Educ Stud Math (2017) 94:55–68
DOI 10.1007/s10649-016-9712-9

Mathematics education in Lebanon: gender differences in attitudes and achievement

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Published online: 13 June 2016

Abstract The purpose of this study was to investigate gender differences in students' mathematics achievement and in their attitudes toward mathematics. Another purpose was to examine mathematics teachers' beliefs and their perceptions of their male and female students' ability. The sample consisted of 692 students (353 girls, 339 boys) between the ages of 12 and 16 years, enrolled in grades 7–9 at four private schools in Lebanon. Data were collected using the Attitudes Toward Mathematics (ATM) scale (Aiken in *Journal for Research in Mathematics Education*, *5*, 67–71, 1974), school records, and interviews with teachers. Results showed no significant gender differences in either achievement or attitudes toward mathematics, thus dispelling the common belief that female students in traditional cultures do not perform well in mathematics and dislike the field. A main effect for grade level was found with ninth graders significantly outperforming their younger counterparts. Also, teachers viewed mathematics as a male domain and attributed boys' success to ability and girls' success to effort. They also interacted with boys more frequently regardless of the nature of the exchange. Implications for future research and for instructional practice are overviewed.

Keywords Mathematics education · Gender differences · Adolescence

Gender differences in mathematics education is a topic much debated in the literature (Fennema, Peterson, Carpenter, & Lubinski, 1990; Hanna, 2003; Stoet & Geary, 2013; Villalobos, 2009). As Halpern (2012) stated, "The topic is probably as old as humankind and as new as this morning's news" (p. 2). Recent studies have shown a narrowing of the gender gap in mathematics achievement, but such differences still exist among students, mostly at the high school level (Georgiou, Stavrinides, & Kalavana, 2007; Preckel, Goetz,

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Pekrun, & Kleine, 2008; Tapia & Marsh, 2004, Tsui, 2007). Students' attitudes toward mathematics were also studied at length, as their effect on learning and performance is well documented (Brandell & Staberg, 2008; Heilbronner, 2013). Hamzeh (2009) argued that the reason males outperform females in mathematics is due largely to males having a better attitude toward mathematics rather than a better aptitude in mathematics.

In Lebanon, a small country in the Middle East where this study took place, the field of mathematics is still considered a male domain (Sarouphim, 2010). The Lebanese context of this study is significant for two reasons. First, there is a lack of literature on gender differences in mathematics and, secondly, the Lebanese culture remains fairly traditional with prevailing patriarchal values. Lebanon still suffers from gender discrimination in many areas, particularly in choice of schooling tracks and career orientation (Ayyash-Abdo, Bahous, & Nabhani, 2009; Sarouphim, 2009). Thus, this study highlights a controversial issue in a male-dominated field in the context of a male-dominated culture.

As stated, research on gender differences in mathematics in Lebanon is scarce. The few studies conducted on this topic demonstrated that boys outperform girls slightly but not significantly in elementary and middle school (Hassan, 2001). But in other studies in the West, gender differences started appearing in middle school and were accentuated in high school (Tapia & Marsh, 2004). Hence, the focus of this study was on 12- to 16-year-old students in middle school or what is called "the intermediate cycle" in the Lebanese schooling system (grades 7, 8, and 9) where gender differences are emergent.

The purpose of this study was to examine gender differences in mathematics education in relation to students' achievement and attitudes toward this subject matter. Another purpose was to investigate mathematics teachers' gender-related beliefs and classroom behaviors. Questions that guided the study were:

1. Do significant gender differences exist in the mathematics achievement of middle school Lebanese students?
2. Do gender differences exist in the students' attitudes toward mathematics?
3. What are the teachers' beliefs concerning the characteristics, abilities, and mathematics performance of their male and female students?
4. Do mathematics teachers show differential behavior in the classroom with male and female students?

1 Lebanon's cultural and educational influences

Given that this investigation took place in Lebanon, it is critical to understand this cultural and educational context. Lebanon's population is about 4 million, mostly Christians and Muslims, although about 19 officially recognized sects exist in the country (Ayyash-Abdo et al., 2009). Arabic is the official language and is taught in schools, but strong Western influences have impacted significantly all aspects of Lebanese life (Zouein, 2003).

The Lebanese society is patriarchal in nature; thus, gender inequalities prevail, especially in relation to social and cultural norms (Ayyash-Abdo, 2007; Sarouphim, 2015). For example, girls are expected to preserve the family's honor by remaining virgins until marriage and men are expected to be providers for their family. Surprisingly, no gender differences exist in the access to basic school education. According to national reports, 98.1 % of boys and 98.4 % of

girls are enrolled in primary schools (United Nations, 2001), and at the high school and university levels, the ratio is 40 males to 44 females (World Bank, 2002). Thus, although social gender inequality is remarkably prevalent in Lebanon, it is surprisingly lacking in the areas of schooling and higher education.

Lebanon has the highest literacy rates, highest percentage of females in the work force, and the best universities in the Arab world (Ayyash-Abdo et al., 2009). Being educated and having a college degree are of great importance to the Lebanese population. Thus, Lebanese parents consider providing an education for their children regardless of gender one of their utmost priorities. In public schools, educational access is free, but the quality of that education is poor compared to that of private schools. Public schools in Lebanon cater to students from low socioeconomic status and parents who can afford high tuition fees would rather send their children to private schools, as these have higher rates of student success on national and university entrance examinations (Bahous & Nabhani, 2008).

Schools in Lebanon follow a lock-step system, with grade levels extending from K-13. Upon successful completion of the ninth grade, students must choose to follow one of four possible tracks: mathematics, natural sciences, economics, and philosophy (Ayyash-Abdo et al., 2009). These tracks are fundamental and preset the student's choice of a college major. Thus, students who choose to follow the mathematics track at school will usually study engineering or mathematics in college. Similarly, students who choose the natural sciences track will typically study biology and medicine, and those in the Economics track will choose business as their major in college. Finally, students in the Philosophy track will end up selecting a major in the social sciences. Marked gender differences exist in the choice of these tracks. Specifically, only 34 % of the students who choose either the mathematics or the natural sciences are females. By comparison, the overwhelming majority of students (68 %) who choose the Philosophy track are females (United Nations Economic and Social Commission for Western Asia, 2002). Thus, the fields of mathematics, science, engineering, and technology (STEM) are considerably more dominated by males in Lebanon, and high achievement in the mathematics and science subject matters at school is associated with a masculine label (Sarouphim, 2009, 2011).

2 Mathematics achievement

Given that this study examines gender differences in mathematics, a review of the literature on how scholars and researchers have addressed this issue as well as their pertinent conclusions is warranted.

Theories explaining gender differences in mathematics have focused on either biological influences or sociocultural factors. The one conclusion that these theories concur on is that no simple answers exist to the complex questions raised by these differences. On the one hand, researchers who have investigated the biological aspect of this debate attribute the differences to genetic and innate factors, such as hormonal and brain pathway connections (Ingalhalikar et al., 2014). But on the other hand, researchers focused on the social and cultural factors have examined the environmental influences on the boys' and girls' performance in mathematics and their attitudes toward this subject matter. Their findings showed a multitude of factors, all attributed to social, cultural, and behavioral influences (Halpern, 2012). Similarly, Hoffman, Gneezy, and List (2011) found that spatial ability gender differences appear in patrilineal, but

not matrilineal, societies, thus attributing these differences to cultural and not genetic influences. The debate is ongoing and is not expected to be resolved any time soon.

Compatible with the theories, research on gender differences in mathematics achievement has yielded mixed findings. For example, in the TIMSS study conducted in 2007, significant gender differences in mathematics achievement were found among eighth graders in 24 out of 47 countries, 8 in favor of boys and 16 in favor of girls. The findings for Lebanon, one of the participating countries, showed that boys outperformed girls by a large and statistically significant margin (Gonzales, Williams, Jocelyn, Roey, Kastberg, & Brenwald, 2008). These results were surprising given that one of the largest studies in Lebanon (Hassan, 2001) has yielded opposite findings. In that study, the sample consisted of 7059 third graders and 3788 seventh graders who represented almost 10 % of the Lebanese population for each age group. The results did not show any significant gender differences in the overall achievement of boys and girls in mathematics in both third and seventh grades.

One explanation for the discrepancy found between the TIMSS study and that of Hassan (2001) might be related to the grade levels investigated. In Hassan's (2001) study, the sample consisted of students in third and seventh grades, whereas the sample in the TIMSS study included eighth graders. Typically, gender differences do not appear in elementary grades, but rather in middle and high school, possibly because the mathematical content in higher grades becomes more complex and abstract (Leahy & Guo, 2001; Lindberg, Hyde, Petersen, & Linn, 2010). However, these differences are not universal. For example, in a large comparative study, Tsui (2007) did not find significant differences in the mathematics achievement of eighth graders in either China or the USA. Moreover, Hyde (2005) cautioned against exaggerating such differences, as they are not consistent with scientific data.

Traditionally, the gender gap in mathematics achievement signified that males outperformed females. However, this is not the case in many countries, including Arabic-speaking countries in the Middle East. In fact, findings from TIMMS 2007 revealed that the largest achievement differences favoring girls were in Middle Eastern countries, including Qatar, Oman, Kuwait, Jordan, and Bahrain (as cited in Forgasz, Leder, & Tan, 2014). Similarly, recent studies in the West are showing a slight superiority of girls in mathematics achievement (Gherasim, Butnaru, & Mairean, 2013; Robinson & Lubinski, 2011).

3 Attitudes toward mathematics

Students' attitudes toward mathematics is another topic that has been widely investigated. Earlier research has revealed that mathematics teachers give more attention to male students and believe that they have higher ability than their female counterparts (Fennema et al., 1990). It is presumed, therefore, that these differential behaviors and beliefs are in turn internalized by the students and consequently reflect on their mathematics achievement scores as well as their attitudes toward mathematics (Li, 1999). Similar results were obtained in more recent research. For example, Cai, Luo, Shi, Liu, and Yang (2016) found that the gender-science stereotype (the belief that men are more talented and interested in science and mathematics fields) still exists among young adults with a significant magnitude, leading to a persistent and continuous underrepresentation of women in many STEM fields (Nosek et al., 2009; Weis et al., 2015).

Along the same lines, in a study by Brandell and Staberg (2008), the question posed was "Mathematics: a female, male or gender-neutral domain?" This question was answered with data from 1300 Swedish 15- and 17-year-olds. The results showed that mathematics was

viewed mostly as a male domain. This view was stronger among boys, especially those enrolled in science programs. Success, interest, and importance of mathematics for the future were viewed as male traits. Girls' success was perceived to be the result of diligent hard work. Similarly, Heilbronner (2013) found that both mathematics and science were considered to be male domains by both adolescent males and females.

Surprisingly, different results were obtained in Lebanon. Hamzeh (2009) assessed students' and mathematics teachers' attitudes toward mathematics. The sample consisted of 132 seventh, eighth, and ninth graders from two different private schools in Lebanon. The results showed that students generally had positive attitudes toward mathematics and no significant gender differences existed in these attitudes. A significant and strong positive correlation ($r = 0.76$) was found between students' attitudes toward mathematics and their attitudes toward their mathematics teachers. Also, teachers perceived their students as having favorable attitudes toward mathematics and toward their mathematics teachers in general. However, this study included a small sample and further research on larger and more representative samples of students in Lebanon needs to be conducted before solid conclusions could be drawn.

4 Teachers' beliefs and perceptions

Teachers' beliefs and perceptions affect their behavior and influence their classroom instruction, as shown in an extensive meta-analysis of 50 articles on the topic (Li, 1999), revealing that teachers from different parts of the world generally perceive mathematics as a male domain. The analysis also showed that teachers tend to overrate boys' mathematics ability and to have higher expectations for them and a more positive attitude toward them in general. These biased beliefs are, in turn, recognized by students who tend to act accordingly and develop gender-biased views of their own abilities and those of the opposite sex.

Teachers' perceptions were also investigated in a seminal study conducted by Fennema et al. (1990). Thirty-eight third grade female teachers were interviewed to assess their attributions of success and failure of their male and female students. The results showed that teachers attributed boys' success to ability and intrinsic motivation and girls' success mostly to effort. The boys' failure was attributed to lack of effort and lack of teacher help and girls' failure to lack of effort and task difficulty. Teachers described successful boys as competitive, enjoying mathematics, and highly independent. Girls were described in terms of similar characteristics but in lower ratings.

Opposite results were found in a more recent study by Helwig and colleagues (2001). In this study, 15 third grade teachers and 14 fifth grade teachers from a US Midwestern state rated the skill level and classroom behavior of their students. The results showed that teachers disregarded gender when rating the mathematical skills of their students. Rather, they relied mostly on test scores and their perceptions of students' effort.

In sum, research on gender differences in mathematics has yielded mixed results. On the one hand, evidence seems to indicate that the gender gap is closing, but on the other hand, recent research is still revealing differences in the mathematics performance of boys and girls. As Forgasz et al. (2014) concluded, "…after more than four decades of research on gender and mathematics, there is only limited consensus on the size and direction of gender differences in performance in mathematics" (p. 171).

5 Method

5.1 Participants

The sample of this study consisted of 692 students enrolled in grades 7 ($n = 244$), 8 ($n = 258$), and 9 ($n = 190$) at four private schools in Lebanon. The schools cater to students from middle socioeconomic class, as evidenced by their location and tuition fees. No attempt at sampling was made, as all students in the four middle schools (grades 7–9) were included in the study. The sample was purposive and the schools were selected based on ease of access and location. It was not possible to include students from public schools in the sample because the authors were unable to secure a permission from the Ministry of Education to access these schools. Thus, the sample consisted of 353 girls and 339 boys (106 boys and 138 girls in grade 7; 142 boys and 116 girls in grade 8; 91 boys and 99 girls in grade 9) with an age range of 12 to 16 years (mean = 13.8, SD = 3.9), enrolled in 24 different classes. Parental consent was obtained through signed letters sent home with the students.

In addition, the 12 mathematics teachers (eight females and four males) who taught the participants also took part in this study. All teachers were interviewed outside of class hours. Each teacher taught an average of two classes, resulting in a total of 24 interviews. The teachers' overall work experience in teaching mathematics ranged from 6 to 15 years.

5.2 Instruments

Students' school grades in mathematics for the academic years 2009–2010 and 2010–2011 were used as achievement data. In Lebanon, standardized tests do not exist and all achievement data are based solely on school records.

Students' attitudes toward mathematics were measured using the Attitude Toward Mathematics Scale (ATM) developed by Aiken (1974). This instrument was selected based on its simplicity and brevity, as well as its high technical adequacy (Chapman, 2003). The more popular Fennema-Sherman Mathematics Attitudes Scales (FSMAS) (Fennema & Sherman, 1976) was considered for use in this study, but its length of nine subscales comprising 108 items that require 45 min to complete was a deterrent, as schools where data were collected did not allow class disruption for such an extended time. Also, the validity, reliability, and integrity of the FSMAS scores have been questioned (Tapia & Marsh, 2004).

The ATM is a five-level Likert-type scale designed to measure two subscales of ten items each, students' enjoyment of mathematics (E) and the value they attribute to mathematics (V). Items assessing the first subscale (E) address the following domains: enjoyment of mathematics, developing mathematical skills, stress related to mathematics, extending mathematical knowledge, and emotions toward mathematics. Items of the value of mathematics subscale were grouped into three domains which are (a) importance of mathematics as a subject, (b) interest in mathematics, and (c) implications of mathematics outside the classroom. Internal reliability as measured by coefficient alpha was .95 and .85 for (E) and (V), respectively.

Teachers' beliefs were assessed using a two-part attribution interview developed by Fennema et al. (1990). In the first part, the teachers were asked to nominate the two most successful (MS) and the two least successful (LS) students in their class. Next, they were asked to identify the causes of success and failure of these students from a list (e.g., intrinsic motivation, high ability). In the second part of the interview, teachers were presented with a

list of attributes (e.g., active, independent, effortful) from which they had to select those that best characterized the female and male students they had nominated as MS.

A checklist developed by the researchers was used for classroom observations. The checklist was based on relevant literature concerning mathematics teachers' behaviors with male and female students, such as interactions denoting praise, reprimands, calling on a student to answer a question, and giving one-on-one instructions (Merrett & Wheldall, 1992; Myhill, 2002; Patrick, Turner, Meyer, & Midgley, 2003; Turner, Meyer, Anderman, Midgley, Gheen, Kang, & Patrick, 2002). Observers were instructed to record occurrences of behaviors only (rather than possible interpretation of these behaviors) and to note whether the interactions took place between the teacher and a male or a female student. According to Hoepfl (1997), observations lead to deeper understandings than interviews alone, as they shed light on the context in which events happen, and may lead to revealing realities that participants themselves are not aware of or are unwilling to disclose. Thus, this additional source of data had the purpose of identifying and quantifying the mathematics teachers' behaviors with students in the classroom for supplemental evidence to support or refute data from interviews.

5.3 Procedure

After obtaining the principals' permission to collect data at their schools, the researchers met separately with each of the participating teachers and informed them of the purpose of the study. All teachers gave their consent for classroom access and for being interviewed.

The questionnaires were distributed to students during periods other than the mathematics period so that the students would have complete freedom to express their opinions in the absence of their mathematics teacher. Two 50-min classroom observations took place in each participating classroom, resulting in a total of 48 classroom observations. For interrater reliability, two observers were present at all times during each classroom observation.

5.4 Data analysis

Data pertaining to the ATM scale (students' attitudes toward mathematics) were analyzed using SPSS. Each student received one total score (full-scale) representing overall attitudes toward mathematics. Students' full-scale scores ranged between −48 and +48, where −48 corresponded to the most negative attitude and +48 to the most positive attitude.

To assess gender differences, a $2 \times 3 \times 2$ MANOVA (gender × grade level × mathematics scores), and a follow-up 3×2 ANOVA (grade level × gender) were performed.

The teachers' interviews were analyzed in three phases. In the first phase, the teachers' nominations of the two MS students and the two LS students were compared to the students' mathematics school grades to determine the accuracy of the teachers' selections. Secondly, the reasons to which the teachers attributed these students' success and failure were identified. In the third and last phase, the characteristics attributed by the teachers to the most successful male students were compared to those used to describe the most successful female students.

Observation checklists were analyzed in three phases as well. At first, the number of interactions that occurred between the teacher and students were computed and classified according to the nature of the interaction. Next, a chi-square was performed to assess gender differences in these interactions. Finally, Cohen's Kappa correlation coefficient was calculated to determine the classroom observers' interrater reliability.

6 Results

6.1 Gender differences in Students' mathematics achievement and their attitudes toward mathematics

As shown in Table 1, students' mean scores in mathematics were moderately high and ranged between 11.92 and 15.01 (in the Lebanese schooling system, students' scores range between 0 and 20). The differences between the mathematics scores of boys and girls in all grades were negligible. Similar results were obtained for students' attitudes toward mathematic (see Table 2). The participants in all grade levels had scores corresponding to moderately positive attitudes toward mathematics, with ninth graders having the most positive attitudes ($\bar{x} = 18.07$ for boys and 16.71 for girls).

The MANOVA showed no significant interaction effect by the Wilk's Lambda Criterion between gender and grade level for either achievement or attitudes toward mathematics, $F([2, 383] = 0.295$, $p = 0.745$. No significant effect for gender was found either $F([2383] = 0.01$, $p = 0.99$. Compatible with the literature, the results revealed a significant main effect for grade $F([4, 212] = 5.65$, $p = 0.01$. Post hoc univariate analysis showed that ninth graders outperformed seventh and eighth graders $F([2, 179] = 3.95$, $p = 0.04$, with an effect size of 0.69 (see Table 3).

6.2 Teachers' beliefs

Interviews with teachers showed that they nominated 26 boys and 22 girls as their MS students. Based on the students' mathematics grades, the teachers were accurate 46 out of 48 times. The inaccuracy applied to nominating two boys as most successful when in fact their mathematics scores did not match the nominations. Similarly, the teachers were accurate 46 out of 48 times for their nomination of the LS students, 28 girls and 20 boys. Again, the teachers' inaccuracy applied to nominating two girls as the least successful, when in fact their mathematics grades reflected otherwise.

The results also showed that teachers attributed the boys' success mostly to high ability and intrinsic motivation and girls' success to effort and help received from the teacher (see Table 4). On the other hand, the girls' failure was attributed to low ability, and the boys' failure to lack of effort and intrinsic motivation (see Table 5).

Moreover, the teachers used the following characteristics to describe their MS male student: independent, active, competitive, logical, direct, adventurous, makes decisions easily, self-confident, volunteers to answer questions, enjoys mathematics, and persists on hard tasks. Few differences were found in the traits that teachers chose to describe their MS female students.

Table 1 Students' achievement in mathematics

	Grade 7		Grade 8		Grade 9		Total	
	Male	Female	Male	Female	Male	Female	Male	Female
Mean[a]	12.82	12.12	11.92	12.32	15.01	14.81	13.25	13.08
SD	3.91	3.58	3.74	3.62	6.31	8.10	4.65	5.1

[a] Score range is 0–20

Table 2 Students' attitudes toward mathematics

	Grade 7		Grade 8		Grade 9		Total	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Male	14.76	5.54	14.97	2.32	18.07	7.72	15.93	5.19
Female	14.34	5.29	13.6	3.1	16.71	6.11	14.88	4.83
Total	14.55	5.41	14.28.	2.71	17.39	6.91	15.40	5.01

−48 to −30, negative attitude; −29 to −10, moderately negative attitude; −9 to +9, neutral attitude; +10 to +29, moderately positive attitude; +30 and +48, positive attitude

However, in one instance when asked whether being adventurous was a characteristic of MS girls, one teacher answered "Adventurous!? No, that's only for boys!"

6.3 Teachers' behaviors

Classroom observations showed significant differences in the number of interactions that the teachers had with male students and female students χ^2 (2, 234) = 4.35, $p = 0.02$. In view of the frequencies (Table 6), teachers interacted with male students about twice as often as they did with female students (331 incidences of interaction with boys as opposed to 178 with girls), regardless of the nature of the interaction. The highest frequencies were in the areas of "reprimands" (96 given to boys and 41 to girls), and the lowest were in "one-on-one instructions" given to boys (29 incidences) and to girls (23 incidences). For interrater reliability, Cohen's Kappa correlation coefficient yielded a value of 0.92, indicating high agreement among observers concerning the nature and frequency of teachers' behavior in the classroom.

7 Discussion

The purpose of this study was to examine gender differences in mathematics education among a sample of 692 middle school students in Lebanon. The results failed to reveal significant gender differences in either students' mathematics achievement or their attitudes toward mathematics. The results also showed that the teachers gave twice as much attention to boys and attributed their male students' success in mathematics to high ability and their female students' success to high effort.

Table 3 Post hoc ANOVA (gender by grade level) for students' achievement in mathematics

Source	*df*	MS	*F*	*P*
Gender	1	23.987	0.090	0.912
Grade	2	16.346	3.95	0.049
Gender by Grade	2	4.828	0.295	0.745
Error	179	16.368		

Table 4 Frequencies of teachers' attributions of success by gender

	Attributions of success					
	N	High ability	High effort	Intrinsic motivation	Help from others	Good luck
Male	26	24	2	26	8	1
Female	22	4	18	13	19	4

7.1 Gender differences in mathematics achievement and attitudes toward mathematics

The results of this study showed that both boys and girls had moderately positive attitudes toward mathematics, with no significant gender differences. These findings are consistent with previous research (Georgiou et al., 2007; Hamzeh, 2009) and dispel a common myth among the Lebanese about the dislike for mathematics on the part of female students. Given that Lebanon is a fairly traditional culture, these findings might indicate that girls' attitudes toward mathematics are not as negative as is commonly believed in patriarchal societies. One recommendation that stems from this study is that future research must address this issue in larger samples, not only in Lebanon but also in the other Arab countries where traditional values are even more predominant (Zouein, 2003). Another recommendation is that mathematics teachers need to be made aware of this prevalent and false notion concerning girls' dislike of mathematics and give them equal attention, so that these young female students can thrive and perform at their best in this traditionally male-dominated field.

Although mathematics is seen as a male domain in Lebanon, the results of this study did not reveal significant gender differences in mathematic achievement. One explanation might be related to the changing educational status of women in Lebanon (ESCWA, 2002). Thus, the lack of gender differences in mathematics achievement in Lebanon could be attributed to a growing awareness among female students of the importance of studying mathematics in preparation for a prospective career in the STEM fields. In future research, examining gender differences in college majors as well as in the choice of careers among females in Lebanon would shed light on whether the narrowing of the gender gap in mathematics education is also occurring in the Lebanese context.

Table 5 Frequencies of teachers' attributions of students' failure by gender

	Attributions of failure					
	N	Low ability	Low effort	Lack of intrinsic motivation	Lack of help from others	Bad luck
Male	20	3	17	18	5	–
Female	28	22	6	26	6	–

Table 6 Frequency of teachers' behavior occurrences in the classroom

Teachers' behavior	Boy	Girl
Praise	65	30
Reprimand	96	41
Calls on…to answer a question	56	33
Calls on….to solve a problem on the board	39	26
Clarifies a point to a…	46	25
Gives one-on-one instructions to…	29	23
Total	331	178

7.2 Teachers' beliefs and behaviors

The results of this study were compatible with previous research (Fennema et al., 1990; Li, 1999; Tiedemann, 2000) and showed that teachers attributed boys' success mostly to ability and girls' success to effort, whereas the boys' failure was attributed to low effort and the girls' failure to low ability. These findings were not surprising, considering that the Lebanese society is patriarchal in nature. Thus, schoolteachers in this study were only reflecting the general beliefs that people in Lebanon have about mathematics being a male domain and males having higher innate ability in mathematics.

Although research findings have established that teachers' beliefs impact students' achievement and attitudes toward the subject matter they teach (Helwig, Anderson, & Tindal, 2001; Li, 1999), findings from this study did not reveal such a pattern. Female participants in this study had mostly positive attitudes toward mathematics as well as moderately high achievement, although their mathematics teachers perceived mathematics as a male domain and gave more attention to male students. The results showed that most of the attention given to male students was in the form of reprimands (see Table 6), a finding compatible with the literature (Beaman, Wheldall, & Kemp, 2006; Kelly, 1988); but these findings must be interpreted with caution as further research is needed to investigate the relation between reprimands and learning. For example, does the context in which the reprimands are delivered play a role? That is, could reprimands be useful to learning if they are given following low performance rather than a discipline problem? Also, further investigation is needed to assess students' perceptions of reprimands and their interpretation of the teacher's motive in delivering reprimands. Similarly, these findings highlight the need to examine the effect and size of teachers' beliefs and expectations on students' learning, as well as the impact of teachers' behavior on students' performance.

7.3 Limitations

One limitation of this study that cannot be ignored is the lack of standardized achievement data. The sole reliance on school grades to measure mathematics achievement might have biased the results, as the process of grading students' performance may fluctuate from one teacher to the next. Different results could have been obtained had standardized test scores been used. Therefore, in the absence of this kind of data in the country, the results of this study should be interpreted with caution. Despite this limitation, the findings are useful and shed light on a highly controversial and under-investigated topic in traditional societies. School

grades do constitute a valuable indicator of students' overall achievement since they are used as the chief index for students' grade promotion or retention in Lebanon. They also provide some insight into the current state of mathematics education in the country with regard to gender differences. On the other hand, for the analysis of teachers' perceptions, using school grades for achievement data does not constitute a major obstacle given that the students were not compared across grades, but rather a general view of students as high or low achievers was required in order to determine the existence or absence of differences in gender perceptions by the teachers.

Another limitation is the non-representativeness of the sample. A sample that includes students from both private and public schools would have drawn a more accurate picture of gender differences in mathematics education in Lebanon. However, the results are of value although limited to private education, and they pave the way for further research involving larger and more representative samples on the national and regional levels.

7.4 Future directions

This study contributed to the literature by challenging a widespread belief about the existence of a large gender gap in mathematics achievement among Lebanese students (Gonzales et al., 2008). The results showed that male and female students' mathematics achievement was equally high and that their attitudes toward this subject matter were equally positive as well. Further research is needed to examine whether these results would hold for larger groups of students, from different socioeconomic status, and across different regions in Lebanon, as well as in other traditional cultures.

Another recommendation is about investigating the reasons that mediate the positive attitudes that students in this sample were found to have toward mathematics. Identifying factors that promote positive attitudes could lead teachers to capitalize on these specific areas and create classroom environments that foster students' liking and appreciation of mathematics. Thus, future research must focus on determining the relation between classroom climate and school ecology on one hand and students' positive affect toward mathematics on the other.

In sum, this study has highlighted a topic much investigated in the Western literature but barely addressed in the Arab world. The results expand the pool of research by adding evidence that support the recent trends of a narrowing of the gender gap in mathematics education. This is significant given the prevalent belief that females in traditional societies have negative attitudes toward mathematics and do not achieve as well as males in this field. The results of this study provide empirical evidence to the contrary, paving the way to further research on this topic and inciting changes in practice to promote equity among the genders in mathematics education.

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