Gender and Ethnic Differences in Israeli and Australian Mathematics Teachers’ Views of Mathematics: Educational implications

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An interview was conducted with 30 female teachers of mathematics in each country. The interview was conducted in the spring of 2010 in Israel and in the fall of 2010 in Australia.
4. Research Proposal

4.1 Abstract

This study builds on the earlier research of the grant applicants in which Australian and Israeli grade 9 mathematics students’ views on the gender stereotyping of mathematics, and the views of pre-service teachers from both countries have already been gathered. For students and pre-service teachers, the Israeli data have also been examined by cultural/ethnic identity – Jewish and Arab – and sociological dimensions postulated to explain the observed differences. Since teachers are a major influence on students’ learning outcomes, both cognitive and affective, their views will provide a missing perspective in furthering explanations for the variations in the views of students and pre-service teachers, and among the ethnic groups and will help in understanding patterns of gender difference among students in Australia, Israel and within Israel’s two main ethnic groups (Jews and Arabs). Quantitative and qualitative survey data will be gathered from large samples of mathematics teachers in both countries in order to meet these goals.
4.2 Theoretical framework of the Research

Background

Improving mathematics learning outcomes for all students is a key objective of mathematics education. Achieving gender equity in mathematics learning outcomes is another. (Grouws, 1992). Teachers’ beliefs about the nature of the discipline of mathematics will influence how they teach and what is taught, and therefore the learning activities students will experience (Nickson, 1992).

Gender differences in mathematics learning outcomes persist (Leder, 1992). Females’ participation rates in the most demanding mathematics courses remain lower than males’ and, for the most complex, high cognitively demanding mathematical tasks, males generally outperform females, particularly among the highest achievers. In gender-related research much attention has been paid to the relationships between learning outcomes, participation and performance and postulated contributing factors: affective, societal, and genetic. Gender differences on key affective variables are well-documented. They have been included in many models explaining gender differences in mathematics learning outcomes (Leder, 1993).

A. Mathematics as a Male Domain

The extent to which mathematics was stereotyped as a male domain, that is, perceived to be more suited to males than to females, was identified as one of the explanatory variables of gender differences in mathematics. Historically, mathematics has been viewed as a male domain, that is, males have been considered more suited to the study of challenging mathematics and to pursue careers in which mathematics is used. Gender differences in mathematics education are frequently reported favouring males with respect to achievement, participation rates, and with respect to students’ attitudes and beliefs about mathematics (e.g., Leder, Forgasz & Solar, 1996; Vale & Bartholomew, 2008).

Fennema and Sherman published their groundbreaking *Mathematics Attitude Scales* [MAS] (Fennema & Sherman, 1976) which comprised nine subscales including *Mathematics as a male domain*. This subscale has been widely used to assess the extent to which respondents stereotype mathematics as a male domain. The *Mathematics Attribution Scales* [MAtS] were published in 1979 (Fennema, Wolleat &
Pedro, 1979). The operational definitions of the affective variables incorporated in their respective subscales serve as a partial basis for the present study; they also form the basis for operational definitions of related behaviours. The variables of interest from the MAS are: confidence as a learner of mathematics, perceived usefulness of mathematics, perceptions of teacher support, and mathematics as a male domain. From the MAtS are: success and failure attributions to ability, effort, task and the environment.

The above mentioned studies showed that males are more likely than females to stereotype mathematics as a male domain. International studies using the same scale replicated these findings (see Forgasz, 1992, 1993) with Australian grade 7 students. Forgasz, Leder and Gardner (1999) argued that the wording of some of the items on the MAS subscale was anachronistic, and that the assumptions underpinning the scoring of the subscale did not allow respondents to express the view that mathematics was a female domain. Leder and Forgasz (2002) described the development of two new instruments – the Mathematics as a gendered domain instrument and the Who and mathematics instrument – to overcome the identified limitations of the Mathematics as a male domain subscale. Both instruments allow respondents to reflect their views of mathematics as a male, female, and/or neutral domain. Forgasz, Leder and Kloosterman (2004) reported findings from the two instruments for grades 7-10 students in Australia and the USA. Changes in gendered perceptions of mathematics appeared to have shown some change. They concluded that:

*Taken as a whole the responses indicate that most students see mathematics as relatively gender neutral but there are situations, including distraction of others and completing class work, where more recent accounts of gender differences have been given more credence.* (Forgasz, Leder & Kloosterman, 2004: 416-417).

The two instruments (Leder & Forgasz, 2002) will be modified and adapted for the present study. The instruments have already been translated into several languages and administered to high school students and pre-service teachers in several countries - USA (e.g., Forgasz, Leder & Kloosterman, 2004), Greece, Sweden, Finland, and Israel (in Hebrew and Arabic - see Forgasz & Mittelberg, 2008 for student results, Mittelberg & Forgasz, 2009 for pre-service students results). As well as student results, Forgasz, Leder and Kloosterman (2004) also reported findings from these instruments for pre-service teachers from Australia and the US. While students’ gendered perceptions of mathematics appeared to have shown some change since
earlier times, that is, were less traditionally gender stereotyped, the pre-service teachers’ views had not.

B. Attribution Theory, Gender and Mathematics Learning

Attribution theories deal with the reasons or attributions individuals believe account for their previous successes and failures and how these attributions translate into future action. Weiner (1974) postulated a model of achievement-related behaviour within an expectancy-value framework. Four elements to which people ascribed their successes and failures had been identified (Weiner et al., 1972): ability, effort, task difficulty and luck. Weiner’s model assumed that values were attached to each of the four elements and that task outcomes were differentially ascribed to the four causes. Although Weiner recognised there were other causes for success and failure, the four factors were considered “the most general and salient of the causes of achievement outcomes” (ibid:52). The four factors varied along two dimensions: (1) locus of control (internal and external) and (2) stability over time (stable and unstable, Weiner et al. 1972; Weiner, 1974). According to the model, ‘ability’ is an internal and stable factor, ‘effort’ is internal and unstable, ‘task difficulty’ is external and stable, and ‘luck or environment’ is external and unstable. Weiner et al. (1972) contended that locus of control “influences the affective reactions to an event” (ibid:240) and that stability factors “primarily influence the changes in expectancy of success following success or failure” (ibid).

Individuals attributing success to internal causes and failure to external factors are said to exhibit ‘mastery orientation’, considered a functional attribution style (Kloosterman, 1993). The distinguishing characteristics of mastery-oriented individuals are willingness to exert continued effort and to persist at difficult tasks. Attributing failure to internal causes and success to external ones represents a pattern of attributions characterising the ‘learned helpless’ individual. This less functional pattern of attributions is likely to lead to cognitive, motivational and/or emotional deficits such as lack of persistence or curtailment of effort (Leder, 1992). The higher attribution for success to effort by females but to ability by males is consistent with ‘fear of success’ imagery: a feeling that females have to work harder than males to have their achievements recognised (Leder, 1992).

Kloosterman (1993) provided an historical overview of the literature on attributional theories of motivation and their applicability to mathematics learning. Weiner’s (1974) model has been the basis of much of the research on attributions in mathematics
education. As in the general field, most work has been done with the original four causes. The two by two categorisation formed the theoretical basis of the widely used Mathematics Attribution Scales [MAtS] developed by Fennema et al. (1979).

Several studies in mathematics education have investigated attributions for success and failure among school-aged children. The research indicates that males were more likely than females to attribute success in mathematics to ability and failure to lack of effort, a finding consistent with the more general attribution literature. Females, on the other hand, were more likely than males to attribute success to effort and failure to lack of ability or an external factor (Forgasz, 1993; Kloosterman, 1988.

4.3 Context of the Research

Cross-national comparisons of students’ mathematics achievements, and/or the factors that underpin them, provide valuable insights into the complexities associated with finding explanations for observed patterns of gender difference in cognitive and affective measures. Cultural, ethnic, and societal factors are found to interact with gender in many such explorations (e.g., Barkatsas, Forgasz, & Leder, 2002; Forgasz & Mittelberg, 2008).

The study will be conducted in Israel and in Australia. Both societies are built of large waves of immigration and are comprised of a diverse number of ethnic/cultural groups. In addition, Israeli society is further divided into two major groups: Jews and Arabs. Israeli Arabs are the largest minority in Israel; in 2006 they comprised 19.7% (Moslems 83.0%; Druze 8.3%; Arab Christians 8.5%) of the overall population (Central Bureau of Statistics, Israel, 2007). In Israel, the educational systems for Arabs and Jews are segregated, but both are run by the Ministry of Education (Ayalon, 2002; Birenbaum & Nasser, 2006; Zuzovsky 2008). Hebrew and Arabic are the languages of instruction in the pertinent systems, and the intended mathematics curriculum is the same in both.

The Arab population of Israel is considered more conservative than the Jewish population, and “Arab women are not expected to be active outside their homes and labour market participation is still low” (Ayalon, 2002: 63). Indeed, while females comprise 56% of all Arab matriculants, only 20% of all Arab women are found in the labour force in Israel, compared to 51% of all Jewish women (Fogel-Bizau, 2003).
In Israel, teachers and classroom dynamics have been recognised as important contributors to gender differences. Avrahami-Ainat (1989) believed that gender gaps resulted from socialisation, with parents and the Israeli educational system being the main influences. Teachers’ attitudes towards boys and girls and those in the cultural milieu of both groups outside school can differ. Mittelberg and Lev-Ari (1999) maintained that teachers had a strong influence on students’ confidence, self-esteem, and future study directions. Ben Artzi (2000) believed that teachers’ expectations strongly affected learning outcomes (the Pygmalion effect). These findings from Israel echo those found in western, English-speaking nations (e.g., Leder, Forgasz, & Solar, 1996; Vale & Bartholomew, 2008).

In the proposed study, the aims are to examine Australian and Israeli mathematics teachers’ gendered perceptions of mathematics and to compare the findings by country (Israel and Australia) and by gender within country, and to compare the Israeli data by ethnicity (Jewish and Arab) and by gender within the two ethnic groups. The aim is to determine whether there are any discernible patterns in the views expressed by the three groups: grade 9 students, pre-service teachers, and practising mathematics teachers. Comparisons by gender, by country, by Israeli ethnic group, and by gender within these groups are also of interest.

4.4 Research Aims and Questions

There are two aims of the proposed study:

- To explore for patterns of similarity and difference in the teachers’ views of the stereotyping of mathematics learning by country, gender and ethnic group.

- To compare students’, pre-service teachers’, and practising teachers’ views on the stereotyping of mathematics learning.

Answers to the following research questions will be sought in the present study:

1. Is there a difference in the gendered beliefs about mathematics of Jewish and Arab Israeli mathematics teachers?

2. Do male and female teachers within each of the two ethnic groups - Jews and Arabs - hold different gendered beliefs?
3. Is there a difference in the gendered beliefs about mathematics between Israeli students, pre-service teachers, and mid career mathematics teachers?

4. Is there a difference between Israeli teachers and Australian teachers in their gendered beliefs about mathematics?

**4.5 Research Methods**

**4.5.1 Research design**

This study will employ a quantitative cross-sectional correlational research methodology, which focuses on the relationships between variables in a natural setting at a given point in time. The survey will include closed and open-ended items. That is, much of the data will be strictly quantitative and will be analysed using appropriate statistical testing as outlined below. In addition the study will utilise the qualitative methodology when analysing the open ended questions to be included in the survey. In Israel, a pen-and-paper version of the instrument will be adopted; in Australia, an online survey will be used.

Cultural sensitivities will be taken into account in devising the open-ended survey items. Due care will also be taken not to violate cultural expectations with respect to the timing of the administration of the surveys.

**4.5.2 Data Sources**

**Israel:** Jewish and Arab high schools (public and private) in northern Israel will be approached and permission sought for mathematics teachers to complete the surveys. To enable robust statistical analyses to be undertaken, data will be needed from at least 30 Jewish and 30 Arab mathematics teachers. Target sample sizes are 60 Jewish and 60 Arab teachers in the field. In addition, 120 teachers who will also be first year MEd students at a college of education. An acceptable gender balance will be sought, recognising that there are more female than male teachers in Israel.

**Australia:** The Australian Association of Mathematics Teachers [AAMT] will be approached to gain permission for the online survey to be linked to its website. AAMT members will be provided with information about the online survey through AAMT’s state-affiliated associations; links to the online survey will also be made from the state association websites. From across Australia, a sample of around 200
mathematics teachers might be expected; this would be more than adequate for the purposes of the proposed study.

4.5.3 Research Variables

Independent and Dependent variables

Independent variables will include gender, ethnicity (Jewish /Arab), type of school (private/public), religion (Jewish/Muslim/Christian/other), socioeconomic background of respondents, tertiary educational level, seniority in teaching, mathematics backgrounds (including pre-service education), in-service education. Dependent variables include the various measures of the degree of stereotyping of mathematics as well as perceived mathematics achievement. These variables will be measured using modified versions of the Leder and Forgasz (2002) instruments to tap beliefs about the stereotyping of mathematics and its learning, as well as Fennema et al.’s (1979) Mathematics Attribution Scales. The modified versions of these instruments, which were used with Israeli pre-service teachers (Mittelberg & Forgasz, 2009), will again be used with mathematics teachers in Israel and in Australia. For the versions to be used with the mathematics teachers, several open-ended items will be added. These items will focus on the teachers’ views of the boys and girls in their own classrooms:

- whether they believe boys and girls learn differently
- whether they consider there are differences in boys’ and girls’ mathematical abilities
- whether mathematics is considered more important for girls or boys and why etc.

These qualitative data will carefully designed to enable the researchers to seek explanations for the directions and sizes of the related quantitative data derived.

4.5.4 The Research Instruments

The Mathematics as a Gendered Domain instrument and the Who and Mathematics instruments (see Leder & Forgasz, 2002 for details) were normed on Australian students in grades 7-10, including grade 9 students. The Mathematics as a Gendered Domain instrument is comprised of three subscales with 16 Likert-type items scored on five-point scales from Strongly Disagree=1 to Strongly Agree=5 on each. The
three subscales are: *Mathematics as a Male Domain* [MD], *Mathematics as a Female Domain* [FD], and *Mathematics as a Neutral Domain* [ND]. The full set of items is listed in Leder and Forgasz (2002) and reproduced in the appendix of Forgasz and Mittelberg (2008). Forgasz and Mittelberg translated these instruments into Hebrew and Arabic and administered them to ninth grade Israeli students. Factor analysis was performed on these items and the three subscales were clearly identifiable. Reliability tests were conducted on each subscale. Each was found to be robust with Cronbach-alpha values as follow: MD: $\alpha = 0.85$; FD: $\alpha = 0.85$; ND: $\alpha = 0.75$. Items can be seen in Appendix below.

Sample items from each subscale 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

As for the earlier study with Israeli pre-service teachers described above, the survey to be used in this study will comprise a subsample of 8 items from each subscale which reflect the original theoretical domains.

An instrument called *Who and Mathematics and Computers* that was also used in the study of Israeli pre-service teachers will again be used in the present study. It was comprised of three sets of items: *Who and Mathematics* (10 items eg. *Have to work hard in mathematics to do well*); *Who and Computers* (5 items eg. *Like using computers*), and *Who and Computers for Mathematics* (5 items eg. *Do not like using computers for doing mathematics*). The 10 *Who and Mathematics* items were selected from the original 30 *Who and Mathematics* statements devised by Leder and Forgasz (2002). The five *Who and Computers* items and the 5 *Who and Computers for Mathematics* items were drawn from an additional instrument, *You, Your Students, Mathematics and Computers*, used by Forgasz (2002). The 20 items used with the Israeli pre-service teachers will be used again in the present study. For each item, respondents indicate who they believe is more likely to match the wording: Girls, boys, or no difference between girls and boys.
The 20 statements stand alone and cannot be combined into any sort of total scale or subscale score. In order to interpret responses to each item, mean scores are calculated for each item to determine the direction and strength of the beliefs, represented by the ‘distance’ from the neutral value of 3 (no difference between boys and girls). Thus, mean scores less than three indicate that, on average, respondents believe that boys are more likely than girls to match the wording of the item; mean scores greater than three that they believe that girls are more likely than boys to do so. One-sample t-tests are used to determine whether or not mean scores close to 3 are significantly different from 3; critical values are sample size dependent.

As reported in Forgasz and Mittelberg (2008), the Mathematics as a Gendered Domain and the Who and Mathematics instruments were translated into Hebrew and into Arabic by fluent English-speaking native speakers of Hebrew and Arabic. The reliability of the translations was determined by asking a different pair of Hebrew and Arab speakers fluent in English to back translate into English. The same procedure was adopted for the Who and computers instrument used with the Israeli pre-service teachers that will also be used in the present study.

It should be noted that the original instruments devised by Leder and Forgasz (2004) have been translated into several languages and none of the items was considered culturally sensitive.

**Mathematics Attribution Scales**

In the study with Israeli pre-service teachers, and in the proposed study, four of the original eight MAtS items were used (Fennema, Wolleat, & Pedro, 1979), two success statements and 2 failure statements. Each item is comprised of a stem statement. For each statement, four “causes” are listed, one each corresponding to four attributional factors – ability, effort, task difficulty, and luck or environment. Respondents respond on a five-point Likert format from Strongly Disagree = 1 to Strongly Agree = 5 to each cause.

Scores for each of the four success attributions and for each of the four failure attributions are found by summing the scores to the pertinent responses on each success or failure statements.
In an additional section of the questionnaire, participants are asked to indicate perceptions of their own mathematics achievement levels on a 5-point scale, ranging from 1=weak to 5=excellent.

4.5.5 Research Process

The survey instrument will be checked for face and content validity by the administration of a pre-test of the Hebrew questionnaire amongst MEd students at a College of Education who will be asked to comment on the wording of items. The reliability of the various subscales comprising the instrument will be checked against those previously found with Israeli pre-service teachers (see Mittelberg & Forgasz, 2009). SPSS will be used to calculate Cronbach-alpha values and comparisons will be made to the previously obtained values. Factor analysis will be performed to determine the robustness of the dimensions of the subscales comprising the dependent variables.

4.5.6 Data analysis

All scorable data will be entered into an SPSS database and appropriate statistical analyses undertaken. Depending on data type and sample sizes, the tests adopted will be drawn from the following: t-tests, one-way and/or two-way ANOVAs, and chi-square tests; some bivariate correlations will also be conducted. The tests will be used to identify if there are statistically significant differences in the response patterns on the various items and subscales by gender, country, ethnic group, and combinations of these factors (if sample sizes allow).

Many of these quantitative items will be complemented by open-ended items to which qualitative response will be provided. Initially, these responses will be analysed by coding against anticipated potential categories identified from the literature and/or which are included in the theoretical framework of the study (described above). Since not all possible responses can be anticipated, a grounded approach (Strauss and Corbin, 1990) will be adopted. That is, unanticipated categories emerging from the data will be identified.

Manual analyses of the open-ended responses will be conducted. As noted above, while the literature and theoretical framework will provide guidance for themes that might be evident, unpredictable and emerging themes will also be sought.
4.5.7 Protecting rights of respondents

Authorisation to implement this research will be sought from the Research Authority, X Academic College of Education. All questionnaires will be completed anonymously. Participation will be voluntary. Teachers will have the right to refuse to participate, that is, principals will not be permitted to coerce participation. Respondents may choose not to respond to particular items or to stop completing survey questions at any time. No payment is associated with participation in this study.

The process to gain clearance from the Monash University Human Ethics committee will be sought; the Monash University guidelines for the conduct of ethical research will be adopted for the entire study.

4.5.8 Involvement of Students

MEd students enrolled in the course “Mathematics and Gender” offered by Dr. David Mittelberg at X, will be involved in the conduct of this research. They will serve both as a source of qualitative data as respondents in focus groups conducted by the researchers, being mid career teachers in Mathematics and Sciences. Once permissions are obtained from their schools and colleagues, they will also serve as administrators of the questionnaires in the schools where they work.

4.6 Importance of Research

The gender-stereotyping of mathematics as a male domain remains a deterrent to females’ participation in higher level mathematics and in careers for which mathematics is a pre-requisite or an essential component. Since males’ participation rates in mathematics and related fields remain higher than females’ (Forgasz, 2006), and in light of recent data indicating that achievement gaps may once again be widening in favour of males in Australia (e.g., Thomson, Wernert, Underwood, & Nicholas, 2008), it is important to monitor practising mathematics teachers’ views of the discipline and of those who study or engage in it to seek explanations for these trends. How Australian teachers’ views compare with those of Israeli Hebrew and Arabic-speaking mathematics teachers will enrich understandings of the effects of national and cultural factors. In light of the strong equity component in the national curriculum for mathematics in Australia currently being developed (see National...
Curriculum Board, nd), the findings of the proposed study are likely to have implications for pre-service mathematics teacher education programs in Israel and in Australia and for the professional development of practising mathematics teachers.

4.7 References


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6. פורוט הבקשה לתקציב

6.1 פורוט לכלל הבקשה לתקצאת שיעות:

* ש"ש

 theological

6.1.1 

* ש"ש

6.2 פורוט הבקשה לתקציב משלי:

6.2.1

6.2.2

6.2.2.1

| הפריט | סיה' כמות | מניה
|---------|-----------|--------|
| זריך פריט | ידה ביד | סכום
| גבעת זריך פריט + טלפונים | בتكون
| ברכנות טלפונים | בברך

6.2.2.2

| הפריט冒险 | סיה' conoscw | מניה
|---------|-----------|--------|
| שוכפל שאלונות | ידה ש"ש | ע"ש
| הלם | ש"ש

6.2.2.3

| הפריט冒险 | סיה' conoscw | מניה
|---------|-----------|--------|
| ע"ש מחקר, לאיסוף | ידה ש"ש | לAtlטס
| התרומת על ידי חלוץ | שאלונות
| שאלונות בכיתות בצ"ש | לAtlטס

| הפריטAdventure | סיה' conoscw | מניה
|---------|-----------|--------|
| חלוץ התרומת | ידה ש"ש | לAtlטס
| התרומת הפרטים | ש"ש

| הפריטAdventure | סיה' conoscw | מניה
|---------|-----------|--------|
| מדריך | ידה ש"ש | לAtlטס
| לברית | ש"ש

| הפריטAdventure | סיה' conoscw | מניה
|---------|-----------|--------|
| בברך | ידה ש"ש | LAtlטס
| ש"ש | LAtlטס

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