Babeș-Bolyai University

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Doctoral school "Applied Cognitive Psychology"

Math Anxiety, Test Anxiety, and Math Gender Stereotype Threat: Prevalence and Correlates Among Palestinian Primary Schools Children and Their Parents

Summary of PhD Thesis

Doctoral Candidate: Nagham Anbar

Scientific coordinator: Assoc. prof. dr. Laura Visu-Petra

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Contents

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Notes:

Statement of Original Authorship

(1) This is to certify by Nagham Anbar that:

(a) The thesis includes the original research work of Nagham Anbar (author) towards the Ph.D.

(b) Parts of the thesis have been already published, in press, or submitted for publication; appropriate citations for these publications were included in the thesis. Other co-authors have been included in the publications, if they contributed to the exposition of the published text, data interpretation etc (their contribution was clearly explained in the footnotes of the thesis);

(c) The thesis was written according to the academic writing standards (e.g., appropriate scientific acknowledgements and citations have been made in the text by the authors of the thesis). All the text of the thesis and its summary were written by Nagham Anbar, who assumes all responsibilities for the academic writing; also:

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CHAPTER 1. GENERAL THEORETICAL FRAMEWORK AND RESEARCH PROBLEM

Introduction

Anxiety is considered as one of the most common psychological and cognitive disorders in children and adolescents (Benga, Ţincaş & Visu-Petra, 2010). The construct of anxiety refers to a set of cognitive, physiological and behavioral responses that accompany high-stress tasks and stressful events, evoke worries about the situation and its consequences (Cassady & Johnson, 2002; Dowker, Sarkar & Looi, 2016).

Many researchers and educators recognized mathematics as one of the most important disciplines both in the education phase and in whole life aspects. One of the most common learning disorders during mathematics-related activities is "math anxiety" (Furner & Duffy, 2002). Math anxiety has been correlated with negative feelings and attitudes toward math and adverse consequences on math performance, math-self-concept, math self-efficacy, (Jansen et al., 2013) and can affect the long-term orientation of participation in math-related activities and an individual's decision about the future professional position (Fialova, 2017; Widmen & Chavez, 1982).

A large body of literature viewed math anxiety as a subject-specific manifestation of test anxiety (Ho et al., 2000). Many psychologist researchers indicated math anxiety as a kind of subject-specific test anxiety (Ma, 1999). While, test anxiety was seen as a specification form of general anxiety which may only occur in evaluative situations (e. g. Dew, Galassi, & Galassi, 1984; Hembree; 1990; Zeidner, 2007) and can therefore be recognized as a situation-specific personality trait (Schnell et al., 2013; Trudeau, 2009).

Research Problem

In the 21st century, Mathematics is considered fundamental for preparing the new generation to compete in the global economy. It also plays an essential role in academic and professional success, both personally and internationally. Also, mathematics is seen as a gateway

to employment in well-payed positions, it is a major component of all of the (STEM) fields like science, technology, engineering, and mathematics (Geist, 2010; Smith, 2016).

According to the Palestinian department of educational measurement and evaluation, based on a study conducted in the academic year of 2015-2016 on the fourth-grade performance national assessment in Arabic, Math and science, the findings reported that the success percentage in mathematics for the fourth grade was only 38%, meanwhile, mathematics average score was 47 for girls and 42 for boys (the full score is 100). On the other hand, the TIMSS data (2003) stated that the Palestinian students' performance of the 8th grade in mathematics is below the lowest International Benchmark, the average was 390 points, while in 2007 it was 376 points and 404 points in 2011. Despite this improvement of the performance level of Palestinian students, it still lags behind some of their peers in the MENA region, disparities favoring girls have also been documented in over 3 cycles. For example, in 2007 the difference in favor of females in mathematics performance was 36 points, while in 2011 it was 19 points. Historically, males outperform females when it comes to mathematics achievements. (Gunderson et al., 2012). In the last decade of the 20th century onwards, many studies have reported small or no gender differences in math outcomes (Abu-Hilal & Nasser, 2012).

Two key factors are raised: math anxiety and gender stereotypes (Bieg et al., 2015; Casad, Hale & Wachs, 2015; Chang & Beilock, 2016). For many years mathematics has been viewed as a male domain (Tiedemann, 2002). The common stereotypes that men are naturally talented in math and more interested in math-related activities influence math achievements and aspirations of career opportunities in both men and women. For example, women who endorse such stereotype ‘math = male’’ reported less interest in math and science, and are less likely to be involved in future math courses or related activities (Tenenbaum & Leaper, 2003; Nosek et al., 2009).

In the Palestinian education system, mathematics determines the future educational opportunities. Without actually passing the degree of success in the 12th grade students would have limited chances. For instance, in order to study engineering branches, computer sciences or medicine, the students must successfully pass the high school exam for the scientific or commercial pathways with good rates in mathematics, statistics and physics. Despite the fact that girls outperform boys in high school exams, particularly in scientific and commercial pathways,

they are still underrepresented in science, technology, engineering and mathematics (STEM) fields.

For example, according to the Palestinian Statistical Center, the percentage of female graduates with a diploma or bachelors in educational sciences in 2017 was 21%, compared to 6.5% of their male counterparts, while in engineering branches it was 3% compared to 9% of their male counterparts. The same gap continued to be seen in 2018, whereas the highest percentage of male graduates was seen in business and administration, followed by engineering branches.

These disparities favoring males in the STEM fields are reflecting the power of stereotype threats and adults as socializing agents of children. According to social structural theory, when girls grow up in a societal context where women are rarely being involved in STEM careers, they receive a clear message that these fields are a male domain and therefore, feel anxious about math and are less confident about their mathematical abilities. In addition to this, they are less likely to get involved in careers related to these fields (Else-Quest, Hyde & Linn, 2010).

The socio-cultural contexts may differ across countries. According to The International Men and Gender Equality Survey (IMAGES) 2017, Palestine represents a masculine society and displays inequitable gender attitudes. For instance, 80% of men believe that "woman's most important role is to take care of the home and to cook for the family", while 83% of men reported that "When work opportunities are scarce, men should have access to jobs before women". Moreover, 87% of women stated that "We as Palestinians need to do more to promote the equality of men and women". In 2020, Karama conducted research to examine the gender bias in the Palestinian school mathematics textbooks among Grades (1-12). The results indicated that Palestinian school math textbooks are male-biased, therefore females are less likely to be represented by names, pictures, verbs (actions), pronouns and professions in students' math textbooks.

Women's underrepresentation in STEM fields emerge from these gender biases, women in the Palestinian society are affected by the common traditional stereotypes that the main role for females is to take care of their families. Hence, they may tend to choose a career that allows them to play their social role. In addition to this, they may avoid math-related positions posed by their beliefs that these areas are unimportant to their self-image as females. Finally, Palestinian students' mathematical achievement has not met the national expectations for decades and, although,

mathematics' achievement in favor of girls continues at the local and international levels, their presence is still insufficient on the labor market, especially in mathematics-related jobs. Therefore, math anxiety and math-gender stereotypes are needed to be examined to determine their impact on women's math performance and their participation in STEM's workforce.

Conceptual Clarification and Empirical Data

Math anxiety, test anxiety and math performance

Many studies have emphasized that math anxiety already arises in primary school (Birgin et al., 2010; Ma, 1999; Merritt, 2011). For example, 21% of nine-year-old children reported that doing mathematics made them nervous (Joseph, 2009). In Jordan, Tunisia, Argentina, Mexico, Korea, Indonesia, Uruguay, Malaysia and Romania at least 75% of students stated feeling worried about doing mathematics e.g. (I often worry that it will be difficult for me, I worry that I will get poor grades) (PISA, 2012).

Test anxiety has been seen as a set of negative emotions and worries that especially occur during the evaluation situation, which could have serious implications for physical and mental health, as well as for educational and professional developments (See Zeidner, 2007; Cassady & Johnson, 2002). Many previous studies indicated that 25–30% of students have experienced test anxiety (Sung, Chao & Tseng, 2016).

Despite the overlap among the anxiety forms, results found in many empirical studies reported that math anxiety is a separate phenomenon. In consideration of the fact that math anxiety was viewed as a form of test anxiety, the majority of math anxiety questionnaires consist of some items regarding math test situations and it was expected that both of them to be correlated (Dew et al., 1984). Studies have shown moderate correlations between math anxiety and test anxiety about (.30- .50), however, measures of math anxiety are more related to each other, the correlation was found about (.50 - .80), which suggests that math anxiety and test anxiety are overlapped, but both are distinct constructs (Devine et al., 2012).

Numerous studies have indicated the negative impact of math anxiety on math performance, (Wilder, 2013). Math-anxious students may achieve less in mathematical tests than non-anxious students (Devine et al .2012), as well as they tend to avoid math-related activities

(Carey et al., 2017), and to be underrepresented in many domains of science, technology, engineering and mathematics (STEM) (Goetz et al., 2013; Maloney & Beilock, 2012; Brown & Stone, 2016). In his meta-analysis Hembree (1990) found a moderate negative correlation of -.34 between math anxiety and math performance. A similar finding was reported in a later meta-analysis, where a correlation of -.27 was calculated (Ma, 1999).

Various studies have been investigating the effects of test anxiety on performance, it turned out that test anxiety has a harmful impact on an individual's competence (For a review see Hembree, 1988; Muchenje, 2016). Empirical studies showed that test anxiety is a major debilitating factor crossing all grades, from elementary school to higher education levels, (Birenbaum & Nasser, 1994). Furthermore, studies pointed out that 25%–30% of students suffer from test anxiety, notably children in elementary schools (Sung et al., 2016) Test anxiety seems to explain about 4% of the performance variance in a variety of evaluative circumstances (Zeidner, 2007).

Gender differences

Gender differences between females and males in math competence and math anxiety are ones of the most investigated areas, several findings reported that females are more anxious than males in math-related situations (Ashcraft, 2002; Hembree, 1990; Ho et al., 2000; Else-Quest et al., 2010; Hopko et al., 2003). Women express higher levels of math anxiety compared to men, despite that, they can still perform better in mathematics tasks and math tests (Xie et al., 2018; Schnell et al., 2013; Devine et al., 2012). In 2012, as stated by the Programme for International Student Assessment (PISA), the data showed that at the majority of (OECD) countries girls reported stronger feelings of mathematics anxiety than boys, while, no significant gender differences have been found in Albania, Turkey, Bulgaria, Kazakhstan, Indonesia, Serbia, Romania, Montenegro, and Malaysia, however, boys reported greater feelings of anxiety than girls in Jordan, the United Arab Emirates and Qatar.

In 2012 Devine et al. conducted a study among secondary school students in England, about measuring the levels of math anxiety, the results showed t no gender differences were found in mathematics performance although, girls scored higher on the math anxiety scale. Also, the results of Frenzel et al. (2007) suggested that, although there were no gender differences in math

achievement, girls reported higher levels of math-related anxiety. Similar results were confirmed by Huang et al. (2019) a significant gender differences were detected in mathematics anxiety, and boys reported less mathematics anxiety than girls, while no significant gender differences were found in mathematics self-efficacy.

On the other hand, Erturan and Jansen (2015) results showed a significant effect of gender on test anxiety, girls reported higher levels of test anxiety, while math scores and math anxiety did not differ based on gender. Similar finding has been reported about the gender differences regarding test anxiety, males obtained lower scores than females at evaluative tests (Popa et al., 2019; Cassady & Johnson, 2002). The same results were also reported by Kavanagh and Mesagno (2016) about the high level of test anxiety among females compared to males (e.g. Cassady & Johnson, 2002; Hembree, 1988). Trait anxiety was also found to differ based on gender, according to Macher et al. (2011) study, a higher levels of trait anxiety among female's students than males. In addition, many studies indicate that women tend to report higher trait anxiety scores than men do (Putwain & Daly, 2014).

Parental math anxiety

Do we often think about the influence of parents 'math anxiety on their children's math anxiety? According to many studies, home environment, parents' feelings, attitudes and perceptions about their children have a notable impact on their children's emotions, attitudes, self-esteem, and even their cognitive abilities (Parsons et al., 1982; Jameson, 2013; Batchelor et al., 2017). Parents can promote or frustrate their children's behaviours or emotions toward something just because they have negative or positive beliefs or attitudes toward the same thing, for instance, parents' attitudes toward school or a specific school material are positively correlated with their children attitudes toward the same subjects (Pugsley & Price, 2018; Casad et al., 2015). It is also noted that parents' own perception of the value of mathematics has a significant impact on their children's' motivation to pursue related fields in the future (Soni & Kumari, 2017). Math-anxious parents are more probably to pass their math anxiety to their children particularly when these parents help their children on math homework frequently. On the other hand, parents' attitudes toward math play a significant role in children's mathematics achievement, people don't think commonly about the importance of parents' own attitudes in determining their children's academic performance, however, if a parent is walking around saying, 'Oh, I do hate math' or 'doing math

is difficult', kids simply catch these messages that negatively affect their success and attitudes toward math (Foley, at el., 2017; Smith, 2016; Chang & Beilock, 2016).

There is a common view that teachers are the primary responsibility for students' math achievement. Nevertheless, parents' engagement in their children's math education is also critical (Rossnan, 2006). A study conducted by Batchelor et al. (2017) indicated that children's mathematics anxiety is related to parents' mathematics anxiety, more specific, a positive association between parents' math anxiety and sons was calculated while no association with daughter's levels of math anxiety was found, these findings could be accounted for by the mediating effect of parental involvement in the child homework. Although parents' math anxiety may not be the only variable related to children math achievements, it is indeed a strong predictor (Casad & Wachs, 2015; Maloney et al., 2015). Acutely, parents' involvement does not really require parents to show a high skill in math, rather, they can elevate children's math performance by simply offering positive encouragement about math learning. For instance, children with negative math attitudes show lower math achievement than children with more positive math attitudes (Pugsley & Jill, 2018; Wilder, 2015).[1]

Studies also suggested that children who are more engaged in-home math-related activities (e.g., board games, play with puzzles, cards) reported more positive attitudes and better math achievement than children who were involved in fewer home math-related activities. Indeed, parents who try to enhance positive math attitudes as far as possible at home environment, regardless of their emotions or comprehension about math the more to improve their children's achievements in math and to establish positive behaviors toward math learning (Hart et al., 2016; Wilder, 2015). Daches Cohen & Rubinsten (2017) findings showed that parental involvement raised second graders' math performance skills such as problem-solving.

The role of parental involvement effects on children's achievements is still debatable, although, Fan and Chen (2001) meta- analysis revealed that parental involvement was positively correlated with math achievement, and it may limit negative attitudes toward mathematics (Mohr-

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Schroeder et al., 2017). However, other findings of meta-analyses suggested that at-home parental involvement was negatively related to children's achievement a negative correlation was found between students' academic performance and homework parental assistance (Wilder, 2015). Concerning the parental impacts on children math attitudes and outcomes, the gender gap in the transmission of attitudes and anxieties have been investigated in many studies and it was emphasized on the role of gender stereotype threat among adults and children (Chang & Beilock, 2016). For instance, parents reported that girls need to spend more efforts in mathematics learning than boys do, while girls declared less- efficiency and less confidence in their math abilities than boys which resulted from many years of exposure to math stereotype threat (Batchelor et al., 2017). It is very challenging to identify the parental influences on the relation between academic achievement and math anxiety, due to various several factors, for example family structure, parent educational level, family income, parents' occupation and the history of parents' performance at mathematics (Hill & Taylor, 2004; Soni & Kumari, 2017). Parental involvement at school activities could also vary across ethnic or cultural backgrounds, overall, parents from lower socioeconomic backgrounds are less likely to be involved in schooling than parents of higher socioeconomic status (Van Der Bruggen et al., 2008; Daches Cohen & Rubinsten, 2017).

Math-gender Stereotype Threat:

Stereotype threat was first introduced by Steele and Aronson (1995) and it refers to the unconscious or conscious shared beliefs that an individual belongs to a stigmatized group known of specific deficits (Stoet & Geary, 2012; Hakim, Kurman & Eshel, 2017). In the last decade, many studies have investigated an important area which is strongly affected by the gender role socialization, mathematics and math-related domains where the gender gap is noticeable (Stoet & Geary, 2012; Else-Quest, Hyde & Linn, 2010).

Math gender stereotypes are shaped early and affect math self-concepts prior to ages at which differences in math achievement arise, for instance, Cvencek, Meltzoff and Greenwald (2011) study findings indicated that children identify math as a boy domain on both implicit and explicit measures. Maloney et al. (2013) have reported that math anxiety and stereotype threats share a common underlying mechanism, both of them cause poor performance in mathematics as a result of the cognitive impairments. When the individual begins to experience negative thoughts and worries about mathematical tasks, these irrelevant thoughts can narrow the working memory

capacity, hence, consuming working memory resources allocated to the main mathematical task which is carried out. Such anxiety-induced thoughts disrupt the working memory system to oversee the on-going task, hence, performance may suffer (Beilock, Rydell & McConnell, 2007).

In recent years, stereotype threat has received a lot of attention as a significant factor in explaining the gender disparities in STEM subjects (Forgasz, Leder & Kloosterman, 2004). For example, a study has shown that, by age 9, girls reported stronger implicit gender stereotypes than boys did, and therefore they shifted away from math-related activities toward languages (Steffens et al., 2010). Generally, languages are stereotyped as feminine while math is stereotyped as masculine, in many countries' boys outperform girls in math and science while girls demonstrate better competence in reading literacy (Heyder & Kessels, 2013).

A meta-analysis of stereotype threat (ST) conducted by Picho, Rodriguez and Finnie (2013) showed that in Scandinavian countries, the stereotype impact was weak to non-existent, while the impact was larger in African countries, which is plausible given that Scandinavian countries have the smallest gender gap around the world while on the contrary gender roles are strong and more distinct in Africa. Indeed, in countries where culturally, gender roles are more limited and weaker, the performance of females is not expected to be largely affected by stereotype threat.

CHAPTER 2. RESEARCH OBJECTIVE AND GENERAL METHODOLOGY

The current study extends the existing literature related to math anxiety in several directions. For the first time, to our knowledge, both parent and child math anxiety in the Palestinian community were measured, checking for possible gender differences in relation to their mathematics achievement and for the congruence with other forms of anxiety (trait and test anxiety).In doing that, we also looked at potential mechanisms responsible for the transmission of math anxiety between parents and children, such as the parental involvement in child math homework, the history of parents' math performance and parents' math anxiety. Moreover, we explored the possible mediators in the relation between children math anxiety and math achievement. Finally, we attempted to investigate parents' math gender stereotype and its relation with their children's math anxiety and math performance.

The main objective of our study was to investigate the prevalence of math anxiety and gender differences among primary school students and their parents. In addition, we explored the relation between math anxiety and math achievement and the function of parental factors as a potential mechanism through which math anxiety might be transmitted throughout generations. More specifically four studies were conducted to cover the purpose of this research, including the following objective:

First, we aimed to adapt two scales of math anxiety in Palestinian primary school, by transition both versions from English into Arabic (The modified abbreviated math anxiety scale (MAMAS) and the scale for early math anxiety (SEMA), then to validate the adapted scales.

Secondly, we aimed to investigate the levels of math anxiety and test anxiety among the Palestinian students in 3rd and 4th grad. Also, to explore the gender differences in both math anxiety, test anxiety, trait anxiety and math performance. Also, to figure out if there is a relation between math anxiety and test anxiety and with student's achievements in mathematics.

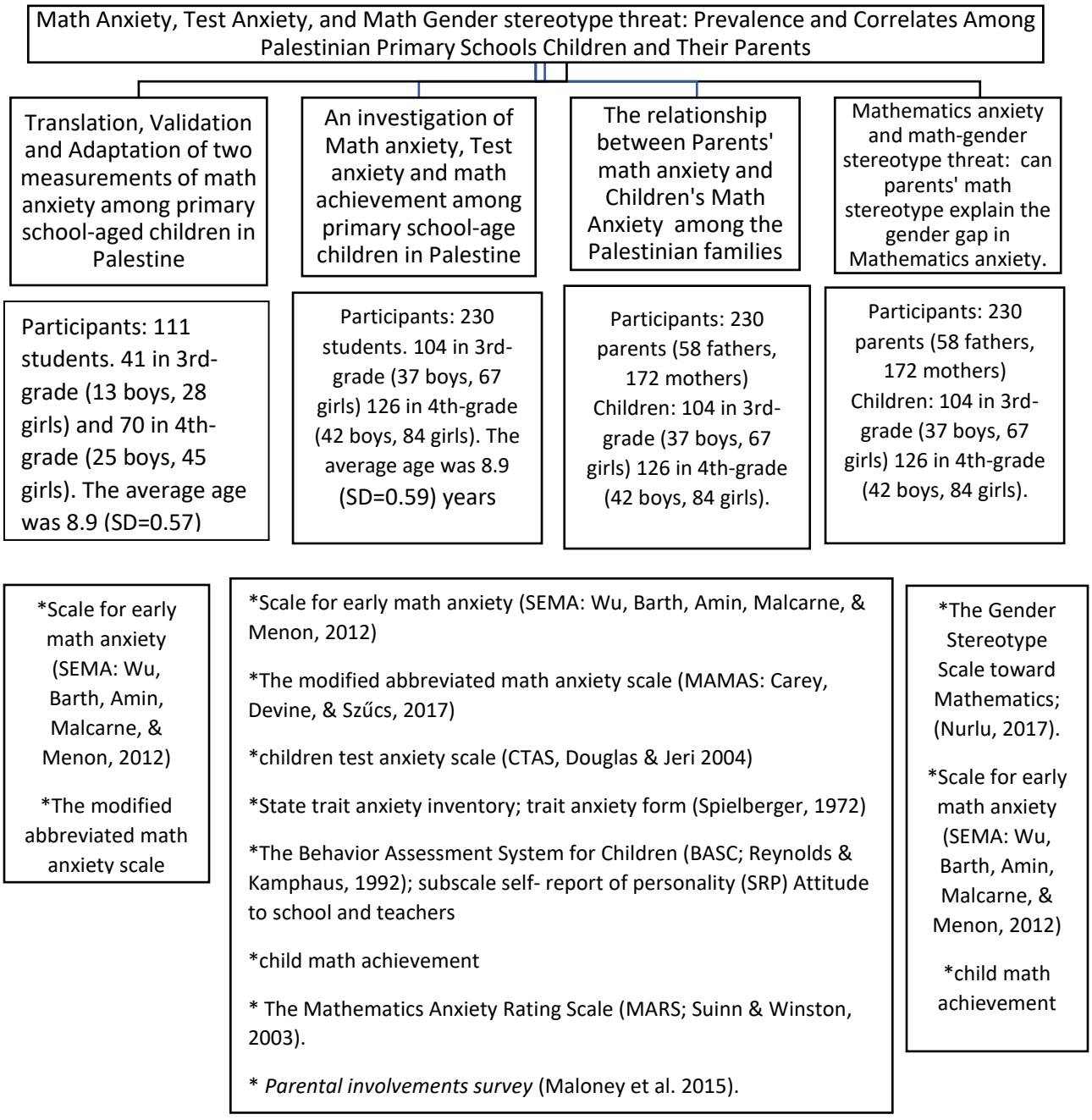
Thirdly, we aimed to explore the relationship between parents' math anxiety and their children's math anxiety, and the function of parental factors such as their involvement in the child's math homework, Parents history of math performance and parents' math anxiety as a potential mechanism through which math anxiety might be transmitted throughout generations.

Finally, we aimed to investigate parents' math gender stereotype in four subscales (environment, career, competence and attribution) and its relation with children's math anxiety and math performance.

The present research has practical implications as well. Unfolding and documenting math anxiety, by addressing several factors affecting mathematics achievements and future career orientations such as investigating the levels of mathematics anxiety, test anxiety, and parents' math anxiety, moreover investigating the mediating role of parental factors in the relations between children's math anxiety and their math achievements. Since math anxiety is a common phenomenon and correlates with math outcomes, our study expands the current literature by demonstrating the utility of exploring the related factors of math achievements. The current research offers an investigation of math anxiety in the Palestinian primary schools, specifically the relation between mathematics achievements and mathematics anxiety and gender differences, in

addition to parents' role in the transmission of math anxiety, and it may explain the female under presence in math-related fields in the Palestinian workforce. We have highlighted the theoretical directions and empirical data we have in the light of other previous findings and explanations. We recommend further directions of investigation in the same field; this research also might offer new insights for interventions helping students to cope better with math anxiety and improving math achievement.

The Structure of The Current Thesis



Chapter 3. Original contributions

CHAPTER 3. ORIGINAL CONTRIBUTIONS

Study 1. Translation, Validation and Adaptation of Two Measurements of Math Anxiety Among Primary School-Aged Children in Palestine

Introduction

During the last years many researchers have developed self-report inventories to measure and rate math anxiety. However self-report questionnaires are the most used widespread instruments to identify math anxiety (Ramirez & Maloney, 2018).

Various studies have indicated and supported the validity and utility of using self-report inventories in the investigation of anxiety and depression. For instance, Self-report questionnaires such as the ones utilized in this study could allow a researcher to implement the assessment instruments and acquire a significant amount of data among a wide number of participants at one time in a relatively short period of time, also, it was proposed by Reynolds (1993) that using self-report less intrusive process because the researcher may not involve personally as the situation of the individual interviews. moreover, the self-report scales ensure internal validity by avoiding inquiry variability. In other words, because the participant is required to answer the same question, in the same way, each time, there is a limited chance to the variability associated with alternative differences likewise, in interviewing style and other methods (Kahan, 2008).

the two measures that used in our study are The Modified Abbreviated Math Anxiety Scale (MAMAS) and The Scale for Early Math Anxiety (SEMA). For our knowledge, this study is the first attempt to translate, adapt and validate these tow instruments for measuring math anxiety among primary school-aged children in Palestine.

Methodology

The current study is a methodological cultural adaptation of two math anxiety scales aims to translate the two scales of math anxiety from the original versions in English into Arabic language (The modified abbreviated math anxiety scale (MAMAS) and the scale for early math anxiety (SEMA), and to investigate the validity and the reliability of the two translated scales of math anxiety.

Participants

Data gathered from 111 students in three primary schools in Ramallah city. 41 participants were in the 3rd grade (13 boys, 28 girls) and 70 were in the 4th grade (25 boys, 45 girls). The average age was 8.9 Years (SD=0.57 Years).

Measures and Scoring

1- The Modified Abbreviated Math Anxiety Scale (MAMAS) (Carey, Hill, Devine & Szűcs, 2017). Which consists of 9 items, with 2 subscales representing learning math anxiety and mathematics evaluation anxiety, a 5-point Likert scale was used to indicate how anxious they would feel during certain situations involving math (1 = I'm not nervous at all till 5 = I'm very very nervous) item example: “Finding out that you are going to have a surprise math’s quiz when you start your math’s lesson”. The total score was calculated by the sum of answers on all items. The range of score is 9 - 45, which means a higher scale values indicate higher levels of math anxiety.

2- The Scale for Early Math Anxiety (SEMA) (Wu, Amin, Barth, Malcarne & Menon, 2012). Which consists of a total of 20 items, the first 10 items were formulated to assess the numerical processing anxiety and the last 10 items were worded to assess situational and performance anxiety, Items were rated on a scale of 5 to indicate how nervous would feel children during certain situations involving math (1= I don't feel nervous at all- 5= very very nervous). The overall scoring represented by the summation of the 20 items, the total range of the SEMA is from 20 to 100, accordingly the higher summed scores indicate greater math anxiety.

Procedure

Both math anxiety original scales were translated by the author (Arabic native speaker) into Arabic (forward translation), some phrases were modified to fit the culture of Palestinian society. For example, item 3 in the original (SEMA) is "How much money does Annie have if she has two dimes and four pennies?" we replace the "two dimes and four pennies" by the common used currency keeping the same sense of the original question, also items 1 and 10 in the SEMA contains names which is not familiars to our students such as "George", "Francesca", "Daisy" and "Ernie" all of them were replaced by common Arabic names in order to avoid students being confused by the unfamiliar names. After that the Arabic form were translated back into English by a professional bilingual translator who was not familiar with the original scales before (back translation), and then the original forms and the back-translated English forms were checked by the researcher and an expert professor to ensure the accuracy and the validity of the translation. Finally, the Arabic versions were checked by two primary schools' teachers (Arabic speakers) for verification the clarity of items and its suitability to the age of students in our sample. The students completed in the questionnaires during a regular school day they have been told about the purpose of the study and were assured that their responses wouldn't be released to the school administration or their teachers. After 15 days from the first testing session, the retest session took a place using the same instructions and conditions.

Results

Children's math anxiety scales in both test and retest scenarios are shown in table1.

Table 1. Compare means

	N	Min	Max	M	SD
Test/ Children Early Math Anxiety Scale	111	20	82	28.3	9.8
Retest/ Children Early Math Anxiety Scale	110	20	63	27.3	8.0
Test/ Children Modified Abbreviated Math Anxiety Scale	109	9	35	14.5	5.3
Retest/ Children Modified Abbreviated Math Anxiety Scale	110	9	27	13.2	4.2

Validity

Person correlation was conducted between both scales for children's math anxiety in both test and retest scenarios. Significant association was found between MAMAS in both test and rest studies, $r(108) = 0.7$, $p < 0.001$. Significant association was also found between SEMA in both test and retest studies, $r(108) = 0.66$, $p < 0.001$

Internal consistency

The 20 – Item SEMA measuring children's' math anxiety showed a good internal consistency (Cronbach Alpha = 0.88, C.I. 0.84–0.91), while the retest of SEMA showed a moderate internal consistency (Cronbach Alpha = 0.84, C.I. 0.79–0.88). The second scale of 9 items representing children modified abbreviated math anxiety (MAMAS) also showed a good internal consistency (Cronbach Alpha = 0.75, C.I. 0.67–0.81) and a moderate (Cronbach Alpha = 0.67, C.I. 0.65–0.75) was calculated for the retest version of MAMAS.

Test-Retest Reliability Coefficients

The Children Early Math Anxiety Scale test – retest reliability examination showed a Cronbach Alpha of (0.78), while The Children Modified Abbreviated Math Anxiety scale showed a Cronbach's Alpha of (0.81) of the test – retest reliability analysis. The Cronbach's Alpha values for subscales for both scales are presented in the table.2 below.

Table 2. Test-Retest Reliability

Scale	Subscale	Cronbach Alpha
The Children Early Math Anxiety Scale	Numerical processing anxiety	0.64
	Situational performance anxiety	0.81
The Children Modified Abbreviated Math Anxiety	learning math anxiety	0.55
	Evaluation anxiety	0.77

Intraclass correlation coefficient (ICC)

A high degree of reliability was found between MAMAS measurements, the average measure ICC was 0.81 with a 95% confidence interval from 0.72 to 0.87 (F (109,109) = 5.29, P<0.001), SEMA measurements were also tested for reliability and showed a high degree of reliability where ICC was 0.78 with a 95% confidence interval from 0.68 to 0.85 (F (109,109) = 4.59, P<0.001).

Discussion and conclusion

The main goal of this study was to adapt two scales of math anxiety in Palestinian primary school, we started by translation both versions from English into Arabic then to validate the scales.

Summary of main findings

1. Results indicate that the Arabic versions of the math anxiety scales seems to be a valid to asses math anxiety among primary school-aged children in Palestine

2. The mean values of math anxiety score were lower than the studies used the same English scales

3. A moderate positive correlation was found between test and r-test scales of math anxiety (The modified abbreviated math anxiety scale (MAMAS) and the scale for early math anxiety (SEMA)

4. We calculated moderate to strong internal consistency for all test and r-tests scales: MAMAS and SEMA

5. We calculated a good reliability scores for both test and r-test scales.

Our results for the Arabic adaptation of math anxiety scales showed lower means of math anxiety score (i.e., 28.3, 14.5) for SEMA and MAMAS respectively compared to the other studies used the English versions of the measurements (i.e., 34.3, 19.6) for SEMA and MAMAS respectively (Wu et al., 2012; Carey et al., 2017). Our findings reveled a positive moderate correlation between the first administration of the modified abbreviated math anxiety scale and the second session, and the same between the first administration of the early math anxiety scale and the second session, r = 0.7, r= 0.66 respectively. The moderate correlation between the test and the r-test scales confirm the validity of our translated versions of math anxiety.

Our results also showed a high internal consistency coefficients of the SEMA both test and r-test scale α= .88, α= .84 respectively, while a moderate internal consistency of the MAMS both test and r-test scale, α= .75, α = .67, these alpha coefficients, which are evidence of construct validity, suggest that the SEMA and MAMAS are a relatively reliable instruments, these results indicated that our measures are valid to assess math anxiety. Regarding the test-retest reliability both of The Children Early Math Anxiety Scale (SEMA) and The Children Modified Abbreviated Math Anxiety (MAMAS) scale showed high value of Cronbach's Alpha.

Our analyses suggest that both translated versions of The Children Early Math Anxiety Scale (SEMA) and The Children Modified Abbreviated Math Anxiety (MAMAS) scale provides valid and reliable measurements of math anxiety of Palestinian children in third and fourth grade in primary schools, which may be utilized by educational researchers and policymakers for the benefit of the educational outcomes.

Study 2. An Investigation of Math Anxiety, Test Anxiety and Math Achievement Among Primary School-Aged Children in Palestine

Introduction

Nowadays, anxiety is an everyday phenomenon that occurs as a response to threat of math fear, playing a crucial role in our everyday life (Alam& Halder, 2018) Math anxiety has been defined as a combination of unpleasant feelings such as stress, strain, fear, and apprehension in situations demand mathematical or arithmetic skills (Rossnan, 2006; Kazelskis et al., 2000; Xie et at., 2018). Also, fear of testing situation where an individual's abilities are being evaluated, defined as test anxiety (Zeidner, 1998; Hancock, 2001; Erturan & Jansen, 2015). Or when a one under examination situation thinks that the evaluation does not suit his or her potentials and is beyond person's intellectual and social capabilities (Ahmad, Hussain & Khan, 2018).

The previous reviews indicated that the concept of "test anxiety" is often difficult to separate from math anxiety thus, *The relationship between math anxiety and test anxiety* has recently been investigated (Joseph, 2009), previous studies found a moderate correlation (about 0.3 & 0.5) between test anxiety and math anxiety, these studies assumed that both of them are linked, but not identically overlapped in construct.

The meta-analysis by Hembree (1990) included 151 studies related to mathematics anxiety indicated that crosswise all grades, girls declared heightened levels of mathematics anxiety than boys. Regardless of these high levels of anxiety females were able to maintain their performance level without degradation or even avoiding math activities. Hembree (1988) conducted a meta-analysis of 154 studies involving test anxiety and gender, the results emphasized that women experienced significantly higher test anxiety than men did, with a mean effect size of 0.29 (Cassady & Johnson, 2002; Zeidner, 2007). Many studies emphasized that math performance was affected negatively by math anxiety and test anxiety (Muchenje, 2016; Erturan & Jansen, 2015), while no difference was found in math grades (Schnell et al., 2013; Sung, Chao & Tseng, 2016).

Methodology

The main purpose of this study was to investigate the relationship between math anxiety and test anxiety among the Palestinian primary students, other objectives are to investigate the levels of math anxiety, test anxiety and trait anxiety. Also, to explore the gender differences in both math anxiety and test anxiety. Also, to figure out if there is a relation between math anxiety and test anxiety with student's achievements in mathematics.

Participants

The participants in the study were 230 students from four primary schools in Ramallah city, the sample was randomly selected, from this sample, 104 participants were in the third-grade students (37 males, 67 female) and 126 were in the fourth-grade students (42 males, 84 female). The average age was 8.9 Years (SD=0.59 Years)

Measures and Scoring

1- The Modified Abbreviated Math Anxiety Scale (MAMAS) (Carey et al., 2017). Which consists of 9 items, with 2 subscales representing learning math anxiety and mathematics evaluation anxiety, a 5-point Likert scale was used to indicate how anxious they would feel during certain situations involving math (1 = I'm not nervous at all till 5 = I'm very very nervous) item example: “Finding out that you are going to have a surprise math’s quiz when you start your math’s lesson”. The total score was calculated by the sum of answers on all items. The range of score is 9 - 45, which means a higher scale values indicate higher levels of math anxiety.

2- The Scale for Early Math Anxiety (SEMA) (Wu et al., 2012). Which consists of a total of 20 items, the first 10 items were formulated to assess the numerical processing anxiety and the last 10 items were worded to assess situational and performance anxiety, Items were rated on a scale of 5 to indicate how nervous would feel children during certain situations involving math (1= I don't feel nervous at all- 5= very very nervous). The overall scoring represented by the summation of the 20 items, the total range of the SEMA is from 20 to 100, accordingly the higher summed scores indicate greater math anxiety.

3- The Children Test Anxiety Scale (CTAS) (Douglas & Jeri, 2004), consist of a 30-item ,9 items on the Autonomic reaction's subscale (physical anxiety), 8 items on the Off-Task behaviors subscale, and 13 items on the thought's subscale. A 4-point Likert scale was used to describe how children would feel, think and act while taking the tests (1= almost never, 2=sometimes, 3=often, 4= almost always) e.g., "My heart beats fast", "I play with my pencil". the higher summed scores indicate greater test anxiety, the rang of scoring 30-120, while the alpha reliability co-efficient of the scale for the present study is .88

4- The State-Trait Anxiety Inventory; only Trait Anxiety form was used (STAI-T; Spielberger, 1972), the trait anxiety form consists of 20 items were rated on a scale of 3, the children were asked to describe themselves in general (1= very much, 2= moderate, 3= a little), item example: "I have disturbing thoughts". Higher scale values indicate higher levels of trait anxiety. The total score was calculated by the sum of answers on all items. In this sample the scale shows high internal consistency (Cronbach's α=.85).

5- The Behavior Assessment System for Children (BASC; Reynolds & Kamphaus, 1992); the utilized subscale was the self- report of personality (SRP) attitude to school and teachers, the form consists of 14 items the first three are true or false statements and the responses of the last 11 items were rated based on a 4-point Likert scale (1= almost never - 4= almost always). Total scale scores were computed by the summation of answers on all items; hence, the highest score refers to more negative attitudes toward school and teachers.

6- Student's math achievement was documented by using the teacher's evaluation record at the end of the first school semester for tow subjects Math and Arabic language, range of scoring (0-100).

Procedure

After permission was granted from the school authorities, a written informed consent was obtained from the parents whose children were in the 3rd and 4th grades at those schools in Palestine. Consequently, we organized a meeting during school hours with the students whose parents provided their informed consent. Children were also informed and assured about the confidentiality of their responses. They were then asked to fill in the questionnaires in the following order: math anxiety, test anxiety, trait anxiety.

Results

Descriptive data presenting children's anxieties and math achievement according to gender are shown in Table 3. below.

Table 3. Compare means by gender

	SAMPLE N=230				Boys N=79		Girls N=151	
	M	SD	Min	Max	M	SD	M	SD
Children Modified Abbreviated Math Anxiety Scale	15.0	5.68	9	35	13.3	5.09	15.9	5.7
Children Early Math Anxiety Scale	29.1	10.32	17	82	26.9	8.36	30.2	11.2
Children Test Anxiety	52.4	14.83	30	95	50.7	14.7	53.2	14.9
Children Trait Anxiety	30.2	7.27	20	60	28.5	6.7	31.0	7.4
Math Achievement	84.7	12.12	50	99	85.99	11.8	84.02	12.5
Children Attitudes toward school and Teacher	20.9	5.33	12	43	21.81	5.6	20.4	5.1

Gender differences

Significant differences were found in the MAMAS & SEMA based on gender under the confidence level of 95%, $t\,(228) = -3.47$, p = .01, $t\,(228) = -2.32$, $p = 0.021$ with a moderate effect size of Cohen's d of 0.47, and 0.33 respectively. Trait anxiety relation with gender was also significant with moderate effect size as well with $t\,(228) = -2.48$, $p = 0.014$, Cohen's d = 0.35. Regarding test anxiety and math achievement, no significant differences were found as $t\,(228) = -1.23$, $p = 0.218$, and $t\,(228) = 1.34$, $p = 0.181$ respectively.

Correlation between forms of anxiety and math achievement variables

Pearson correlations revealed positive moderate correlations among the three forms of anxiety measured in children: Math anxiety, trait anxiety, and children test anxiety (see Table 4), suggesting that while they all tap the same general concept, they measure different faucets of anxiety. Negative correlations were found between children's math achievement and their Math anxiety, test anxiety, and trait anxiety**.**

Table 4. Correlation matrix

		1	2	3	4
1	Children Early Math Anxiety Scale	-			
2	Children Modified Abbreviated Math Anxiety Scale	.67**	-		
3	Children Test Anxiety	.55**	.52**	-	
4	Children Trait Anxiety	.55**	.46**	.52**	-
5	Math achievement	-.25**	-.17**	-.14*	-.09

**p<.001, *p<.005

Discussion and conclusion

The primary purpose of this study was to determine the levels of math anxiety and test anxiety among the Palestinian students in 3rd and 4th grad. And to explore the gender differences in both math anxiety and test anxiety. Also, to figure out if there is a relation between math anxiety and test anxiety with student's achievements in mathematics, in addition to the expected relation between the two forms of math anxiety.

Summary of main findings

1.There are gender differences in math anxiety and trait anxiety. Gils reported higher levels of math anxiety and trait anxiety.

2.There are no significant gender differences in test anxiety as well in math achievement.

3.The two forms of math anxiety (MAMAS and SEMA) are strongly correlated.

4.There is a positive moderate correlation between test anxiety and math anxiety and between the previous mentioned and trait anxiety

5.There is a negative relationship between the higher level of math anxiety and test anxiety with student's achievements in mathematics as well as the attitudes toward school and teacher

Gender differences in Math anxiety

Our results showed significant gender differences in math anxiety, as girls reported higher scores compared to boys, consistent with many previous studies conducted in China, Poland, England and Uganda (Xie et al., 2018; Schnell et al., 2013; Devine et al., 2012; Hunt et al., 2021). Our findings are in line with the results of a meta-analysis of 151 studies (Hembree, 1990), which found that females tend to have higher levels of math anxiety than males do, which may account for some of the gender gaps in math achievement and math-related professions.

A similar finding was reported by Carey et al. (2017) among British children aged 8–13, where a significantly higher levels of math anxiety among girls compared to boys were found. A study was conducted by Ho et al (2000) among 6th-grade students from the USA, China, and Taiwan revealed that there were significantly higher scores of math anxiety among Taiwanese girls, while no gender differences were found among Chinese and American students. On the other hand, Birgin et al (2010) or Tapia (2004) reported no significant difference between boys and girls in math anxiety.

One potential explanation for girls/females generally experiencing greater levels of math anxiety than males may stem from the gender differences in socialization practices. In particular, women are socialized to express their feelings and emotions, this may result in the inclination for women to admit their fears more than men do (Devine, 2012; Kavanagh et al., 2016). Another potential reason is that math is traditionally seen as a male domain, so females may be socialized to perceive their mathematical skills as less competent and therefore may even avoid mathematical activities. It was expected for females in this study to report higher levels of math anxiety compared to males, according to the Arabic culture that imposes such gender roles, where boys are raised to be tough and brave, which can lead them to report lower levels of math anxiety. Not surprisingly, females may be more willing to admit their worries and anxiety (Kavanagh, 2016). Also, there is less recent research examining the gender biases in the Palestinian school

mathematics textbooks indicating these textbooks are male-biased, with females being less likely to be represented by names, pictures, verbs (actions), pronouns and professions (Karama, 2020). Women's underrepresentation in science, technology, engineering, and mathematics (STEM) fields emerges from these gender biases, Palestinian women avoid math-related positions due to their beliefs that these areas are unimportant or even damaging to their self-image as females (Rube & Ehrenfeld, 2020).

Gender differences in other forms of anxiety

Girls reported higher levels of trait anxiety than boys, confirming many similar findings in the literature across various age groups (Macher et al., 2011; Putwain & Daly, 2014), while no significant gender differences were found in test anxiety. The results among Australian, American, Romanian and Chinese students confirmed our previous findings of no gender differences in test anxiety (Kavanagh, 2016; Popa, 2019; Xie, 2018). However, our results are not in line with previous studies that did find gender differences in test anxiety in favour of boys (Erturan & Jansen, 2015) or in favour of girls (McDonald, 2001; Putwain & Daly, 2014).

A cautionary note refers to the overall lower levels of test anxiety found in our sample. In the Palestinian educational system, primary students during 1st to 4th grades are not exposed to formal examination sessions, but teachers still have to evaluate children's performance using many strategies such as team or pair work, homework, and class evaluative papers. The absence of standardized tests or formal examination environments could explain the lower levels of test anxiety compared to Wren and Benson (2004) findings, who used the same scale of children's test anxiety.

Gender differences in Math achievement

Although our results indicated that girls were more math anxious than males in math-related situations, no significant differences in math achievements were documented. This result is confirming many previous findings suggesting that the gender gap in math performance has been significantly minimized in the last decades, especially within primary school students (Devine et al., 2012; Schnell et al., 2013). One possible explanation for girls outperforming or performing equally in math is that girls are more self-disciplined than boys, in general girls tend to study longer hours and do more homework, while boys need more monitoring to do their

homework (Duckworth & Seligman, 2006). On the other hand, our results do not confirm previous findings suggesting that males outperform females in math (Else-Quest et al., 2010, Erturan & Jansen, 2015; Osborne, 2006). Although many recent studies showed the gender gap minimizing across the years (Gunderson et al., 2011; Hyde et al., 2008; Schnell et al, 2013) fewer girls end up pursuing math courses or math-related career paths (Eccles, 2009), a tendency visible in Palestine as well (Rubel & Ehrenfeld, 2020).

Congruence between anxiety measures

Our results also revealed a positive moderate correlation between the math anxiety and the Trait Anxiety. Similar findings were revealed by Ashcraft and Moore (2009), who reported a positive correlation between math anxiety and trait anxiety. Although we confirmed this consistency among the mentioned scales, it also appears that each one of them still measures different aspects of anxiety. A positive correlation between Math anxiety and Test Anxiety was found, also a positive correlation between Trait Anxiety and Test Anxiety. Similarly, Devine's et al (2012) study among secondary school students in England, and Joseph (2009) study among secondary students in Singapore also reported positive correlations between math anxiety and test anxiety. In fact, math anxiety was conceptualized as a situation-specific anxiety demonstrated in mathematics-related activities (Rubinsten et al., 2015), while Test Anxiety was seen as a situation-specific personality trait, which specifically arises in evaluative situations (Schnell et al., 2013).

Math anxiety and math performance

We also found a negative correlation between child math performance and child math anxiety. In this respect, Hembree's meta-analysis (1990) showed that math anxiety negatively correlates with math achievement and math grades. Later, a similar finding was confirmed by Ma (1999) in his meta-analysis. Also, Cipora et al. (2015) and Schnell et al. (2013) findings revealed a negative association between math anxiety and math performance among Polish and German students respectively.

Based on the previously presented discussion, we conclude that math anxiety and test anxiety levels differ based on gender, as girls reported higher levels of both. On the other hand, both of these forms of anxiety are positively and moderately correlated, while a negative correlation was found between them and math achievement.

Study 3. The Relation Between Parents' Math Anxiety and Children's Math Anxiety among the Palestinian Families

Introduction

Research has confirmed that home the environment including parents' feelings, attitudes, and perceptions about their children has a notable impact on children's emotions, attitudes, self-esteem, and even their cognitive abilities (Jameson, 2013; Anbar & Visu-Petra, 2021). It is also noted that parents' own perception of the value of mathematics has a significant impact on their children's motivation to pursue related fields in the future (Soni & Kumari, 2017). Math-anxious parents are more likely to pass their math anxiety to their children, particularly when trying to help their children with math homework frequently (Maloney et al., 2015). Parental expressed attitudes toward math, such as 'Oh, I used to hate math as a child' or 'doing math is difficult' are negatively related to children's success and attitudes toward math (Chang & Beilock, 2016). In contrast, studies suggest that children who are more engaged in-home math-related activities (e.g., board games, play with puzzles, cards) report more positive attitudes and better math achievement than those involved in fewer home math-related activities. Indeed, parents who try to enhance positive math attitudes as much as possible in the home environment, regardless of their emotions or their comprehension of math, are more likely to improve their children's achievements in math and establish positive behaviours toward math learning (Wilder, 2015).[2]

The role of parental involvement in children's achievement is still debatable. Most findings reveal that parental involvement is positively related to children's math achievement and suggest that it may limit negative attitudes toward mathematics (Mohr-Schroeder et al., 2017). However, other meta-analytic findings suggest that at-home parental involvement is negatively related to children's achievement, as a negative correlation was found between students' academic performance and homework parental assistance (Wilder, 2015). Moreover, the gender gap in terms of transmission of attitudes and anxieties has been investigated in several studies, findings

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emphasizing the role of gender stereotype threat among adults and children (Chang & Beilock, 2016). For instance, parents reported that girls need to spend more effort in mathematics learning than boys do, while girls declared less efficiency and less confidence in their math abilities than boys following many years of exposure to this type of math stereotype (Batchelor et al., 2017). It is very challenging to identify parental influences on the relation between academic achievement and math anxiety, due to various several factors, such as family structure, parent educational level, family income, parents' occupation, and the history of parents' performance in mathematics (Soni & Kumari, 2017).

Methodology

The study aimed to investigate the levels of math anxiety and gender differences between mothers and fathers. Also, to explore if the parents' gender controls the level of math anxiety, they will pass it to their child whether he is a boy or a girl, as well as to examine the role of some parental factors in the transmission of math anxiety between parents and their child and to explore the relation between the Parents' math anxiety and their children's math anxiety.

Participants

Our sample consists of 230 students from four primary schools in Ramallah city (151 girls; Mean age = 8.9 years; SD = 0.59 Years). From our total sample (N = 230), 104 participants (37 boys, 67 girls) were enrolled in the third grade, whereas 126 (42 boys, 84 girls) in the fourth grade. All children were Palestinian, had intact or corrected vision, and had Arabic as their primary language. Most children had a middle-class background, with 88.8% of parents earning the average to above-average wage per capita, 37.4% of the mothers and 25.3% of the fathers having a high-school diploma, while 41.8 % mothers and 28.7% fathers having a college or university degree. Data was also collected from all students' parents (N = 230, 74.8% mothers).

Measures and scoring

Parent Measurements:

1- Math anxiety: The Mathematics Anxiety Rating Scale (MARS, based on the original MARS 98-item scale; Suinn &Winston, 2003) The MARS scale consists of 30 items, the first 10 items were designed to assess Math Situational Performance Anxiety (Math Test Anxiety) and the last

10 items were formulated to assess Numerical Processing Anxiety (Numerical Anxiety), a-5 likert scale was used to indicate how nervous would feel the individual during certain situations related to mathematics, (e.g., “Reading a cash register receipt”. (1 = I'm not nervous at all, 2 = I'm a little nervous, 3 = I'm somewhat nervous, 4 = I'm very nervous, 5 = I'm very very nervous. The total score was calculated by the sum of answers on all items. The total range of the MARS is from 30 to 150 while the range of the two subscales, Math Situational Performance Anxiety and Numerical Processing Anxiety is from 15 to 75, hence, higher scale values indicate higher levels of math anxiety. In this sample, the scale shows a very good internal consistency (Cronbach’s α=.93).

2- Parental involvements in child’s math homework also was assessed, Parents completed an assessment about their engagements at child's homework, using the main question “indicate how often you engage in the following behaviors to help your child with math homework?” (e.g., “Check out the homework at the end”). A-7 likert scale was used to indicate the frequency, (1= never to 7= more than once a day). Total scale scores were computed by the summation of answers on all items; hence, the highest score refers to more involvement in at child’s math homework.

3- Parental history of school performance, Parents filed a form of 9 items about their performance in mathematics, Arabic, and the other subjects in primary, middle and high school. they were required to indicate their level in these subjects during the school years, (e.g., “Math in primary school”, “Arabic in primary school”, “other materials in primary school”). A-5 likert scale was used to indicate the level of performance, (1= Poor to 5= Excellent). Total scale score was computed summing all points received on the 9 items; hence, the highest score refers to higher performance. The Cronbach’s alpha of the used survey was .94.

Children Measurements:

1- The Scale for Early Math Anxiety (SEMA, based on MARS; Wu, Amin, Barth, Malcarne & Menon, 2012). A self-report questionnaire was demonstrated with a total of 20 items, the first 10 items were formulated to assess the numerical processing anxiety and the last 10 items were worded to assess situational and performance anxiety, Items were rated on a scale of 5 to indicate how nervous would feel children during certain situations involving math (1= I don't feel nervous at all, 2= a little nervous, 3= somewhat nervous, 4= very nervous, 5= very very nervous). The overall scoring represented by the summation of the 20 items, the total range of the SEMA is from 20 to 100 while the range of each subscale is from 10 to 50, accordingly the higher summed scores

indicate greater math anxiety, for the present sample, internal consistencies (Cronbach´s Alpha =. 87).

2- The student's math achievement, the teacher's evaluation record at the end of the first school semester was used, range of scoring (0-100).

3- The Children Test Anxiety Scale (CTAS) (Douglas & Jeri, 2004) from the previous study.

4- The State-Trait Anxiety Inventory; only Trait Anxiety form was used (STAI-T; Spielberger, 1972) from the previous study.

Procedure

After permission was granted from the school authorities, a written informed consent was obtained from the parents whose children were in the 3rd and 4th grades at those schools in Palestine. Consequently, we organized a meeting during school hours with the students whose parents provided their informed consent. Children were also informed and assured about the confidentiality of their responses. They were then asked to fill in the questionnaires in the following order: math anxiety, test anxiety, trait anxiety. Parents who accepted to participate received the questionnaires via their child or while they were picking the child from school, they completed the forms in the following order: demographic information, parental involvement, parental history of school performance, and the math anxiety scale.

Results

Descriptive data for child measurements are represented below in table.5. The variables are described via mean, standard deviation, minimum value, and maximum value.

Table 5: Means and standard deviations for children's measures

	N = 230	Boys (n = 79)	Girls (n = 151)
	M(SD)	M(SD)	M(SD)
Math anxiety	29.09 (10.32)	26.92 (8.36)	30.20 (11.07)
Math achievement	84.70 (12.12)	85.99 (11.81)	84.02 (12.26)

Gender differences

A significant gender-related difference was found in math anxiety, t(228) = -2.32, p = .021 with a moderate effect size, Cohen's d = .33, revealing that girls reported higher levels of math anxiety (M = 30.2, SD = 11.07) compared to boys, (M = 26.9, SD = 8.36). Yet no significant differences were found math performance, t (228) = 1.34, p = .18. Means and standard deviations as function of children's gender are presented in Table 6.

Looking at gender-related differences in parental reports, mothers reported higher levels of MA, t (169) = -2.43, p = .016, Cohen's d = 0.40, while nonsignificant differences were found between mothers and fathers in terms of parental involvement and history of math performance. Means and standard deviations as function of parents' gender are presented in Table 6

Table 6: Means and standard deviations for parents′ measures

	Fathers		Mothers	
	n	M(SD)	n	M(SD)
Parents′ Math anxiety	74	71.23 (25.69)	124	81.26 (23.40)
Parents′ involvement in homework	57	27.15 (6.13)	168	27.82 (6.28)
Parents′ history of math performance	47	10.61(2.90)	146	10.90 (2.98)

Correlations among study variables

Pearson correlations revealed a negative correlation between children's math achievement and their math anxiety. Moreover, children's math achievement was also negatively associated with their parents' own math anxiety, but positively associated with parental involvement in children's math homework and history of math performance. Nevertheless, the correlation between parents' math anxiety and their children's math anxiety did not reach significant levels. Additionally, we found a negative moderate correlation between parents' math anxiety and their own math performance history (see Table 7) below. To check for potential different associations between the same-gender parent-child dyads, correlations computed between mothers and daughters and between fathers and sons revealed a significant positive association between mother's math anxiety levels and daughters' levels of math anxiety, (r = .25, p = 0.02). In contrast,

nonsignificant associations were found between fathers' math anxiety levels and sons' math anxiety (p = .98).

Table 7: Correlations among study variables

	Measures	1	2	3	4
1	Math anxiety				
2	Math achievement	-.25**			
3	Parents' Math anxiety	.13	-.27**		
4	Parents' involvement in homework	-.04	.15*	-.07	
5	Parents' history of math performance	-.15*	.37**	-.55**	.23**

Predictors of children's math achievement

To analyze contributions of individual characteristics, parental factors, and specific math-anxiety factors to children's math achievement variation, a three-step hierarchical multiple regression was conducted with children's math achievement as the criterion. Potential baseline individual differences (gender, grade, trait anxiety, test anxiety) were entered Step 1. Based on previous results and current correlations, parental variables (parents' math anxiety, parental involvement in children's math homework, and the history of parents' math performance) were added in Step 2. To test whether children's own math anxiety levels contribute to variations in math achievement over and above the influence of parental history with math and homework involvement, children's math anxiety was added in Step 3 (see Table 8) below.

The hierarchical multiple regression revealed that baseline individual differences predictors had a nonsignificant contribution to the regression model. Introducing the parental variables explained an additional 11.1% of variation in children math achievement and this change in R^2 was significant, $F(3,158) = 4.35$, $p < .001$. As visible in Table 8, parents' math anxiety was a significant predictor of children's math achievement, with higher levels of parental anxiety predicting lower math achievement scores in children. On the other hand, parental history in terms of math achievement and parental involvement with the child's math homework did not prove to be significant predictors of the child's math achievement. Adding children's own math anxiety to

the regression model explained an additional 4.6% of the variation in the dependent variable, F (1,157) = 5.14, p < .001. When all independent variables were included in this third step of the regression model, the significant predictors of children's math achievement were: baseline differences in children's trait anxiety, parents' math anxiety, and children's math anxiety. This final model accounted for 20.7% of the variance in children math achievement.

Table 8: Summary of hierarchical regression analysis for potential predictors of children's math achievement

Predictor	B	β	t	R	R2	ΔR2	p
Step 1				.23	.05	.05	.07
Gender	-2.83	-.11	-1.42				
Grade	-3.12	-.12	-1.54				
Trait anxiety	.17	.09	.94				
Test anxiety	-.16	-.19	.04*				
Step 2				.40	.16	.11	.00
Parents' history of math performance	.77	.14	1.47				
Parents' Math anxiety	-.10	-.12	-2.12*				
Parents' involvement in homework	.28	.17	1.69				
Step 3				.46	.21	.05	.03
Gender	-3.54	-.13	-1.83				
Grade	-3.14	-.12	-1.67				
Trait anxiety	.41	.21	2.11*				
Test anxiety	-.07	-.08	-.92				
Parents' history of math performance	.55	.09	1.08				
Parents' Math anxiety	-.09	-.19	-2.12*				
Parents' involvement in homework	.25	.12	1.57				
Math anxiety	-.38	-.29	-3.32*				

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

Discussion and conclusion

The study aimed to investigate the prevalence of math anxiety and identify gender differences among primary school students and their parents, and explore the relation between math anxiety and math achievement as a function of parental factors. The main findings included confirming higher levels of math anxiety among girls/mothers than among boys/fathers, a negative relation between children's math anxiety and their math achievement, also a negative association between children's math achievement and their parents, math anxiety. In addition, we uncovered the possible predictors of math achievement and the possible moderating role of parental variables in the relation between children's math anxiety and their math achievement. Next, we will discuss these results, integrating them in the growing body of literature on factors generating or minimizing math anxiety in primary school children.

Parent-child Math anxiety

Our present results indicated that parents' math anxiety and child math achievements were negatively correlated. Similar results were found by Berkowitz et al (2015), who conducted a study about math at home and child achievements. Such results suggested when parents are more anxious about math, their children learned less math during first grade compared to children of less math-anxious parents. Another study reported that children's math performance was negatively associated with high parent math anxiety, but only when both mothers and daughters or when fathers and sons had high math anxiety (Casad et al., 2015).

Our results also showed significant associations between mothers' math anxiety and their daughter's math anxiety, while no correlation was found between fathers and sons. A possible explanation for this gender effect arises from the fact that mothers and girls in this study are found to be more math-anxious compared to males. Also, the gender stereotype threat of math as a male domain may negatively affect female's math anxiety levels across the lifespan.

In the line with the present findings, Casad et al. (2015) carried out a study among students in the 6th to 8th grades. Their results confirmed that parents' math anxiety was related to children's math anxiety and both variables interacted to predict mathematics outcomes. Also, in a sample of Indian children aged 10 to 15 years, Soni and Kumari (2017) confirmed that parents' math anxiety was positively associated with children's math anxiety and negatively affected their mathematics

attitude. In contrast, Jameson (2013) examined the environmental factors relating to math anxiety in 2nd-grade students (aged 7–9 years) and found no significant association between parents' math anxiety and their children's math anxiety. Another study conducted by Batchelor et al (2017) indicated that children's math anxiety is related to parents' math anxiety, more specifically, a positive association between parents' math anxiety and sons was calculated, while no association with daughter's levels of math anxiety was found.

Predictors of child math achievement

A weak but positive correlation was found between parental involvement in child math homework and child math achievement. Similar findings were reported by Fan's and Chen's (2001) meta-analysis in which a positive association was calculated between academic achievement in young children and parental involvement at home and school. Our findings are not in line with other studies indicating home parental involvement to be negatively related to children's achievement (Wilder, 2015).

Our findings revealed that children's math anxiety and parents' math anxiety were both predictors of children's math achievement, being consistent with the Maloney et al (2015) study, which confirmed the role of parents' math anxiety as a predictor of children's math achievement but only for children whose parents were involved in math homework. Similar results were reported by Casad and Wachs (2015), who suggested parents' anxiety as a predictor of children's math education outcomes. In addition, a meta-analysis proposed that students' math anxiety levels can significantly predict their mathematics performance (Ma, 1999). However, Hembree's meta-analysis (1990) revealed that math anxiety was more predictive of math performance in boys than in girls. In contrast to our findings that are not revealing a predictive role of parents' involvement in child math homework for their math performance, other studies confirmed the suggestion of parental involvement as an important predictor of math achievements (Harackiewicz et al., 2012; Hill & Taylor, 2004). Interestingly, the way parents interact with their children and their spontaneous reaction to math is a better predictor of children's outcomes than the level of school parental involvement (Wilder, 2015).

A moderation interaction analysis was run to examine if parental variables (parents' math anxiety, parent involvement in child math homework, and the history of parents' math performance) moderate the relation between child's math anxiety and child math performance.

Our results showed that none of them was playing a moderator effect on the relation. It is important to note that regardless of causal direction, parental variables didn't moderate the relation between anxiety and performance. In fact, a majority of parents in our sample tended to rate themselves as highly involved, so there was little variation in the levels of parents' involvement that could be a reason for making parental involvement moderate the relation between child math anxiety and child math performance. Due to the self-reported measure used in this study, parents may have provided socially desirable responses about their level of involvement in their child's math homework, rather than indicating their actual parental involvement level (Warren et al., 2018).

Based on the previously presented discussion, we conclude that there are significant gender differences in math anxiety levels, young girls in primary school and also their mothers, reported higher levels of math anxiety. In addition, the study showed that math anxiety levels significantly and negatively affected mathematics achievements. Both child's math anxiety and their parents' math anxiety were found to be strong predictors of children's math achievements.

Study 4. Mathematics Anxiety and Math-Gender Stereotype Threat: Can Parents' Math Stereotypes Explain the Gender Gap in Mathematics Anxiety

Introduction

Despite its importance and robust presence in our daily life, mathematics is often viewed as a complicated, difficult subject and preferably avoided (Ramirez, Shaw & Maloney, 2018). Math-related fears represent a worldwide phenomenon affecting all age groups and have been collectively termed "Math anxiety" (Hembree, 1990; Ma, 1999). Math-anxious students may achieve less in mathematical tests (Devine et al., 2012), and tend to avoid math-related activities and careers (Casad, Hale & Wachs, 2017) such as STEM domains (science, technology, engineering and mathematics) (Maloney & Beilock, 2012; Brown & Stone, 2016). Women are even more vulnerable to developing math anxiety (Foley et al., 2017), and STEM avoidance due to the gender stereotype threat consisting of a commonly shared view of math as a male domain (Carey et al., 2017).

Stereotype threat refers to the conscious or unconscious belief or the absolute persuasion that someone belongs to a stigmatized group known for certain deficits (Steele & Aronson, 1995; Stoet & Geary, 2012). Given that both math anxiety and stereotype threat induce insufficient achievement in mathematics, many theoretical approaches have assumed that Stereotype threats and gender-role socialization process are considered a major factor that explains the gender gap in mathematics (Anbar & Visu- Petra, 2021; Picho & Schmader, 2017). [3]For many years mathematics has been viewed as a male domain (Tiedemann, 2002; Bieg, Goetz, Wolter & Hall, 2015). The common stereotypes that men are naturally talented in math and more interested in math-related activities influence math achievements and career orientations in both genders. For example, women who endorse such stereotype: 'math = male'' reported less interest in math and science, and are less likely to be involved in future math courses or related activities (Tenenbaum & Leaper, 2003; Nosek et al., 2009). In fact, females' math performance is disrupted not because they are

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incompetent but due to threatening situations and the possibility that their performance will confirm the gender stereotype and the assumption of math as "a male domain" (Tomasetto, Alparone & Cadinu, 2011).

Methodology

The study aimed to investigate parents' math gender stereotypes and their relationship with their child's math anxiety and their math achievement, also to explore children's math anxiety and math achievement and examine the gender differences in both math anxiety and math achievement

Participants

The same sample from the third study, our sample consists of 230 students from four primary schools in Ramallah city (151 girls; Mean age = 8.9 years; SD = 0.59 Years). From our total sample (N = 230), 104 participants (37 boys, 67 girls) were enrolled in the third grade, whereas 126 (42 boys, 84 girls) were in the fourth grade. Data were also collected from all students' parents (N = 2

Measurements and scoring

1- Child Math anxiety The Scale for Early Math Anxiety (SEMA, Wu, Amin, Barth, Malcarne & Menon, 2012) the same in second study
2- Child Math achievement, teachers' evaluation math's record, represent student's final performance in math subject at the end of the first school semester, the marks scale range was 0- 100.
3- Parents math's gender stereotype, The Gender Stereotype Scale toward Mathematics, (Nurlu, 2017) was used, it is 34 items in total and consists of two subscales: Boy's form and Girl's form, each form includes 17 items which are divided into four main subscales: environments, career, attribution, and competence (See table. 9 below). A 5-point Likert scale was used to measure parents' accordance (1= strongly disagree – 5= strongly agree) with the 34 statements about gender stereotypes toward mathematics. Both forms of the scale have adequate reliability, Cronbach's alpha value for boys' form was .91, and for girls' form was .91.

Table.9. Items distribution of each subscale

subscale / Items	Environment	Career	Competence	Attribution	Total
Boys form	4	4	6	3	17
Girls form	3	3	8	3	17
total items	7	7	14	6	34
Item Examples					
Environment	"Boys are expected more than girls to do well in mathematics by their parents"				
Career	"Boys are encouraged more than girls to choose a career in a mathematically-related area"				
Competence	"Boys have higher mathematical thinking abilities than girls have"				
Attribution	"Boys mostly increase their mathematical achievement, because of the support of their teachers"				

Results

Descriptive results are presenting in tables below. Children's math anxiety and math achievement according to gender are presented in Table. 10 below Parents' math gender stereotypes for each subscale as a function of child gender are presented in Table. 11.

Table.10

Means and standard deviations for children's measures as a function of gender

	N = 230	Boys (n = 79)	Girls (n = 151)
	M(SD)	M(SD)	M(SD)
Math anxiety	29.09 (10.32)	26.92 (8.36)	30.20 (11.07)
Math achievement	84.70 (12.12)	85.99 (11.81)	84.02 (12.26)

Table.11

Means and standard deviations for Parents' math stereotypes as a function of child gender

	Boys (n = 230)	Girls (n = 230)
	M(SD)	M(SD)
Parents' math gender stereotypes (Total)	43.25 (11.09)	47.97 (11.09)
Parents' math gender stereotypes (Environment)	9.32 (2.90)	8.00(2.63)
Parents' math gender stereotypes (Career)	10.82 (2.96)	7.87 (2.33)
Parents' math gender stereotypes (Competence)	15.49 (4.62)	23.88 (6.11)
Parents' math gender stereotypes (Attribution)	7.61 (2.26)	8.21(2.42)

Correlations among study variables

Pearson correlations revealed a negative correlation between children's math achievement and their math anxiety (r =.25, p =.00). No significant association was found between parents' math gender stereotypes and child math anxiety or between parents' math gender stereotypes and child achievements.

Gender differences

A significant gender-related differences were found in child math anxiety, t(228) = -2.32, p = .021 with a moderate effect size, Cohen's d = .33, revealing that girls reported higher levels of math anxiety (M = 30.2, SD = 11.07) compared to boys, (M = 26.9, SD = 8.36). while, no significant gender differences were found in math performance, t (228) = 1.34, p = .18. In addition, a significant gender differences were found in parents' math gender stereotypes, t(229) = -6.16, p = .00 with a moderate effect size, Cohen's d = .41, and in all subscales of parents' math gender stereotypes scale such as, a significant gender differences were found in the environment subscale, t(229) = 6.36, p = .00 with a moderate effect size, Cohen's d = .47, and a significant gender differences were found in the career subscale, t(229) = 15.25, p = .00 with a large effect size, Cohen's d = .1.10, also, a significant gender differences were found in the competence subscale, t(229) = -20.56, p = .00 with a large effect size, Cohen's d = 1.54, as well, a significant gender

differences were found in the attribution subscale, t(229) = -3.66, p = .00 with a small effect size, Cohen's d = .25.

Discussion and conclusion

The main findings included confirming significant differences in parents' math stereotypes as a function of child gender, and significant differences in child math anxiety, higher levels of math anxiety among girls than among boys, while, no gender differences were found in math achievement. Also, a negative relation between children's anxiety and their math achievement was found. Next, we will discuss these results, integrating them into the existing literature on factors increasing math achievements and enhancing women's participation in the STEM fields.

Parents' Math gender stereotypes

Significant differences were found in parents' math gender stereotypes as a function of child gender, and these differences were also found in all subscales (environments, career, attribution and competence). In 2015 Flore's and Wicherts's meta-analysis confirmed the previous results of identifying math as a male domain. These gender disparities are reflecting the power of stereotype threats and adults as socializing agents of children (Kurtz-Costes et al.,2008).

Our results showed that there are gender differences in parents' math stereotypes in favor of boys in the environment and career subscales, while there are gender differences in parents' math stereotypes in favor of girls in the competence and attribution subscales. In other words, the mean values were found to be significantly higher for boys in the subscales of environment and career, for example, "boys are encouraged more than girls to choose a career in a mathematically-related area" or "boys are expected more than girls to do well in mathematics". Also, the mean values were found to be significantly higher for girls in the competence and attribution subscales, such as "Girls have higher mathematical thinking abilities than boys have or "girls mostly increase their mathematics scores because their parents provide them with mathematical support". Regarding the environmental and the career orientations, parents are considered to be more supportive to their sons than their daughters, sons are seen as more willing than girls to work in mathematically-related areas and they are expected to outperform in math-related fields compared to girls. Although parents admit their daughter's math competence and even, if they are seeing girls outperforming in math, they still believe that this is coming from other sources like parents'

or teachers' support or studying longer hours, not from their own abilities, which is confirming the assumption of math as male domain (Batchelor et al., 2017).

In fact, Arab countries have a larger gender gap due to cultural reasons, common beliefs regarding mathematics, and stereotypical gender roles. In Arabic communities, it is common to see boys and girls treated differently, with girls expected to take on traditional household roles when they grow up, as housewives or mothers, and if they are encouraged to work, their suitable jobs that do not require late working hours or night shifts, while masculine tasks such as many tasks considered the domain of males (Rapp, 2015).

Due to these common stereotypes threat, Girls' aspirations and performance are negatively affected, and they are discouraged to make a part in the STEM domains, limiting their chances of active participation in the global workforce market (Ongiti, 2014). According to social theory, when girls grow up in a societal context where women are rarely being involved in STEM careers, they receive a clear message that these fields are a male domain and therefore, feel anxious about math and are less confident about their mathematical abilities, hence they are less likely to get involved in careers related to these fields (Else-Quest, Hyde & Linn, 2010).

Congruence between children's and parents' measures

Our results did not reveal any significant correlation between parents' math gender stereotypes and child math anxiety or between parents' math gender stereotypes and child achievements. We justify this result by gender stereotypes awareness at an early age, simply being aware of a negative stereotype is enough to push children to perform under their actual abilities, hence, at a young age, children haven't yet sufficiently developed enough awareness of the stereotypes threat (Flore & Wicherts, 2015). A stronger association between parents' gender stereotypes and child performance is more likely to be found in middle school-aged students rather than primary school-aged students (Kurtz-Costes et al., 2008).

We concluded, there are significant differences based on child gender in the levels of parents' stereotypes beliefs about mathematics, we calculated higher means favor of girls than boys. Also, there are differences based on gender in the all four subscales factors levels of parents' math stereotypes, the environment, career, competence and attribution, while there are significant gender differences in parents' math stereotypes in favor of boys in the environment and career

subscales, while there are significant gender differences in parents' math stereotypes in favor of girls in the competence and attribution subscales.

CHAPTER 4. CONCLUSION AND GENERAL DISCUSSION

General Conclusions

The current research extends the existing literature related to math anxiety and math achievement in several directions. For the first time, to our knowledge, we started by translation and validation of two measurements of math anxiety in the Palestinian community. Secondly, we measured both parent and child math anxiety, checking for possible gender differences in a relation with mathematics achievement and with other forms of anxiety such as trait and test anxiety. We also investigated the potential mechanisms responsible for math anxiety transmission between parents and children, such as the parental involvement in child math homework, the history of parents' math performance and parents' math anxiety. Moreover, we explored the possible mediators in the relation between children math anxiety and math achievement, in addition to the child math performance predictors. Finally, we investigated parents' math gender stereotype and its relation with their children's math performance and math anxiety.

Summary of the main findings and the main measured variables and the used instruments are represented in the table. 13 below

Table. 13 Summary of the main findings

study	Participants	Main variables	Measurements	Main findings
1	N=11 Girls=73, Boys=38. Age =8.9, SD = 0.57 years	Math anxiety Test-Retest scales	Scale for early math anxiety (SEMA: Wu et al., 2012) The modified abbreviated math anxiety scale (MAMAS, Carey et al,.2017)	*Results indicate that the Arabic versions of the math anxiety scales seems to be a valid to asses math anxiety among primary school-aged children in Palestine *The mean values of math anxiety scores were lower than

1				the studies used the same English scales *A moderate positive correlation was found between test and r-test scales of math anxiety (The modified abbreviated math anxiety scale (MAMAS) and the scale for early math anxiety (SEMA * We calculated moderate to strong internal consistency for all test and r-tests scales: MAMAS and SEMA * We calculated a good reliability scores for both test and r-test scales.
2	N=230 Girls=151, Boys=79. Age =8.9, SD = 0.59 years	Math anxiety Test anxiety Trait anxiety Math achievement Gender	*Scale for early math anxiety (SEMA: Wu et al., 2012) *The modified abbreviated math anxiety scale (MAMAS, Carey et al., 2017) *Children test anxiety scale (CTAS, Douglas & Jeri 2004) *State trait anxiety inventory; trait anxiety form (Spielberger, 1972) *The Behavior Assessment System for Children (BASC; Reynolds & Kamphaus, 1992); subscale self- report of personality	*We found gender differences in math anxiety and trait anxiety. Gils reported higher levels of math anxiety and trait anxiety. *There are no significant gender differences in test anxiety as well as in math achievement. *The two forms of math anxiety (MAMAS and SEMA) are strongly correlated. *There is a positive moderate correlation between test anxiety and math anxiety and between the previous mentioned and trait anxiety *There is a negative relation between the levels of math

			(SRP) Attitude to school and teachers *Teacher record of math achievement	anxiety and test anxiety with student's achievements in mathematics as well as the attitudes toward school and teacher *Trait anxiety and test anxiety are both predictors of child math anxiety.
3 3	N=230 children Girls=151, Boys=79. Age =8.9, SD = 0.59 years N= 230 parent 58 fathers, 172 mothers	Child math anxiety Child test anxiety Child trait anxiety Child math achievement Parents math anxiety' Parental involvements in Math homework Gender History of parents' math performance	The same children measurements from study 2 in addition to these parents' instruments * The Mathematics Anxiety Rating Scale (MARS; Suinn & Winston, 2003). * Parental involvements survey (Maloney et al., 2015)	We found gender differences in parents math anxiety. mothers reported higher levels of math anxiety compared to fathers *A significant positive weak correlation was found between mother's math anxiety levels and their daughters' math anxiety but not between father's math anxiety levels and their sons. *Differences in the child's math anxiety levels were found to be significant based on the similarity of genders between parents and child, for example, the levels of child math anxiety were found to be higher of the similar gender dyads compared to different dyads. *Children math anxiety and parents' math anxiety were found as predictors of children math achievement *Parents' gender, mother education and the history of

				parents' school performance at Mathematics were found as a predictors of Parents' math anxiety. *Parental variables (parents' math anxiety, parent involvement in child math homework, and the history of parents' math performance) do not mediate the relationship between child math anxiety and child math performance
4 4	The same sample of the third study	Math achievement Gender Child math anxiety Parents math anxiety Parental involvements in Math homework Parents math gender stereotypes	*The Gender Stereotype Scale toward Mathematics; (Nurlu, 2017). In addition to the previous measures in second and third study	*There are gender differences in math anxiety, girls reported higher levels of math anxiety, while there are no gender differences in math achievement. * There are differences based on child gender in the levels of parents' stereotypes beliefs about mathematics, we calculated higher means favor of girls than boys. *There are differences based on gender in the all four subscales factors levels of parents' math stereotypes, the environment, career, competence and attribution. *There are significant gender differences in parents' math stereotypes in favor of boys in

				the environment and career subscales, while there are significant gender differences in parents' math stereotypes in favor of girls in the competence and attribution subscales.

Theoretical Insights

The previous research contributes with new theoretical insights to psychological and educational field. As far as we know, it's the first of its kind in the Palestine. Our findings provide some useful theoretical directions as well as empirical data. In what follows, we will interpret our findings in light of the previous literature framework.

In the second study, our findings revealed a negative relation between math anxiety and math achievement, in this respect, Hembree's meta-analysis (1990) and Ma's (1999) meta-analysis confirmed the same result. The relation between math anxiety and math achievement is debatable due to the two possible causal directions. Based on the ***Cognitive Interference Theory*** (Wine, 1980), which claims that anxiety causes individuals to underperform in math by affecting their working memory resources, and suggested that anxiety hinders optimum performance due to the fact that math anxiety reduces the available working memory capacity and depletes the cognitive resources that support complex mathematics tasks (Erturan & Jansen, 2015; Ashcraft, 2002). In fact, these negative thoughts partially occupy working memory capacity, as a result, less attention is accessible for task-directed efforts, and accordingly, this leads to performance degradation (Hembree, 1988; Birenbaum & Nasser, 1994; Trudeau, 2009). The more working memory capacity individuals have, the better their competence in high-order thinking skills as problem-solving and reasoning is. Beilock, 2008; Berch & Mazzocco, 2007). Another theory discussed the negative relation between math anxiety and math achievement was the ***Deficit Theory*** (Tobias, 1986), which claims that the awareness of poor mathematical skills leads to higher math anxiety. Individuals who have weaker math abilities are more likely to not attend math classes and to avoid related-math activities which can trigger inadequate math skills and therefore more math anxiety

(Devine et al., 2012; Ramirez et al., 2018; Carey et al., 2016). Some studies found that poor mathematics performance brings higher math anxiety, that is to say children diagnosed with mathematical disabilities revealed more math anxiety moreover incompetent skill levels may increase the potential of being anxious, obviously the interplay relationship between math anxiety and performance is still an open argument and needs further research (Devine et al., 2012; Dowker et al., 2016; Bruno, 2015). We argue that our study extends and adds to the current literature, by confirming the negative association between math anxiety and math achievement, students with less math competence tend to report higher levels of math anxiety, while higher-anxious students may underperform in math and be poor math's achievers.

In the third study, our finding we attempted to investigate the between child math anxiety and parents' math anxiety and the potential mechanisms responsible for the transmission of math anxiety between parents and children. According to the ***Social Learning Theory*** (Bandura, 1986), Parents are considered as role models for their children and children likely tend to embrace the attitudes, beliefs, values and emotions of their parents. Parents' academic values could be transmitted to their children through school educational activities or direct and indirect home educational activities (Gniewosz & Noack, 2012). Math-anxious parents are more likely to pass their math anxiety to their children, particularly when trying to help their children with math homework frequently (Maloney et al., 2015). Our finding didn't reveal a significant relation between child math anxiety and parents' math anxiety, but a significant positive weak correlation was found between mother's math anxiety and their daughters' math anxiety but not between father's math anxiety and their sons. We argue that in our study, the significant relation between mothers and daughters' level of math anxiety is more affected by the common stereotype of math as male domain, hence we did not find this significant relation between fathers and boys' level of math anxiety. In addition, we found significant differences in the child's math anxiety levels based on the similarity of genders between parents and child, for example, the levels of child math anxiety were found to be higher of the same gender dyads compared to different dyads. According to (Bandura, 1977) theory the same-gender parents' values seem to be more evident, which facilitates values transmission. In our sample the levels of child math anxiety were higher in the same-gender dyads, for example when fathers they were involved in child math homework, the levels of math anxiety were higher for boys than girls, and that confirm again the model role of the social learning theory.

In the last study we explored parents 'math gender stereotypes with the relation of child math achievement and child math anxiety, our findings Significant differences were found in parents' math gender stereotypes as a function of child gender, and these differences were also found in all subscales (environments, career, attribution and competence), while there are no significant association between parents' math gender stereotypes and child math anxiety or between parents' math gender stereotypes and child achievements. According to ***Social Structural Theory*** (Eagly & Wood, 1999), when girls grow up in a societal context where women are rarely being involved in STEM careers, they receive a clear message that these fields are a male domain and therefore, they may develop avoidance behavior toward math and they are less likely to get involved in careers related to these fields. On the other hand according to ***the social-role theory*** (Eagly 1987), that argues because math is traditionally seen as a male domain, females may be socialized to perceive their mathematical skills as incompetent and therefore females may avoid mathematical activities and if they do participate in math activities they may experience more math anxiety than males do (Forgasz, Leder & Gardner, 1999; Eccles, 2009).

Our results showed that there are gender differences in parents' math stereotypes in favor of boys in the environment and career subscales, while there are gender differences in parents' math stereotypes in favor of girls in the competence and attribution subscales. In other words, the mean values were found to be significantly higher for boys in the subscales of environment and career, for example, "boys are encouraged more than girls to choose a career in a mathematically-related area" or "boys are expected more than girls to do well in mathematics". Also, the mean values were found to be significantly higher for girls in the competence and attribution subscales, such as "Girls have higher mathematical thinking abilities than boys have or "girls mostly increase their mathematics scores because their parents provide them with mathematical support". Regarding the environmental and the career orientations, parents are considered to be more supportive to their sons than their daughters, sons are seen as more willing than girls to work in mathematically-related areas and they are expected to outperform in math-related fields compared to girls. Although parents admit their daughter's math competence and even, if they are seeing girls outperforming in math, they still believe that this is coming from other sources like parents' or teachers' support or studying longer hours, not from their own abilities, which is confirming the assumption of math as male domain as was claimed by ***the social-role theory*** (Batchelor et al., 2017).

Practical Insights and Recommendations

The presented findings provide practical insights into the prevalence of math anxiety and gender differences, in addition to parents' role in the transmission of math anxiety and their gender stereotype toward mathematics. Mathematics is the core of many sciences; it is used in everyday activities and nowadays it's essential for the overall development of each country. Math anxiety is a widespread phenomenon and it results in poor math skills and avoidance behavior of math and math-related domains and careers. Given the importance of math and its critical role in the technological and economic growth of any nation, it's become imperative to investigate the levels of math anxiety and to understand when it starts to emerge, from where it comes, what we can do to reduce it, and to ensure that we are equipping students with sufficient mathematical skills needed for the 21st-century workplace.

Our outcomes provide a realistic analysis and practical evidence of the existing associations between math anxiety and math performance, also between parental factors (e.g., parents' math anxiety, parental involvement at child math homework, parents' math gender stereotypes) and child math anxiety. Since many environmental, pedagogical, and cultural factors play a role in developing math anxiety, become necessary to establish new strategies and interventions to reduce it and minimize the gender differences.

Parents and teachers are the basic educators of any child, starting from home and class environments we can suggest effective strategies to reduce math anxiety levels and to enhance positive attitudes toward mathematics. We suggest using modern teaching methods based on reasoning skills rather than memorizing mathematical concepts, adopting different learning styles according to individual differences, motivating students to enjoy doing math, and making math relevant by endorsing the belief that math is valuable in daily life. On the other hand, giving students the chance to choose the questions they answer on a test, relaxing time restrictions and offering second chances by providing the option to retake the test, developing alternatives to written exams and making sure that all instructions are clear. All of these techniques likely function to decrease anxiety by enhancing students' perceived control and alleviating expectations of math anxiety.

Parents are imposing on their children academic demands that are difficult to accomplish, in addition to parental involvement in child math homework, parents' math anxiety and parents gender stereotypes toward math, in fact all these parental factors may increase child anxiety. We recommend some directions to help parents to be more involved in child math education in school more than at home, inviting parents to school and encourage them join their child in math class, simply having them engage in some math activities or games with their child such as counting, drawing, building blocks, measuring distance or playing with puzzles, etc. by applying this we aim to break the fear of math and to help parents to see and evaluate their child math skills out of traditional way like math exams or math homework. Also math anxious parents may transmit their negative feeling to their children via helping them in math homework or indirect math activates such as recalculate supermarket bill with stress, measuring destines or volume with unconfident in their math abilities or even spontaneous words about math (e.g., it's hard to do math, math for smart ones, not everyone can do math), therefore we can tell parents participation in their child education in school which is guided by math teachers or effective instruction by specialist in math teaching defiantly will lessen both parents and child math anxiety.

Gender differences in math also it should be highlighted, support young girls and mothers to believe more in their math abilities and to overcome the stereotype belief of math as male domain, by raising the awareness of math achievements, recently female outperform male in may national and international exams, nowadays women are capable to compete in math or math-related domain during the study period in the workplace. There are many examples of outstanding women in various fields that are seen as a male field, we know it's not easy to change cultural rooted norms but we can start by doubting the common belief of man superiority in math.

According to Karama research conducted in 2020 to examine the gender bias in the Palestinian school mathematics textbooks among Grades (1-12). The findings indicated that Palestinian school math textbooks are male-biased. We suggest for educational specialist and math text book designer to take these findings in consideration, by modifying math textbook so as not to be male gender biased for example, more pictures and structure or text should be added to math text book representing female, as well as in all disciplines.

We believe that math anxiety studies contribute to an understanding that pursuing success in mathematics requires not only mathematical skills but also the right mindset. When students are

math anxious, they perform below their actual abilities. Their math anxiety not only drives them to underperform in mathematics, but also to avoid math and math-related disciplines, resulting in fewer professionals in STEM fields. We recommend policymakers consider math anxiety when designing student's textbooks or any programs aimed to grow the STEM workforce, and by educating teachers who can, in turn, help their students and their parents to reduce their math anxiety and its negative impact on math achievement, we will create a stronger STEM workforce that is better prepared to meet the technological and economical demands of the 21st century.

Limitations

Our research is limited by the flowing limitations. First of all, the sample was taken from four primary schools in Ramallah city (Palestine). This study represents the opinions of 230 students studying in 3rd and 4th grades within the academic year of 2019-2020, with the participation of 172 mothers and only 58 fathers. Another limitation refers to the instruments utilized for this study, only self-report scales were used, could lead to response bias. Future studies could gain further insight from combining self-reports with physiological measures like the direct observation of the autonomic responses such as heart rate, temperature, or brain imaging technology, which can increase the validity of math anxiety and test anxiety measures.

Additionally, the number of students who participated in each school may have varied significantly based on obtaining consent. Participation in this study was voluntary: therefore, students more vulnerable to math anxiety were less likely to participate. On the other hand, some parents refused to participate or provide consent to their child, which may stem from their awareness of their child's poor performance in math or insufficient overall outcomes.

Moreover, the current study may have experienced some limitations regarding the classroom environment. Each grade had different math teachers who utilized varied teaching strategies and testing techniques, therefore, the students' responses were biased according to these differences. Also, the measurement of academic performance used in this study was based on teachers' records of each student. Given the fact that every teacher uses their own methods and scoring rubric, it was very challenging to compare students' outcomes across classes also it would be more accurate if specific mathematical tasks measured math performance during the academic

semester. Finally, the absence of previous research studies on the subject of our study in Palestine made it challenging to find any previous specific data.

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