AUSTRALIAN AND US PRESERVICE TEACHERS' PERCEPTIONS OF THE GENDER STEREOTYPING OF MATHEMATICS[1]

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Historically mathematics was considered a pursuit more suited to males than females. Using a new instrument, contemporary high school students' beliefs about the gender stereotyping of mathematics have been measured and an apparent change in beliefs reported. The same instrument was administered to preservice teachers in Australia and the USA. These countries share common social and cultural characteristics and both were active in addressing identified female disadvantage in mathematics education outcomes. The preservice teachers were asked to respond to the survey items as they believed high school students would answer. The Australian and US preservice teachers' responses were compared. The results are reported and discussed in this paper.

Introduction

Over the past 25 years or so, researchers, practitioners, and policy makers have been active in attempting to redress gender differences favouring males in mathematics learning outcomes (for extensive reviews, see Leder, Forgasz, & Solar, 1996; Forgasz, Leder, & Vale, 2000). Areas in which females had been identified as disadvantaged included: enrolments in the most advanced mathematics subjects and in courses requiring these subjects as pre-requisites, and the attainment of well-above average scores. In the past, mathematics was strongly believed to be a male domain. This view was not only held by students and their parents but also by teachers (e.g., Leder, 1986). Researchers postulated that this belief contributed to females' decisions not to pursue studies in non-compulsory and/or challenging mathematics courses to the same extent as males.

More recently considerable attention has been placed on boys' educational issues. 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.

Background to the study

Mathematics as a male domain. It is widely accepted that "affective issues play a central role in mathematics learning and instruction" (McLeod, 1992, p.575). The Fennema-Sherman [F-S] *Mathematics Attitudes Scales* [MAS] are frequently used to measure students' attitudes towards mathematics (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 Likert format makes the scales easy to administer and score. One of the subscales of the MAS is the *Mathematics as a male domain* [MD] scale. Based on the assumption that "the less a female stereotyped mathematics as a male domain, the more apt she would be to study and learn mathematics" (Fennema & Sherman, 1976, p.7), the MD was designed so that high scores reflected less stereotyped beliefs and low scores more strongly held views stereotyping mathematics as a male domain. Consistent with the prevailing Western societal views of the 1970s when the MD scale was developed, it is not surprising that no allowance was made for beliefs that mathematics might be considered a *female* domain. Forgasz, Leder and Gardner (1999) provided research evidence to demonstrate that this view was no longer tenable and argued that many of the items on the MD scale were anachronistic and others no longer valid. The scale was, they claimed, much in need of revision.

Two new instruments. Two new instruments – *Mathematics as a gendered domain* and *Who and mathematics* - have been developed and trialed. The aim of both versions is to measure the extent to which mathematics is stereotyped as a gendered domain; that is, the extent to which it is believed that mathematics may be more suited to males, to females, or be regarded as a gender-neutral domain. Details of the process for the development of the items on the scales, and the establishment of the validity and reliability of the items are described elsewhere (see Forgasz & Leder, 2000; Leder & Forgasz, 2000).

The results of the administration of the two new instruments to 861 Australian grade 7-10 students during 1999 have been reported (Forgasz, 2000; Forgasz & Leder, 2000; Leder & Forgasz, 2000). The findings appeared to challenge notions of mathematics as a *masculine* endeavour.

In this paper, data from only one of the two instruments – the *Who and mathematics* scale – are presented. Specifically, two groups of preservice teachers – one in Australia and one in the USA[2] – were asked to complete the instrument as they expected students to do. Comparisons could thus be made between the two preservice teacher groups, and those of Australian students.

The *Who and mathematics* scale

An innovative response format was adopted for the Who and mathematics version of the instrument. Thirty statements were presented and for each statement, respondents 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

Scoring. In order to interpret responses to items on the *Who and mathematics* instrument, the categories are scored as follows: BD = 1, BP = 2, ND = 3, GP = 4 and GD = 5. Responses are entered into a database and analysed using SPSS_{WIN}. Mean scores are calculated for each item. One-sample t-tests are conducted on the item means to test for statistically significant differences (at the $p<.01$ level) from the middle score (ND) value of 3.

Interpretation of results. For items with means not significantly different from 3, respondents, on average, believe that there is no difference between girls and boys with respect to the wording associated with the item.

For items with mean scores statistically significantly different from 3:

- mean scores <3 mean that, on average, respondents believe that boys are more likely than girls to match the wording of items, and
- mean scores >3 mean that, on average, respondents believe that girls are more likely than boys to do so.

The items, predicted responses. The 30 items, in the order they appear on the *Who and mathematics* instrument are shown in Table 1. The predicted gendered response directions for the items, based on previous research findings on perceptions of mathematics as a *male domain*, are also shown.

Previous findings from the new 'Who and mathematics' instrument. The previously reported response directions of the Australian grade 7-10 students (see Forgasz, 2000; Leder & Forgasz, 2000), based on mean scores for each item on the *Who and mathematics* scale, have also been included in Table 1. The data reveal that for only eight out of the 30 items students' responses were in the directions predicted by previous research in the field (Items: 2, 3, 10, 16, 21, 24, 28, 30).

The study

Aim. In 2000, the *Who and mathematics* instrument was administered to preservice teachers in Australia and the USA. The aim was to explore whether Australian and US preservice teachers held common or different views of contemporary high school students' beliefs about the gendering of mathematics. It should be noted that data from US high school students have also been gathered. As yet, comparisons between the US students' and US preservice teachers' views have not been reported.

Sample and methods

The sample sizes were: 394 Australian and 96 US preservice teachers. The 30 items of the *Who and mathematics* instrument (Table 1) were administered to the Australian and US pre-service teachers. Because of the wording of items, the instructions to the preservice teachers were slightly different from those given to the high school students. Students were asked for their reactions to each statement. The preservice teachers were asked to answer as they believed high school students would respond. Thus comparisons between the findings of high school students and preservice teachers reflect consistencies and differences in students' beliefs and pre-service teachers' beliefs about student beliefs.

The data gathered from the preservice teachers from both countries were entered into a database and analysed statistically using $SPSS_{WIN}$.

Analyses, results and discussion

Independent groups t-tests, by country, were conducted for each of the 30 items. Mean scores for all items and the p-levels for items with statistically significant different means are shown in Table 2.

Table 1. *Who and mathematics*: The 30 items, predicted directions of item responses (Pred), and response directions of 861 Australian grade 7-10 students (Aus students).

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

Table 2. Mean scores by country and significance levels of independent groups t-tests by country

Item No.	Australia	USA	p-level	Item No.	Australia	USA	p-level
1	2.68	2.38	<.001	16	2.18	2.31	nd
2	*3.07*[1]	*3.02*	nd	17	*3.02*	3.14	<.05
3	2.67	2.28	<.001	18	2.76	2.47	<.001
4	*2.98*	3.45	<.001	19	2.76	*2.86*	nd
5	3.14	3.33	<.01	20	3.12	3.41	<.001
6	2.76	2.54	<.01	21	2.69	2.79	nd
7	3.18	*3.15*	nd	22	3.23	3.41	<.05
8	3.33	3.43	nd	23	3.1	3.29	<.01
9	2.71	*2.83*	nd	24	2.45	2.48	nd
10	2.74	2.61	nd	25	2.87	*2.78*	nd
11	2.68	2.42	<.01	26	3.11	3.35	<.01
12	*2.92*	2.72	<.05	27	3.23	3.43	<.01
13	2.87	2.44	<.001	28	3.59	3.26	<.001
14	2.72	2.58	nd	29	2.84	2.55	<.001
15	2.73	2.6	nd	30	2.64	2.58	nd

[1] For each country, a one-sample t-test was conducted on the mean score for each of the 30 items to test for a statistically significant difference from 3 – the middle of the range of potential mean scores. Mean scores not significantly different from 3 (at the $p < .01$ level) are shown in italics in the Table 2.

The mean scores for the Australian and US preservice teachers are also represented graphically in Figure 1. The line down the middle of the graph is at the value 3 – the mid-point of the range of possible mean scores. Bars to the left of the centre line represent mean scores <3; bars to the right, mean scores were >3.

As is evident from Figure 1 (and Table 2), for all items except Item 4, the *direction* of the beliefs of the pre-service teachers from the two countries were the same. The means for Item 4 indicate that the Australians believed that high school students would respond that there would be no difference between girls' and boys' likelihood to "give up when they find a mathematics problem is too difficult"; the Americans, however, indicated that they believed high school students would consider girls were more likely than boys to do so (mean score >3).

When the directions of the preservice teachers' responses are compared to the predictions from the research (see Table 1), it is clear that the pre-service teachers in both countries believe that high school students hold views consistent with previous research findings. In other words, the preservice teachers believe that high school students still have traditionally stereotyped views of mathematics as a male domain.

Table 2 reveals that there were 17 items (1, 3-6, 11-13, 17, 18, 20, 22, 23, and 26-29) for which there were statistically significant differences in mean scores by country.

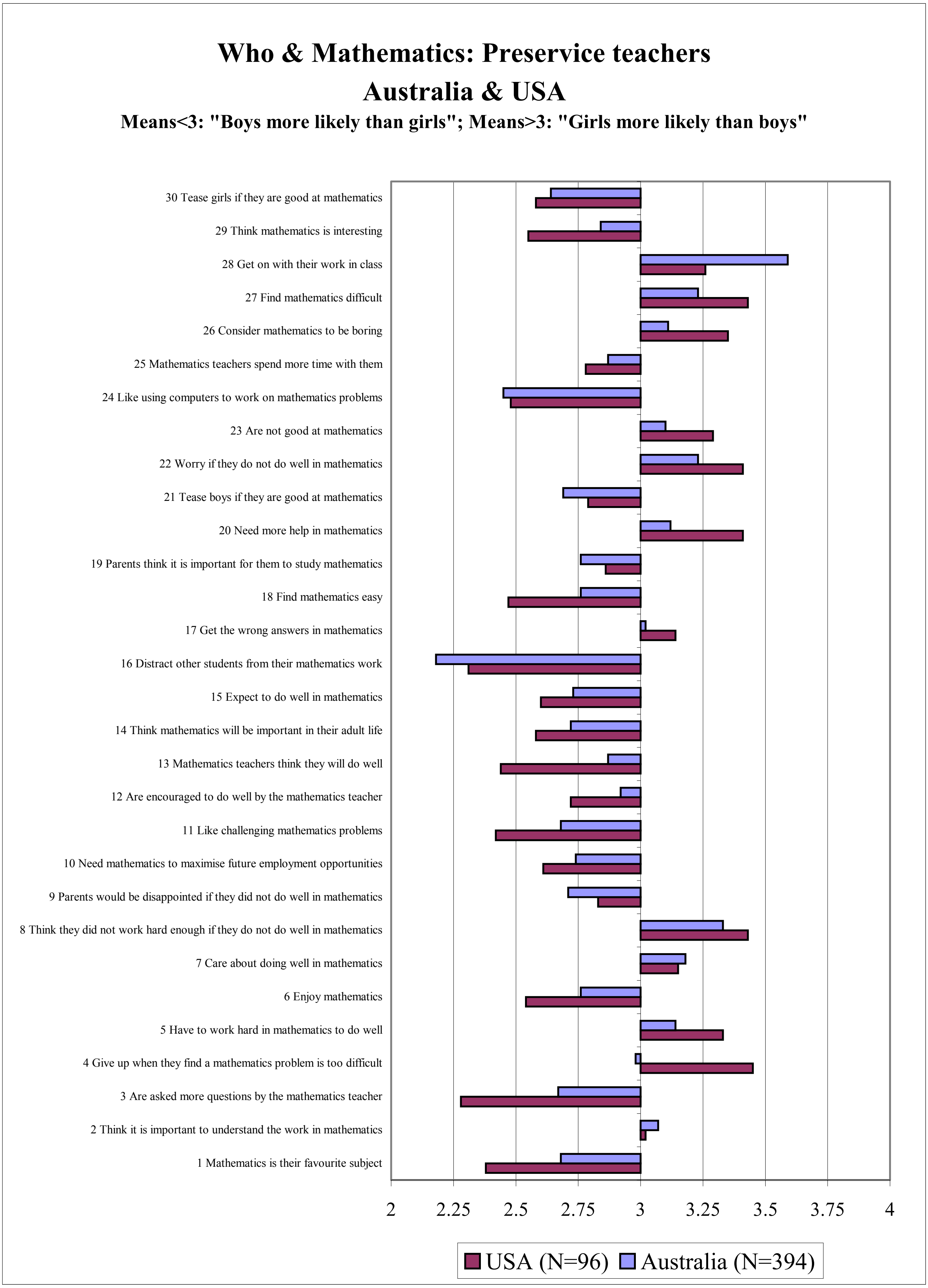

Figure 1. Mean scores: Australian and US Pre-service teachers

From the Australian data, it is clear that the preservice teachers' views (Table 2 and Figure 1) did not match with the students' views (Table 1). The gendered directions of their responses differed on many of the items. It is tempting to speculate that the same will be found when the US student and preservice teacher data are compared.

Final words

The responses of the pre-service teachers to the *Who and mathematics* instrument were consistent with the predicted gendered directions of responses based on previous research in the field. The preservice teachers in both countries held similar gender-stereotyped expectations that high school students' beliefs would continue to reflect views that mathematics was a male domain.

In reality, it is highly likely that the pre-service teachers' views of high school students' beliefs actually reflected their own personal experiences and beliefs. The Australian preservice teachers would have been in grade 7 at least six years earlier; others, earlier still. When the Australian high school students' views are considered, it seems that the preservice teachers (about 10 years older than the participating grade 7 students), are 'out of touch' with contemporary high school students' views on the gender-stereotyping of mathematics. It is interesting to speculate what will happen when the preservice teachers enter the profession to find that many of their expectations differ from those of their students.

The data gathered from the *Who and mathematics* instrument appear to raise more questions than answers. Alternative data gathering methods would be needed to try to understand what has brought about the apparent change in student views of the gender stereotyping of mathematics and why preservice teachers' understandings of the high school students' views differ so much from the teenagers' beliefs.

Interestingly, in both countries the majority of respondents was female – Australia: 83% and USA: 89% - a telling reflection of the gender profile of the future teaching profession in both countries. To undertake a valid gender analysis of the data (particularly from the USA) and make comparisons, larger samples would have been required to compensate for the gender imbalance in participant numbers.

In the study reported here, other socio-cultural factors were omitted – for example, developed/developing nation status, ethnicity/race, culture/religion, and socio-economic background/class. Researchers using the *Who and mathematics* instrument and including these factors may uncover differences in views that would assist in more effectively identifying gender-based inequities demanding action. It remains important, however, to continue monitoring broadly-based gender issues in mathematics.

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Endnotes

1. Gilah Leder and I are co-researchers on this project.

2. With thanks to Peter Kloosterman and his colleagues for administering the instrument in the USA.