The gender-stereotyping of mathematics: Pre-service teachers' views [for00168]

Helen J. Forgasz

Deakin University

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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 belief, researchers postulated, 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). Clearly, the impact of gender on performance and participation in mathematics continues to be of concern to the community.

Background to the present 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. The MD was designed so that "the less a person stereotyped mathematics, the higher the score" (Fennema & Sherman, 1976, p.7). This was done because 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" (Fennema & Sherman, 1976, p.7).

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 were 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 since 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)

Findings from the administration of the instruments to Australian grade 7-10 students (Forgasz & Leder, 2000; Leder & Forgasz, 2000) and to Singaporean students (Forgasz, Leder & Kaur, 1999) have been reported. The Australian data indicated that students now consider boys more likely than girls to find mathematics difficult, and to need additional help. Girls were considered more likely than boys to enjoy mathematics and find mathematics interesting. Findings such as these appear to challenge notions of mathematics as a *masculine* endeavour.

The same instruments were recently administered to primary and secondary pre-service teachers. In this paper, data from only one of the two instruments - the *Who and mathematics* scale - are presented.

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

The results reported here are from a sample of pre-service teachers, at only one university, from whom data were gathered during Semester 1, 2000. The findings from the pre-service teacher data are compared to those from the grade 7-10 students gathered in 1999. It should be noted that more data have been gathered from pre-service teachers at two other Australian universities and are currently being analysed. The interpretation of the findings presented here is necessarily tempered.

The items and predicted responses

The 30 items, in the order they appeared on the survey questionnaires completed by the grade 7-10 students and the pre-service teachers, are shown in Table 1. The predicted response directions for the items, also shown in Table 1, were based on previous research findings in the field.

PLACE TABLE 1 ABOUT HERE

Instructions to respondents

The instructions for completing the instrument were different for the pre-service teachers and the students. The students were asked for their reactions to each statement; the pre-service teachers were asked to answer as they believed high school students would respond. Thus comparisons between the findings of the two groups will reflect consistencies and differences in students' beliefs and pre-service teachers' beliefs about student beliefs.

Sample sizes

Grade 7-10 students

N = 861 (F: 402, M: 436, ?: 23).

By grade level: grade 7 - 188; grade 8 - 215; grade 9 - 251; grade 10 - 182; grade unknown - 25.

Pre-service teachers

N = 133 (F: 118, M: 14, ?: 1)

Analyses

In order to interpret the response patterns to items on the *Who and maths* instrument, the categories were scored as follows:

BD = 1, BP = 2, 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. One-sample t-tests were conducted on the mean scores for each item to test for statistically significant differences, at the $p<.05$ level, from the middle score (ND) value of 3.

There were a few items for which the means were not significantly different from 3. For these items, respondents, on average, considered that there was 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 meant that, on average, respondents believed that boys were more likely than girls to match the wording of the items, and
- mean scores >3 that they believed girls were more likely than boys to do so.

Results

The mean scores for the 30 items for the sample of grade 7-10 students are illustrated graphically on 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. The items for which the mean scores were not significantly different from 3 are shown with an asterisk at the end of the wording of the item. The bars on the graph representing these items clearly reveal that the mean scores were very close to 3. Bars to the left of 3 represent items for which the mean score was <3 and indicate that, on average, the students believed "boys were more likely than girls to...". Bars to the right of 3 represent items with scores >3 and indicate that the students, on average, believed that "girls were more likely than boys to...".

PLACE FIGURE 1 ABOUT HERE

Students' beliefs

When Table 1 and Figure 1 are examined together, it is clear that there are only a few items for which the grade 7-10 students' responses were in the directions predicted by previous research in the field (Items: 2, 3, 10, 16, 21, 24, 28, 30). There were many more items in the opposite direction (Items: 1, 4-6, 8, 9, 13-15, 17, 18, 20, 23, 26, 27, 29) or now revealing perceptions of no differences between boys and girls (Items: 11, 12, 19, 25). In the past, the directions of response to Items 7 and 22 (caring about doing well in mathematics and worrying about not doing well) have been inconsistent. In this study, both items were scored in the direction of 'girls'.

Pre-service teachers' beliefs about students' beliefs

Table 1 and Figure 2 should be examined together. It can be seen that for 20 items the pre-service teachers' beliefs about students' beliefs were consistent with previous research findings (Items: 1-3, 5, 6, 9-11, 14-16, 18, 19, 21, 23, 24, 27-30). Only on item 8 was the response in the opposite direction to that predicted from earlier studies. Items for which the pre-service teachers believed students would respond that there was no difference between girls and boys included: 4, 12, 13, 17, 20, 25 and 26. The pre-service teachers were consistent with the students' beliefs about items 7 and 22 (the items for which mixed results are reported in earlier studies), scoring both in the direction of girls.

PLACE FIGURE 2 ABOUT HERE

Comparisons between students' beliefs and pre-service teachers' beliefs about students' beliefs.

The similarities and differences in the scoring directions of the students and the pre-service teachers are clearly evident in Figure 3.

PLACE FIGURE 3 ABOUT HERE

The items on which there was agreement in the direction of 'boys' were: 3, 4, 10, 16, 21, 24, and 30. An inspection of the wording of these items indicates that they are related to:

- those who tease boys and girls who are good at mathematics
- liking to use computers in mathematics
- distracting others in class; and
- requiring mathematics for future employment

The items for which there was agreement in the directions of 'girls' were: 2, 7, 8, 22, and 28. The wording of these items relate to:

- the importance of understanding the work
- caring about succeeding and worrying if they do not succeed
- believing that they did not work hard enough if they do not succeed

- getting on with work in class

There were two items on which the students and pre-service teachers agreed that there was no difference between girls and boys: Items 12 and 25. Both items related to the mathematics teacher with respect to encouragement to succeed and spending time with students.

The items for which there was disagreement - either in opposite directions or with one group indicating a belief that there was no difference between girls and boys and the other group clearly responding in favour of girls or boys - were: 1, 5 (small), 6, 9, 11, 13-15, 17-20, 23, 26, 27, and 29. The wording of these items was related to:

- those for whom mathematics is a favourite subject, and who think mathematics is interesting/boring
- who is good at mathematics, enjoys challenging problems, expects to succeed, and who the teacher expects to do well
- who gets wrong answers, finds mathematics difficult, needs more help, gives up in the face of difficulty, and who has to work hard to do well
- those for whom parents think it is important to study maths and would be disappointed in if unsuccessful

Final words

The *Who and Mathematics* is a new instrument. Considerable care went into its construction. Some of the items were based on the widely used Fennema-Sherman *Mathematics Attitudes Scales*, others on the results of previous work in the field of gender and mathematics learning. The instrument was subjected to a rigorous procedure to refine wording and to eliminate psychometrically unsatisfactory items.

Thus the apparently changing pattern of beliefs expressed by the grade 7-10 students about the gendering of mathematics challenge historical stereotypes about mathematics and perceptions of learners of mathematics, and appear to be consistent with the now prevalent perceptions of boys as the educationally disadvantaged group. Interestingly, the pre-service teachers' beliefs in regard to students' beliefs on these issues did not match the students' views. In fact, the pre-service teachers generally hold views about today's high school students' beliefs that probably reflect their own beliefs at the time they were in these grades at high school. At a minimum it would be four years since some of the first year pre-service teachers were grade 10 students. Hence it is tempting to speculate that the change in views has occurred during the last decade - that is, during the 1990s. Is it co-incidental that it is in the same period of time that we have seen increasing interest expressed in boys' educational issues and the media hype on the topic?

It will indeed be of interest to see if the same patterns as those reported here are evident when the entire sample of pre-service teacher data are examined (approximately 400). If consistency is found, there may well be implications for the mathematics classroom with respect to the learning environment, differences in expectations. There is also the potential for learning outcomes to be affected.

Several research questions arise from the findings discussed in this paper. For example, are these changing patterns of beliefs evident in other English-speaking nations including the USA, or is this an Australian (in fact Victorian) phenomenon? If the findings are unique to Victoria, for example, what factors in the educational environment of Victoria might have contributed to the findings? A colleague in the USA has gathered data from grade 7-10 students and from pre-service teachers. The Australian-US comparisons are eagerly awaited.

Other factors that may affect the results reported here include, for example, socio-economic background, cultural/ethnic background, location (rural/urban) and school type attended. We have already examined the data from the grade 7-10 students by gender; the findings are reported in Leder and Forgasz (2000). The gender break-up of the pre-service teacher cohort for whom the data were examined for this paper was very one-sided - predominantly female. It was not considered prudent to explore for gender differences with this sample. The larger sample may prove more fruitful.

We recognise the limitations of large scale survey data of the type described in this paper. However, the data gathered appear to trumpet a change in the patterns of beliefs of our junior high school students. The data cannot assist us in understanding the reasons for the change nor when it took place. Other data sources and research approaches are needed to try to probe and expose the answers to these questions.

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Table 1. *Who & Mathematics*: 30 items and predicted responses based on previous research

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

29	Think mathematics is interesting	M
30	Tease girls if they are good at mathematics	M

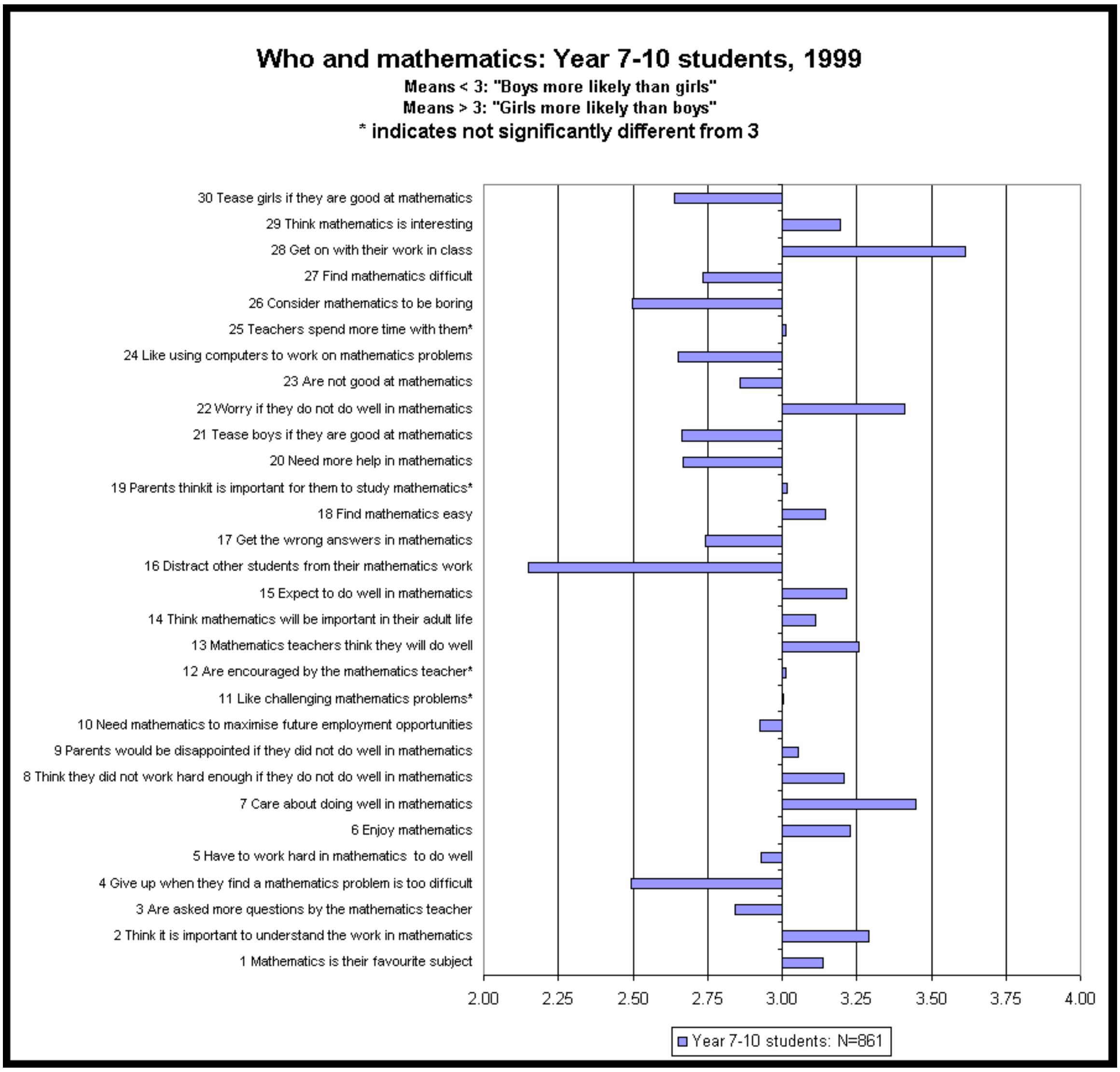

Figure 1. Mean scores for grade 7-10 students (1999) on the *Who and mathematics*instrument

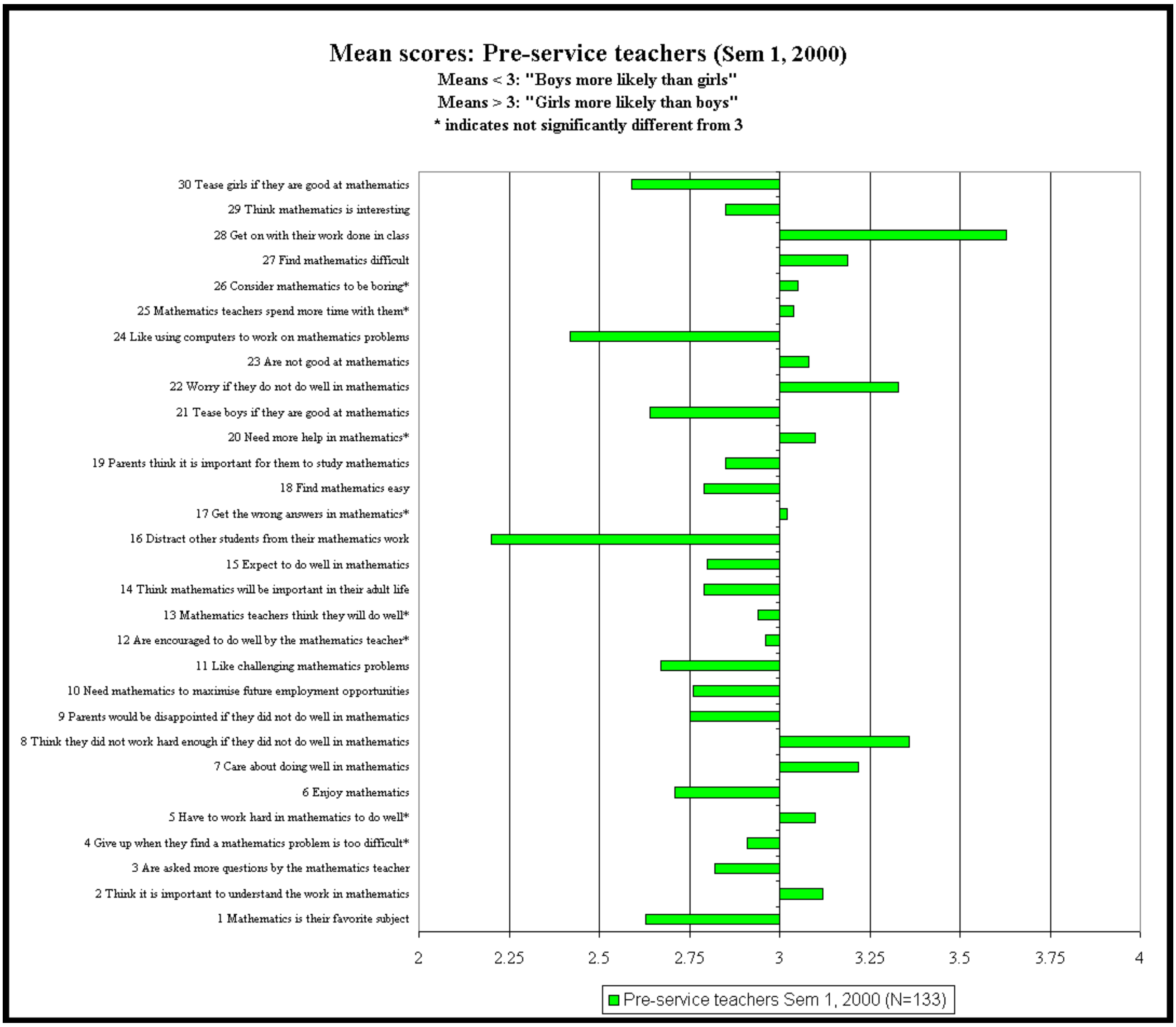

Figure 2. Mean scores for pre-service teachers (Sem 1, 2000) on the *Who and mathematics* instrument

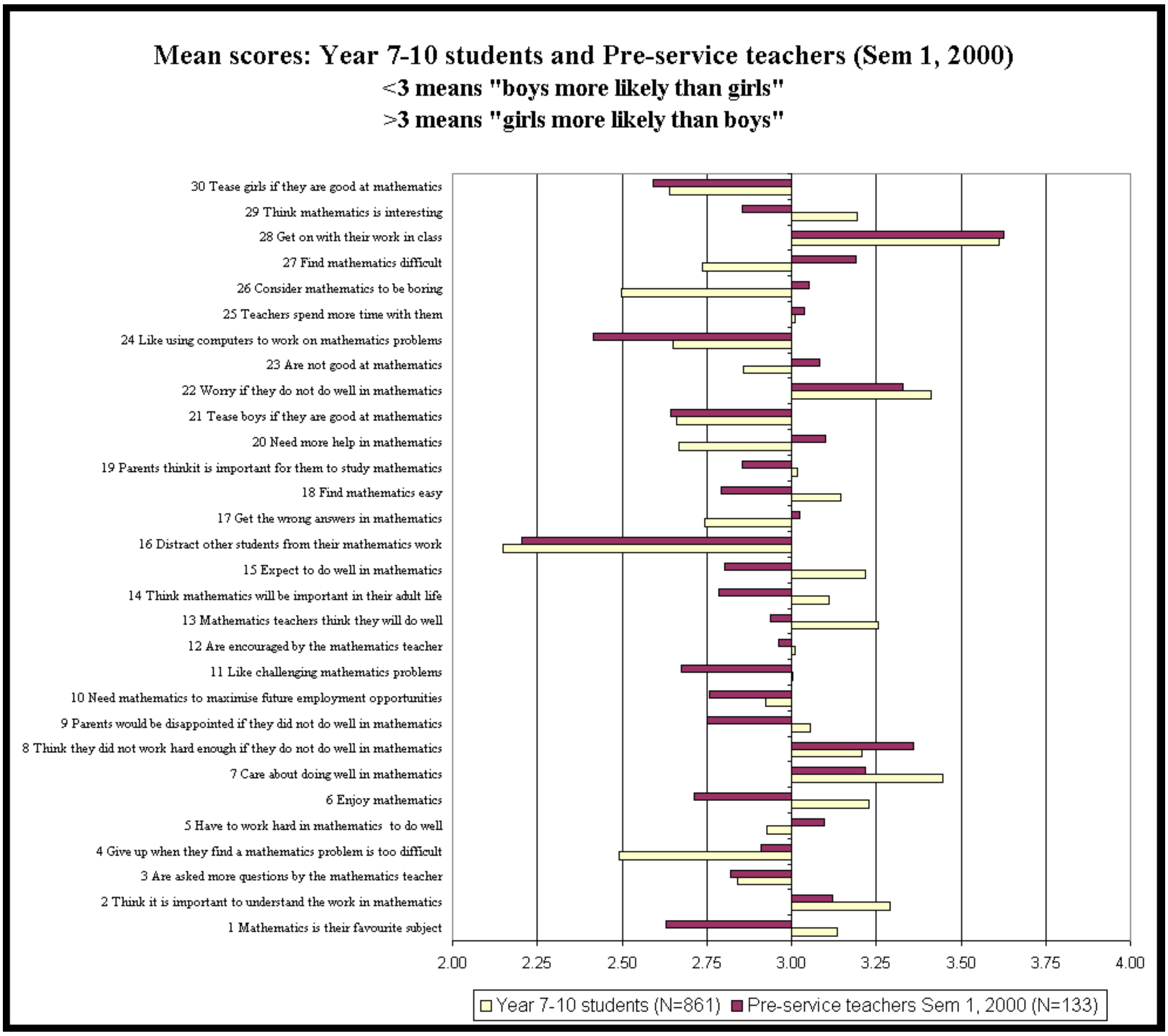

Figure 3. Comparison of mean scores for grade 7-10 students (1999) and pre-service teachers (Sem 1, 2000) on the *Who and mathematics*instrument