematics* version of the instrument. Thirty statements were presented. For each statement, students had to select one of the following responses:

BD – boys definitely more likely than girls
BP – boys probably more likely than girls
ND – no difference between boys and girls
GP – girls probably more likely than boys
GD – girls definitely more likely than boys

In developing the items, we drew on the F-S *Mathematics Attitudes Scales* and on previous research findings about gender issues in mathematics learning. We devised items related to ability, career, general attitude, environment, peers, effort, and task. Feedback on the items was obtained from 10 volunteer mathematics educators and some two dozen volunteer

grade 7 to 10 students. Various items were omitted or further modified on the basis of reactions obtained from these groups. In the first trial, approximately 400 Grade 7-10 students from Victorian schools completed each questionnaire. The effectiveness of the different items and formats was examined statistically. Possible gender and grade level differences were also explored. Selected results from this trial have been summarised in Forgasz, Leder and Barkatsis (1998; 1999).

In preparation for the second trial, psychometrically unsatisfactory items were deleted from the original questionnaires and others added to produce the second version of the instruments. These modified questionnaires were administered to approximately 1600 students from eight schools situated in the metropolitan and country regions of Victoria. At each school, approximately half of the students completed each version of the questionnaire.

In the remainder of this paper we report gender trends elicited by the *Who and Mathematics* instrument. The specific items retained for the second trial of the questionnaire are listed in Table 1. Selected findings from the second trial of the *Mathematics as a gendered domain* scale are described in Forgasz and Leder (in press).

## *The "Who and Mathematics" Instrument*

### Sample Size

The sample size for trial 2 was 861 (402 females, 436 males, 23 unknown). By grade level there were: grade 7: 188; grade 8: 215; grade 9: 251; grade 10: 182; grade unknown: 25.

### Analyses

In order to interpret the response patterns to items, the categories were scored as follows: BD = 1, BP = 3, ND = 3, GP = 4 and GD = 5.

The data were entered into a database and analysed using $SPSS_{WIN}$. Mean scores were calculated for each item. Thus, a mean score <3 meant that, on average, the students believed that boys were more likely than girls to match the wording of the item; mean scores >3 that they believed girls were more likely than boys to do so. Independent groups t-tests, by gender, were used to explore for gender differences in the responses to each item.

## *Results*

### Gender Trends in Response Patterns

Anticipated directions for students' responses as inferred from previous research findings and findings from the study (bold italics) are shown in Table 1. As can be seen in Table 1, there were only eight items for which the responses were consistent with previous findings. These items were largely related to the learning environment and to peers. For example, boys were believed to be asked more questions by the teacher (Item 3), to distract others from their work (Item 16), to tease both boys (Item 21) and girls (Item 30) who did well in mathematics, and to like using computers to solve problems (Item 24). That students' beliefs on so many items were inconsistent with previous findings implies a fairly recent change in gendered perceptions related to mathematics education. In the past, boys were generally believed to have more natural ability for mathematics than girls, and were considered to enjoy mathematics and find it more interesting than did girls. The findings in the present study reveal that, on average, students now consider boys more likely than girls to give up when they find a problem too challenging (Item 4), to find mathematics difficult (Items 27 & 18),

and to need additional help (Item 20). Girls were considered more likely than boys to enjoy mathematics (Item 6) and find mathematics interesting (Item 29).

Table 1
*Predictions Based on Previous Research and Findings from the Study (Italics)*

| | Item | Pred | *Find* | | Item | Pred | *Find* |
|---|---|---|---|---|---|---|---|
| 1 | Maths is their favourite subject | M | *F* | 16 | Distract others from maths work | M | *M* |
| 2* | Think it is important to understand the work | F | *F* | 17* | Get wrong answers in maths | F | *M* |
| 3* | Are asked more questions by the maths teacher | M | *M* | 18 | Find maths easy | M | *F* |
| 4* | Give up when they find a maths problem too difficult | F | *M* | 19* | Parents think it is important for them to study maths | M | *nd* |
| 5* | Have to work hard to do well | F | *M* | 20* | Need more help in maths | F | *M* |
| 6 | Enjoy mathematics | M | *F* | 21 | Tease boys if they are good at maths | M | *M* |
| 7* | Care about doing well | M/F | *F* | 22* | Worry if they don't do well in maths | M/F | *F* |
| 8* | Think they did not work hard enough if don't do well | M | *F* | 23* | Are not good at maths | F | *M* |
| 9* | Parents would be disappointed if they don't do well | M | *F* | 24 | Like using computers to solve maths problems | M | *M* |
| 10* | Need maths to maximise employ opportunities | M | *M* | 25 | Teachers spend more time with them | M | *nd* |
| 11 | Like challenging maths problems | M | *nd* | 26* | Consider maths boring | F | *M* |
| 12 | Are encouraged to do well by the maths teacher | M | *nd* | 27* | Find maths difficult | F | *M* |
| 13 | Maths teacher thinks they will do well | M | *F* | 28 | Get on with their work in class | F | *F* |
| 14* | Think maths will be important in their adult life | M | *F* | 29* | Think maths is interesting | M | *F* |
| 15* | Expect to do well in maths | M | *F* | 30* | Tease girls if they are good at maths | M | *M* |

*Note.* Statistically significant gender differences were found for items marked with an asterisk (see Figure 1)

Gender Differences in Response Patterns

The mean scores for each item, by gender, are shown in Figure 1. Itcan be seen that male and female students were consistent in their beliefs about which group (boys or girls) was more likely to match the wording for 22 of the 30 items. The extent of agreement varied

considerably on several of these items – the statistical significance of gender differences on specific items was assessed by independent groups t-tests. For example, the female students were more convinced than the males that girls "think it is important to understand the work" (Item 2, $p<0.001$) and "worry if they do not do well in mathematics" (Item 22, $p<0.001$), and that boys "teased girls who were good at mathematics" (Item 30, $p<0.001$). Males were more convinced than females that boys "need more help with mathematics" (Item 20, $p<0.001$) and "give up when they find a mathematics problem too difficult" (Item 4, $p<0.01$).

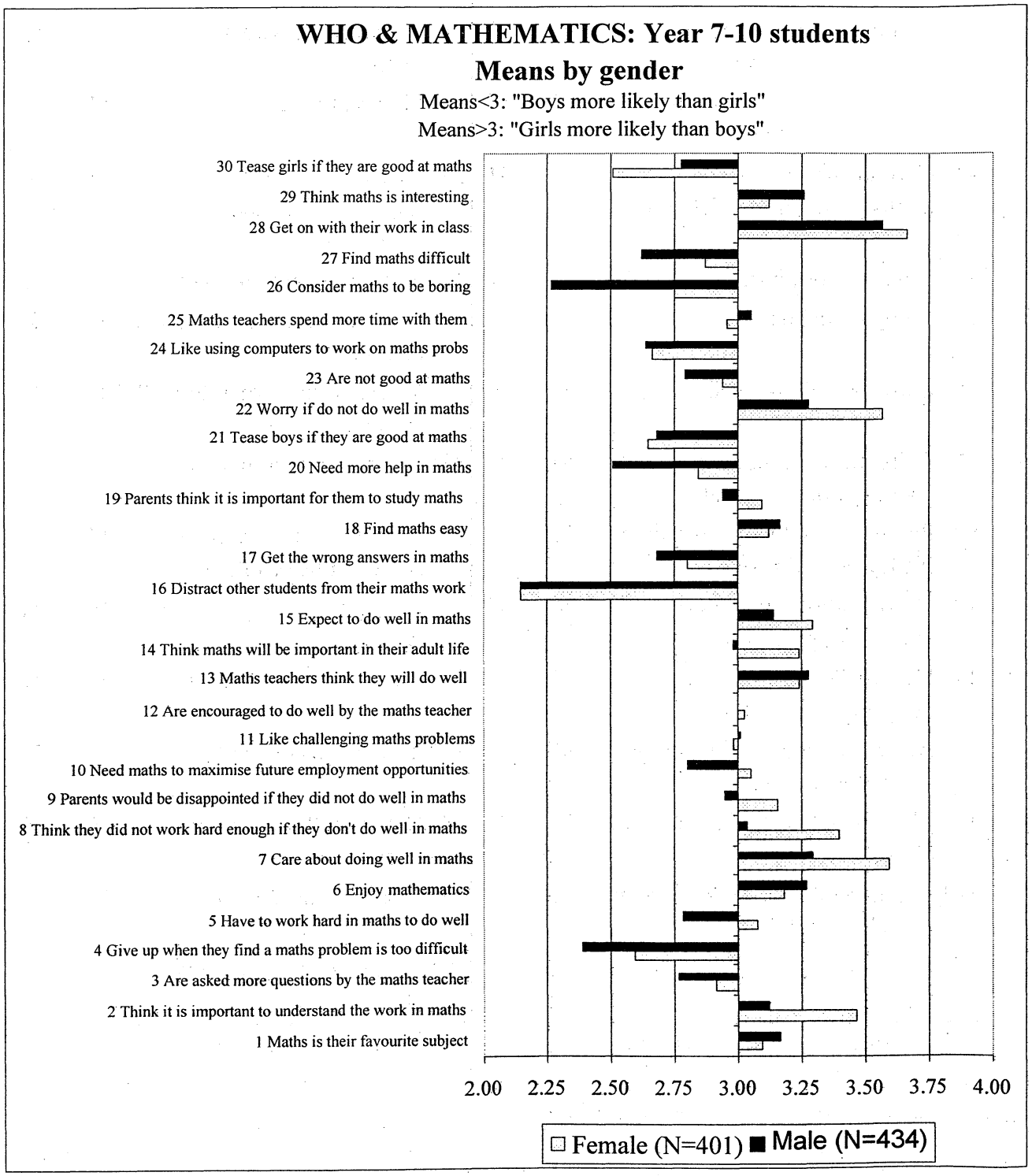


*Figure 1. Who and Mathematics.* Item means by gender

There were several items on which the male and female students' beliefs supported their own sex. (Independent groups t-tests were again used to determine the statistical significance of gender differences found). For example, the females believed it was girls and the males believed it was boys who "have to work hard to do well in mathematics" (Item 5, $p<0.001$), "who need mathematics to maximise their employment opportunities" (Item 10, $p<0.001$), whom "parents think it is important to study mathematics" (Item 19, $p<0.01$) and about whom parents "would be disappointed if they did not do well in mathematics" (Item 9, $p<0.001$). There were no statistically significant differences for items on which there was cross-gender support. There were, however, several significant gender differences on items for which one group's beliefs were in the direction of either girls or boys whilst the other group considered there was no difference between boys and girls. For example, the female students believed that girls were more likely than boys to "think they did not work hard enough if they did not do well in mathematics" (Item 8, $p<0.001$); the males considered that there was no difference between boys and girls.

## Concluding Comments

Although the *Who and Mathematics* is a new, and previously untried instrument, considerable care went into its construction. Some of its items were based on the widely used Fennema-Sherman *Mathematics Attitudes Scales*, others on the results of previous research on gender and mathematics learning. The initial instrument was modified after trials with a small sample of mathematics educators and students from the age groups at which the questionnaire was aimed. A first trial of the instrument with a sample of some 400 students selected from a diverse set of schools led to further modifications, and in particular rejection of psychometrically unsatisfactory items. Thus the changing beliefs expressed by the students in our sample about the importance of mathematics and perceptions of learners of mathematics were elicited by a carefully devised and trialed instrument which contained new items as well as, where appropriate, items used and validated in earlier work. The attitudes and values elicited by the students in this study challenged historical stereotypes about mathematics and perceptions of learners of mathematics and were consistent with the now prevalent perceptions of boys as the educationally disadvantaged group. The statistical significance of many of the differences found warrants some generalisations of the findings beyond the specific sample in the study. However, further research is needed to determine to what extent these findings are replicated in other Australian states, among subgroups of the Australian school population (e.g., extremely high achievers, students from a non-English speaking or socio-economically disadvantaged background) and students in other societies.

## References


Colebatch, T. (2000, February 18). Gender gap in literacy skills widens. *The Age*, 4.

Fennema, E., & Sherman, J. (1976). Fennema-Sherman mathematics attitude scales. *JSAS: Catalog of selected documents in psychology, 6*(1), 31 (Ms. No. 1225).

Forgasz, H. J., & Leder, G. C. (in press). The mathematics as a gendered domain scale. *Proceedings of the 24th annual conference of the International Group for the Psychology of Mathematics Education.* July 23-27, Hiroshima, Japan.

Forgasz, H. J., Leder, G. C., & Barkatsis, T. (1998). Mathematics – For boys? For girls? *Vinculum, 35*(3), 15-19.

Forgasz, H. J., Leder, G. C., & Barkatsis, T. (1999). Of course I can't do mathematics: Ethnicity and the stereotyping of mathematics. In J. M. Truran, & K. M. Truran (Eds.), *Making the difference: Proceedings of the twenty-second annual conference of the Mathematics Education Research Group of Australasia* (pp.

200-206). Sydney: Mathematics Education Research Group of Australasia Inc.
Forgasz, H. J., Leder, G. C., & Gardner, P. L. (1999). The Fennema-Sherman 'Mathematics as a male domain' scale re-examined. *Journal for Research in Mathematics Education, 30*(3), 342-348.
Forgasz, H. J., Leder, G. C., & Vale, C. (in press). Gender and mathematics: changing perspectives. In K. D. Owens & J. Mousley (Eds.), *Research in mathematics education in Australasia 1996-1999*. Sydney: MERGA.
Gough, K. (2000, January 31). Different strokes. *The Australian*, 19.
Hyde, J. S., Fennema, E., Ryan, M., Frost, L. A., & Hopp, C. (1990). Gender comparisons of mathematics attitudes and affect: A meta-analysis. *Psychology of Women Quarterly, 14*, 299-324.
Leder, G. C., Forgasz, H. J., & Solar, C. (1996). Research and intervention programs in mathematics education: A gendered issue. In A. Bishop, K. Clements, C. Keitel, J. Kilpatrick, & C. Laborde (Eds.), *International handbook of mathematics education, Part 2* (pp. 945-985). Dordrecht, Netherlands: Kluwer.
McLeod, D (1992). Research on affect in mathematics eduction: A reconceptualization. In D. A. Grouws (Ed.), *Handbook of research on mathematics, teaching, and learning* (pp. 575-596). New York: Macmillan and the National Council of Teachers of Mathematics.
Walberg, H. J., & Haertel, G. D. (1992). Educational psychology's first century. *Journal of Educational Psychology, 84*, 6-19.