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A CROSS COMMUNITY STUDY OF MATHEMATICS ANXIETY BETWEEN THE HIGH SCHOOL STUDENTS IN ILLINOIS USA AND JORDAN

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ABSTRACT

The purpose of the study is to examine whether there are any significant differences in the mathematics anxiety levels between high school students in Jordan and their counterparts in the United States. Another purpose is to examine whether there are gender differences related to mathematics anxiety among high school students of both communities. A total of 1,386 high school students in the United States and Jordan participated in main study. This study showed that Jordanian high school students exhibited a significantly higher mathematics anxiety than United States high school students. Furthermore, the study revealed that female high school students in the United States acquired a significantly higher mathematics anxiety level than males. Another finding of this study was that males in Jordan had a significantly higher level of mathematics anxiety than males in the United States. The findings and educational implications of the study are discussed in light of the cultural difference between the two communities.

Keywords: *Mathematics, gender, anxiety*

INTRODUCTION

Mathematics anxiety is defined as "feelings of tension and anxiety that interfere with the manipulation of mathematical problems in a wide variety of ordinary life and academic situations" (Richardson and Suinn, 1972:551).

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It can result from a variety of different sources, including environmental, intellectual, and personality factors (Frankenstein, 1984; Newstead, 1998; Trujillo & Hadfield, 1999; Vinson, 2001; Preises & Biggs, 2001; Woodard, 2004). Many researchers believe that mathematics anxiety can lead to a decline in mathematics performance, avoidance of mathematics courses, and limitation regarding future careers (Richardson & Suinn, 1972; Betz, 1978; Brush, 1978; Hendel, 1980; Powers, 1984; Tobias, 1978; Ma, 2004). In today's high-tech world, it is critical for mathematics educators of any nation to promote students' confidence in mathematics and reduce their mathematics anxiety in order to help them solve problems and understand mathematical concepts. Reducing students' anxiety towards mathematics is critical for their future success in today's high-tech competitive global world that relies heavily on mathematics, technology and science. Furthermore, reducing mathematics anxiety in the young generation of students of any nation might contribute to the nation's economy and overall success in the global world.

SIGNIFICANCE OF THE STUDY

According to Valverde (2005), large-scale cross-cultural studies of education have rarely included countries from the Middle East as their participants. This study is the first to compare and contrast the mathematics anxiety levels of high school students in Jordan and the United States. Furthermore, factors related to mathematics achievement, including students' attitudes and anxiety toward mathematics, have been ignored in the Arab societies including Jordan (Alkhateeb, 2001; Hammouri, 2004). This study sheds light on this issue among Jordanian high school students. In the same vein, gender related differences in mathematics achievement and mathematics anxiety among students in Arab societies has also received little attention (Alkhateeb, 2001). Therefore, this study investigates how the results for Jordanian students compared to those of the United States students.

Most research findings conducted in the United States link anxiety towards mathematics to achievement in mathematics (Hembree, 1990; Ma, 1999b; Norwood, 1994; Vinson, 2001). Besides, most findings show that females in the U.S. exhibit higher levels of mathematics anxiety than males (Benbow & Stanley, 1980; Bernstein, Reilly & Cote-Bonanno, 1992;

Betz, 1978; Brush, 1978; Cooper & Robinson, 1989; Hembree, 1990; Hunt, 1985; Richardson & Suinn 1972). Social reasons, including stereotyping mathematics as a male domain, contribute to increasing female students' anxiety towards mathematics in the United States. This study examines gender differences in mathematics anxiety of high school students in both countries in light of the cultural and educational differences in Jordan and the United States. The differences between the United States and Arab cultures are obvious in terms of religion and tradition.

Thus this study investigates the differences in the school systems, education and cultural differences in the two countries. For example, in Jordan, public schools are single-sex schools and, therefore, girls are not consistently compared to boys by teachers as is the case in the United States (Sadker & Sadker, 1994). Furthermore, girls in Arab societies have more indoor activities than boys, and hence might spend more time studying than the Arab boys. This study could help United States educators increase their understanding and knowledge of Jordan's educational culture in general, and high school students' mathematics anxiety, in particular. In addition, it might highlight the effect of single-sex schools on students' mathematics anxiety towards mathematics. The issue of single-sex education is a controversial topic among the United States educators (Haag, 2000; Monaco & Gaier, 1992; Riordan, 1990; Sadker & Sadker, 1994; Streitmatter, 1998). This study might provide some answers as to whether or not there are any benefits to single-sex classrooms on reducing students' mathematics anxiety level.

LITERATURE REVIEW

Research conducted in the United States has shown that mathematics anxiety is significantly related to several variables, such as gender, performance, age, race, and the quality of teaching (Newstead, 1998; Woodard, 2004). In general, most research studies reveal that there are gender differences related to mathematics anxiety among high school and college students, with females exhibiting higher levels than males (Benbow & Stanley, 1980; Bernstein, Reilly & Cote-Bonanno, 1992; Betz, 1978; Brush, 1978; Cooper & Robinson, 1989; Hembree, 1990; Hunt, 1985; Richardson & Suinn 1972). In contrast, in early grades most studies show that there are no significant gender differences in mathematics anxiety (Gierl & Bisanz,

1995; Woodard, 2004). Around the seventh grade, females begin to doubt their ability to do mathematics and they exhibit more mathematics anxiety in secondary school and in college than males (Birenbaum & Kraemer, 1995; Hembree, 1990; Woodard, 2004; Zaslavasky, 1994). Levine (1995) raises the question of whether it may be more socially acceptable in the United States for females to exhibit higher mathematics anxiety levels than males.

Mathematics anxiety has been used to explain low mathematics performance by many United States educators (Betz, 1978; Cooper & Robinson, 1991; Frankenstein, 1984; Hembree, 1990; Ma, 2004; Norwood, 1994). Numerous studies conducted show a negative relationship between anxiety towards mathematics and mathematics performance (Green, 1990; Ma, 1999b; Norwood, 1994). Furthermore, the quality of teaching plays an important role in reducing students' mathematics anxiety (Newstead, 1998). For example, several studies show that teaching mathematics through rules and rote memorization increases students' mathematics anxiety levels (McClellan, 1984; Newstead, 1998; NCTM, 2000; Vinson, 2001). Thus, it appears that reducing students' anxiety towards mathematics might contribute towards improving students' performance and understanding of mathematical concepts.

Unfortunately, much of the research done on cross-cultural mathematical studies has not included Arab students among their participants (Valverde, 2005). According to Alkhateeb (2001), gender related to differences in mathematics achievement of students in Arab societies has received little attention. Nevertheless, Alkhateeb selected a random sample of 2,000 high school students in the United Arab Emirates who participated in the National High School General Examination of United Arab Emirates and found that females scored higher in mathematics achievement than males in the last six years. A cross-cultural study conducted by Mittelberg and Lev-Ari (1999) reveals that Arab females reported a much higher level of self-confidence in their ability to do mathematics than Jewish females. Furthermore, data from the Trends in International Mathematics and Science Study (TIMSS) conducted in 2003 reveals that Jordanian females at the eighth grade had significantly higher mathematics achievement than their counterpart Jordanian male counterparts. On the other hand, in the United States, males had significantly higher mathematics achievement than females. In addition, Jordan reported a large percentage (81% of its students) at a high level of

students' valuing mathematics. Whereas in the United States 58 percent of students indicated a high level of valuing mathematics.

RESEARCH QUESTIONS

1. Are there significant differences between the mathematics anxiety levels of high school students in Jordan compared to the mathematics anxiety levels of high school students in the United States?

2. Are there significant differences between the mathematics anxiety levels of the following four groups: female high school students in Jordan, male high school students in Jordan, female high school students in the United States and male high school students in the United States?

SUBJECTS

The subjects of the study were students in grades nine through twelve in both the United States and Jordan. A total of 1,386 high school students in the United States and Jordan participated in main study. However, 48 students in the United States and 53 students in Jordan did not complete all the items in the survey, and hence were considered missing data. Therefore, a total of 1285 students were included in the main study and their data were analyzed. Of those, 604 (47%) students were from the United States and 684 (53%) from Jordan.

INSTRUMENT

The data collection instrument used in this study had two major sections. The first section was a background questionnaire, and the second section included the Mathematics Anxiety Rating Scale for Adolescents (MARS-A). For the American sample, the background questionnaire included three questions about students' gender, grade level, and race. On the other hand, the background questionnaire for the Jordanian sample included questions about students' gender, grade level, and school name.

The following steps were performed before the Arabic version of MARS-A was obtained.

1. A university professor in Linguistics studies, translated MARS-A from English into Arabic.

2. The first draft of the Arabic version of MARS-A was sent to a professional translation center in Jordan, in which they had no knowledge of the text of the original MARS-A, and then the center translated the Arabic version of MARS-A back into English.

3. The researcher communicated with a panel of four experts in the Arabic and English language. The panel studied and compared the original MARS-A, the back-translated version of MARS-A, and the Arabic version of MARS-A

4. The researcher and each one of the experts examined the three versions of MARS-A item by item, and discussed whether the different versions convey the same meaning, taking into consideration the different cultures of Jordan and the United States.

5. The panel of experts decided that the first version of the Arabic MARS-A had some limitations due to some cultural differences between Jordan and the United States. Therefore, several items were modified to accommodate the Arabic culture's sensitivities or differences, and at the same time, maintain the same meaning of the original MARS-A.

RELIABILITY MEASURES

Prior to using the Arabic version of MARS-A, the researcher piloted the instrument and established measures of reliability and validity for the scores of the Arabic version of MARS-A. The researcher estimated the internal consistency of the Arabic MARS using Cronbach's coefficient alpha, in order to examine whether the items are correlated with each other and whether they all measure the same thing (see results of pilot study 1). Second, the researcher estimated the test-retest reliability of the Arabic

MARS-A in order to test the stability of students' responses over time. For that purpose, a group of high school students in Jordan was asked to complete the Arabic MARS-A, and the same group of students was asked to complete the same the instrument after two weeks. The scores obtained from week 1 and week 2, were then correlated using the Pearson product-moment correlation coefficient, in order to correlate students' initial responses to those after two weeks (see results of pilot study 1).

VALIDITY MEASURES

Content validity: The extent to which the content of the measurement reflects the subject matter about which conclusions are to be made (Isaac & Michael, 1995). In this study, the same panel of experts who assisted the researcher in performing the back-translation procedure was asked to review the Arabic version of MARS-A to evaluate whether the Arabic version of MARS-A makes sense to the reader, and was measuring what it was supposed to measure. All the experts decided that the second draft of the Arabic version of MARS-A was comparable to the original version of MARS-A and was an acceptable instrument to measure the mathematics anxiety of high school students in Jordan.

Criterion-related validity: The experimental demonstration that a test is measuring the construct it claims to be measuring (Brown, 2000). This is usually done through the focus on the correlation of the test being validated with some well-respected outside measure (Brown, 2000).

For the purpose of this study, a convenient sample of bilingual high school students in the United Stated and Jordan was selected and asked to complete the original Arabic version of MARS-A, and two weeks later the same group of students was asked again to complete the original version of MARS-A. The students' scores were then correlated using the Pearson product-moment correlation coefficient in order to correlate students' responses to the English MARS-A and those of the Arabic version. This was done to verify that the English and Arabic version of MARS-A were approximately parallel. That is, if students were proficient in both languages and scored approximately the same in both versions, then this suggests that the two versions of MARS-A were approximately equivalent (see pilot study 2).

Pilot Study 1

Fifty high school students in Al-Shamleh High School in Irbid/Jordan participated in the first pilot study. All subjects were females in the 10th grade. For this sample, the Cronbach's alpha (α=0.966) calculated indicated that the Arabic version of MARS-A had a high internal consistency, that is, the items of the scale are all related to each other, and are all measuring the same thing (Devellis, 1991).

This same group of students completed the same instrument after two weeks. Afterwards, the scores of each student on the Arabic version of MARS-A in both Week1 and Week 2 were correlated using the Pearson product-moment correlation coefficient. The results showed that r=0.849 (p<0.001) which indicates a high test-retest reliability and consistency of scores over time (Isaac & Michael, 1995).

Pilot Study 2

The participants of this study were all bilingual (Arabic and English) high school students in Jordan and the United States. Thirty high school students from the Universal High School in Chicago, a private school, of which majority of the students' are from the Middle East, participated in the second pilot study. The students were selected by their school teachers and were fluent in Arabic and English. These students completed the Arabic version of MARS-A. Two weeks later, the same group of students completed the English version of MARS-A. However, only fifteen students completed the English version of MARS-A while three of them didn't respond to all items. Hence, they were not included in the analysis of the second pilot.

Another group of bilingual students were selected from a private school in Irbid/Jordan. Those students were chosen by their teachers and were also fluent in English and Arabic. Most of these students had spent some time in the United States and studied in both the American and Jordanian school systems. Both groups of students completed the Arabic version of MARS-A first and after two weeks completed the original MARS-A. The sum of scores for each student in Week 1 and Week 2 were correlated using the Pearson product-moment correlation coefficient. The results showed

that r=0.898 (p<0.001) indicating that both the Arabic version of MARS-A and the English MARS were highly correlated and hence, were parallel and very much conveying the same meaning.

The main study began directly after the pilot studies by the administration of the Arabic and English Mathematics Anxiety Rating Scale-Adolescences (MARS-A) in Jordan and in the United States.

RESULTS

Part I: Raw Data

The results of this study are based on the participation of 604 high school students in the United States and 684 high school students in Jordan. Table 1 provides some descriptive data for the Jordanian and American sample.

Table 1: Descriptive data for the American sample and the Jordanian Sample

	United States	Jordan
N	604	684
Mean	195.89	213.35
Std Dev	68.27	51.41
Minimum	98	98
Maximum	431	480

Table 1 shows that the mean for the American sample is 195.89, while the mean for the Jordanian sample is 213.35. Table 1 also shows the standard deviations in addition to the minimum and maximum scores for both the American sample and Jordanian sample.

The scores distributed by gender for the American sample are given in Table 2 while the scores distributed by gender for the Jordanian sample is given in Table 3.

Table 2: Descriptive Data Distributed by Gender for the American Sample

	Female	Male
N	336	266
Mean	206.330	181.176
Std Dev	65.780	67.273
Minimum	99.0	98.0
Maximum	431.00	382.0

six students did not indicate their grade level and were excluded.

Table 3: Descriptive data Distributed by Gender for the Jordanian Sample

	Female	Male
N	260	424
Mean	213.77	213.09
Std Dev	55.65	48.71
Minimum	98.0	98.0
Maximum	480.0	362.0

The first research question was answered using an independent samples t-test in order to test for significant mean differences between high school students' mathematics anxiety level in the United States and that in Jordan. In Table 1, we see that the Jordanian sample's mathematics anxiety mean is (M=213.35, SD=51.42), while the American sample's mathematics anxiety mean (M=195.89, SD=68.27). Table 4 provides the t-test of significance for the mathematics anxiety between Jordan and the United States.

Table 4 shows that the mean for the Jordanian sample is significantly higher than that of the American sample (t=5.22, with d.f. 1286, p<.0001) at the 0.05 significance level.

Table 4: Independent Sample t-Test for the Mathematics Anxiety between the United States and Jordan

	N	Mean	t	df	P
United States	604	195.89			
			5.22	1286	<0.0001
Jordan	684	213.35			

$\alpha = 0.05$

The second research question was answered using an analysis of variance to test for significant group differences in the following four groups: males in the American sample (MA), females in the American sample (FA), males in the Jordanian sample (MJ), and females in the Jordanian sample (FJ). The researcher then performed a post hoc analysis using the Scheffe' post hoc criterion for the significance. This procedure was conducted to determine where the significant differences are among the four groups.

In Table 2 we see that the mean for the females in the American sample is (M=206.33, SD=65.78), and the mean for males in the American sample (M=181.176, SD=67.27). On the other hand, in Table 1, the mean for females in the Jordanian sample is (M=213.77, SD=55.65) and the mean for males in the Jordanian sample (M=213.09, SD=48.71).

Table 5 provides the Analysis of Variance for the gender differences in Jordan and the United States. The results for the analysis of variance in Table 5 show that there are significant differences among the four groups: males in the American sample (MA), Females in the American sample (FA), males in the Jordanian sample (MJ), and females in the Jordanian sample (FJ). The ANOVA yields F=18.16 with d.f. 3,1282, p<0.0001 demonstrates a significance at the 0.05 levels.

Table 5: Analysis of Variance for Gender Differences in Jordan and the United States

Variable	N	Mean	F	df	P
MA	266	181.176			
FA	336	206.330			
			18.16	3,1282	<0.0001
MJ	424	213.09			
FJ	260	213.77			

Note: $\alpha = 0.05$
Note: MA stands for males in the American sample, FA stands for females in the American sample, MJ stands for males in the Jordanian sample, FJ stands for females in the Jordanian sample.

Table 6 provides the results for the Scheffe' post hoc procedure for the following four groups: MA, FA, MJ, and FJ. The results of the Scheffe' post hoc procedure reveal that females in the United States scored significantly higher than their counterpart males in the United States (mean difference

= 25.154). In addition, the results reveal that the males in Jordan scored significantly higher than males in the United States (mean difference = 31.213). On the other hand, no significant difference can be seen between the female and the male high school students in Jordan. Further, no significant difference can be seen between the female high school students in Jordan and female high school students in the United States.

Table 6: Results for Scheffe' Post Hoc Procedure

Gender Comparison	Mean Difference	Significant
FJ – MJ	0.676	
FA-MA	25.154	***
FJ-FA	7.461	
MJ-MA	31.213	***
FJ-MA	0.742	
MJ-FA	6.718	

Note: comparisons significant at the 0.05 level are indicated by ***
Note: MA stands for males in the American sample, FA stands for females in the American sample, MJ stands for males in the Jordanian sample, FJ stands for females in the Jordanian sample.

PSYCHOMETRIC DATA

This section includes the results of the reliability measures using Cronbach's coefficient alpha for the American and Jordanian sample.

Cronbach's coefficient alpha is the basic measure of for determining the reliability based on internal consistency (Nunnally, 1967). Table 7 shows the results of Cronbach's alpha for the American and Jordanian samples. Table 7 shows that for the American sample, a total of 604 students, the Cronbach's alpha was found to be 0.9812. While the Jordanian sample, a total of 684 students, the Cronbach's alpha was 0.9593. Both figures demonstrate a high internal consistency reliability of scores for both samples.

Table 7: Cronbach's Alpha for the Jordanian Sample and American sample

Country	N	Alpha
United States	604	0.9812
Jordan	684	0.9593

CONCLUSION

As indicated previously, the study showed that the Jordanian high school students exhibit a significantly higher mathematics anxiety than that of the United States. One possible explanation to this finding is that MARS-A was originally developed to be used with high school students in the United States. Although, MARS with all its different versions including MARS-A being translated into other languages such as Spanish, Japanese and Turkish, the researcher believes that students from different cultures may have different experiences relative to the same items mentioned in the instrument, and hence may respond to the items differently. For example, in the case of translating MARS-A to Arabic, the word "tax" appeared in several items. The high school students in the United States may have experienced paying taxes much more than high school students in Jordan. Although all high school students in Jordan understand the meaning of the word "tax", some may have never experienced paying one, unlike in the United States, for example, buying some items in grocery shops requires one to pay tax. In Jordan, the case is different in which only certain items require tax to be paid.

Thus the researchers believes that the lack of experiences of Jordanian high school students to such situations and others stated in MARS-A may have contributed to their reporting a higher mathematics anxiety than the United States students. In addition, generally, people may tend to be more anxious if they have not experienced something themselves compared to having had experienced it.

Another explanation is that there are some cultural differences between Jordan and the United States. Such differences may contribute to different ways in which students in Jordan express themselves differently from those in the United States. For example, in Jordan, the indication that one does not experience any anxiety or little anxiety when it comes to dealing with mathematics or any other subject, conveys the impression to others that one is not modest. In the Middle Eastern culture, people tend to avoid speaking about themselves for fear of appearing arrogant. On the other hand, they prefer that others talk about them; whereas, in the United States people have a larger tendency to recount their achievements more openly. Such cultural differences may have contributed to why the high school students in Jordan expressed a higher mathematics anxiety than the United States students.

Another explanation is that the educational system in Jordan is totally different from that in the United States. One of these differences is that students in their last year of high school are required to sit for the National High School General Examination (Al-Twjehee), which is a government exam prepared, administered and scored by the Ministry of Education. This exam causes a great deal of anxiety in students since it determines their future career. The score the student earns in that exam will determine their admission to major or any other university in Jordan. For example, being admitted to technical fields courses relies on their mathematics scores. Hence, students in Jordan may be more anxious about mathematics than those in the United States since they may feel that how they fare at mathematics will determine their choice of career.

The study also revealed that the female high school students in the United States had a higher mathematics anxiety than the males. This finding is consistent with many previous research (Benbow & Stanley, 1980; Bernstein, Reilly & Cote-Bonanno, 1992; Betz, 1978; Brush, 1985; Cooper & Robinson, 1989; Hembree, 1990; Hunt, 1985; Richardson & Suinn 1972; Tobias, 1976). The explanation given by most American researchers and educators to this difference is that non-cognitive factors such as stereotyping mathematics as a male domain, contribute to females in the United States acquiring a higher level of mathematics anxiety than the United States males (Tobias, 1976).

Another finding of this study was that there were no significant gender differences with regard to mathematics anxiety in Jordan. A possible explanation is that, in Jordan, public schools are unisex. Therefore, it could be that this aspect of education contributes to reducing females' feelings of mathematics anxiety. In such classrooms, females learn in a gender free atmosphere and could be beneficial to them. However, further research should be conducted before one can generalize to such a conclusion.

Another explanation to this finding is that in Jordan, female students do not feel that they cannot compete with the males at Mathematics, as is the case in the United States. The results of the TIMSS of 2003, in which the Jordanian females scored significantly higher than their males counterparts, support this explanation. As mentioned earlier, research shows that mathematics anxiety is negatively related to mathematics

performance. That is, acquiring high levels of mathematics anxiety causes low mathematics performance, or vice versa. Therefore, it could be that the equal or the higher performance of the Jordanian females in comparison to the males contributes to the lack of significant differences in mathematics anxiety between the female and male students.

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