The Gender Stereotyping of Mathematics: Cultural Dimensions

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The 'Who and mathematics' instrument is used to measure the extent to which mathematics is considered a male, female or gender-neutral domain. Data from students in grades 7-10 in Australia and Greece were compared to explore whether a cultural dimension was evident. A small sample of Australian students attending a school with strong Greek affiliation completed a trial version of the instrument that included 20 out of the 30 items on the final version. Findings from these students provided an additional perspective – the role of competing cultures, Greek ethnic background and the Australian milieu.

Historically, mathematics was viewed as the preserve of white, middle-class, males. Since the rise of the *Women's movement* in the 1970s, there have been stringent efforts, in some parts of the world, to re-dress this perception. Intervention programs aimed at improving female participation rates and attaining equity in levels of achievement have flourished and, to some extent, succeeded (Leder, Forgasz, & Solar, 1996). Attitudes and beliefs about the stereotyping of mathematics as a 'male domain' had earlier been recognised as contributing factors in females' reluctance to pursue mathematics and to excel in it. Continued monitoring of this construct has been a feature of research in the field of gender and mathematics. Forgasz, Leder and Gardner (1999) argued that one of the most widely used instruments to measure these attitudes, the *Mathematics as a male domain* subscale of the Fennema-Sherman *Mathematics Attitude Scales* (Fennema & Sherman, 1976) was no longer valid and was in need of revision. New instruments have since been developed and findings from them have been reported (e.g., Forgasz & Leder, 2000, Leder & Forgasz, 2000).

Data from the new instruments have been gathered from Australian and US grade 7-10 students and pre-service teachers. The results from the Australian and US students were almost identical and challenged previously reported findings (Forgasz, 2001). The similarities in the cultural and social contexts of Australia and the USA may have contributed to the non-emergence of cultural differences. In an earlier trial of the instrument, Forgasz, Leder and Barkatsas (1999) found that differences in students' ethnic backgrounds may have partially accounted for observed differences in response patterns to particular items on the trial version of the instrument used. The final version of the new *Who and mathematics* instrument has been translated and administered to grade 7-10 students in Greece. In this paper, the findings from the Greek students are compared to the Australian data and to a limited data set from students attending an Australian school with strong Greek affiliation.

The Study

In previous work with the new instrument, the focus has been on gender differences (Leder & Forgasz, 2000), comparisons in the responses of secondary school students and pre-service teachers (Forgasz, 2000) and across similar cultural contexts, Australia and the USA (Forgasz, 2001; Leder, 2001). In this exploratory study, cultural differences among Australian students, Greek students, and Australian students attending a school with strong Greek affiliation are the main focus. Interactions with gender were also of interest.

The Instrument

The *Who and mathematics* scale, its 30 items, its five item response categories – 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) and GD (girls definitely more likely than boys) – and the method for scoring the items are described in detail elsewhere (see Forgasz, 2000; Leder & Forgasz, 2000; Leder 2001). Based on previous research in the field, the response directions for each item – boys or girls more likely to match the wording of each item – were able to be predicted. The 30 items and the predicted response directions have been tabulated elsewhere (Forgasz, 2000, Leder & Forgasz, 2000; Leder, 2001) and are also shown in Table 1.

To determine whether respondents believe more strongly that boys or girls are more likely to match the wording on each item, mean scores for each item are calculated based on the assignment of a score of 1 to the BD response, 2 to BP, 3 to ND, 4 to GP, and 5 to GD. Hence a mean score < 3 indicates a belief that 'boys are more likely to…' and scores > 3 that 'girls are more likely to…'.

In the development of the *Who and mathematics* instrument, two earlier versions were trialed. One of these was completed by students attending an Australian school with a strong Greek affiliation. This trial version had 20 items in common with the final version of the *Who and mathematics* instrument. Thus, comparisons that could be made between this group of students and the others (described below) were restricted to the 20 common items. The *Who and mathematics* scale was translated into Greek for administration to students in Greece.

The Sample

The sample comprised three different groups of students, all in grades 7 to 10:

- Students attending coeducational schools in an Australian capital city (N = 861; 436M, 402F, 23?)
- Students attending a coeducational school with an explicit and strong Greek affiliation located in the same capital city (N=72; 36M, 33F, 3?), and
- Students attending coeducational high schools in a major city in Greece (N = 340; 144M, 174F, 22?)

The quite substantial variation in the size of the three groups was inevitable. Country differences in directives pertaining to access to students was one factor; the unique composition of the school attended by students in the second group another.

The first group of students was administered the final version of the *Who and mathematics* in 1999; the second group an earlier, trial version in 1998; and the third group, the final version, translated into Greek, in 2000.

Results and Discussion

As described before, the longer, 30-item instrument was administered only to the students in the first and third groups. As well as the predicted direction of findings described earlier, the response directions (M = 'boys more likely than girls'; F = 'girls more likely than boys') found among the Australian and the Greek students are summarised in Table 1.

For each country, statistically significant gender differences in mean scores for each item (based on independent groups t-tests) are indicated with asterisks. It is important to note that when the distributions of the responses to each item were examined, the most frequent response category in the vast majority of cases was ND – "no difference between boys and girls". For the Australian data, this was true for 27 of the 30 items e.g., item 12: 67.2% and item 17: 59.2%; the exceptions to this trend were items 4, 16 and 28. The high ND response rates indicate that most students in both countries did not gender-stereotype those aspects of mathematics tapped in the wording of the majority of the items on the instrument. However, subtle gender differences in response patterns were observed among students who did not use the ND category. These differences are discussed below.

As shown in Table 1, there were only eight items (2, 3, 10, 16, 21, 24, 28, & 30) for which the response directions of Australian students were consistent with previous findings. These items were generally related to the learning environment and to peers. For the Greek students, there were 21 items (1-3, 5, 9-11, 13-21, 24, 25, 27, 29, & 30) with response directions consistent with earlier research. Seven of these overlapped with the Australian findings (2, 3 10, 16, 21, 24 & 30). Four of these common items were related to classroom behaviour. Students in both countries believed that boys were more likely than girls to be asked more questions by the teacher (item 3), to distract others from their work (item 16), and to tease both boys (item 21) and girls (item 30) who did well in mathematics. The other three items indicated that boys were believed more likely to like using computers to work on mathematics problems (item 24) and to think mathematics will be important in their adult lives (item 10); girls were considered more likely to think it was important to understand the work (item 2).

The other items for which the Greek students' results paralleled previous findings were related to ability and interest in mathematics, parental beliefs, and teacher expectations. For example, the Greek students believed that boys were more likely than girls to: like challenging mathematics problems (item 11), expect to do well in mathematics (item 15), find mathematics easy (item 18), think mathematics is interesting (item 29), and have mathematics as their favourite subject (item 1). Girls were considered more likely than boys to: have to work hard to do well (item 5), get more wrong answers in mathematics (item 17), find mathematics difficult (item27), and need more help in mathematics (item 20). The Greek students also believed that parents were more likely to: think it important for boys than girls to study mathematics (item 19), and be disappointed if boys did not do well in mathematics (item 9). Consistent with this, the students also believed that boys were more likely than girls to think that mathematics will be important in their adult lives (item 14). Teachers, the Greek students believed, were more likely to spend more time with boys than girls (item 25) and to think that boys will do well in mathematics (item 13).

Table 1
Predictions from Previous Research (Pred) and Findings from Australian (Aus) and Greek (Grk) Grade 7-10 students

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

Note: For each country, items with statistically significant gender differences are marked with an asterisk
Shaded items: LIGHT= findings from both countries consistent with predictions from previous research
DARK= findings from only one country consistent with predictions from previous research

The mean scores for the entire samples of Australian and Greek secondary students are illustrated in Figure 1. The similarities and differences in the directions of the responses from the Australian and Greek students are evident:

- For 15 of the items (2-4, 6-8, 10, 12, 16, 21-24, 26 & 30), the directions of the responses of students in both countries were the same. Of these, the response directions for seven items (2, 3, 10, 16, 21, 24 & 30) were consistent with previous findings (see Table 1).
- There were 15 items (1, 5, 9, 11, 13-15, 17-20, 25, & 27-29) for which there were differences in the direction of students' responses by country. The directions of the Greek students' responses were consistent with previous findings on 14 of the 15 items (1, 5, 9, 11, 13-15, 17-20, 25, 27 & 29) and the Australian students' responses only on item 28.

For the majority of items on the *Who and mathematics* instrument, the Australian students' beliefs were inconsistent with previous research. The exceptions appeared to relate to perceptions of classroom behaviour and peer relations. Australian students' gendered perceptions of aspects of mathematics education seem to have undergone a change. In contrast, Greek students' beliefs were generally consistent with previous research. One possible interpretation of this finding is that the Greek students' gendered perceptions with respect to mathematics education are deeply rooted and represent the values of the Greek mathematics education community at large. The influence of pure mathematicians and a rigid mathematics curriculum, based on a rigorous axiomatic approach (Karageorgos, 2000) could account for the observed pattern of beliefs, despite the fact that in the past ten years or so girls have been performing at least as well as boys in Science and Engineering University entrance examinations (Katsikas, 2000).

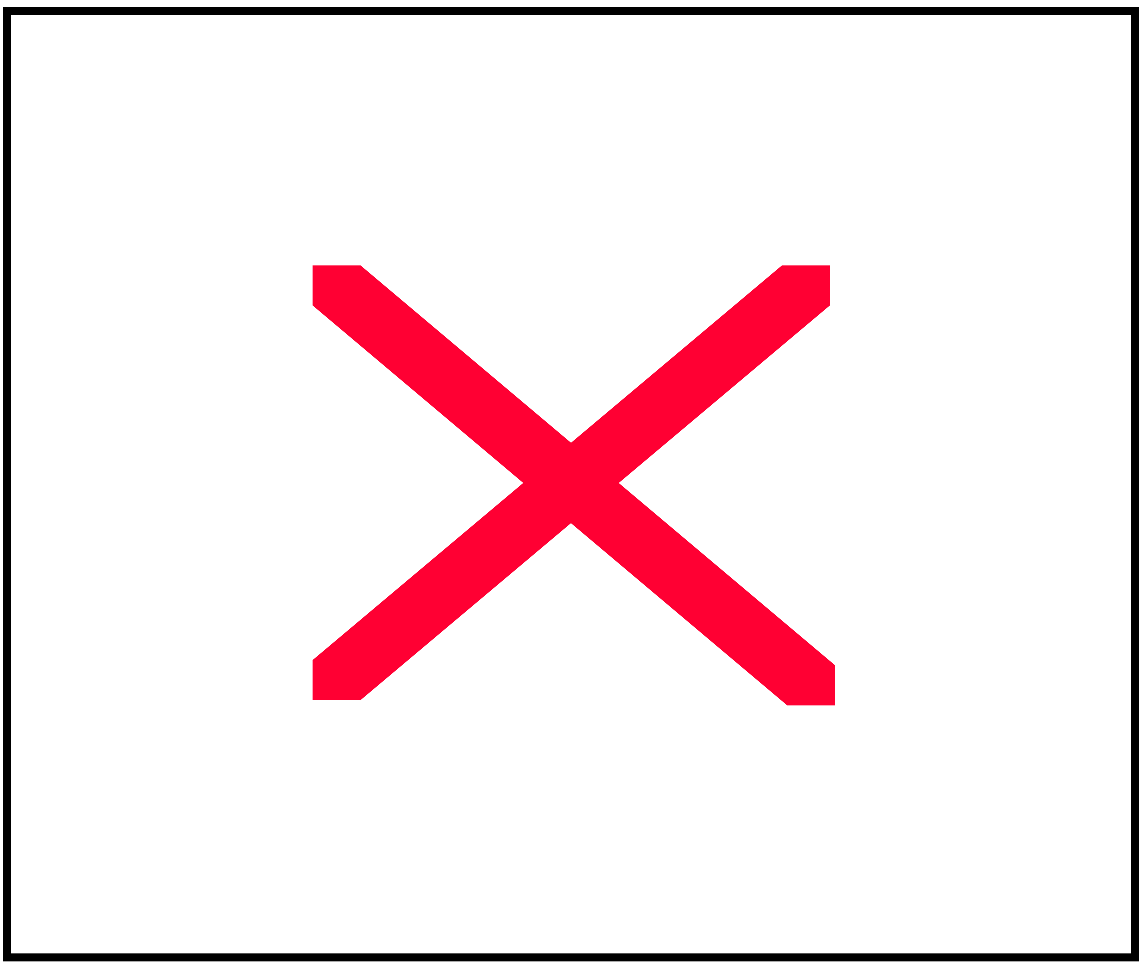

Figure 1. "Who and mathematics": Mean scores for grade 7-10 students in Australia and Greece.

Official results of the Ministry of Education of Greece for the period 1988-1992 show that girls, on average, represented 27.8% of the candidates for Science and Engineering University entrance exams but that the number securing a University place was 29.3%

(Official results, Ministry of Education and Religion of Greece, cited in Katsikas, 2000). That is, as a group, the girls performed better than boys. Another reason that might explain the degree to which mathematics continues to be perceived as a 'male domain' among Greek students, could be that attempts to change such perceptions have been sparse. Any such attempts are more likely to be due to individual teachers than to sophisticated systemic efforts aimed at establishing balanced and unbiased gender perceptions by both male and female students.

Gender Differences in Responses

For each country separately, independent groups t-tests were used to test for gender differences in the mean scores for each of the 30 items. Overall there were more items for which statistically significant gender differences were found among the Australian students (19 – Items 2-5, 7, 8-10, 14, 15, 17, 19, 20, 22, 23, 26, 27, 29 & 30) than among the Greek students (9 – Items 3, 11, 17, 18, 21-23, 26 & 30) – see Table 1. The different sample sizes may have partially contributed to this finding.

Leder and Forgasz (2000) previously reported the gender-related findings for the Australian sample. For 22 of the 30 items, the response directions were the same for males and females. Of the 19 items with statistically significant gender differences in mean scores, most were due to either the males or the females having a stronger belief that either 'boys were more likely than girls' or 'girls were more likely than boys to match item wording. None of the gender differences was due to males holding beliefs one way and females the other.

In the Greek sample, male and female students responded in the same directions on 24 of the 30 items with the extent of agreement varying considerably on several. Of the six items (7, 17, 20, 22, 23 & 27) on which males and females responded differently, only three (17, 22, & 23) had statistically significantly different means. Of the other items for which statistically significant gender differences were found (3, 11, 18, 21, 26, & 30), all were related to items for which 'boys were considered more likely than girls' to match the item wording. There was no consistent pattern, however, in whether it was males or females holding the stronger view.

Comparisons Among Students From Australia, Greece and the Greek School

An earlier trial version of the *Who and mathematics* instrument was administered to a large number of grade 7-10 students in Australia including the students at one school with a strong Greek affiliation (referred to as the 'Greek school (Aus)' to simplify the discussion). The version of the instrument used had 20 items (2-4, 7, 8, 10, 13-18, 20-23, 25, 26, 28, & 30) in common with the final version that was administered to the groups of Australian and Greek students whose findings have already been described.

The directions of the responses from the three groups of students on the 20 common items were compared. For each group, the mean score for each item is shown on Figure 2. The response directions are clearly revealed. On Figure 2 it can be seen that:

- the response direction is the same for the three groups on 12 items (2-4, 7, 8, 10, 16, 21-23, 26 & 30)

- the response direction is the same for the Australian and the Greek school (Aus) students on 19 of the 20 items; response directions differed only on 25
- the response direction is the same for the Greek and the Greek school (Aus) students on 13 items (2-4, 7, 8, 10, 14, 16, 21-23, 26 & 30)

The response patterns of the students in the Greek school (Aus) show greater overlap with those of Australian students than with those of the Greek students. Thus it appears that the first group – students in the Greek school (Aust) – have been influenced more by the greater Australian culture than by the culture associated with their ethnic backgrounds.

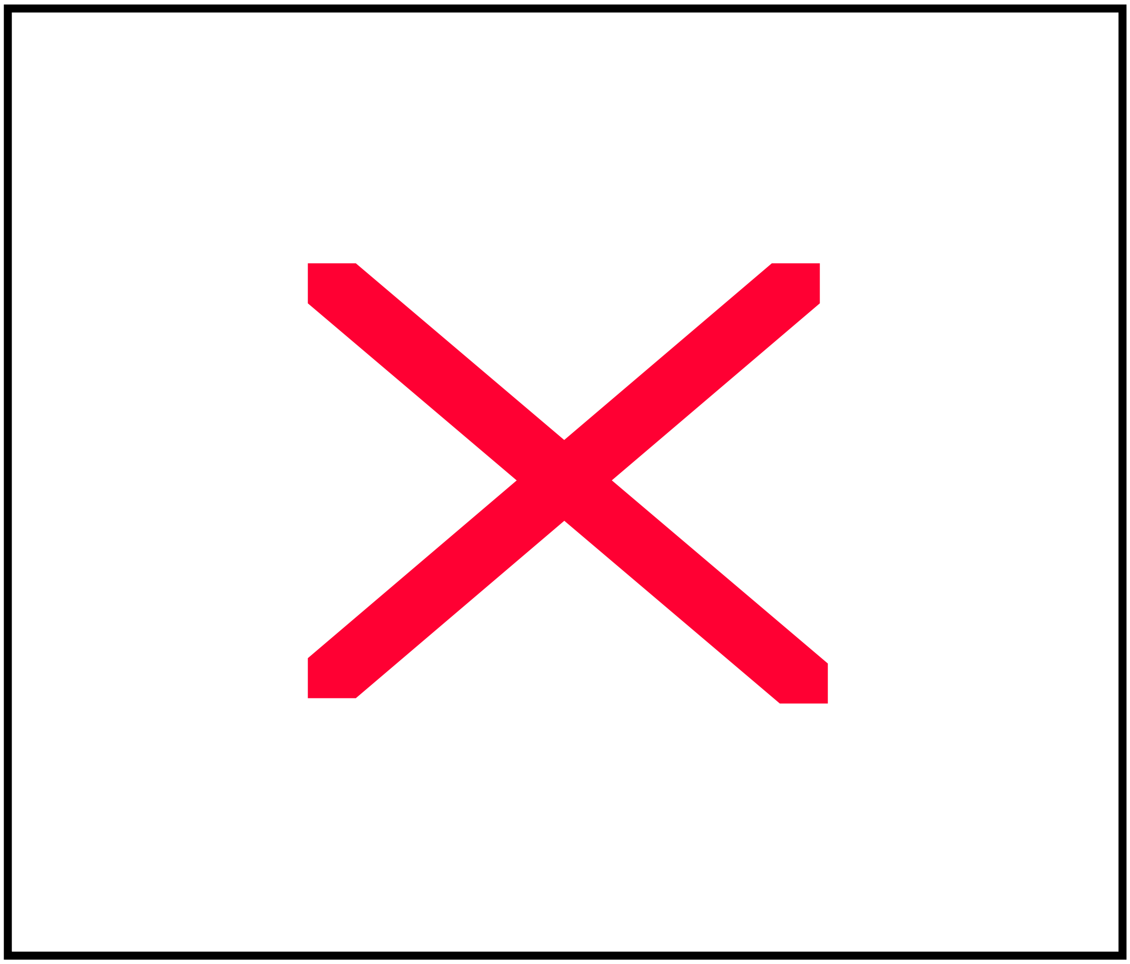

Figure 2. “Who and mathematics”: Mean scores for the 20 common items administered to grade 7-10 students in Australia, Greece and the Greek school (Aus)

Conclusions and Implications

The results of the comparisons of the Australian and Greek grade 7-10 students’ responses on the *Who and mathematics* instrument indicate that the Greek students hold more traditional gender-stereotyped beliefs about mathematics as a ‘male domain’ than do the Australians. We postulate that the traditional Greek mathematics curriculum, the more conservative culture with respect to gender role expectations, and the absence of targeted interventions to redress female disadvantage with respect to participation in post-compulsory mathematics courses and related areas as possible contributing factors to this finding. The differences in the gender linked response patterns between students in the two countries on the ‘Who and mathematics’ scale can also be interpreted as an indication of the impact on students of system wide attempts to redress once culturally accepted inequities.

When the more restricted data set gathered from the Australian students attending a school closely aligned to the Greek community was compared to the data from the Australian and Greek students, the results indicated that the Greek school (Aus) students’ views were more consistent with the Australian than with the Greek students’ perspectives. It would appear that the larger cultural milieu associated with Australian society may have a greater influence on attitudes and beliefs than the cultural effects associated with the students’ ethnic background.

Collectively, the data reported in this paper illustrate that students seem sensitive to, and aware of, the cultural climate in which learning takes place, and adjust their beliefs about mathematics and themselves as learners of mathematics to reflect prevailing societal norms. The findings reported in this paper of the apparent impact of the broad social and cultural climate on students’ beliefs and expectations invite further investigation.

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