

# Gendered beliefs about mathematics among Australian and Israeli grade 9 students

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## Abstract

*In English-speaking, Western countries, mathematics has traditionally been viewed as a "male domain", a discipline more suited to males than to females. Using two instruments (Leder & Forgasz, 2002) tapping students' beliefs about the gendering of mathematics, recent data from Australian and American students appeared to challenge the traditional gender-stereotyped view of the discipline. Whether the patterns of beliefs were similar or different among students from different cultural and ethnic backgrounds were of interest in the study reported here. The two instruments were translated into Hebrew and Arabic and administered to a large sample of grade 9 students attending Jewish and Arab schools in northern Israel. Data from only one of the two instruments, "Mathematics as a gendered domain" are reported in this paper. When compared, the Israeli and Australian students held similar views, although the Israelis' beliefs less strongly challenged the masculine image of mathematics. Whether cultural differences could be identified was explored by comparing the data from Jewish and Arab students. The Israeli Jewish students' views were found to be very closely aligned with those of the Australian students. That is, mathematics was considered a neutral domain, and neither a male or a female domain. The Israeli Arabs students' beliefs, however, suggested that they considered mathematics to be either a neutral or a female domain and were unsure if it was a male domain. Gender differences among the Israeli Arab students revealed interesting patterns that were not easily explained.*

## Background

Gender inequities in mathematics education are frequently reported with respect to achievement, participation rates, and in regard to students' attitudes and beliefs about mathematics (e.g., Leder, Forgasz & Solar, 1996). While some changes have been reported over time in stereotyped attitudes and beliefs (e.g., Forgasz, Leder & Kloosterman, 2004), PISA 2003 results (OECD, nd) revealed that males generally outperformed females, while gender differences were found for some countries but not in others in TIMSS 2003 (Mullis, Martin, Gonzalez, & Chrostowski, 2004). Participation data in Australia (Forgasz, 2006) still reveal that males outnumber females in the most challenging mathematics subjects offered at the grade 12 level.

In Israel, the educational systems for Arabs and Jews are segregated, although both are run by the Ministry of Education (Birrenbaum & Nasser, 2006). Hebrew and Arabic are the languages of instruction in the pertinent systems, while the intended mathematics curricula are the same. Ayalon (2002) maintained that Jewish students generally had greater choice of advanced level subjects leading to matriculation than students in Arab schools, where advanced courses were often limited to mathematics, sciences, and history. The restricted curriculum in Arab schools was hypothesised to benefit females with respect to access to *valued* knowledge such as mathematics (Ayalon, 2002). Mittelberg and Lev-Ari (1999) reported that Arab girls' preparedness "to adopt a mathematically-based profession in the future is particularly high both when compared to Jewish girls as well as Jewish boys" (p.88).

Based on data from the Israeli Central Bureau of Statistics, it was found that “gender inequality among Arab students was relatively moderate, with higher proportions of Israeli Arab than Jewish girls taking advanced courses in mathematics (Ayalon, 2002). Ayalon (2002) cited findings indicating that between 1948 and 1980 Arab females’ enrolments at all levels of secondary education had equalled males’ and that they had higher participation rates in post-secondary education. Mittelberg and Lev-Ari (1999) reported that Arab females also had high levels of perceived achievement and self-confidence in mathematics and were willing to consider mathematically-based studies and professions in the future. However, cultural factors appear to work against Arab females being able to capitalise on their potential. Compared to the Jewish population in Israel, the Arab population is more conservative and “Arab women are not expected to be active outside their homes and labour market participation is still low” (Ayalon, 2002, p.63). Indeed, while females comprise 56% of all Arab matriculants, only 20% of all Arab women are found in the labour force, compared to 51% of all Jewish women and 65% of all Arab men (Fogel-Bizau, 2003).

Jewish students in Israel appear to follow more closely the gender-stereotyped patterns of participation reported widely in other western nations such as the USA and Australia. That is, more males than females are enrolled in the most challenging mathematics courses offered at the secondary level (Mittelberg & Lev-Ari, 1999). In 2003, Australian and Israeli grade 8 students participated in TIMSS. The Australians (ranked 14) performed slightly better than the Israelis (ranked 19) of the 46 countries participating. In both Israel and Australia, there were no significant gender differences in performance, although males did slightly better than females (see Mullis et al, 2004). It must be recognised that Israeli Arabs comprise only 20% of the Israeli population and thus the overall Israeli TIMSS results reflect more closely the Israeli Jewish students’ performance. Zuzovsky (nd), however, has shown that the achievement gap favouring Israeli Jews over Israeli Arabs has closed between TIMSS 1999 and TIMSS 2003.

In the study reported here Israeli Jewish and Israeli Arab grade 9 students’ beliefs about the gender stereotyping of mathematics were compared. Within group gender comparisons were also undertaken. Data were also gathered on perceptions of mathematics achievement levels which were compared by ethnic group and by gender within ethnic group. Further comparisons were made with Australian grade 9 student data gathered in an earlier study (see Forgasz, Leder & Kloosterman, 2004).

### **Aims and methods**

The *Mathematics as a Gendered Domain* instrument was developed by Leder and Forgasz (see Leder & Forgasz, 2002 for details) and normed on Australian students in grades 7-10 that included 253 (122 males, 131 females) grade 9 students. It is comprised of three subscales with 16 Likert-type items scored on five-point scales from SD=1 to SA=5 on each. The three subscales are: *Mathematics as a Male Domain* [MD], *Mathematics as a Female* [FD], and *Mathematics as a Neutral Domain* [ND]. Sample items from each scale include:

MD: Boys understand mathematics better than girls do

FD: Girls are more suited than boys to a career in a mathematically-related area

ND: Boys are just as likely as girls to help friends with their mathematics

The instrument was translated into Hebrew and into Arabic and administered to 103 grade 9 students in 4 Jewish schools and 112 grade 9 students in 3 Arab schools in Northern Israel. While recognising that this purposeful sample was not representative of the entire Israeli grade 9 population, it enabled robust comparisons to be made between the beliefs of Israeli Jewish and Arab students, and was large enough to make comparisons with the earlier gathered Australian data. Also included on the instrument was an item asking students "How good are you at mathematics" [HGM]. Students responded on a five-point scale ranging from 1=weak to 5=excellent.

## Results

### Israeli and Australian grade 9 students' perception of mathematics achievement

Mean scores for perceived levels of mathematics achievement [HGM] were compared by country using an independent groups t-test. The Israelis were found to have a significantly higher mean level of perceived mathematics achievement than the Australians (Israelis: 3.67, Australians: 3.43,  $p < .01$ ). These findings are inconsistent with the TIMSS findings that revealed that the Australians had performed better than the Israelis. As noted earlier, Israeli Arabs are a minority of the Israeli population and the difference is most likely due to the unrepresentative sampling of Israeli students, that is, using approximately equal numbers of Jewish and Arab Israelis. The Israeli data were disaggregated by ethnic group, and comparisons between the three ethnic groups were undertaken.

### Perceptions of mathematics achievement: Ethnic comparisons

A one-way ANOVA was conducted to determine if there were differences in mean scores on students' perceptions of their mathematics achievement levels by ethnic grouping: Israeli Jews, Israeli Arabs, and Australians. Scheffe post-hoc tests were used to determine which pairs of mean scores were significantly different. The results are shown in Table 1.

Table 1. HGM: ANOVA results by ethnic group

Ethnicity	N	Mean	F, p-level	Scheffe post-hoc
Israeli Jews	103	3.59		Israeli Jews – Israeli Arabs: ns
Israeli Arabs	107	3.75	4.15, $p < .05$	Israeli Jews-Australians: ns
Australians	250	3.43		Arab-Australians: $p < .05$

As can be seen in Table 1, there was a statistically significant difference between the three groups ( $p < .05$ ). The Scheffe post-hoc tests revealed that this difference was due to the difference between the mean scores for Israeli Arabs and Australians ( $p < .05$ ) with the Israeli Arabs believing they were higher achievers (mean=3.75) than Australians (mean=3.43). There were no significant differences in mean scores for the Israeli Jews and Israeli Arabs or for the Israeli Jews and Australians.

Gender differences within each ethnic group were examined using independent groups t-tests. The results are shown in Table 2. The only gender difference was found among Australian students with males believing they were higher achievers than females ( $\text{mean}_{(M)} = 3.56$ ,  $\text{mean}_{(F)} = 3.30$ ).

Table 2. HGM: Means and t-test results by gender within ethnic group

Ethnicity	Male		Female		T, p-level
	N	Mean	N	Mean	
Israeli Jews	50	3.56	52	3.60	ns <sup>1</sup>
Israeli Arabs	57	3.81	54	3.67	ns
Australians	121	3.56	129	3.30	-2.28, p<.05

<sup>1</sup> ns = not significant

In summary, the Israeli Arabs had the highest perceived mathematics achievement levels among the three groups. The beliefs of the Israeli Jews about their mathematics achievement levels were similar to those of the Australians, consistent with the TIMSS 2003 data. Unlike the Australians, however, there were no gender differences in the beliefs of Israeli Jews with respect to mathematics achievement levels.

### **Mathematics as a gendered domain: Differences by country**

The mean scores of the grade 9 students on the MD, FD and ND subscales were compared by country using independent groups t-tests. Statistically significant differences by country for mean scores on each of the three subscales were found. The mean scores are shown in Table 3.

Table 3. Mean scores on MD, FD, and ND by country

Country	MD	FD	ND
Australia	2.28	2.68	3.83
Israel	2.82	3.00	3.58

The data in Table 3 reveal that:

- Both Israeli and Australian students disagreed that mathematics was a main domain (means <3) but the Israelis ( $\text{mean}_{(\text{Israel})}=2.82$ ) disagreed less strongly than the Australians ( $\text{mean}_{(\text{Aus})}=2.28$ )
- Israeli students were unsure if mathematics was a female domain ( $\text{mean}_{(\text{Israel})}=3.00$ ) while the Australians disagreed that it was ( $\text{mean}_{(\text{Aus})}=2.68$ )
- Australians believed more strongly ( $\text{mean}_{(\text{Aus})}=3.83$ ) than the Israelis ( $\text{mean}_{(\text{Israel})}=3.58$ ) that mathematics was a neutral domain;

### **Gendered beliefs about mathematics: Ethnic differences**

The mean scores for each of the three ethnic groups on each of the three subscales of the *Mathematics as a gendered domain* scale are illustrated in Figure 1.

As can be seen in Figure 1, the order of the belief measures on the three subscales was the same for all three groups: highest score on ND, and lowest score on MD, that is, they agreed most strongly that mathematics was a neutral domain and least strongly that mathematics was a male domain. However, while all three groups strongly agreed that mathematics was a neutral domain (means >> 3), for the MD and FD subscales, the directions of the beliefs of the Israeli Arabs differed from those of the Israeli Jews and the Australians. The Israeli Arabs were unsure if mathematics was a male domain (mean approx. 3) whereas the Australians and Israeli Jews disagreed that it was

(means < 3), and the Israeli Arabs believed that mathematics was a female domain (mean > 3) whereas the Australians and Israeli Jews disagreed that it was (means < 3).

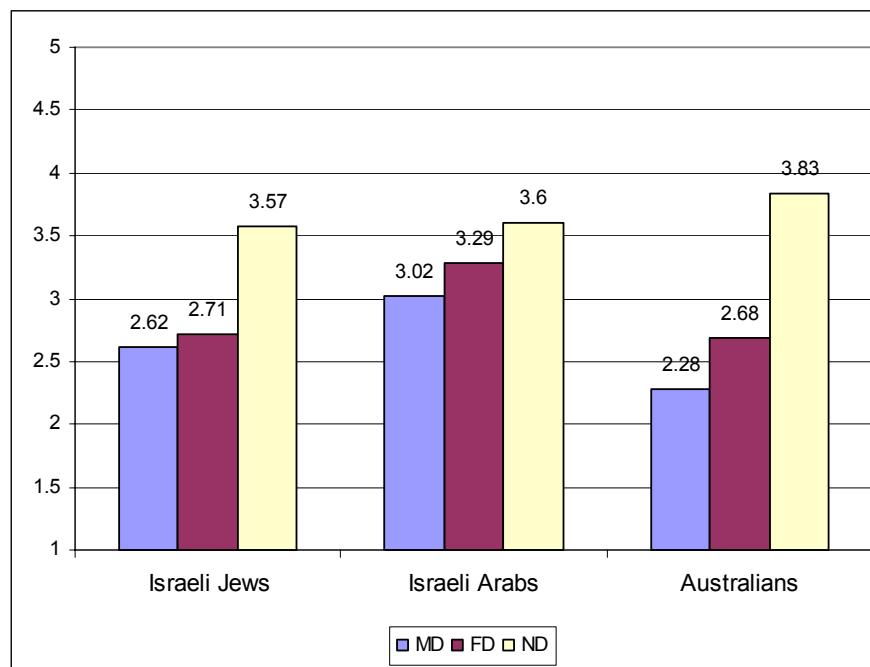


Figure 1. MD, FD, and ND: Mean scores by ethnic group

ANOVAs followed by post-hoc tests were conducted to determine if there were statistically significant ethnic differences in the students' gendered beliefs on the three *Mathematics as a gendered domain* subscales. The results are shown in Table 4.

Table 4. MD, FD, and ND: Means and ANOVA results

			F,		
Subscale	Ethnicity	N	Mean	p-level	Scheffe post-hoc
MD	Israeli Jews	103	2.62	42.26, <.001	Israeli Jews-Israeli Arabs: p<.001
	Israeli Arabs	107	3.02 <sup>1</sup>		Israeli Jews-Australians: p<.001
	Australians	233	2.28		Israeli Arabs- Australians: p<.001
FD	Israeli Jews	99	2.71	36.42, <.001	Israeli Jews-Israeli Arabs: p<.001
	Israeli Arabs	100	3.29		Israeli Jews-Australians: ns
	Australians	236	2.68		Israeli Arabs- Australians: p<.001
ND	Israeli Jews	101	3.57	13.89, <.001	Israeli Jews-Israeli Arabs: ns
	Israeli Arabs	104	3.60		Israeli Jews-Australians: p<.001
	Australians	224	3.83		Israeli Arabs- Australians: p<.001

<sup>1</sup> One sample t-test indicated that this mean was not significantly different from 3

As can be seen in Table 4, statistically significant differences were found among the mean scores of the three ethnic groups on MD, FD and ND. Scheffe post-hoc tests indicated that the only non-significant differences in mean scores were for Israeli Jews and Australians on the FD, and for Israeli Jews and Israeli Arabs on the ND.

The statistically significant findings indicated that:

- MD: Australians (mean = 2.28) disagreed more strongly than Israeli Jews (mean = 2.62) that mathematics was a male domain; Israeli Arabs were not sure if mathematics was a male domain (mean = 3.02)
- FD: Australian (mean = 2.68) and Israeli Jews (mean = 2.71) similarly disagreed that mathematics was a female domain; Israeli Arabs agreed that mathematics was a female domain (mean = 3.29)
- ND: All three groups agreed that mathematics was a neutral domain (means >3), with the Australians (mean = 3.83) agreeing more strongly than Israeli Jews (mean = 3.57) and Israeli Arabs (mean = 3.60).

### **Gendered beliefs about mathematics: Gender differences within ethnic groups**

To determine if there were gender differences in the grade 9 students' gendered beliefs about mathematics within each ethnic group, independent groups t-tests were conducted. The results are shown in Table 5.

Table 5. MD, FD, and ND: Means and t-test results by gender within ethnic group

Ethnicity	Subscale	All	Male		Female		t, p-level
			N	Mean	N	Mean	
Israeli Jews	MD	2.62	49	2.51	53	2.73	ns
	FD	2.71	50	2.59	48	2.86	2.346, <.05
	ND	3.57	49	3.57	51	3.56	ns
Israeli Arabs	MD	3.02	55	2.81	51	3.25	3.241, <.01
	FD	3.29	49	3.39	51	3.20	ns
	ND	3.60	49	3.58	54	3.62	ns
Australians	MD	2.28	112	2.47	121	2.11	-4.35, <.001
	FD	2.68	115	2.66	121	2.70	ns
	ND	3.83	108	3.79	116	3.87	ns

A few interesting trends are apparent from the data in Table 5.

- There was a clear similarity in the belief patterns of the Australian males, Australian females, Israeli Jewish males, and Israeli Jewish females. All held that mathematics was a neutral domain (means > 3) and disagreed that it was either a male or a female domain (means < 3).
- The pattern was different among the Israeli Arabs. The females believed that mathematics was a neutral domain as well as being both a male domain and a female domain (means > 3), and the males agreed that mathematics was a neutral and a female domain (means > 3), but disagreed that it was a male domain (mean < 3).

The three statistically significant gender differences, one for each ethnic group, showed that:

- Israeli Jews: Males (mean = 2.59) disagreed more strongly than females (mean = 2.86) that mathematics was a female domain [FD]

- Israeli Arabs: Females agreed (mean = 3.25) and males disagreed (mean = 2.81) that mathematics was a male domain [MD]
- Australians: Females disagreed more strongly (mean = 2.11) than males (mean = 2.47) that mathematics was a male domain [MD]

In summary, the Israeli Jews and the Australians (as well as the males and females in each country) held similar views. They agreed that mathematics was a neutral domain and rejected mathematics as either a male or a female domain. The findings for the Israeli Arabs' were quite different and are ambiguous. They agreed that mathematics was both a neutral and a female domain, and were uncertain if it was also a male domain (mean = 3.02). The gender difference on the MD subscale appears to explain the overall uncertainty among the Israeli Arabs; while the females agreed that it was a male domain (mean = 3.25), the males disagreed (mean = 2.81).

## **Conclusions**

Consistent with the TIMSS findings for mathematics performance (Mullis et al., 2004), the beliefs about mathematics performance levels and the gendered beliefs about mathematics of all the Israeli students and the Israeli Jewish students but not the Israeli Arab students were similar to the Australian students'. On average, the Israeli Jews and the Australians believed they were above average in mathematical performance, believed that mathematics was a neutral domain, and disagreed that it was either a male or a female domain. These findings suggest that there is a cultural similarity between the Israeli Jewish and the Australian grade 9 students. The statistically significant differences between the mean scores of the Australians and the Israeli Jews indicated that the Australians' beliefs were more strongly held. That Australian society may be less gender stereotyped than Israeli society may partly explain these findings but further research is needed. It is noteworthy that the Israeli Jewish students' views were consistent with findings from the *Mathematics as a gendered domain* scale in the USA as well as Australia (Forgasz, Leder & Kloosterman, 2004).

Of the three groups, the Israeli Arabs had the highest perceived levels of mathematics performance, a finding that may be partially explained by the limited curriculum offerings in Israeli Arab schools (Ayalon, 2002) that may limit students' perceptions of which discipline areas they are relatively stronger or weaker. The Arab Israeli students' gendered views of mathematics were, however, intriguingly different from the views of the Israeli Jews and the Australians and are not easily explained. Like the others, the Israeli Arabs (both males and females) also believed that mathematics was a neutral domain. However, both the males and females simultaneously believed that mathematics was a female domain and, while the Israeli Arab males disagreed, the Israeli Arab females agreed that mathematics was a female domain. Despite the prevailing male dominant stereotypes in traditional Israeli Arab society, Arab females in mathematics classrooms may be less disadvantaged. The data from this study reveal that they strongly believe that mathematics is a neutral domain and simultaneously believe that it is both a male and a female domain. One arguable interpretation of these data is that they are egalitarian and see mathematics as suitable for both males and females. The views of the Arab males are less easy to interpret. They believed that mathematics was a neutral domain and simultaneously that it was a male domain but not a female domain.

The *apparently* ambiguous findings for Arab males and females strongly suggest that there may be a cultural factor operating within the Israeli Arab community in which

there are conflicting beliefs associated with the gender stereotypes of the adult community and what takes place in classrooms and school settings. There may be an unresolved tension between school and post-school expectations and employment options for both male and female Israeli Arab students. Clearly more research is needed to understand better the ambiguity in the Israeli Arab students' findings about the gendering of mathematics.

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