GENDER DIFFERENCES IN THE MATHEMATICS ACHIEVEMENT OF YEAR 10 STUDENTS IN JORDAN

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Abstract

This study examines potential gender differences in the mathematics achievement of students in Jordan. The data were collected in the 2008/2009 academic year. The student sample consisted of 450 students (220 males and 230 females) at 14 randomly selected schools in the Ma’an Governorate. The results for males and females were compared. The comparison shows that female students outperformed male students on three different mathematics topics out of four, and on the overall mathematics achievement.

1. Introduction

Research on gender differences is one of major interests in the field of research in mathematics education. Among the research on mathematics
education and gender, a great number of studies have been conducted by measuring the mathematics achievement of school students and thus describing the differences of achievement between girls and boys. This area of research has received attention all over the world (e.g., Ai [1], Cox [6], Deborah [8], El Hassan [10], Leonidas and Panayiotis [20], Mubark [27], Uekawa and Lange [35] and Young [36]). In this article, mathematics achievement is taken as a measure of overall performance across those mathematical abilities that are typically necessary to pass comprehensive school examinations successfully. This study focused on the curricular contents of triangles, analytic geometry, probability/statistics and financial mathematics, because these are precisely the mathematical areas covered by the compulsory state administered mathematics textbook for the grade 10 in Jordan.

1.1. The educational system of Jordan

The educational system of Jordan, as those of other Islamic Middle East countries, is based on single sex schooling. Two levels of education structure in the Jordan educational system vertically: basic education at a primary level (6-16 year olds), followed by secondary education at an optional level (16-18 year olds). Schooling in Jordan is free of charge, and it is compulsory for the first 10 years (Ministry of Education [24]). Before 1990, the primary education lasted 9 years. However, in order to increase the students’ achievement rates the primary level was extended to 10 years.

2. Literature Review

The literature on gender differences in mathematical achievement is extensive. A great number of the studies summarize their results by stating that, according to their analyses, boys outperform girls, or girls outperform boys, or that no significant difference could be detected. Of course, these diverging research results can follow from the diverse methodological designs of the various studies. A second explanation lies in the well-documented contextual character of gendered achievement (Keitel [19] and Rogers and Kaiser [30]). The corresponding results of the Trends in
Gender Differences in the Mathematics Achievement …

International Mathematics and Science Study (TIMSS [33]) can be interpreted as an indication for the soundness of the second argument. TIMSS [33] reported that male 8th grade students had higher scores as their female counterparts in mathematics achievement in 11 out of the 49 participating countries; females had higher scores than males in 9 countries; and in 29 countries no significant difference could be observed. In the next round of the TIMSS [34], 8th grade males had higher scores for mathematics achievement than females in only 8 out of 49 participating countries, while female students outperformed male students in 16 countries. Interestingly Jordan was one of the countries, in which the girls’ scores were higher than the boys’ scores.

In addition to large-scale studies, possible gender differences in mathematics achievement have been analyzed by several more contextually confined empirical studies. The results of these studies validate and specify the non-universalistic TIMSS results.

(a) In some studies, mathematics achievement shows to be related to students’ gender in certain areas of mathematics, particularly in the context of post-elementary schooling, with male students slightly outperforming female students (Halpern and LaMay [12] and Hyde et al. [16]). These differences tend to increase with the students’ age/grade (Fennema [11], Hanna [13], Hyde et al. [16] and Marshall [23]). A larger part of the studies that document higher scores for male students has been carried out in the 1980s and 1990s.

(b) Other studies have not found significant relationship between gender and mathematics achievement. For the grades 7-10 in a Californian context, Ai [1] reported no relationship between two groups of high achieving students. Young [36] found in Western Australia that girls and boys in their year 3 and year 7 cohorts had identical mean scores. In a comparative study between Korea and the United States of America, Uekawa and Lange [35] reported no differences between boys’ and girls’ mathematics achievement in year 8 in U.S.A. (based on TIMSS-data), while recording gender differences for Korea. El
Hassan [10] tested the gendered achievement in secondary schools in Lebanon in specific subjects, and found no statistically significant difference between the male students and the female students as long as mathematics achievement is concerned.

A third group of studies identified relationships between mathematics achievement and gender, whether favoring males or females. Leonidas and Panayiotis [20] showed in Cyprus that male students outperformed female students on the hardest items in a mathematics test for 4 different primary school grades. Similar results have been found by others for grade 10 (Young [36]) and for mathematics at senior level (Low and Over [21]). In contrast, other researchers concluded that female students achieve better than male students. For example, Randhawa and Hunt ([29]), investigating the grades 3, 7, and 10 in Canada, reported that females outperformed males in mathematics computation. Leonidas and Panayiotis [20] showed that female students had higher scores than male students on the easiest items of their mathematics test instrument. In U.S.A., Cook [5] also found that females scored higher than males, but only when tested in a single-sex setting. In Jordan, Ministry of Education [25] evaluated the national test data for grade 9 in mathematics. They found that the overall mean test scores for female students were higher than those for male students.

Apparently, no globally coherent picture can be drawn. It seems to be necessary to continue investigating possible gender differences in local settings, in order to better understand the factors that influence mathematical achievement.

This article approaches this problématique by relating female and male students’ mathematics achievement to different school mathematical areas. As in the general literature on gender differences in mathematics achievement, the concerning research results seem to be incoherent. We restricted our review to those mathematics topics that are in the focus of our investigation. These topics are: triangles, analytic geometry, probability/
statistics, and financial mathematics. We exemplarily display the review for the school mathematics area of geometry.

For geometry, El Hassan [10] examined gender differences in mathematics achievement at 13th grade in Lebanon. He found that male students scored higher than female students. Hanna [13] investigated gender differences in mathematics achievement at 8th grade in Ontario, Canada. Her test covered five areas: arithmetic, algebra, geometry, measurement, and probability/statistics. She found that male students show higher scores than the female ones only at the geometry and measurement scales. Huntley et al. [15] conducted another study concerned with gender differences in geometry. The test consisted of 32 geometrical problems. Some of the problems included a related diagram and others did not. As a result, the male candidates achieved significantly higher than the female candidates independent of the provision of a diagram. Senk and Usiskin [32] conducted a study to investigate gender differences in the understanding of geometrical proof for students ranging from 7th to 12th grade. The students were tested on their knowledge of geometry at the beginning of the year and on their understanding of three types of geometry proofs at the end of the year. They found significant gender differences favoring males on geometrical knowledge. This finding is consistent with Battista [3], but not with the meta-study of Heinze et al. [14], which did not find significant differences in geometrical argumentation.

In contrast, other researchers found that female students outperformed male students in geometry topics (Senk and Usiskin [32]). Mubark [27] showed that female students had higher scores than male students in mathematical proof. In addition, the TIMSS [33, 34] produced - in some countries with Jordan being one of these countries - a significantly higher average score for the geometry subset for female students than for male students.

As a remark, Cox [7] argued that students’ results on examinations measuring single components of mathematical knowledge generally correlate with the overall scores of the same students on mathematics achievement tests.
2.1. Research questions

The research questions for this study arose from the literature review and its result that more detailed research on gender differences seems to be pertinent. This study attempts to address the following research questions in the context of year 10 students in Jordan:

(1) Do male and female students’ achievements differ in different mathematical topics and in the total mathematics achievement score?

(2) What are the most difficult and the easiest topics from the four different mathematical topics of the year 10 curriculum?

3. Methods

The mathematics achievement will be measured on a single aspect incorporating curriculum factors and reflecting the school achievement tests. The content of the mathematics subject for the year 10 in Jordan is based on a mathematics textbook published by Ministry of Education, that has been used in all schools of this study. The mathematical content of the mathematics textbook (second semester of the year 10) has been analyzed first. The mathematics achievement test was prepared from the textbook covering four units: triangles, analytic geometry, probabilities/statistics, and financial mathematics; the range of scores was 0-60, 15 scores for each topic. 450 students were tested, 230 females and 220 males. The test took one and a half hours.

Jordan has 12 governorates. The sample for the study was selected from the Ma’an governorate, because this location is close to the first author’s home, and the first author was teaching in this governorate. Students involved in the study were selected randomly from all schools in the Ma’an governorate that provided year 10 education in the academic year 2008/2009. The year 10 class students (approximately 16 years old) were selected because the 10th grade is the end of the compulsory level.

The Ma’an governorate contains four directorates: Ma’an directorate, Petra directorate, South Badin directorate, and Ash shoubk directorate. There
were 1927 students in the year 10 in Ma’an, 850 (44%) male students and 1077 (56%) female students. The breakdown by gender and directorates is displayed in Table 1.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Directorate</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>Ma’an directorate</td>
<td>288</td>
<td>318</td>
<td>606</td>
<td>31%</td>
</tr>
<tr>
<td>Female</td>
<td>Ma’an directorate</td>
<td>318</td>
<td>288</td>
<td>606</td>
<td>31%</td>
</tr>
<tr>
<td>Total</td>
<td>Ma’an directorate</td>
<td>606</td>
<td>606</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proportion</td>
<td>Ma’an directorate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** These numbers were provided by Department of Planning (Jordan) in each educational directorate in the academic year 2008/2009.

Differences in mathematics achievement between male students and female students for the whole sample and for each mathematical area were tested using an independent t-test. In addition, the mean and standard deviation were calculated for each area.

The mathematics achievement test had a scale reliability of 0.73, whereas the content and construct validities of the test were confirmed by consulted experts and curriculum documents and by principal component factor analyses, respectively.

### 4. Results

All 14 schools involved in this study were single sex, as is the case throughout Jordan for all public schools. Seven of the fourteen schools were for male students only and seven for female students only. The differences in mathematics achievement that might exist between the genders would automatically relate to school differences, at least for the two groups of schools.

The male and female students’ mean scores on each of the four areas of the mathematics achievement test, and the total scores for mathematics achievement were compared using independent sample t-test. There was a
significant gender difference for three topics out of four and for the total mathematics achievement. Female students had significantly higher scores than male students for analytic geometry, probability/statistics and financial mathematics as well as for the total mathematics achievement. The mean scores by gender are shown in Table 2.

Table 2. Results for gender differences in mathematics achievement areas and the total of mathematics achievement

<table>
<thead>
<tr>
<th>Area</th>
<th>Mean (M)</th>
<th>Mean (F)</th>
<th>SD (M)</th>
<th>SD (F)</th>
<th>T-vale</th>
<th>Prop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triangles</td>
<td>7.4</td>
<td>7.8</td>
<td>3.76</td>
<td>3.61</td>
<td>.999</td>
<td>.318</td>
</tr>
<tr>
<td>Analytic geometry</td>
<td>4.2</td>
<td>5.7</td>
<td>3.59</td>
<td>3.44</td>
<td>3.537</td>
<td>.000</td>
</tr>
<tr>
<td>Probability/statistics</td>
<td>7.9</td>
<td>8.5</td>
<td>3.13</td>
<td>3.34</td>
<td>2.029</td>
<td>.043</td>
</tr>
<tr>
<td>Financial mathematics</td>
<td>8.4</td>
<td>10.1</td>
<td>3.38</td>
<td>2.61</td>
<td>5.949</td>
<td>.000</td>
</tr>
<tr>
<td>Mathematics achievement (total)</td>
<td>28.2</td>
<td>32.1</td>
<td>10.26</td>
<td>9.39</td>
<td>4.134</td>
<td>.000</td>
</tr>
</tbody>
</table>

The most difficult of the mathematical areas was analytic geometry. The results showed that the overall mean for analytic geometry was 5.14 out of 15. Analytic geometry is traditionally a challenging area in the mathematics curriculum; this is evident through the students’ results. This area requires the students to use specific theorems and make a connection between them for proving other theorems, and to explicate justifications for every step. In contrast, financial mathematics shows to be the easiest topic. All information about the mathematical areas with mean, SD, etc. can be found in Table 3.

Table 3. Results for mathematics areas with Mean, SD, Min score awarded and Max score awarded

<table>
<thead>
<tr>
<th>Topic</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Min score awarded</th>
<th>Max score awarded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triangle</td>
<td>450</td>
<td>7.60</td>
<td>3.68</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>Analytic geometry</td>
<td>450</td>
<td>5.14</td>
<td>3.56</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>Probability/statistics</td>
<td>450</td>
<td>8.19</td>
<td>3.25</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>Financial mathematics</td>
<td>450</td>
<td>9.26</td>
<td>3.13</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>Mathematics achievement (total)</td>
<td>450</td>
<td>30.19</td>
<td>10.00</td>
<td>3</td>
<td>57</td>
</tr>
</tbody>
</table>
5. Discussion of the Results

Comparing the mean scores of both genders for the different mathematical areas, there was a significant gender difference for three areas and for the total score of mathematics achievement. Females had significantly higher mean scores than males on analytic geometry, probability/statistics, financial mathematics and for the total mathematics achievement. For analytic geometry, the results do not conform with the findings of some of the studies which we considered in Section 2: Findings that either showed that males had higher mean scores than females or that there were no significant differences between them (Battista [3], El Hassan [10], Hanna [13], Huntley et al. [15], Ma [22] and Senk and Usiskin [32]). However, the findings for the geometry area are consistent with Mubark [27], Senk and Usiskin [32] and the Jordanian part of TIMSS. In particular, in TIMSS [33, 34] Jordanian females had a significantly higher average score than males in geometry and in the mathematics overall achievement.

For the overall mathematics achievement, this result is interesting as it contributes to our knowledge of the global distribution of gendered mathematics achievement. It is opposite to some previous studies that found, in general, that males outperformed females in mathematics achievement (Cox [6], El Hassan [10], Hanna [13], Low and Over [21], Ma [22], Randhawa and Hunt [29], Uekawa and Lange [35] and Young [36]), and complementary to research where in some domains no connections between mathematics achievement and gender were found (Ai [1], El Hassan [10], Hanna [13], Low and Over [21], Uekawa and Lange [35] and Young [36]).

The result, however, is partially consistent with other research findings (Ai [1], Cook [5], Cox [6], Ma [22], Mubark [27] and Randhawa and Hunt [29]). In addition, it is consistent with the results of a statewide test, administered by the Ministry of Education, for the 9th grade students throughout Jordan, where females achieved significantly higher scores than their male counterparts. In the Irbid governorate, female students outperformed male students with a mean score of 50% over 36% (Ministry of Education [25]). These results are consistent with the results of this study where female students also outperformed males with mean scores of 64.4%
and 56.4% respectively. For TIMSS [33, 34] in Jordan, as with some of other
Arabic countries participating in TIMSS, such as Bahrain, females also
outperformed males in mathematics achievement, although in many other
countries, both Islamic and non-Islamic, this was not the case.

The present study, in which Jordanian females achieved higher than
males, focuses on older, year 10 students. In comparison with a Jordanian
study on year 8 students (Mubark [27]), it seems as if the initial year 8
difference is not lost over the intervening two-year schooling period, at least
for this relatively high performing group.

There seems to be a reason to assume that the observed achievement
difference is related to sociological arguments. As with any Arabic country,
the social activities feasible for female students in Jordan tend to be more
restricted than for the male students, with female students spending more
time at home than male students due to the strictures of religion (Mubark
[27]). As female students spend more time at home, they might use it as an
additional time for study and learning. This argument might explain partially
why female students achieve higher than male students. Another explanation
is related to the different social behavior of male and female teachers.
Throughout Jordanian girls’ schools, female teachers teach female students,
and in the boys’ schools male teachers teach male students. It seems to us
that the female students feel more relaxed about asking questions to their
teachers than do the male students to their male teachers, because of a more
pronounced caring orientation of female teachers. As Noddings [28] argues,
caring is a means “to cultivate trusting relationships with students” (p. 203),
that is, “safe spaces” (Boostrom [4]) in which learning is more probable to
occur. In this context, Cook’s [5] study is relevant. Cook found that even for
students taught in co-educational classes, when she tested males and females
separately, females achieved 12% higher than when tested together with
males. Jones and Dindia [17] and Jungwirth [18] reconstructed that in co-
educational school systems, teachers generally tend to interact more
frequently with males, and they dedicated them more attention and
opportunity to answer mathematically challenging questions. This problem is
unknown to single-sex schools, as in Jordan.
Finally, in Jordan, female students seem to have a greater incentive than males to complete their schooling. Males are more likely to be able to get a job without graduating, such as in the military, in industries and in private businesses. A Jordanian department of statistics survey (Department of Statistics [9]) about employment showed that the unemployment percentage in Jordan for those students who did not complete their undergraduate studies was 14.5% for males and 22.5 for females. However, as it is difficult for females to get a job without completing their education, they tend to have a greater incentive to study well at school in all subjects, including mathematics. This contention is in part supported by the fact that only 70% of the male students proceed their educational path in upper secondary schools, compared with 75% of the female students (Ministry of Education [26]).

With regard to the difficulty of the four mathematical areas tested, analytic geometry was by far the most difficult area. This result was expected, because of the nature of analytic geometry in the Jordanian curriculum. It is conceptualized as an area, in which the students need to understand the mathematical concepts behind procedures, need to be able to justify each procedural step, and in which high abilities in mathematical thinking are required. For instance, many students faced difficulties when tasks required the construction of a proof (cf., Baker and Campbell [2]). This result is consistent with Mubark [27] who found that mathematical proof was the most difficult aspect among the different mathematical thinking aspects in 11th grade mathematics in Jordan. In addition, Senk [31] found that writing proofs was one of most difficult processes for the students she tested. Complementary, the easiest area was financial mathematics, possibly because the test items constructed for this area focused on the rate of change, currency exchange, simple profit and command profit, insurance, commission and interest, which represent rather routine problems for most of the students. According to gender differences with probability and statistics, the results showed that female students achieved significantly higher than male students, which is inconsistent with Hanna [13].
References


