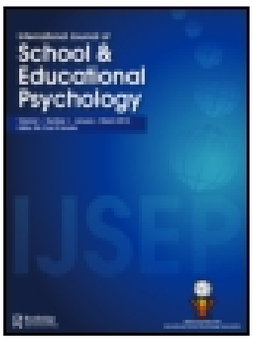

International Journal of School & Educational Psychology

ISSN: 2168-3603 (Print) 2168-3611 (Online) Journal homepage: https://www.tandfonline.com/loi/usep20

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To cite this article: Najib A. Mozahem, Farah M. Boulad & Carla M. Ghanem (2020): Secondary school students and self-efficacy in mathematics: Gender and age differences, International Journal of School & Educational Psychology, DOI: 10.1080/21683603.2020.1763877

To link to this article: https://doi.org/10.1080/21683603.2020.1763877

Published online: 22 May 2020.

INTERNATIONAL JOURNAL OF SCHOOL & EDUCATIONAL PSYCHOLOGY
https://doi.org/10.1080/21683603.2020.1763877

Secondary school students and self-efficacy in mathematics: Gender and age differences

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ABSTRACT

Gender differences in academic performance has received considerable attention over the years. Studies have found that even when there are no gender differences in math performance, female students exhibit larger levels of apprehension toward the subject and that this gap between the genders increases with time. This study investigates gender differences in the sources of information that lead to perceived self-efficacy in math and whether the information changes with age. Using items developed by Ellen Usher and Frank Pajares, 347 surveys were collected from six private schools in Lebanon. Confirmatory factor analysis is used to establish the validity of the measurement tool in a non-Western country. A structural component is then introduced into the model to account for age. Results indicate that older girls are more likely to receive negative information from the four sources, thus leading them to develop lower levels of perceived self-efficacy in math. These findings indicate that different socialization processes are at work, thereby providing support for social roles theories.

KEYWORDS

Gender; math; school psychology; self-efficacy; social cognitive theory

Introduction

Occupations are a source of identity and self-worth (Bandura et al., 2001), as well as being a source of income. As such, career choices have significant implications on the lives of individuals (Savickas et al., 2009). It is therefore imperative that both educators and parents have a better understanding of the development process of adolescents (DuBois, 2001). Of particular importance is the finding that strong gendered differences exist in career choices. One of the most prominent theories to explain this finding is social cognitive theory (Bandura, 1986). The theory posits that individual beliefs about self-efficacy influence the choices made by individuals through behavioral and psychological processes. Individuals construct their self-efficacy beliefs from different sources: mastery experience, vicarious experience, social persuasions, and physiological state.

Given that gendered differences have been found to be most evident in science, technology, engineering, and mathematics (collectively referred to as STEM) (Master et al., 2017), researchers have paid particular attention to self-efficacy beliefs in the domain of math. This paper seeks to test and validate the measurement tool developed by Usher and Pajares (2009). Once the validity and reliability of the tool is verified, this study will investigate whether there are gender differences in terms of the four sources of information from which self-efficacy develops. By including children in both middle school as well as in high school, the study will be able to test the hypotheses that girls witness a decline in their self-efficacy beliefs as they grow due to gendered differences in the sources of information.

Literature review

Gender differences in academic achievement have received a lot of attention over the past decades. Two seemingly opposite results have emerged from many of these studies. First, despite traditional stereotypes (Hilliard & Liben, 2010; Lane et al., 2012), there is strong empirical evidence that suggests that male students do not perform better than female students in math (Else-Quest et al., 2010; Hedges & Nowell, 1995; Hyde & Linn, 2006; Lindberg et al., 2010). Some researchers, in keeping with traditional biological explanations (Geary et al., 2000), have argued that while the average performance of the two genders is the same, boys display more variation. As a result, boys are overrepresented in both the upper and lower-tails of the distribution (Ellison & Swanson, 2010; Guiso et al., 2008). This explanation, referred to as the variability hypothesis (Shields, 1975), has been criticized because the alleged variability between the two genders

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was neither found to be constant (Hyde & Mertz, 2009), nor culturally indifferent (Feingold, 1994). As such, the data does not support the notion that males are better than females in math.

The second finding from research is that male students are more confident in their mathematical abilities, even when no gender differences exist in achievement (Devine et al., 2012). In another study, Goetz et al. (2013) found that female students reported higher levels of anxiety in mathematics, and lower levels of perceived competence than their male counterparts even though both groups had the same average grades. In a more comprehensive meta-analysis, Else-Quest et al. (2010) found that males reported more positive attitudes in math than females. Studies have also found that the gap between the genders in perceived math ability increases during high school (Ceci et al., 2014; Hyde et al., 1990).

Why is it that females have a more negative attitude about math than males, even though performance measures do not differ? In one of the earliest studies about gender differences in perceived self-efficacy, Betz and Hackett (Betz & Hackett, 1981; Hackett & Betz, 1981) found that female college students displayed lower levels of self-efficacy for certain occupations that were traditionally held by males despite the fact that there were no gender differences in math scores. The authors concluded that girls in society were either not encouraged, or worse yet, actively discouraged from pursuing some activities that might have led to strengthen their sense of self-efficacy.

The concept of self-efficacy plays a central role in Bandura's Social Cognitive Theory (Bandura, 2001, 1999, 1982). In Social Cognitive Theory (SCT), individuals are neither controlled by their environment, nor are they completely autonomous (Bandura, 2001). Instead, the relationship is viewed as being bidirectional, where the environment can limit the options that are available to an individual, but at the same time, the individual has the ability to determine which part of the potential environment will actually be experienced (Zimmerman, 1990). This process of activating certain elements of the environment is referred to as *selection processes* (Bandura, 1989). These selection processes, in turn, depend on the individual's self-efficacy since people avoid activities that they believe exceed their capabilities, even if the belief is not factual (Badura, 1977). Therefore, in SCT, what matters is perceived self-efficacy, not actual efficacy. Thus, according to this view, perceived self-efficacy becomes the foundation of human agency since it determines which actions the individual will undertake and which he or she will avoid (Bandura, 1982; Zimmerman, 1990). Studies have found that perceived self-efficacy was more useful than outcome expectations in predicting occupational preferences (Lent et al., 1987).

The concept of self-efficacy has received considerable support from research. Studies have found that children's perceived self-efficacy regulates their own learning activities (Bassi et al., 2007) by affecting their motivation (Zimmerman, 1995), their achievements in math, science, and writing (Klassen & Usher, 2010; Pajares & Urdan, 2006), and their likelihood of remaining in school (Caprara et al., 2008).

Since self-efficacy is domain-specific (Betz, 2004; Pajares, 1996; Vogt, 2008; Zimmerman, 1990), SCT provides an attractive framework that explains why girls' perceived self-efficacy in certain fields, such as math, is lower than that of boys. The theory posits that an individual's perceived self-efficacy develops from information gathered from four sources: mastery experience, vicarious experience, social persuasion, and physiological state. The four sources are illustrated in Figure 1 and explained in Table 1.

Since success heightens perceived self-efficacy, mastery experience is a very important source of information. Despite the fact that girls do not do worse than boys on math, mastering a subject requires repeated and continuous attempts (Bandura, 1982). However, if girls avoid math because of the heightened sense of anxiety that it induces in them, they will find themselves engaging in a self-fulfilling prophecy (Betz, 2004). Boys, on the other hand, are more likely to be exposed to mechanical and technical activities while growing up (Betz & Hackett, 1997). As a result, this source of information will lead to a heightened sense of self-efficacy for boys and a lowered sense of self-efficacy for girls.

Vicarious experience is also an important source of information since seeing similar people successfully

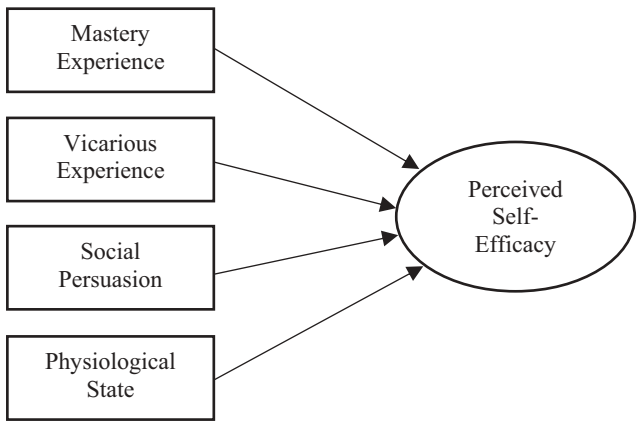

Figure 1. Bandura's model of the sources of self-efficacy and the outcomes.

Table 1. The sources of mathematics self-efficacy with examples of items for each (Source: Usher and Pajares (2009)).

Source	Description	Sample items
Mastery experience	The interpreted result of one's own previous attainments. "Successes build a robust belief in one's efficacy. Failures undermine it, especially in earlier phases of self-development" (Bandura, 1999, p. 181).	I have always been successful with math Even when I study very hard, I do poorly in math
Vicarious experience	Seeing similar others perform the same task. "If people see others like themselves succeed by sustained effort, they come to believe that they, too, have the capacity to succeed" (Bandura, 1999, p. 181).	When I see how my math teacher solves a problem, I can picture myself solving the problem in the same way Seeing kids do better than me in math pushes me to do better
Social persuasion	Encouragement from important others, such as parents, teachers, and friends, can increase an individual's confidence. "If people are persuaded that they have what it takes to succeed, they exert more effort and are more perseverant than if they harbor self-doubts and dwell on personal deficiencies when problems arise" (Bandura, 1999, p. 181).	My math teachers have told that I am good at learning math Adults in my family have told me what a good math student I am
Physiological state	Students interpret their physiological arousal as an indicator of personal competence. "They read their tension, anxiety and depression as signs of personal deficiency" (Bandura, 1999, p. 181).	Just being in math class makes feel stressed and nervous I get depressed when I think about learning math

perform a task enhances an individual's belief in his or her own abilities in performing the task (Schunk & Pajares, 2001). Research has supported this in the context of mathematics self-efficacy (Matsui et al., 1990).

Concerning social persuasion, studies have shown that the information received by children from their social surroundings is mediated by the gender of the child (Frome & Eccles, 1998; Tenenbaum & Leaper, 2003). Studies have found that parent's perception of their children influences how they behave toward their children (Jacobs & Eccles, 1992), which influences the children's self-perception (Simpkins et al., 2012) and even achievements (Hill & Tyson, 2009). Teachers' expectations have also been found to be influenced by the gender of the child (Gunderson et al., 2012).

Finally, as discussed above, girls have been found to exhibit higher levels of math anxiety than males (Devine et al., 2012; Goetz et al., 2013), thus leading them to have more negative attitudes toward the subject (Else-Quest et al., 2010). Given the above, it comes as no surprise that studies have found that boys have a greater sense of self-efficacy in math than girls (Bandura et al., 2001; Pastorelli et al., 2001). As noted by Usher and Pajares (2009), previous studies asses physiological state as an individual's feelings of anxiety, due to the fact that anxiety is the most salient form of the state. However, it is important to note that a number of factors can influence an individual's physiological state. These factors include mood and distress levels. Another important point to note is that higher values of this construct indicate a greater level of physiological agitation, as illustrated by the sample items included in Table 1.

Purpose of the study

While the concept of self-efficacy has received considerable interest from researchers, there remain three pertinent gaps in the literature. The first gap is that most of the studies measuring self-efficacy were conducted exclusively in Western countries such as the U.S. (Usher & Pajares, 2008), Italy (Bandura et al., 2001; Bassi et al., 2007; Caprara et al., 2008), Hungary and Poland (Pastorelli et al., 2001), and France (Joët et al., 2011). The second gap, as noted by Usher and Pajares (2009) is that the sources of self-efficacy have not been examined thoroughly. Given that self-efficacy is domain-specific (Bandura, 1986), different tools are required to measure the construct in different domains. With regard to measuring the sources of self-efficacy in academic settings, researchers have yet to reach a consensus on the best measurement tool (see Usher and Pajares (2009) for a review). In addition, the tools that have been used in previous studies have not been validated using rigorous statistical techniques. Some studies used composite scores instead of individual item scores (Lent et al., 1996), while other studies have reported poor internal reliability (Usher & Pajares, 2006). In other cases, researchers had to revise the model due to poor fit (Stevens et al., 2006). The third gap is that most of the studies investigating mathematics self-efficacy were conducted with high school and college students, thereby not allowing for an understanding of how time factors into the model since by the time students reach high school, their perception of self-efficacy would have been formulated.

Given the above, the purpose of the present study is threefold. First, the study seeks to expand the literature by studying academic self-efficacy in a non-Western country, which is Lebanon. Lebanon is situated in the Middle East and has a population of around 6 million. In the 2016– 2017 academic year, a total of 1,065,490 students were enrolled in schools over the country. Almost half of these students (49.8%) were female (Center for Educational Research and Development, 2018). Recently, researchers have started to pay more attention to gender differences in career choices in the country. Data published by the Ministry of Education clearly show that in

vocational schools females are underrepresented in fields such as car mechanics, industrial mechanics, electronics and construction, and at university level females are underrepresented in majors such as mechanical engineering, computer science, and civil engineering (Mozahem et al., 2018). Even more crucially for the present study, results suggest that gender differences in interest in occupations such as computer and communications engineering, mathematics, and computer science develop over time (Mozahem et al., 2018). In a more detailed qualitative study, Mozahem et al. (2019) found that successful female engineers report significant social pressure and obstacles, with many of the respondents reporting incidences of ridicule with regard to their major of choice. While these previous studies dealt with career choices, the present study seeks to add to the literature by investigating one of the explanations put forth for these differences.

Second, the study seeks to validate the measurement tool developed by Usher and Pajares (2009). Some of the items included in this tool are shown in Table 1. Unlike previous tools, this particular tool was tested and validated by the authors using a combination of exploratory factor analysis and confirmatory factor analysis. The tool developed by the authors was found to have both a good fit with data as well as having good internal consistency. This study will also use confirmatory factor analysis in an attempt to validate the final measurement model in a different cultural context.

Finally, this study will include both middle school as well as high school students in the sample. By including these two different age groups, it will be possible to investigate whether age plays a role in the model. As discussed in the literature review, research has found that gaps between the genders tend to increase over time, where the increase is in favor of boys. Specifically, this study will test the following four hypotheses:

Hypothesis 1: Compared to boys, older girls report lower levels of mastery experience than younger girls.

Hypothesis 2: Compared to boys, older girls report lower levels of vicarious experience than younger girls.

Hypothesis 3: Compared to boys, older girls report lower levels of social persuasions than younger girls.

Hypothesis 4: Compared to boys, older girls report higher levels of physiological state than younger girls.

Methodology

Data collection

There are four types of schools in Lebanon: public schools, free private schools, tuition-based private schools, and schools for Palestinian refugees. According to data published by the Ministry of Education, 52.5% of students at school level attend a tuition-based private school while 30.8% are in public schools. French is the primary language of instruction in 52.3% of schools, while English is used in the remaining 47.7%. When looking at these numbers for the different types of schools, English is the primary language in 41.2% of public schools, while it is the primary language in 48.3% of tuition-based private schools. Public schools in Lebanon are under-developed and under-funded when compared to private schools, thereby leading parents to send their children to a tuition-based private school if they can afford to do so. The result is that public school students tend to come from lower-income families. This social division is illustrated by the fact that 50.7% of middle-school students and 34.5% of high school students in public schools are classified as being behind, i.e., they are expected to be in a higher class given their age. In comparison, the numbers for all four types of schools combined are 27.9% and 25.9%, respectively. In addition, 22.2% of middle-school students and 10.1% of high school students in public schools are repeating their current class, while the numbers for all types of schools combines are 9.9% and 5.6% (Center for Educational Research and Development, 2018).

Given that this study seeks to investigate gender differences in self-efficacy in math, we wanted to control for factors such as family income and school resources. As such, we targeted tuition-based private schools in the same geographic location. The surveys were distributed in six private schools in Chouf, an administrative district in the governorate of Mount Lebanon. In order to use the same survey as the one used by Usher and Pajares (2009), the surveys were distributed in English with no modifications. Therefore, the schools where the surveys were distributed were English teaching institutes, in that all subjects, except the languages, were taught in English. The schools were contacted in advance in order to set up a meeting where two of the researchers explained the nature of the research to the school administrators. Once the school's official approval was secured, the surveys were distributed to students while they were in their respective classes. One of the researchers, as well as a school administrator, was present while the students were filling out the surveys. The researcher was there to answer any question that students might have regarding any of the items in the survey.

A total of 435 surveys were distributed, out of which 347 contained no missing information. The average age of the respondents was 15.33, with a standard deviation of 1.36. The youngest respondent was 11 years old, and the oldest was 18. Of the 435 respondents, 53.10% were female, 45.98% were male, and 0.92% did not indicate their gender. In addition to the age, gender, and the 24 items used to measure the four sources of self-efficacy, the surveys asked students to indicate in which section they were enrolled. In the Lebanese system, once a student reaches grade 11, he or she is enrolled in either the Science section or the Social/Literature section, depending on their grades and on their interests. In the final year, students are further divided into the following sections: Life Sciences, General Science, Social and Economic, and Humanities. The survey that we distributed asked students to indicate in which section they were enrolled if they were in grades 11 or 12. Of the 131 students who were in grade 11, 71.76% were in the Science section, and 28.24% were in the Social/Literature section. Of the 149 students who were in grade 12, 25.5% were in the Life Sciences section, 44.97% were in the General Science section, 26.85% were in the Social and Economic section, and 2.68% were in the Humanities section. Tables 2 and 3 show the gender distributions of both genders in each of these sections. Data published by the Center for Educational Research and Development (2018) indicates that 70.81% of students in grade 11 are enrolled in the science section. With regard to students in grade 12, the data suggests that 33.75% are enrolled in the Life Sciences section, 13.56% are enrolled in the General Science section, 46.92% are enrolled in the Social and Economic section, and that 5.77% are enrolled in the Humanities section.

Data analysis

We used confirmatory factor analysis (CFA) to test the validity of the measurement model developed by Usher and Pajares (2009). CFA allows each item to have its own unique variance, thereby separating the shared variance from the items' unique variances. This allows for better estimates of the latent variables (Acock, 2013). The goodness-of-fit of the models is measured using the comparative fit index (CFI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR). Models that are considered to have a reasonable fit have a CFI greater than 0.90, and RMSEA and SRMR less than 0.08. If the model has a CFI greater than 0.95 and RMSEA and SRMR values less than 0.05, then it is considered to be a well-fit model (Hu & Bentler, 1999).

Another important advantage of CFA is that it utilizes a structured means approach in order to compare the means of more than one group. This technique provides a more accurate test than traditional tests such as multivariate analysis of variance (MANOVA) since it allows for partial measurement invariance across groups (Thompson & Green, 2006).

Table 2. Gender distribution in grade 11 sections in our sample.

	Science	Social/Literature
Girls	70.73%	29.27%
Boys	73.47%	26.53%

Table 3. Gender distributions in grade 12 sections in our sample.

	Life Sciences	General Science	Social and Economic	Humanities
Girls	32.84%	31.34%	29.85%	5.97%
Boys	19.75%	56.79%	23.46%	0.00%

Results

Measurement model validation

The first step in the analysis was to verify the measurement model developed by Usher and Pajares (2009). The reliability of the items used to measure each of the four constructs was measured using Cronbach's alpha. In each case, the value of the statistics was greater than 0.7 (0.85 for *Mastery Experience*, 0.79 for *Vicarious Experiences*, 0.91 for *Social Persuasions*, and 0.88 for *Physiological State*). We next used confirmatory factor analysis in order to fit a measurement model (Figure 2). Following Usher and Pajares (2009), all four constructs were included in the model in order to measure the correlations between each. The model displays acceptable fit, with the CFI index being greater than 0.90 and both the RMSEA and the SRMR being less than 0.08. All of the loadings were significant at the $p < .001$ level with the magnitude ranging between 0.44 and 0.86. Note that only two of the loadings were between 0.4 and 0.5, with all of the rest being greater than or equal to 0.54.

The correlations between the constructs range from 0.61 to 0.86. Similar to the findings of Usher and Pajares (2009), our results indicate that the strongest correlation is between *Mastery Experience* and *Social Persuasions* and that the weakest correlation is between *Vicarious Experience* and *Physiological State*, although in our results the magnitude of the weakest correlation is 0.65.

Gender differences in the sources of self-efficacy

We next conducted analysis in order to measure whether there are gender differences in the sources of

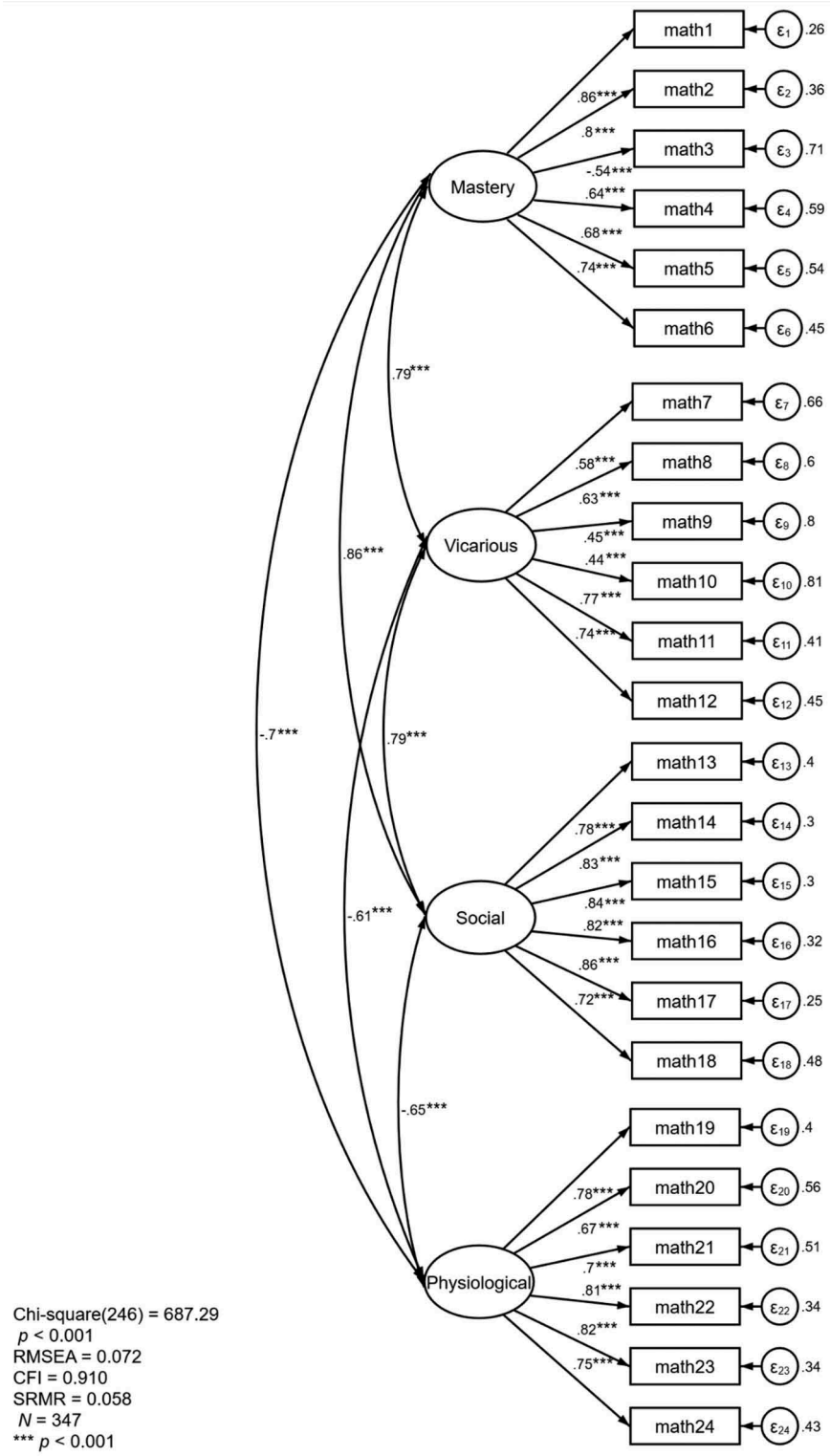

Figure 2. Measurement model for all 24 items.

self-efficacy between boys and girls. In order to do that, we performed separate confirmatory factor analysis on each of the constructs while allowing the means of both groups to differ. This is accomplished by fitting a model that uses girls as the reference group and fixing their mean at 0 for each of the latent variables. The results for fitting these models for each of the sources of self-efficacy are displayed in Table 4. The table displays the differences in the means, as well as the goodness-of-fit statistics in order for us to identify whether the models

Table 4. Results of model fitting when finding the difference in the means between boys and girls.

Model	Girls	Boys	Chi-squared(df)	RMSEA	CFI	SRMR
Mastery Experience	0 (constrained)	0.15	95.81(29), $p < .001$	0.108	0.935	0.073
Vicarious Experience	0 (constrained)	−0.10	134.15(28), $p < .001$	0.137	0.838	0.075
Social Persuasions	0 (constrained)	0.04	72.54(28), $p < .001$	0.090	0.971	0.037
Physiological State	0 (constrained)	0.16	63.94(28), $p < .001$	0.080	0.971	0.047

that assume a difference in the means are reasonably fit or not.

In all models, we see that the difference between the means for boys and girls is small in magnitude and is not statistically significant. With the exception of the construct *Vicarious Experience*, we note that the models display an acceptable fit. Therefore, our results do not indicate that there are gender differences in terms of the four sources of self-efficacy.

Age as a factor in gender differences

The results obtained so far indicate that there are no gender differences. In order to test the four hypotheses, we used a structural model that incorporates the variable *age* into the model. By adding *age* to the model, it will be possible for us to investigate what effect, if any, does this variable have on the four sources. In addition, we will also be able to investigate whether there are gender differences with regard to the effect that *age* might have. Table 5 shows the coefficient of the variable *age* for each gender, along with the goodness-of-fit statistics.

The results shown in Table 5 show that the standardized path coefficient from *age* to each of the four constructs is significant in at least one of the genders. The path coefficient of *age* for girls is negative and significant for the constructs *Mastery Experience, Vicarious Experience*, and *Social Persuasion*. This means that older girls are less likely to receive positive information than younger girls. This supports the hypothesis that as they grow older, girls receive information that steers them away from certain domains. With regard to boys, we see that the path coefficient of *age* for *Social Persuasion* is positive and significant, indicating that older boys are more likely to receive encouraging information about their math ability than younger boys. The path coefficient of *age* for boys was found to be negative and significant for the construct Physiological State. Since, as described in the literature review and as illustrated in the sample items in Table 1, higher values of this construct indicate a greater level of physiological agitation toward math, a negative and significant path coefficient for *age* indicates that older boys feel less agitation toward math.

These findings are evident when we plot the values of the predicted values of each of the four constructs against *age*. Figure 3 displays the plot of each construct for each gender group. Note that the predicted values were calculated using the model that does not include the structural component (with *age* as an exogenous variable), since using the predicted values of the model that includes age as a variable will naturally lead to an observed difference. In other words, these are the predicted values of the model displayed in Figure 2. The figure clearly shows that there is a decrease in the value of the three constructs *Mastery Experience, Vicarious Experience*, and *Social Persuasions* for girls but not for boys. The opposite dynamic is seen for the construct *Physiological State*. Therefore, the figure shows that by the time boys and girls are on the verge of determining their future career, boys display a higher level of self-efficacy due to an increase in the positive information received from the four sources. Unfortunately for girls, the opposite is true.

Discussion

These results obtained in this study have several important implications. First, the results provide support for the use of the measurement tool developed by Usher and Pajares (2008). Given that there has been no consensus regarding which measurement tool to use in these kinds of studies, the fact that our data resulted in a good-fit model provides empirical support for the tool. The support is further highlighted by the fact that

Table 5. Standardized coefficient of age in each of the four sources of self-efficacy.

Model	Boys	Girls	Chi-squared(df)	RMSEA	CFI	SRMR
Mastery Experience	0.05	−0.29***	105.57 (33), $p < .001$	0.111	0.925	0.071
Vicarious Experience	−0.04	−0.34***	124.79 (33), $p < .001$	0.124	0.853	0.079
Social Persuasions	0.18*	−0.19**	71.17(33), $p < .001$	0.081	0.973	0.038
Physiological State	−0.18*	0.08	71.74(33), $p < .001$	0.081	0.967	0.059

*$p < .05$, **$p < .01$, ***$p < .001$

Figure 3. Predicted values of the four constructs plotted against age.

our study was conducted in a completely different cultural setting than the ones in which previous studies of academic self-efficacy have been conducted.

Another important finding of this study is that the information received from the four sources of self-efficacy is mediated by the gender of the children over time. This result provides support for social roles theories that argue that psychological differences between men and women are a result of the different social roles that they are expected to play (Eagly & Wood, 1999). The finding that gender differences seem to accumulate with age indicates that different socialization processes are at work. Since an individual's success requires an alignment between role and attributes (Eagly & Karau, 2002), and since characteristics such as gender become connected with certain beliefs (Ridgeway, 1991), it comes as no surprise that girls do not feel comfortable when working in a field that is traditionally associated with masculinity (Mendick, 2005).

The results obtained in this study are strikingly aligned with previous research conducted in Lebanon (Mozahem et al. (2019, 2018). In a previous study, we found that there were differences in occupational career preferences between girls and boys. These differences were most notable in careers that were included in the Technology cluster: mathematician, computer programmer, mechanical engineer, civil engineer, and computer and communications engineer. The study also found that these gender differences developed with age. These findings, taken together with the findings of the current study, present a more complete picture. Given that the information from which girls construct their math self-efficacy becomes more negative as they grow older, their interest in occupations that seemingly require strong mathematical ability decreases in tandem. As such, these two studies provide support for the use of social cognitive theory in explaining career choices of individuals (Lent et al., 1994), or what has come to be known as social cognitive career theory.

The implication of these results is that bridging the gender gap that is observed in occupational preferences requires a holistic approach that incorporates all four sources of information. The issue is not one of exposing both genders to their potential future occupations. According to the Global Gender Gap Report, the educational parity in Lebanon is 0.959, one of the highest in the world (World Economic Forum, 2016). However, as documented by (Mozahem et al., 2018), strong gender differences continue to exist in many majors. Our results indicate that the problem of girls developing low self-efficacies in math is complex and that it requires solutions on multiple dimensions (Clark Blickenstaff, 2005). Both parents and teachers have a vital role to play since they are primary sources of the four types of information.

Another important implication of this study results from the congruence between the findings obtained here and the findings obtained by studies performed in different countries (Huang, 2013). Ironically, sociobiologists rely on the argument that if the same gender differences are observed in different cultures, then these gender differences are most likely biological in nature

(Buss, 1989). Yet the cross-national finding that gender differences develop with age implies that there are general social mechanisms affecting girls in different countries in the same way. Since the same social mechanisms exist in different countries (a decrease in social persuasion, and not seeing similar others perform the task successfully), the implication is that general solutions can be recommended. As is the case in several other countries, people in Lebanon seem to believe that engineering is a masculine field (Mozahem et al., 2019). Therefore, as noted by Pajares (2005), educators should try to alter students' views by illustrating the utility of these majors to both males and females. Parents also have an important role to play here. As discussed in detail by Mozahem et al. (2019), successful female engineering students reported high levels of support from their parents, especially from the father. Therefore, parents are encouraged to be more active in motivating their daughters to choose careers in STEM fields. The results also indicate that schools should proactively hire female math instructors since this study has found that vicarious experience for female students decreases with age.

Limitations

This study is not without its limitations. Stronger support for age as a factor would have been obtained if the study used a longitudinal design in which the same respondents filled out the surveys at different time points. As it stands, the results warrant further investigation by administering surveys to the same group of respondents over a period of six to seven years.

Acknowledgments

The publication of this article was funded by the Qatar National Library.

Disclosure statement

No potential conflict of interest was reported by the authors.

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