

Gender Differences in Academic Achievement in Saudi Arabia: A Wake-Up Call to Educational Leaders

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Abstract

Educational leaders must consider equity in education as a priority to make sure all students receive the best education possible. Studies on this topic in Saudi Arabia, however, are still in the embryonic stage. This article, thus, examines whether significant differences in academic achievement exist between male and female students based on gender, subject value, and expectations of education attainment. From a sample study of 3,759 students, the findings showed that female outperformed male students in both math, science, and their domains. Further, the more students value a subject or expect to go far in their education, the higher the score for both students, but female still outperformed male students. Educational leaders should consider these findings a wake-up call to the persistent academic achievement disparities.

Keywords: Academic achievement; Education attainment; Gender; Saudi Arabia; Subject value

Introduction

Educational leaders must consider equity in education as a priority to make sure all students—males and females, rich and poor, minority and majority—receive the best

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education possible. One area of equity issues is gender differences in student academic achievement. Achieving gender equity in education has been a difficult task due to factors both beyond human control (biological) and within human control (sociological). Numerous studies have examined the relationship between academic achievement and gender in a variety of disciplines and countries (Buckley, 2016; Castagnetti & Rosti, 2010; Cobb-Clark & Moschion, 2017; Contini, Di Tommaso, & Mendolia, 2017; Dee, 2006; Dee, 2007; Derks & Krabbendam, 2013; Martin, Mullis, Foy, & Hooper, 2016; Voyer & Voyer, 2014).

Findings on gender differences in academic achievement are mixed. For instance, the Trends in International Mathematics and Science Study (TIMSS), which more than 40 countries take part in every four years, presented its findings in science and math in three categories. The first category is countries in which male students outperformed female students (including Hungary, Chile, Hong Kong SAR, Italy, and the United States), the second is countries in which female students outperformed male students (including Bahrain, Kuwait, Oman, and Jordan), and the last category is countries in which no significant differences were found between male and female students (including Japan, Lithuania, New Zealand, Georgia, Sweden, and Singapore) (Martin, Mullis, Foy, & Hooper, 2016). Other studies using different approaches (e.g., single-sex versus co-educational schooling) documented similar findings in favor of males (Contini, Di Tommaso, & Mendolia, 2017; Doris, O'Neill, & Sweetman, 2013) and females (Al-Sindi, 2013; Eisenkopf, Hessami, Fischbacher, & Ursprung, 2015; Jelas, Salleh, Mahmud, Azman, Hamzah, Hamid, Jani, & Hamzah, 2014). It is apparent in these studies that, although they have significant differences, the achievement differences between the two sexes have been argued through the lenses of social or biological perspectives to assert that one sex is better than the other in some subjects (e.g., reading for females and science and math for males) (Dee, 2006; Fryer & Levitt, 2010; Helgeson, 2016; Robinson & Lubienski, 2011; Steinmayr & Spinath, 2008). As each country has its own education system and teaching arrangement, it is essential, in this study, to briefly present Saudi Arabia and its education system and teaching arrangement.

Saudi Arabia is a country located in the Middle East, occupying 80 percent of the Arabian Peninsula. The country was unified in 1932 by King Abdul Aziz Al Saud (the founder and first King of Saudi Arabia). Its population is estimated to be 33,413,660, of whom 20,768,627 are Saudis and 12,645,033 are non-Saudis (Kingdom of Saudi Arabia, 2018).

Education is one of the priority sectors in Saudi Arabia. The country's king stated that "education in Saudi Arabia is the cornerstone through which we can achieve our nation's aspirations towards progress and advancement in sciences and knowledge" (Al-Tuwaijri, 2018, p. 51). According to the country's budget statement for the fiscal year 2019 (Kingdom of Saudi Arabia, 2019), the budget allocated to education was 192 billion Saudi Riyals (51.2 billion U.S. dollars) representing the highest budget allocation among the government's nine sectors. This huge financial investment and policy effort helped the country improve the education sector and achieve universal education goals. The net enrollment rates at the elementary schools, middle schools, high schools, and higher-education institutions 98, 97, 94, and 69 percent, respectively.

Saudi Arabia follows a centralized system of education (Meemar, Poppink, & Palmer, 2018). The administration of its educational affairs is under the responsibility of the Ministry of Education (public and private K–12, and higher education), the Ministry of Technical and Vocational Training (vocational high schools and polytechnic colleges), and the Ministry of Civil Service (the institute of public administration). The organization of the education system is six years of primary education (ages 6–11), three years of middle-school education (ages 12–14), three years of high-school education (ages 15–17), and two to six years of higher education (ages 18–24) (UNESCO-IBE, 2011). As of 2017, Saudi Arabia serves 6,412,128 students in K–12 (3,269,488 males and 3,142,640 females). Out of this figure, 2,409,236 (1,221,082 males and 1,188,154 females) are enrolled in elementary schools; 1,167,933 (591,565 males and 576,368 females) in middle schools; 1,192,012 (640,997 males and 551,015 females) in high schools; and 1,366,405 (676,617 males and 689,788 females) in higher-education institutions (Kingdom of Saudi Arabia, 2017). The qualifications to teach in K–12 are a secondary institute diploma (kindergarten), associate or bachelor's degree (elementary school), bachelor's degree (middle school), or a bachelor's degree in a subject (high school) (UNESCO-IBE, 2011).

The teaching arrangement in Saudi Arabia can be divided into two stages: early childhood up to third grade, and fourth grade up. Up to the third grade, the teaching arrangement is mixed-sex education, known as co-education. However, from fourth grade, the time when puberty is expected to start, the teaching arrangement follows the single-sex education system. This study is based on students attending single-sex schools in the eighth grade.

Single-sex education exists in both developed, developing, and transitional countries around the world, including Saudi Arabia (Baki, 2004), Malaysia (Jelas et al., 2014), Italy (Contini, Di Tommaso, & Mendolia, 2017), Ireland (Doris, O'Neill, & Sweetman, 2013), the United States (Crawford-Ferre & Wiest, 2013; Pahlke & Hyde, 2016; Patterson, 2012), Switzerland (Eisenkopf, Hessami, Fischbacher, & Ursprung, 2015), and South Korea (Dustmann, Ku, & Kwak, 2018), to cite only a few.

The teaching arrangement in the Middle East is largely single-sex education (Al-Sindi, 2013); however, Saudi Arabia is unique. In Saudi Arabia, gender separation (from puberty onward) is not limited to education settings; it is the norm or default in all public domains in Saudi society (Van-Geel, 2016). In educational institutions, all students, teachers, personnel, and school leaders are from the same sex, working in educational institutions designed for their specific gender (male- or female-only schools or sections for universities). The administration of educational affairs is divided into general education for males (in charge of males only) and general education for females (in charge of females only). It is worth noting, however, that in recent years, the two genders have been allowed to share the same venue (women on one side and men on the other) in limited situations (e.g., conferences, workshops, and general meetings). Findings from this study, therefore, bring a unique perspective to the debates on gender differences in academic achievement.

Review of the literature

Numerous studies have examined the gender differences in academic achievement

using a variety of factors (Blair, 2013; Buckley, 2016; Castagnetti & Rosti, 2010; Chong, 2005; Dee 2006; Steinmayr & Spinath, 2008). Whenever significant differences are found, arguments are advanced through the lenses of social or biological factors.

The biological arguments allege that the achievement differences between the two sexes are a result of natural selection, implying that genetic and environmental factors explain individual differences in academic achievement between males and females (Steinmayr & Spinath, 2008). Jeffrey Derks and Lydia Krabbendam (2013) argued in their findings that the sexes differ in brain structures (on average, men have a larger amygdala and hypothalamus, and women have a larger caudate and hippocampus), functionality (activation during rest and the execution of specific tasks), and regions of the brain (women use both hemispheres when performing tasks, while men are more likely to use just one hemisphere). However, the authors pointed out that results have not been consistent, and the brain differences between the two sexes are not large enough to broadly categorize men and women. This is good news for educators, since biological factors are beyond their control; however, they have the power to influence and address inequalities created by social factors.

Studies arguing that social aspect contribute to academic achievement differences between males and females indicate that parents and society at large play a significant role in creating achievement gaps between male and female students. For instance, through their day-to-day distribution of tasks and subsequent rewards, parents teach children early on what it means to be a boy or girl. Subsequently, children learn gender roles, which are confirmed throughout childhood and into adolescence by friends, the media, and the larger society (Robinson & Lubienski, 2011; Witt, 1997).

Schools and education systems are not immune to blame. Thomas Dee (2007) supports that classroom teachers, through their expectations, praise, role-model assignments, interactions, and beliefs, help shape the achievement gap within the education system. Preferences, stereotypes, and role models are some of the ways a teacher might transmit knowledge to students (Mulji, 2016). The Dee, 2007, argued that students of the teacher's gender get more preferential treatment and rewards than students of the opposite gender. Consequently, students perform better when taught by a teacher of the same gender. Dee's (2007) findings support that student achievement scores drop by 0.042 standard deviations when students are assigned to a teacher of the opposite sex. However, when they are assigned to a teacher of the same sex, it reduces close to a third of the gender achievement gap in a subject. Another study noted that before crafting a policy for single-sex classes based on these findings, one should be cautious, as single-sex classes also have drawbacks (Dee, 2006).

Since Saudi Arabia follows a single-sex education system for the target population of this study, it is important to document some findings related to gender differences in academic achievement with respect to single-sex education.

In a random four-year study of female students in Switzerland assigned to co-education and single-sex classes, the students in single-sex classes showed improved academic performance in mathematics. In addition, the study revealed that single-sex schooling strengthens females' self-confidence (Eisenkopf, Hessami, Fischbacher, & Ursprung, 2015). Likewise, findings from South Korea documented robust evidence that students in single-sex schools outperform their peers in co-educational

schools (Dustmann, Ku, & Kwak, 2018). A study based on a single-sex education program in Chicago called “separating the males from the females” (Patterson, 2012, p. 37) showed that gender separation improves the academic achievement of both females and males. Added benefits included a better learning environment and differentiated learning that meets the interests of each gender.

As pointed out previously, findings on gender-based academic achievement are mixed. Aedín Doris, Donal O’Neill, and Olive Sweetman (2013) found a significant gender gap in favor of males in Ireland. They claimed that the gender gap is larger in favor of children in single-sex schools compared to co-educational schools, but they found no evidence that single-sex education reduces the achievement gap. In Malaysia, findings contrast with those in Ireland in favor of females. It is supported that females outperform males in national examinations across all school levels and types (Jelas et al., 2014). In the Middle East (where single-sex schooling is common), a study involving Syria, Oman, Iran, and Jordan, supports that females outperform males in single-sex schooling (Al-Sindi, 2013).

Vincent Anfara and Steven Martens Mertens (2008) and Erin Pahlke and Janet Hyde (2016) documented arguments for and against single-sex schooling. For the proponents, separating males and females improve students’ academic achievement due to substantial biological differences between males and females. They further contend that single-sex education helps reduce stereotypes; improves females’ self-esteem, confidence, and leadership skills; and makes the learning environment less distracting for both males and females. As for the opponents, the achievement differences due to biological differences are small or non-existent. Critics argued that separation is a synonym for inequality; therefore, single-sex education leads to discrimination. However, for Erik Blair (2013), single-sex schooling is “a means to allow children to break out of imposed gender stereotypes—to not feel pressured into acting in certain ways and to feel free to study whatever subjects they choose” (p. 32).

Beyond the biological, social, and teaching arrangement (single-sex versus co-educational) arguments, other factors impact student achievement regardless of their gender and teaching arrangement: subject values and students’ expectations of academic attainment (Linver, Davis-Kean, & Eccles, 2002; Mata, Monteiro, & Peixoto, 2012).

Regarding subject values, one study argues that males and females perceive math and science subjects differently, females have lower self-esteem than males, and females consider math and science as male domains (Mata, Monteiro, & Peixoto, 2012). Dee (2006) argued that females are more likely to see math and science as less relevant to their future than males do. For Miriam Linver, Pamela Davis-Kean, and Jacquelynne Eccles (2002), the argument regarding differences between male and female achievement should not be centered on which gender performs better in math and science. Their argument focuses on how to make math- and science-related occupations more interesting for high-achieving females.

Another factor that plays a key role in academic achievement is students’ expectations of education attainment. The last three decades have witnessed changes in the postsecondary expectations and career choices of high-school students. These changes started emerging as early as middle school (Fortin, Oreopoulos, & Phipps, 2015). There are many reasons for this shift in expectations. For Maha Shuayb

(2016), “higher levels of education are associated with almost every positive life outcome, including better employment, income, health, and political and civic participation” (p. 226). Consequently, students derive their expectations for education attainment from various sources, such as other students, parents, teachers, schools, and society at large (Gil-Flores, Padilla-Carmona, & Suarez-Ortega, 2011; Othman, Nordin, Norzanah, Endot, Azmi, Ismail, & Yaakob, 2013).

No matter where the expectations come from, the relationship between students’ expectations and achievement is strong. Parents’ expectations are described as having a positive effect on student achievement. Students whose parents expect them to finish college have high grades compared to those whose parents do not expect them to finish college or achieve a higher level of education (Gil-Flores, Padilla-Carmona, & Suarez-Ortega, 2011). Othman, Nordin, Norzanah, Endot, Azmi, Ismail, and Yaakob (2013) state that academic aspiration is a key motivating factor for achievement, and it is therefore difficult to separate the two. In addition to aspirations, the social support students receive helps them face challenges in achieving their goals, as academic persistence is a key to success. When students are motivated and inspired, they achieve more (Othman et al., 2013). Barry (2018) made a similar statement; he argued that the driving forces behind students’ success, regardless of whether they are in a disadvantaged position, is their motivation to learn and the learning-teaching practice.

Statement of the problem

Differences in student academic achievement with respect to gender have been investigated in many countries through different lenses (Fortin, Oreopoulos, & Phipps, 2015; Jelas et al., 2014; Pahlke, Hyde, & Mertz, 2013; Penner & Paret, 2008; Robinson & Lubienski, 2011). The findings of these studies attribute the differences to many factors, including biological, social, and expectations of education attainment and subject values, to cite only a few. In the context of Saudi Arabia, however, studies on this topic are rare. For this reason, this study aims to find out whether there are significant differences in academic achievement between male and female students in Saudi Arabia based on gender, expectations of education attainment, and subject values.

Objectives

This study aims to find out: a) whether there are significant differences in academic achievement between male and female students in Saudi Arabia based on gender, expectations of education attainment, and subject values; and b) if there are any significant differences in achievement between the two groups based on the interaction effects of gender, subject value, and expectations of academic attainment.

Research questions

Two research questions guided this study:

1. Do student academic achievements in math and science in Saudi Arabia differ based on:
 - a. Gender?
 - b. Expectations of education attainment?
 - c. Subject values?

2. Are there any significant differences in academic achievement between female and male students in Saudi Arabia based on the interaction effects of gender, subject value, and how far in education students expect to go?

Hypotheses

The study tested two null hypotheses:

Ho1: There is no significant difference in student academic achievement based on:

- a. gender,
- b. expectations of education attainment, and
- c. subject values.

Ho2: There are no significant differences in academic achievement between male and female students based on the interaction effects of gender, subject value, and how far in education students expect to go.

Based on the research questions and hypotheses, there are two types of variables: independent and dependent. The independent variables (IV) are gender, expectations of education attainment, and subject values. The dependent variable (DV) is student academic achievement in math and science and their domains (knowing, applying, and reasoning) for eighth graders in Saudi Arabia.

Definition of variables

The independent variables (IV)

Gender

Gender in this study refers to the sex of the student at birth (male or female).

Expectations of education attainment

This variable refers to how far students expect to go in their education (lower secondary = 1, upper secondary = 2, postsecondary = 3, short-cycle tertiary = 4, bachelor's degree = 5, or postgraduate degree = 6).

Subject values

The subject value variable refers to how students viewed the value of learning math and science subjects for their daily life, getting into university, getting a job, and having more opportunities later in life (strongly value = 1, value = 2, do not value = 3).

The dependent variable (DV)

Student academic achievement in math and science

Student academic achievement was measured using five plausible values in math and science and their domains. The five plausible values are provided by the Trends in International Math and Science Study (TIMSS) (first to fifth plausible values for math, science, and each of their domains).

Methods

This study used data collected by TIMSS for the 2015 assessment. The data on Saudi

Arabia were downloaded from the TIMSS international online database available free of charge (Foy 2017). The database is made available to researchers, analysts, and other individuals interested in the data. The reason for making the data freely available according to Pierre Foy (2017) is “to support and promote secondary analyses aimed at improving mathematics and science education at the fourth and eighth grades” (p. 1). Individuals interested in TIMSS data have the choice to download the files in SPSS or SAS format. This study chose the SPSS files, which were converted into Stata 15 for analysis.

Study sample

The participants in this study were eighth-grade students in Saudi Arabia who took part in the 2015 TIMSS assessment. Out of an eligible population of 402,639 students from 7,343 schools, TIMSS 2015 sampled 3,759 eighth-grade students in 143 schools.

Instruments

Trends in International Math and Science Study 2015 developed a variety of instruments to assess student academic achievement in math and science. This study focused on two main categories of the instruments: students’ achievement items (plausible values: PV01–05) and student context questionnaires. The achievement items described in the methods and procedures in TIMSS 2015 are aimed at measuring students’ learning in math and science. Additionally, for each subject, students were tested in three cognitive domains: knowing, applying, and reasoning. Students’ achievements in each subject and the corresponding cognitive domains constituted the academic achievement of a particular student (the dependent variable for this study). The math questionnaire consisted of multiple choice and constructed response items in numbers (47), algebra (48), geometry (46), and data and chance (41). In science, the questionnaire consisted of multiple choice and constructed response items in biology (60), chemistry (36), physics (43), and Earth science (33). The achievement items in math and science are reported using plausible values (PV1–05) (Foy, 2017). The context questionnaire also contains scales aimed at measuring key educational research topics such as gender, how far student expects to go in education, and subject values. Experts from different countries reviewed and validated the math (Bulgaria, Ireland, Jordan, Korea, Norway, and the United States) and science (Finland, Hong Kong SAR, Netherlands, England, Russian Federation, Slovenia, and the United States) items. Representatives of TIMSS 2015 in each participating country administered the questionnaires to their selected samples. The collected data were then compiled and primary analyses performed by TIMSS 2015. Individuals interested in investigating educational topics such as the aim of this study have the option to use these data to perform secondary analyses of educational topics of interest (for more details on questionnaire development, validation, and implementation, see Hooper, 2016; Mullis, Cotter, Fishbein, & Centurino, 2016).

Using the achievement score (plausible values in math, science, and their domains) as the dependent variable, and students’ gender, expectations of education attainment, and subject values as independent variables, this study aimed to discover

whether there are significant differences in academic achievement between male and female students in Saudi Arabia based on these three independent variables.

Data analysis

To analyze the data, the International Database Analyzer (IEA ID Analyzer version 4.0 (Foy, 2017)) was used to combine students' academic achievement files and context questionnaire files. Using Stata 15 software, both descriptive and inferential statistics were computed. The descriptive statistics consisted of finding the means and standard deviations of each group (males and females) for each subject (math and science) and their domains (knowing, applying, and reasoning); students' expectations of academic attainment; and subject value. The reason for computing the domains associated with the subjects was to find out if the achievement of a group (male or female) is consistent for a subject and its domains (knowing, applying, and reasoning). If that is the case, then one can agree that a group achievement in a subject does not occur by chance. For the inferential statistics, an independent samples *t*-test was used to find whether there were any significant differences between the two groups (male and female) based on gender, subject values, and expectations of education attainment. Additionally, a factorial analysis of variance (ANOVA) was used to test whether there is a statistically significant difference in students' achievement mean (their scores in math and science) based on the interactions of the three independent variables (gender, subject value, and expectations of education attainment).

Results

Descriptive statistics

Table 1a presents the means and standard deviations of students' achievement by gender in math and science and their domains.

Table 1a: Student mathematics and science achievement in eighth-grade by gender

Saudi Arabia		Sex	<i>N of Obs.</i>	<i>Achiev. PV 01-05</i>	<i>SD. PV01-05</i>
Subject	Math	female	1998	375.69	71.15
		Male	1761	361.19	83.21
Math domains	Knowing	female	1998	362.87	79.40
		Male	1761	358.71	93.12
	Applying	female	1998	370.70	69.43
		Male	1761	358.85	79.62
	Reasoning	female	1998	390.11	70.91
		Male	1761	358.44	83.06
Subject	Science	female	1998	424.19	77.89
		Male	1761	369.00	93.36
Sci. domains	Knowing	female	1998	418.31	78.92
		Male	1761	372.77	90.00
	Applying	female	1998	413.81	85.88
		Male	1761	351.85	101.68
	Reasoning	female	1998	434.17	79.51
		Male	1761	374.88	93.19

Notes: *Achiev.* = Means of students' achievement in math, sciences, and their domains; *SD* = standard deviation from the mean; *N of Obs* = number of male and female students who participated in the assessment

Table 1a shows that female students in Saudi Arabia outperformed male students in both math and science, in both the subjects and their domains. Additionally, the standard deviations of male students are larger than those of female students in all

subjects and their domains, indicating that female students are more homogeneous than male students in their level of academic achievement.

Table 1b presents the means and standard deviations of how far in education students expect to go and how they view the value of studying math and science.

Table 1b: Students value subjects and how far in education they expect to go by gender

Saudi Arabia		Sex	N of Obs.	Mean	SD
<i>How far in education students expect to go</i>		female	1990	5.25	1.30
		Male	1744	4.84	1.14
<i>Students Value</i>	<i>Math</i>	Female	1984	1.89	1.23
		Male	1747	2.07	1.68
	<i>Science</i>	female	1993	1.90	1.56
		Male	1756	2.06	1.73

Notes: Students value math/science (1 = strongly value, 2 = value, 3 = do not value). How far in education students expect to go (1 = lower secondary, 2 = upper secondary, 3 = postsecondary, 4 = short-cycle tertiary, 5 = bachelor's degree or equivalent, 6 = postgraduate degree).

As shown in Table 1b, female students ($M = 5.25$, $SD = 1.30$) in Saudi Arabia expect to go farther in their education than their male peers ($M = 4.84$, $SD = 1.14$). The table also reveals that female students value studying math and science ($M = 1.89$, $SD = 1.23$; $M = 1.90$, $SD = 1.56$) more than male students ($M = 2.07$, $SD = 1.68$; $M = 2.06$, $SD = 1.73$). As with the achievement scores, female students are more homogenous (the smaller the standard deviation, the more homogenous the group) than male students in their expressions of subject values and how far in education they expect to go.

To find out whether the differences are statistically significant between the two groups, inferential statistics (an independent two-sample t-test and three-way factorial ANOVA) were performed.

Inferential statistics

Table 2 presents the independent sample t-test between the two groups based on gender, subject value, and how far in education students expect to go.

Table 2: Independent samples t-test of students' achievement in math and science

	Female			Male			df.	t	p	Hedges' g	H0 Reject?
	n	M	SD	n	M	SD					
PVM0105	1988	375.69	71.15	1761	361.19	83.21	3757	5.76	.00	.19	yes
PVS0105	1988	424.19	77.89	1761	369.00	93.36	3757	19.75	.00	.65	yes
HFED	1990	5.25	1.23	1744	4.84	1.74	3732	8.31	.00	.27	yes
SVM	1984	1.89	1.23	1747	2.07	1.68	3729	3.88	.00	.13	yes
SVS	1993	1.90	1.56	1756	2.06	1.73	3747	2.85	.00	.09	yes

Notes: $P \leq 0.05$; PVM0105/PVS0105: Student achievement in math and science using five plausible values; HFED: How far in education students expect to go. SVM: Students value math. SVS: Students value science.

Table 2 shows that there are statistically significant differences between female and male students in terms of academic achievement in math, $t(3757) = 5.76$, $p = .00$;

science, $t(3757) = 19.75, p = .00$; how far in education students expect to go, $t(3732) = 8.31, p = .00$; and how students view the value of studying math, $t(3729) = 3.88, p = .00$, and science $t(3747) = 2.85, p = .00$. Therefore, the null hypotheses (i.e., there are no differences between the true means of the two groups) are rejected in favor of the alternative (i.e., there are differences). All effect sizes as measured by Hedge's g are small, however, except that of student achievement in science.

To compare the interaction effects on student academic achievement in math and science, a three-way factorial ANOVA without repeated measure was conducted (see Table 3a and Table 3b).

Table 3a: Factorial analysis of students' achievement in math

Source	Partial SS	df	MS	F	Prob>F
Model	3040198.2	55	55276.331	10.58	0.0000
SEX	44625.139	1	44625.139	8.54	0.0035
HFED	523742.67	6	87290.445	16.70	0.0000
SVM	61461.846	3	20487.282	3.92	0.0083
SEX#HFED	23112.46	6	3852.0767	0.74	0.6197
SEX#SVM	13162.629	3	4387.5429	0.84	0.4720
HFED#SVM	123366.02	18	6853.6676	1.31	0.1691
SEX#HFED#SVM	79221.913	18	4401.2174	0.84	0.6508
Residual	19083749	3,652	5225.561		
Total	22123947	3,707	5968.1541		

Table 3b: Factorial analysis of students' achievement in science by gender, HFED, SVS, and their interactions

Source	Partial SS	df	MS	F	Prob>F
Model	6972935	55	126780.64	20.25	0.0000
SEX	537969.19	1	537969.19	85.93	0.0000
HFED	783142.57	6	130523.76	20.85	0.0000
SVS	44459.691	3	14819.897	2.37	0.0689
SEX#HFED	109673.69	6	18278.949	2.92	0.0077
SEX#SVS	42116.78	3	14038.927	2.24	0.0813
HFED#SVS	128604.51	18	7144.6947	1.14	0.3038
SEX#HFED#SVS	140586.8	18	7810.3775	1.25	0.2131
Residual	22968785	3,669	6260.2302		
Total	29941720	3,724	8040.204		

For student academic achievement in math, Table 3a shows that the main effects (SEX, HFED, and SVM) are statistically significant at the .05 significance level. The F ratios are $F(1, 3652) = 6.43, p = .01$ for sex; $F(6, 3652) = 61.53, p = .00$ for how far in education students expect to go; and $F(3, 3652) = 23.30, p = .00$ for student value studying math. However, none of the interaction effects (SEX#JFED, SEX#SVM, HFED#SVM, and SEX#HFED#SVM) is statistically significant. Therefore, the null hypothesis (Ho2) is accepted (there are no significant differences) against the alternative (there are significant differences).

For the student academic achievement in science, Table 3b shows that two of the main effects (sex and how far in education students expect to go) and their interaction effect are statistically significant at the .05 significance level. The F ratios are $F(1, 3669) = 85.93, p = .00$ for sex; $F(6, 3669) = 20.85, p = .00$ for how far in

education students expect to go; and $F(6, 3669) = 2.92, p = .00$ for the interaction between how education expectations and sex. The adjusted R -squared (Tables 3a and 3b) shows that this model explains the 12.44 percent for math and 22.14 percent for science.

To show students' achievement in math and science for each group based on subject value and how far students expect to go in their education, predictive margins and margin plots at 95 percent confident intervals (CIs) were used (see Figure 1, Figure 2, and Figure 3).

Figure 1. Mean plot of students' achievement in and value of math by gender

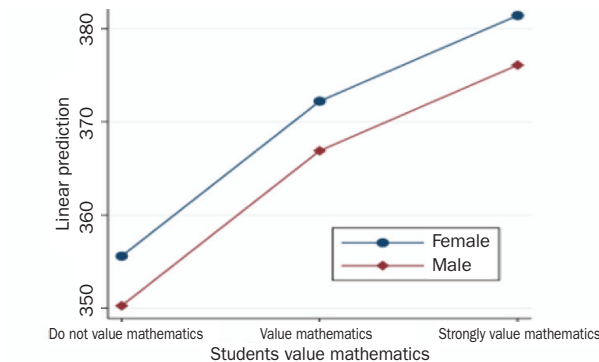


Figure 2. Mean plot of students' achievement in and value of science by gender

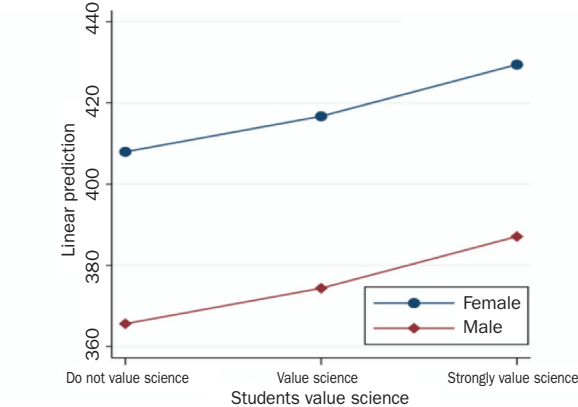
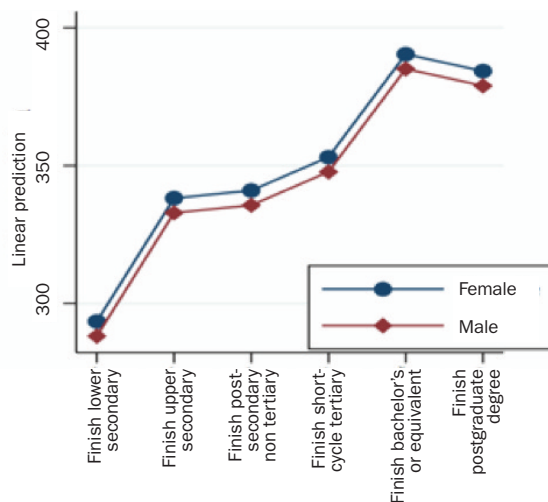


Figure 3. Mean plot of students' achievement by how far in education students expect to go



The predictive margins between male and female students differ at a five percent significance level. Both margin plots show that females' achievement is higher than that of male students in both math and science, based on how they value the subjects. The gap between the two groups is wider in science than in math. It is noted that for both males and females, the more the students value the subject, the higher their achievement scores. As for how far in education students expect to go, the gap between the two groups is not as large as it is for math and sciences, but female students still score higher than male students at all levels of education attainment expectations. Among the six levels, however, as shown in Figure 3, students who expect to finish a bachelor's degree or equivalent are the highest achievers.

Discussion and conclusions

The main aim of this study was to find out whether there are significant differences in academic achievement between male and female students in Saudi Arabia based on three explanatory factors: gender, subject value, and education attainment expectations.

The first research question tried to discover whether student academic achievement in math and science in Saudi Arabia differs based on a) gender, b) expectations of education attainment, and c) subject value.

The descriptive statistics (Tables 1a and 1b) show that female students outperformed male students in all assessed areas in math, science, their domains, subject value, and expectations of academic attainment. Further, females are more homogenous than males in their academic achievement (standard deviations are smaller for females than for males). In addition, the inferential statistics (Table 2) show statistically significant differences between the two groups in favor of female students.

Because female students outperformed male students in math and science and their domains, these findings are not in line with the biological argument, which claims that the two sexes differ in brain structures, functionality, and regions (Derks & Krabbendam, 2013; Steinmayr & Spinath, 2008), and that male students perform better in math and science and female students in reading. Proponents of single-sex education claimed that because of the substantial biological differences between boys and girls, separating the two genders improves academic achievement. The findings of this study support this argument for female students, but not for male students.

To discuss these findings in the context of the social perspective, it is important to point out, as stated earlier, that schools in Saudi Arabia are fully separated based on gender from the fourth grade (the age at which puberty starts) onward. In other words, students, teachers, school leaders, and personnel within a school are all the same sex. Arguments from the social perspective support that gender-separated schooling helps students break out of imposed gender stereotypes and feel free to study any subject they choose (Blair, 2013), provides better a learning environment and differentiated learning based on the interests of each gender (Patterson, 2012), and strengthens females' self-confidence (Eisenkopf, Hessami, Fischbacher, & Ursprung, 2015). The academic achievement of females in this study strongly supports these arguments. The findings of this study showed that female students outperformed their male peers in math and science, their corresponding domains, subject values, and their educational attainment expectations. These findings are

analogous to findings in Malaysia where females outperformed males in national examinations at all levels (Jelas et al., 2014). Similarities also exist between the findings of this study and those documented in other Middle Eastern countries (Jordan, Syria, Oman, Iran) (Al-Sindi, 2013). Findings from these countries support that females generally outperform males in single-sex schooling. The findings of the present study and studies investigating other countries in the region suggest that single-sex education in the Middle East helps improve female academic achievement but not male academic achievement.

With respect to the subject values, previous studies indicate that females are more likely to see math and science as male domains (Mata, Monteiro, & Peixoto, 2012). Therefore, females see math and science as less relevant to their futures (Dee, 2006). These arguments are not supported by the findings of this study, because female students outperformed male students in both subjects and their domains. These findings, however, agree with the arguments (Linver, Davis-Kean, & Eccles, 2002) that academic achievement should not focus on who is better in math and science but rather on how to make the subjects relevant to students' interests and future occupations.

Regarding expectations of academic attainment, the findings agree with Gil-Flores, Padilla-Carmona, and Suarez-Ortega's (2011) findings that the further in education students expect to go, the higher their achievement scores. This is true for both female and male students; however, female students scores are still higher.

The second research question addressed in this study explored whether there are any significant differences in academic achievement between female and male students in Saudi Arabia based on the interaction effects of gender, subject value, and how far in education students expect to go. The main effects (gender, subject values, and education attainment) are statistically significant, but their interactions are not (Table 3a and Table 3b), except for the interaction between gender and education attainment in science (Table 3b).

The conclusion of this study is that female students outperformed male students in academic achievement in Saudi Arabia. The female achievement mean score is higher in math and science and their domains. The same holds true for students' expression of subject value and their expectation of academic attainment. Furthermore, females are more homogenous in their achievement, as the standard deviations of each group have shown (the smaller the standard deviation, the closer the academic ability among students within a group).

Recommendations for policy, practice, and further studies

Findings from this study revealed that in Saudi Arabia, the academic achievement of female students is higher than that of their male counterparts in math and science and their domains, subject values, and expectations education attainment. Based on these findings, a few implications for policy, practice, and recommendations further studies are suggested.

It is recommended that educational leaders, policymakers, and practitioners organize awareness sessions, workshops, and seminars on gender academic achievement disparities so that findings like these can be shared and discussed with school district leaders, school leaders, classroom teachers, and the community. In addition

to raising awareness, educational leaders and policymakers are urged to support and encourage partnership among schools and between schools and universities to investigate academic achievement disparities and share good practices. In these partnerships, teachers, school leaders, and university educators could work together to find out why male and female students following the same curriculum and coming from the same community (sometimes brothers and sisters living in the same household) have such a disparity in academic achievement. This study is based on TIMSS data. Saudi Arabia has participated in TIMSS assessments since 2003. The country's world ranking (at the bottom) is always the big news, but it is important to go beyond the world ranking to analyze the data and share the results with school leaders, classroom teachers, and the community to identify main causes, situate responsibilities, and share good practices.

With regard to recommendations for further studies, it must be recognized that this present study relied on the quantitative research approach as a wake-up call on the gender achievement gap in Saudi Arabia, but to fully understand the main causes, a joint follow-up study using the qualitative research approach is essential. The recommendation for the qualitative study is that the Ministry of Education forms a research team involving university educators, school leaders, and teachers from both sections (males and females) to investigate whether the achievement differences are related to students (how males and female learn, the motivating factors that help females excel in academic achievement), homes (parental characteristics and dynamics in terms of male and female education, family values), schools (how the written curriculum is taught and assessed in male and female schools, the qualifications, experiences, and teaching and leadership styles of teachers and school leaders), the education system (education and teaching arrangement policies), or society (the value of education for females and males, culture, and religious beliefs). A topic for further study is the limited opportunities of employment for the high academic achievers: females.

The findings of this study are not only of great interest to policymakers, school leaders, teachers, and the community in Saudi Arabia, but also to Gulf countries, which share similar education systems, culture, and beliefs and have comparable academic achievement disparities.

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