Jordan Journal of Educational Sciences Vol. 11, No. 1, pp 101-111

Exploring the Jordanian Gender Gap in a Large-Scale Assessment in Mathematics

Mutasem Akour*, Ghaleb AL-Baddareen*, Hassan Alomari** and **Ahmed AL Duwairi*****

Received Date: 1/9/2014 **Accepted Date: 15/1/2015**

Abstract: This study examined the Jordanian mathematics results in the 2012 Programme for International Student Assessment (PISA) with respect to gender differences. A total of 7038 Jordanian students (51.4% males and 48.6% females) took the PISA 2012 math test, where mathematics was the major domain of assessment. Contrary to most PISA countries, female students in Jordan significantly outperformed males on overall math literacy scale and on almost all math literacy contents and processes subscales. The largest differences were on the uncertainty and data and the change and relationships content subscales, and on the employing and the interpreting processes subscales. However, no significant gender differences were found among Jordanian students at level 3 and above of the six proficiency levels on the combined mathematics scale, nor in the higher percentiles, 90th and 95th percentiles. Reasons for the differential gender performance were speculated, and directions of future research were proposed.

Keywords: Gender gap, Mathematics, PISA, Jordan.

الكشف عن الفروق بين اداء الذكور والاناث في الاردن في أحد الاختبارات الدولية المتعلقة بالرياضيات

معتصم العكور وغالب البدارين، الجامعة الهاشمية، الزرقاء، الأردن.
حسان العمري، جامعة جدارا، إربد، الأردن.
أحمد الدويري، جامعة آل البيت، المفرق، الأردن.

ملخص: سعت الدراسة الحالية الى الكشف عن الفروق بين الجنسين في ادائهم على الجزء المتعلق بمعرفة الرياضيات في البرنامج الدولي لتقييم الطلبة (اختبار البيزا) في دورته الخامسة للعام 2012، حيث كانت الرياضيات هي المحور الاساسي في تلك الدورة. شملت عينة الدراسة جميع الطلبة الاردنيين المشاركين في الاختبار وعددهم 7038 طالباً وطالبة (51.4% من الذكور و 48.6% من الاناث). اشارت النتائج والتي كانت مغايرة تماما للنتائج لدى معظم الدول الاخرى المشاركة في هذا الاختبار الى تفوق الاناث على الذكور وبدلالة احصائية في الاداء الكلي، بالاضافة الى تفوقهن في معظم مهارات محتوى الرياضيات ومعظم مهارات العمليات الرياضية. أما فيما يخص اداء الطلبة الاردنيين على مستويات الكفاءة الست في هذا الاختبار، فقد اشارت نتائج الدراسة الحالية الى عدم وجود فروق دالة احصائياً بين الذكور والاناث في المستويات العليا (من المستوى الثالث الى السادس)، بالاضافة الى عدم وجود فروق دالة احصائياً بين الجنسين على المئين 90 أو المئين 95.

الكلمات المفتاحية: الفروق بين الجنسين، الرياضيات، اختبار البيزا، الاردن

Introduction

Gender gap in mathematics achievement has been widely studied in the educational literature, especially in the US and Europe, in the last few decades. However, this issue is still debatable and controversial. Typically, gender differences in mathematics tend to appear in high school (Hyde, Fennema, & Lamon, 1990), and are likely to be associated with the underrepresentation of women in careers in science, technology, mathematics, and engineering (Else-Quest, Hyde, and Linn, 2010).

Numerous studies found little or no gender differences in mathematics achievement and approved the parity of boys and girls in math performance (Azar, 2010; Bevan, 2001; Else-Quest et al., 2010; Gallagher & Kaufman, 2005; Guiso, Monte, Sapienza, & Zingales, 2008; Hyde, 2008; Hyde & Mertz, 2009; Hyde, Lindberg, Linn, Ellis, and Williams, 2008; VanLeuvan, 2004).

On the other hand, several studies confirmed the existence of gender gap in math performance. Particularly, in middle & high school, boys outperformed girls on standardized tests of math (Bevan, 2001; Close & Shiel, 2009; Gallagher & Kaufman, 2005; Hyde and Mertz, 2009; Kyriakides & Antoniou, 2009; Liu & Wilson, 2009; Machin & Pekkarinen, 2008; Shafiq, 2011).

Besides the better performance of boys in mathematics is the finding that boys considerably outnumber girls at both the high and the low end of the mathematics test score distributions (Gallagher & Kaufman, 2005; Kyriakides & Antoniou, 2009). Several studies (Bevan, 2001; Ellison & Swanson, 2010; Hedges & Nowell, 1995; Hyde & Mertz, 2009; Niederle & Vesterlund, 2010) reported that such gender gap in math performance that favors boys over girls is most noticed amongst the highest achievers, or at the right tail of the distribution. Hyde and Mertz (2009) concluded that the literature has shown that boys scored better than girls above the 95th or the 99th percentile, but this gender gap has significantly narrowed over time in the United States and is not found in some ethnic groups and in some nations.

* Hashemite University, Zarqa, Jordan.
** Jadara University, Irbid, Jordan.
*** Al al-Bayt University, Mafraq, Jordan.

Many efforts have been made to determine and explain the factors that are associated with math gender differences. Liu and Wilson (2009) classified these efforts into explanatory and exploratory investigations. The explanatory approach tries to explain the existing gender differences from the students' side through offering social, cultural, and psychological models to explain such differences. Whereas, the exploratory investigation examines the reasons from the assessment side by examining the item characterisitics that are related to differential gender performance. One of the main item-realted factors that has been identified to influence the pattern and magnitude of gender differences is the different cognitive domains measured by math tests. Exploring gender differences across these domains helps in checking if gender effects emerged to any degree in one content area of mathematics rather than another.

Numerous studies had shown inconsistency of gender differences across different math contents and domains. Males dominated females in spatial ability (which is related to geometry) that requires understanding the properties of objects, their relative positions, and the relationships between actual shapes and their visual representations (Gierl, Bisanz, Bisanz, & Boughton, 2003; Halpern, 1997; Liu & Wilson, 2009, Voyer, Voyer, & Bryden, 1995). Males, also, performed better on items that assess reasoning and problem-solving abilities. On the other hand, females have been reported to perform better than males on tasks involving representation of quantities, and tasks involving computational skills (Doolittle & Cleary, 1987; Gallagher et al., 2000; Friedman, 1996; Marshall & Smith, 1987). Females have also outperformed males on items purely presented by formulas or equations, while males performed better on word problems involving the application of theory (Gallagher, 1992; Innabi & Dodeen, 2006).

Given the discussion thus far, it appears that males have the advantage over females in overall mathematics performance. The majority of past research revealed the superiority of males in almost all math contents and domains, and across different percentiles on the math test score distributions. To find out if the issue of gender gap in math achievement is specific to a particular country or if it is a universal phenomenon, investigating large-scale international studies, such as PISA, provides researchers with a much broader base in which to examine this issue. The Organization for Economic Co-operation and Development (OECD) launched the PISA in 1997 in response to the need for cross-nationally comparable evidence on student performance. The assessment does not just ascertain whether students, at age 15, can reproduce what they have learned, but also intended to measure how well they are able to use their knowledge and skills in tasks and challenges likely to be encountered in everyday life situations outside school. The survey takes place every three years starting from 2000. Each of these cycles looks in depth at a major domain, to which two thirds of testing time is devoted; the other two domains are assessed less thoroughly. Major domains have been *reading* in 2000 and 2009, *mathematics* in 2003 and *science* in 2006. In 2012, the major domain was again mathematics (OECD, 2013a).

PISA 2012 Mathematics Framework

In the PISA 2012 mathematics framework, mathematics literacy was defined as "an individual's capacity to formulate, employ, and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena. It assists individuals to recognize the role that mathematics plays in the world and to make the well-founded judgments and decisions needed by constructive, engaged and reflective citizens" (OECD, 2013a, p. 28). This definition distinguishes literacy from the ability to recall and understand math knowledge based on school curriculum. Accordingly, PISA 2012 (OECD, 2013a) designed tasks to assess the following two aspects:

1- The mathematical processes that describe what students do to connect the context of a problem with mathematics and thus solve the problem.
2- The mathematical content that is targeted to use in the assessment items.

The mathematical processes that students do in order to solve the problem refer to an individual's capacity to *formulate* situations mathematically, to *employ* mathematical concepts, facts, procedures, and reasoning, and to *interpret*, apply, and evaluate mathematical outcomes.

The four areas of mathematical content that guided the development of test items for PISA 2012 and characterized the range of mathematical content that is central to the discipline are: *change and relationships*, which involves understanding basic types of changes and relationships among objects or circumstances and modeling them with appropriate functions and equations; *space and shape*, which involves a range of activities such as creating and reading maps, transforming shapes with and without technology, interpreting views of three-dimensional scenes from various perspectives, and constructing representations of shapes; *quantity*, which involves understanding measurements, counts, magnitudes, units, relative size, and numerical trends and patterns; and *uncertainty and data*, which involves recognizing the place of variation in processes, having a sense of the quantification of that variation, and acknowledging uncertainty and error in measurement.

The overall PISA mathematics scale was divided into six levels of proficiency, each characterized by different levels of skills and knowledge. Level 6 is the most advanced and typically involves higher-level skills

such as conceptualizing, generalizing, and modeling of complex problem situations. Level 2 is considered the baseline proficiency level, and level 1 is the least advanced that involves lower-level skills such as carrying out routine procedures, performing obvious actions, and answering questions that are clearly defined. There is also a 'below level 1' category for students who did not demonstrate competencies required by the easiest PISA tasks. Students assigned to a particular level will be expected to possess the skills required at the lower levels, and to complete some items from the next higher level (OECD, 2013a).

Gender Gap in PISA 2006 through 2012

In PISA 2006 and 2009 and on average, boys performed better than girls in overall math performance by approximately 12 score points. In PISA 2006 in which science was the major domain of assessment, girls significantly outperformed boys in mathematics in only one out of 57 participating countries. Boys performed significantly better than girls in 16 countries (OECD, 2006). In PISA 2009 in which reading was the major focus of assessment, boys performed significantly better than girls in 35 out of 65 participated countries, and girls did better than boys in only five countries (OECD, 2009a).

According to the OECD (2013b), in PISA 2012 in which mathematics was the major domain of assessment and on average across OECD countries, boys performed better than girls in mathematics by 11 score points. Boys performed significantly better than girls in 37 out of 65 countries. However, girls significantly outperformed boys in only 5 countries. In many countries the gender gap was narrowed since PISA 2003 because girls' performance improved while boys' performance did not change. This could possibly signal a trend reversal in the future (Quenzel & Hurrelmann, 2013).

Moreover and in almost all participating countries, larger proportions of boys than girls scored at Level 5 or 6 (top performers) and at Level 4 of the defined mathematics proficiency levels. The proportion of girls was larger than the proportion of boys at proficiency level 3 and below, except for nine countries where a larger proportion of boys than girls performed below level 2.

Regarding students' performance on the process subscales of *formulating*, *employing*, and *interpreting*, and on the content subscales of *change and relationships*, *space and shape*, *quantity*, and *uncertainty and data*, the correlation between scores on these subscales and overall mathematics scores was, in general, high. This means that students tended to perform as well on the mathematics subscales as they did in mathematics overall. Therefore, boys did better than girls on the three process subscales and on the four content subscales.

As for the four content subscales, boys performed better than girls in almost all countries with the largest average difference on the *space and shape* subscale and the least average difference on the *uncertainty and data* subscale. Moreover, boys did better than girls on almost all processes subscales across almost all participating countries. The widest gap among the three process subscales was found in the *formulating* subscale, while it was approximately equal for the other two subscales (OECD, 2013b).

Aspects of the Educational System in Jordan

Formal education in Jordan takes place through three cycles under the supervision of the Ministry of Education (MOE). Pre-school cycle begins at age 4 and continues for two years until age 6, where students enter the second cycle of basic education that lasts for 10 years. Basic education is compulsory until the age of 16. The last cycle of 2 years is the secondary education cycle which consists of two streams, the comprehensive secondary education stream and the applied secondary education stream. At the end of the secondary school, students sit for the general secondary education certificate examination (or tawjihi) which is required for admission to higher education (MOE, 2014).

According to the global gender gap index reported by the World Economic Forum (2013), Jordan displayed gender parity in education in enrollment rates at the primary level. At the secondary and tertiary education, enrollment rates of females are higher than those of males. The enrollment rate in secondary education was 88% for females and 83% for males, and in tertiary education was 41% for females and 35% for males.

The results of the national exam that was held in 2008 for the 10^{th} graders in Jordan revealed that girls performed significantly better than boys in mathematics (MOE, 2008). Moreover, in the statistical annual report prepared by the Ministry of Education (MOE, 2013), girls performed better than boys on the tawjihi exam in, approximately, all streams for the years 2006 through 2013.

Statement of the Problem

There is no strong evidence that gender gap in mathematics achievement is eliminated across all nations. Gender differences were examined extensively in USA, Europe, and industrialized countries, but very few studies have been conducted in the Arab and Muslim world, namely Jordan. Therefore, the present study aimed at exploring the gender gap in mathematics achievement among Jordanian students who participated in PISA 2012, where mathematics was the major domain of assessment.

This study was also motivated by two observations: (a) the lack of published demonstrations of Jordanian gender equality in international surveys such as PISA, given that Jordan first participated in this survey in

2006; and (b) it has been noted that females tended to perform better on conventional mathematical items related to textbook context, whereas males were better in solving mathematical items which relate to actual life or cannot be solved using familiar algorithms (Gallagher & De Lisi, 1994; Harris & Carlton, 1993). Therefore, females may be disadvantaged on large-scale assessments because it is unlikely that these assessments will closely resemble classroom assessments (Linn & Hyde, 1989). However, according to the statistics gathered by the MOE in Jordan it seems that the gender gap in mathematics is reversed, in favor of the girls. Therefore, it is important to further investigate this gender gap in a non-curriculum based international assessment to explore the magnitude and the direction of the existing differences.

Aim of the Study.

The main aim of the present study was to examine gender differences in Jordanian students' mathematics literacy as measured by the PISA-2012 survey with respect to their performance on (a) the overall PISA mathematics scale; (b) the four content categories of math literacy; and (c) the three processes that characterized what students do.

Research Questions.

More specifically, the present study tried to answer the following research questions:

1) Are there any statistically gender differences in PISA-2012 mathematics literacy among Jordanian students with respect to the overall PISA math scale?
2) Are there any statistically gender differences in PISA-2012 mathematics literacy among Jordanian students with respect to the distribution of scores across different percentiles?
3) Are there any statistically gender differences in PISA-2012 mathematics literacy among Jordanian students with respect to the distribution of scores across proficiency levels?
4) Are there any statistically gender differences in PISA-2012 mathematics literacy among Jordanian students with respect to the content categories of math literacy?
5) Are there any statistically gender differences in PISA-2012 mathematics literacy among Jordanian students with respect to the various processes of math literacy?

Significance of the Study

It is hoped that this study will contribute to the literature on gender differences in math performance in Jordan, which is not one of the top-performing countries in PISA, given the improvements in the educational, cultural, and social conditions that girls and boys encountered recently in Jordan. Moreover, the present study would provide researchers and policy makers with important information about students' performance at the end of the basic school where students choose to either go to high school moving on the college track, or to prepare for vocational training. Academic preparation at this age can have a vigorous impact on the student's future educational and professional ambitions and attainment.

Definitions of Concepts

Mathematics Literacy: An individual's capacity to formulate, employ, and interpret mathematics in a variety of contexts.

Mathematical Content: Refers to the four areas of change and relationships, space and shape, quantity, and uncertainty and data that guided the development of test items for PISA 2012.

Math Proficiency Levels: The six levels that comprise the overall PISA math scale, and are characterized by different levels of skills and knowledge. These levels ranged from below level 1 category for students who did not demonstrate competencies required by the easiest PISA tasks up to level 6 which involves higher-level skills.

Method

Data

PISA items were arranged in nine clusters, with each cluster representing 30 minutes of testing time. Item clusters were placed in 13 test booklets according to a rotated test design, with each form containing four clusters of material from the mathematics, reading and science domains. Each student does one form, representing a total testing time of 120 minutes. Therefore, not all students answered all questions in the assessment.

A total of 109 mathematics items were used in PISA 2012. These items were distributed evenly across the four content categories, such that each content category represented by, approximately, 25% of score points. The distribution of math items across the three mathematical processes was different. About 50% of the items were assigned for the process *employing*, and 25% for each one of the other two processes.

Target Population and Sample

The target population of PISA in each country consisted of all 15-year-old students attending educational institutions in grades 7 and higher. In each country, the sample of students was chosen using a two-stage stratified sampling procedure. The first stage consisted of sampling individual schools that had 15-year-old students. A minimum of 150 schools were selected in each country. The second stage of the sampling process involved sampling students within sampled schools. Once schools were selected, a list of

each school's 15-year-old students was prepared, and then 35 students were selected with equal probability (OECD, 2009b). In Jordan, a total of 7038 students (51.4% boys and 48.6% girls) took the PISA 2012 math test.

Analysis

For item calibration and ability estimation, PISA used the multidimensional random coefficients multinomial logit model (Adams, Wilson, & Wang, 1997), which is a generalization of the Rasch model. This model can deal with both dichotomously and polytomously scored items. In PISA, each student takes only a portion of the entire test, therefore this model computes their achievement scores based only on the questions they receive. These achievement scores are then rescaled to have an overall mean of 500 and a standard deviation of 100 across participants in all OECD countries. International surveys such as PISA report students' performance through plausible values, which are random draws from the marginal posterior of the latent distribution for each student. A set of five plausible values are drawn for each student for each scale or subscale. Population statistics should be estimated using each plausible value separately. The reported population statistic is then the average of each plausible value statistic (OECD, 2009b).

In the present study, math performance for boys and girls was compared, in terms of overall math achievement, content categories, and mathematical processes. The five sets of plausible values were used to indicate student math proficiency in each dimension. Different SPSS macro programs provided by the PISA 2009 data analysis manual (OECD, 2009c) were used to produce direct estimates of the mean gender difference and the standard error of the difference, on the basis of the plausible values. The SPSS macros on pages 247 and 285 of the manual were used to answer the first, the fourth, and the fifth research questions. To answer the second research question, the SPSS macro provided by the data analysis manual on page 251 was used. Finally, the SPSS macro on page 257 was used to conduct the necessary analysis for the third research question.

A *z* statistic, computed by dividing the mean difference by the estimated standard error, was used to indicate the statistical significance of the mean difference for each comparison. A significant *z* value, equal to or more extreme than ± 1.96, means that the mean difference was significantly different from zero, suggesting a gender performance difference among PISA students.

Results and Discussion

Overall Gender Differences in PISA 2006 through PISA 2012 Math Literacy

In PISA mathematics, Jordan has been placed under the OECD country average in all three cycles. In PISA 2012 with a mathematics mean score of 386 and a standard error (SE) of 3.1 (Table 1), Jordan was classified under the OECD average (OECD average equals 494) and ranked 61 out of 65 participated countries. Table 1 shows that girls performed significantly better than boys by 21 score points which equals about one-fourth of a national standard deviation (national standard deviation = 78). However, no statistically significant differences were found in mathematics performance between Jordanian boys and girls in 2006 and in 2009.

Table 1: Mean scale scores of Jordanian students on PISA math literacy by gender and year

	2006		2009		2012	
Group	Mean	SE	Mean	SE	Mean	SE
All	384	3.3	387	3.7	386	3.1
Boys	381	5.3	386	5.1	375	5.4
Girls	388	3.9	387	5.2	396	3.1
Boys-Girls Difference	-7	6.5	-1	7.1	-21*	6.3

Note. SE= Standard Error. * $p < 0.05$

One possible reason for this is that since PISA 2006, mathematics performance of boys worsened by 6 score points, while girls performance improved by 8 score points (see Table 1). This resulted in a widening of the gender gap in mathematics performance to the extent that the nonsignificant gender gap observed in 2006 and 2009 became statistically significant in 2012. This resonates with the findings from various PISA administrations across different OECD countries in that girls' performance has improved over time since 2006, whereas boys' performance remained unchanged (OECD, 2013b). However, this finding does not agree with Linn and Hyde (1989) in that females may be disadvantaged on large-scale assessments. Also, it does not agree with (Gallagher & De Lisi, 1994; Harris & Carlton, 1993) in that males are better in solving mathematical items that relate to actual life.

Jordan is one of the few countries among PISA participating countries in which girls performed significantly better than boys in mathematics. Jordan results in PISA resemble those in Trends in International Mathematics and Science Study (TIMSS). In 1999, the first time Jordan participated in TIMSS, gender differences were small and not statistically significant, even though the differences of 6 score points were in favor of girls. This gender gap increased in the subsequent cycles, 2003, 2007, and 2011. In each

of these three cycles, girls significantly performed better than boys with the widest gap of 28 score points in 2011 (TIMSS, 2012).

The findings of the present study in PISA 2006 and 2009 agree with the findings of previous studies in the nonexistence of gender gap in math achievement (Azar, 2010; Bevan, 2001; Else-Quest et al., 2010; Fennema et al., 1998; Gallagher & Kaufman, 2005; Guiso et al., 2008; Hyde, 2008; Hyde & Mertz, 2009; Hyde et al., 2008; VanLeuvan, 2004). However, the findings of the present study in PISA 2012 agrees with previous studies (Bevan, 2001; Close & Shiel, 2009; Gallagher & Kaufman, 2005; Hyde and Mertz, 2009; Kyriakides & Antoniou, 2009; Liu & Wilson, 2009; Machin & Pekkarinen, 2008; Shafiq, 2011) in the existence of gender gap in math performance, but they do not agree with the prevalence of boys over girls.

Gender Differences at Different Percentiles on PISA 2012 Math Literacy

In the higher percentiles, 90th and 95th percentiles, Table 2 shows that Jordanian girls did not significantly outperform Jordanian boys. However, girls significantly did better than boys in the 75th percentile and below. The pattern of gender differences in Jordanian students performance across different percentiles can be seen more clearly in Figure 1. At the higher levels, boys and girls did not significantly differ, but the difference increases with lowering ability, and becomes quite distinct in the lowermost percentiles.

Table 2: Jordanian students' performance at different percentiles in PISA 2012 math literacy by gender

Percentile	Boys		Girls		Mean Difference
	Mean	SE	Mean	SE	
95th percentile	515	11.9	513	5.9	2
90th percentile	481	7.2	487	5.0	- 6
75th percentile	427	6.3	442	4.1	- 15*
50th percentile	371	4.9	394	3.4	- 23*
25th percentile	320	5.0	348	2.9	- 28*
10th percentile	273	5.9	308	3.3	- 36*
5th percentile	245	6.5	284	3.9	- 39*

Note. SE= Standard Error. * $p < 0.05$

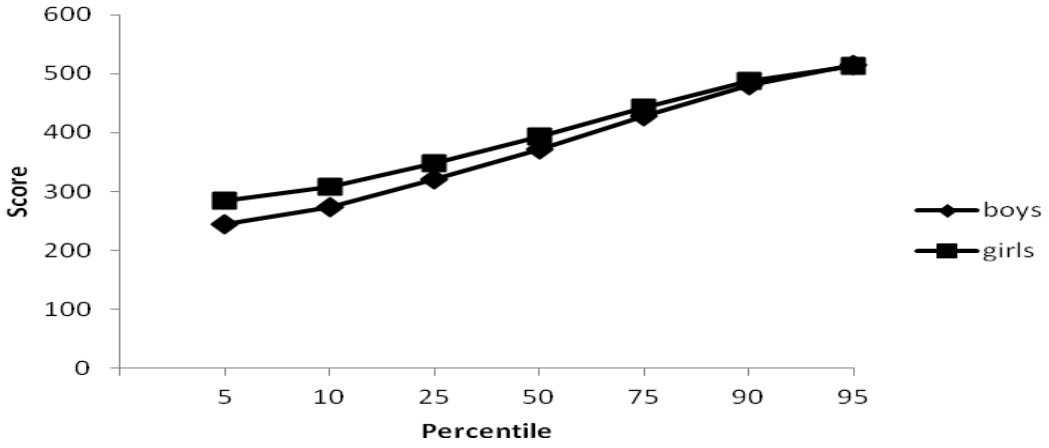

Figure 1. Jordanian boys' and girls' performance at different percentiles in PISA 2012 math literacy

Even though this difference for Jordanian students was not statistically significant, this finding, in part, agrees with (Bevan, 2001; Ellison & Swanson, 2010; Hedges & Nowell, 1995; Hyde & Mertz, 2009; Niederle & Vesterlund, 2010) in that boys scored better than girls above the 95th%. In addition, it agrees with previous research (Gallagher & Kaufman, 2005; Kyriakides & Antoniou, 2009) in that girls outnumbered boys at the low end of the math score distribution. Moreover, this finding agrees with Hyde and Mertz (2009) in that, above the 95th percentile, gender gap is not found in some nations.

Gender Differences across Proficiency Levels on PISA 2012 Math Literacy

According to Table 3, about two thirds of the Jordanian students (72% of boys and 65% of girls) scored below the baseline proficiency level, i.e., level 2. Table 3 and Figure 2 show that there were no significant gender differences among Jordanian students at level 3 and above of the six proficiency levels on the combined mathematics scale. It is noteworthy that even though no statistically significant differences were found between boys and girls at level 4 and above, boys outnumbered girls in these higher levels. No girl scored at the highest proficiency level. This is in line with the findings in

large-scale surveys in that, in general, males are more dominant at the high end of distributions of mathematics achievements (Close & Shiel, 2009; Gallagher & Kaufman, 2005; OECD, 2013b; Kyriakides & Antoniou, 2009).

The percentages of Jordanian girls at levels 1 and 2 were statistically greater than the percentages of boys, which agree with findings from other PISA participating countries (OECD, 2013b). However, more boys were found below level 1; around 43% of boys as compared to around 30% of girls.

Table 3: Percentages of Jordanian students at each combined math proficiency level in PISA 2012 by gender

Level	Boys		Girls		Boys-Girls Difference	
	% students	SE	% students	SE	% Difference	SED
< Level 1	43.3	2.6	29.9	1.7	13.4*	3.42
Level 1	29.2	1.2	34.9	1.2	- 5.7*	1.73
Level 2	17.7	1.5	24.1	1.2	- 6.4*	1.92
Level 3	7	0.9	9.2	1.1	- 2.2	1.48
Level 4	1.9	0.5	1.8	0.6	0.1	0.80
Level 5	0.8	0.6	0.2	0.2	0.6	1.80
Level 6	0.2	0.2	0		0.2	

Not. SED= Standard Error of the Difference, SE= Standard Error. * $p < 0.05$

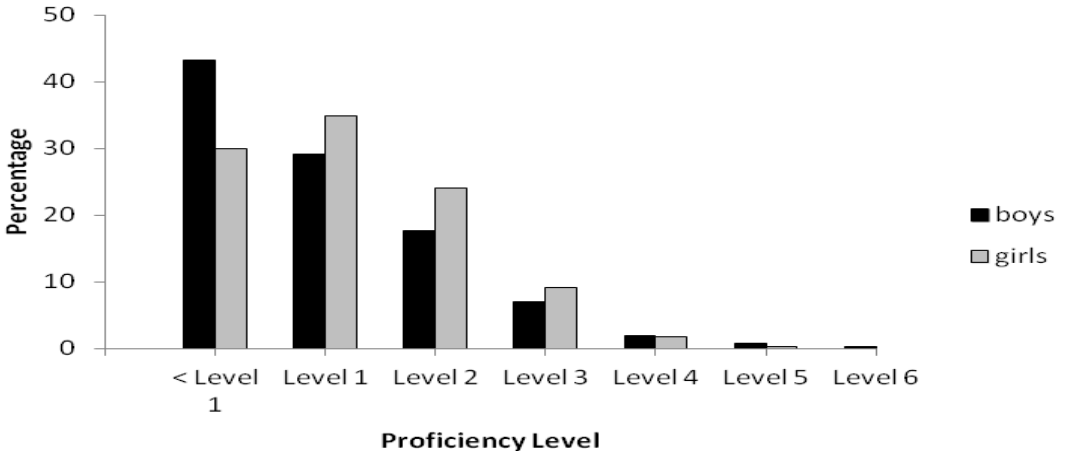

Figure 2. Percentages of Jordanian students at each combined math proficiency level in PISA 2012 by gender

For more investigation of the gender gap among Jordanian students in PISA 2012, we now look at gender differences when analyzed across the two dimensions of the PISA 2012 mathematics framework, i.e., mathematical content and mathematical processes.

Gender Differences on Various Content Areas of PISA 2012 Math Literacy

According to the results in Table 4, Jordanian girls in PISA 2012 scored significantly higher than boys on three content areas: *change and relationships, space and shape, and uncertainty and data.* This was not the case with other PISA participating countries where boys dominated girls on the four content areas and were ahead in performing *space and shape* tasks (OECD, 2103b).

Table 4: Mean scale scores of Jordanian students on PISA 2012 math literacy by gender and content

content	Boys		Girls		Boys-Girls Difference	
	Mean	SE	Mean	SE	Mean Difference	SED
Change & Relationships	373	6.5	402	3.0	-29*	7.2
Space & Shape	377	5.3	393	3.2	-15*	6.3
Quantity	362	5.7	372	3.7	-10	6.9
Uncertainty & Data	378	5.6	409	3.2	-30*	6.5

Not. SED= Standard Error of the Difference, SE= Standard Error. * $p < 0.05$

Gender differences on the *change and relationships* subscale (29 scale points) and on the *uncertainty and data* subscale (30 scale points) were much larger than they were for the other two content areas- *space and shape* (15 scale points) and *quantity* (10 scale points). This finding differs from what was reported in the majority of OECD countries where the smallest gender difference was on the *uncertainty and data* subscale. Moreover, this finding does not resonate with previous research (Gierl, et al., 2003; Halpern, 1997; Liu & Wilson, 2009, Voyer, et al., 1995) in that males tended to be superior in spatial ability. Outside of class spatial activities such as playing computer games and playing sports are correlated with spatial ability (Nuttall, Casey, & Pezaris, 2005). Males tend to be more involved in spatial activities as compared to girls. However, Newcombe, Mathason, and Terlecki (2002) found that after adequate training females performed equally well on items measuring spatial ability. The wide spread of computers and PC tablets in Jordan inside and outside of class provided girls with more opportunities to participate in spatial related activities, which might be contributed to the narrowing of the gender gap, or to the more extreme, the reversing of the gender differences in this ability to the favor of girls.

Table 4 shows that gender parity was achieved in the *quantity* subscale. This finding does not agree with the finding from previous research (Doolittle & Cleary, 1987; Gallagher et al., 2000; Friedman, 1996; Marshall & Smith, 1987) in that females tended to outperform males on items involving representation of quantities and computational skills.

Gender Differences on Various Processes of PISA 2012 Math Literacy

The results in Table 5 show that Jordanian girls performed better than Jordanian boys on all processes. The differences were statistically significant in favor of girls for two processes- *employing* and *interpreting*. This finding does not agree with the findings in other PISA participating countries where boys outperformed girls on all three processes. In addition this finding does not line with the finding in OECD countries in that the widest gender gap on the three processes subscales was found on the *formulating* subscale (OECD, 2013b).

Table 5: Mean scale scores of Jordanian students on PISA 2012 math literacy by gender and processes

Processes	Boys		Girls		Boys-girls Difference	
	Mean	SE	Mean	SE	Mean Difference	SED
Formulating	387	5.8	393	3.1	-7	6.4
Employing	371	5.8	396	3.5	-25*	6.9
Interpreting	370	5.2	395	2.9	-25*	6.1

Not. SED= Standard Error of the Difference, SE= Standard Error. * $p < 0.05$

Jordanian students displayed comparable capacities in formulating the situations presented in the items mathematically, but the superiority of girls appeared in employing mathematical concepts and in interpreting the mathematical outcomes. This finding does not agree with the findings in previous research (Gallagher, 1992; Innabi & Dodeen, 2006) in that males tended to perform better than females on word problems involving the application of theory. The better performance of girls on the two processes subscales *employing* and *interpreting*, might be linked to the advantage of girls over boys on items presented by formulas and equations (Gallagher, 1992; Innabi & Dodeen, 2006), and to the outperformance of girls on items involving computational skills (Doolittle & Cleary, 1987; Gallagher et al., 2000; Friedman, 1996; Marshall & Smith, 1987).

Conclusions

Math and science skills are highly valued in the economy, and math test scores were documented in the literature to be good predictors of future income (Grogger & Eide, 1995; Weinberger, 1999). Therefore, a wealth of research was done in the past few decades to address the issue of gender parity in mathematics performance. Even though gender gap in mathematics has diminished in recent years, males continued to perform better than females in mathematics (OECD, 2013b).

The present study aimed to explore gender differences among Jordanian students on PISA 2012 mathematics items. The findings of the present study confirmed the existence of gender gap among Jordanian students on the overall mathematics scale, even though gender equity was achieved on the 2006 and 2009 administrations of PISA. The patterns of gender differences on the overall math literacy scale and on the content and processes subscales were different when compared to those patterns found in previous research or in most PISA-OECD countries. Girls outperformed boys on overall math literacy and on almost all contents of math literacy and processes subscales. The largest differences were on the *uncertainty and data* and the *change and relationships* content subscales, and on the *employing* and the *interpreting* processes subscales.

These results revealed, on one hand, that Jordan's effective policies and practices in providing a learning environment that benefited both genders equally had led to narrowing the gender gap in math achievement. These findings are linked to the dominance of girls over boys in the enrollment rates in high and tertiary

education and in performance on all national tests conducted by the MOE in Jordan. On the other hand, the results point to a growing problem for males in mathematics. The substantial female advantage on PISA 2012 mathematics performance should raise attention and discussion among researchers, educators, and policy makers in Jordan. Stimulating interest and improving the level of engagement of males in mathematics and mathematics activities need to be a major policy objective if greater gender parity in mathematics performance is to be achieved. The existence of such gender differences on the long run may lead to more pronounced gender disparities in enrollment rates in scientific majors in tertiary education, and later in their educational and occupational careers raising further questions about how the gender gap can be reduced. Therefore, this gender gap requires more attention to the several factors associated with the underperformance of boys in mathematics, such as learning behaviors, motivation, attitudes toward mathematics, and teaching practices.

Several reasons for the existence of such gender differences in math performance may be speculated. In most PISA countries, males outperformed females on overall math performance. PISA (2013 b) reported several factors that might be considered possible reasons for such disadvantage. Females consistently report much lower interest in and enjoyment of mathematics, lower self-related beliefs and much higher levels of helplessness and stress in mathematics classes, and negative attitudes toward mathematics. Accordingly, Jordanian males may be disadvantaged on PISA 2012 in math performance due to any of these factors. Males' schools may be less effective in promoting students' motivation and interest in mathematics as compared to girls' schools.

In terms of disciplinary climate, PISA (2013 b) reported that principals identified student absenteeism as the most frequent student-related obstacle to learning. The next indicated obstacle to learning is disruptive behavior, which is followed by students skipping classes. From the students' perspective, having noise and disorder is the most frequently reported disciplinary problem in their mathematics lessons. In Jordan, boys' classes may suffer to a greater extent from these obstacles as compared to girls' classes, which might be one of the possible factors that led to the underperformance of boys in mathematics.

Finally, Quenzel and Hurrelmann (2013) presented two approaches to explain the growing gender gap in education. The first approach focuses on the stimulating forces that drive young women, and the second on the inhibiting forces that obstruct young men. According to the second approach, the vast dominance of female educators and teachers in pre-school and elementary school institutions, which is the case in Jordan, may have lead to greater girls' motivation than boys. It is the lack of male role-models for performance and social development and the structural disadvantage in the school nurturing process that might lead to the relatively poor performance of young men in Jordan.

The findings of the present study suggest three issues for future research. First, it would be interesting to explore gender differences in forthcoming administrations of PISA to check the consistency of the existing patterns of gender differences in PISA 2012. Second, given that science is related to mathematics, checking if girls also perform better in science would be another interesting area in future research. Finally, it would be beneficial in future research to examine different factors that could explain the existent gender differences among Jordanian students in mathematics, such as motivation, attitudes, anxiety, learning strategies, interest and enjoyment of math, and self-related beliefs.

References

Adams, R. J., Wilson, M., & Wang, W. (1997). The Multidimensional Random Coefficients Multinomial Logit Model. *Applied Psychological Measurement, 21*(1), 1-23. doi: 10.1177/0146621697211001.

Azar, B. (2010, July). Math + culture = gender gap? *Monitor on Psychology*, 41(7). Retrieved from: http://www.apa.org/monitor/2010/07-08/gender-gap.aspx.

Bevan, R. (2001). Boys, girls and mathematics: beginning to learn from the gender debate. *Mathematics in School, 30*(4), 2-6.

Close, S., & Shiel, G. (2009). Gender and PISA Mathematics: Irish results in context. *European Educational Research Journal*, *8*(1), 20-33. doi: 10.2304/eerj.2009.8.1.20.

Doolittle, A. E., & Cleary, T. A. (1987). Gender-Based Differential Item Performance in Mathematics Achievement Items. *Journal of Educational Measurement, 24*(2), 157-166. doi: 10.1111/j.1745-3984.1987.tb00271.x.

Ellison, G., & Swanson, A. (2010). The Gender Gap in Secondary School Mathematics at High Achievement Levels: Evidence from the American Mathematics Competitions. *Journal of Economic Perspectives, 24*(2), 109-128. doi: 10.1257/jep.24.2.109.

Else-Quest, N. M., Hyde, J. S., & Linn, M. C. (2010). Cross-National Patterns of Gender Differences in Mathematics: A Meta-Analysis. *Psychological Bulletin, 136*(1), 103-127. doi: 10.1037/a0018053.

Friedman, L. (1996). Meta-analysis and Quantitative Gender Differences: Reconciliation. *Focus on Learning Problems in Mathematics, 18*(1-3), 123-128.

Fennema, E., & Carpenter, T. P. (1998). New Perspectives on Gender Differences in Mathematics: An Introduction. *Educational Researcher, 27*(5), 4-5. doi: 10.3102/0013189x027005004.

Gallagher, A. M. (1992). *Sex differences in problem-solving strategies used by high-scoring examinees on the SAT-M* (College Board Rep. No. 92-2; ETS RR No. 92-93). New York: College Entrance Examination Board.

Gallagher, A. M., & De Lisi, R. (1994). Gender differences in scholastic aptitude test mathematics problem solving among high ability students. *Journal of Educational Psychology, 86*(2), 204–211. doi: 10.1037/0022-0663.86.2.204.

Gallagher, A. M., De Lisi, R., Holst, P. C., McGillicuddy-De Lisi, A. V., Morely, M., & Cahalan, C. (2000). Gender Differences in Advanced Mathematical Problem Solving. *Journal of Experimental Child Psychology, 75*(3), 165-190. doi: http://dx.doi.org/10.1006/jecp.1999.2532.

Gallagher, A.M., & Kaufman, J. C. (Eds.). (2005). *Gender differences in mathematics: an integrative psychological approach*. Cambridge: Cambridge University Press.

Gierl, M. J., Bisanz, J., Bisanz, G. L., & Boughton, K. A. (2003). Identifying Content and Cognitive Skills that Produce Gender Differences in Mathematics: A Demonstration of the Multidimensionality-Based DIF Analysis Paradigm. *Journal of Educational Measurement, 40*(4), 281-306. doi: 10.1111/j.1745-3984.2003.tb01148.x.

Grogger, J. & Edie, E. (1995). Changes in College Skills and the Rise in the College Wage Premium. *Journal of Human Resources, 30*(2), 280–310. doi: 10.2307/146120.

Guiso, L., Monte, F., Sapienza, P., & Zingales, L. (2008). Culture, Gender, and Math. *Science, 320*(5880), 1164-1165. doi: 10.1126/science.1154094.

Harris, A. M., & Carlton, S. T. (1993). Patterns of Gender Differences on Mathematics Items on the Scholastic Aptitude Test. *Applied Measurement in Education, 6*(2), 137-151. doi: 10.1207/s15324818ame0602_3

Hedges, L., & Nowell, A. (1995). Sex differences in mental test scores, variability, and numbers of high-scoring individuals. *Science, 269*(5220), 41-45. doi: 10.1126/science.7604277

Halpern, D. F. (1997). Sex differences in intelligence: Implications for education. *American Psychologist, 52*(10), 1091–1102. doi: 10.1037/0003-066X.52.10.1091.

Hyde, J. S., Fennema, E., & Lamon, S. J. (1990). Gender differences in mathematics performance: a meta-analysis. *Psychological Bulletin, 107*(2), 139-155. doi: 10.1037/0033-2909.107.2.139.

Hyde, J.S. (2008, September). Girls equal to boys in math performance. *Monitor on Psychology*, 39(8). Retrieved from: www.apa.org/monitor/2008/09/math.aspx.

Hyde, J. S., Lindberg, S. M., Linn, M. C., Ellis, A. B., & Williams, C. C. (2008). Gender Similarities Characterize Math Performance. *Science, 321*(5888), 494-495. doi: 10.1126/science.1160364.

Hyde, J. S., & Mertz, J. E. (2009). Gender, culture, and mathematics performance. *Proceedings of the National Academy of Sciences*. doi: 10.1073/pnas.0901265106.

Innabi, H., & Dodeen, H. (2006). Content Analysis of Gender-related Differential Item Functioning TIMSS Items in Mathematics in Jordan. *School Science and Mathematics, 106*(8), 328-337. doi: 10.1111/j.1949-8594.2006.tb17753.x.

Jordanian Ministry of Education (2008). *Results of the national test for the school year 2007-2008*. Retrieved from: http://www.moe.gov.jo/Files/(15-7-2010)(4-23-37%20PM).pdf.

Jordanian Ministry of Education (2013). *The statistical annual report for the school year 2012/2013.* Retrieved from: http://www.moe.gov.jo/Files/report2013/stRe2013.pdf.

Jordanian Ministry of Education (2014). *Educational System*. Retrieved from: http://www.moe.gov.jo/en/MenuDetails.aspx?MenuID=32.

Kyriakides, L., & Antoniou, P. (2009). Gender differences in mathematics achievement: an investigation of gender differences by item difficulty interactions. *Educational Research and Evaluation, 15*(3), 223-242. doi: 10.1080/13803610902955630.

Linn, M. C., & Hyde, J. S. (1989). Gender, Mathematics, and Science. *Educational Researcher, 18*(8), 17-27. doi: 10.3102/0013189x018008017.

Liu, O. L., & Wilson, M. (2009). Gender Differences in Large-Scale Math Assessments: PISA Trend 2000 and 2003. *Applied Measurement in Education, 22*(2), 164-184. doi: 10.1080/08957340902754635.

Marshall, S. P., & Smith, J. D. (1987). Sex differences in learning mathematics: A longitudinal study with item and error analyses. *Journal of Educational Psychology, 79*, 372–383. doi: 10.1037/0022-0663.79.4.372.

Machin, S., & Pekkarinen, T. (2008). Global Sex Differences in Test Score Variability. *Science, 322*(5906), 1331-1332. doi: 10.1126/science.1162573.

Newcombe, N. S., Mathason, L., & Terlecki, M. (2002). Maximization of spatial competence: More important than finding the cause of sex differences. In A. McGillicuddy-De Lisi & R. De Lisi (Eds.), *Biology, society and behavior: The development of sex differences in cognition* (pp. 183–206). Westport, CT: Ablex Publishing.

Niederle, M., & Vesterlund, L. (2010). Explaining the Gender Gap in Math Test Scores: The Role of Competition. *Journal of Economic Perspectives, 24*(2), 129-144. doi: doi: 10.1257/jep.24.2.129.

Nuttall, R. L., Casey, M. B., & Pezaris, E. (2005). Spatial ability as a mediator of gender differences on mathematics tests. In A. M. Gallagher & J. C. Kaufman (Eds.), *Gender differences in mathematics* (pp. 121–142). Cambridge: Cambridge University Press.

OECD (2006). *PISA 2006: Sciences competencies for tomorrow's world. Volume 1: Analysis*. Retrieved from: http://www.oecd.org/edu/school/programmeforinternationalstudentassessmentpisa/pisa2006results.htm.

OECD (2009a). *PISA 2009 results: what students know and can do. Student performance in reading, mathematics and science (vol 1).* Retrieved from http://www.oecd.org/pisa/pisaproducts/48852548.pdf.

OECD (2009b). *PISA 2009 Technical Report*. Retrieved from: http://www.oecd.org/pisa/pisaproducts/50036771.pdf.

OECD (2009c). *PISA data analysis manual: SPSS, second edition*. Retrieved from: http://browse.oecdbookshop.org/oecd/pdfs/free/9809031e.pdf.

OECD (2013a). *PISA 2012 Assessment and Analytical Framework.* Retrieved from: http://www.oecd.org/pisa/pisaproducts/PISA%20212%20framework%20e- book_final.pdf.

OECD (2013b). *PISA 2012 results: What students know and can do (Volume 1).* Retrieved from: http://www.oecd.org/pisa/keyfindings/pisa-2012-results-volume-I.pdf.

Quenzel, G., & Hurrelmann, K. (2013). The growing gender gap in education. *International Journal of Adolescence and Youth, 18*(2), 69-84. doi: 10.1080/02673843.2012.665168.

Shafiq, M. N. (2011). Gender gaps in mathematics, science and reading achievements in Muslim countries: a quantile regression approach. *Education Economics, 21*(4), 343-359. doi: 10.1080/09645292.2011.568694.

Trends in International Mathematics and Science Study (2012). *TIMSS 2011 international results in mathematics*. Retrieved from: http://timss.bc.edu/timss2011/downloads/T11_IR_Mathematics_FullBook.pdf.

VanLeuvan, P. (2004). Young Women's Science/Mathematics Career Goals From Seventh Grade to High School Graduation. *The Journal of Educational Research, 97*(5), 248-268. doi: 10.3200/JOER.97.5.248-268.

Voyer, D., Voyer, S., & Bryden, M. (1995). Magnitude of sex differences in spatial abilities: A meta-analysis and consideration of critical variables. *Psychological Bulletin, 117*, 250-270. doi: 10.1037/0033-2909.117.2.250.

Weinberger, C. J. (1999). Mathematical College Majors and the Gender Gap in Wages. *Industrial Relations: A Journal of Economy and Society, 38*(3), 407-413. doi: 10.1111/0019-8676.00134.

World Economic Forum (2013). *The global gender gap report*. Retrieved from: http://www3.weforum.org/docs/WEF_GenderGap_Report_2013.pdf.