

## The effect of mathematics anxiety on the achievement of middle school students in Amman

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### ABSTRACT

This study aims to investigate whether student anxiety about the subject of mathematics has any effect on the achievement of middle-school students in Amman, Jordan. It also aims to investigate whether student gender plays a role. The study sample consists of 180 seventh grade students enrolled in Amman public schools during the 2018/2019 academic year. These are distributed into three levels of anxiety as displayed by the students: low, middle, and high. Then, math anxiety measurements are collected, the validity and reliability for which are verified. The results reveal that there are statistically-significant differences in achievement between the middle level of math anxiety and the two other extremes. It is found that middle anxiety level have a positive effect on achievement, whereas for low and high math anxiety levels, no differences in achievement are perceived. In addition, no statistically significant differences ( $\alpha \leq 0.01$ ) were found between males and females with regards to math anxiety; and there is no interaction between the level of math anxiety and gender in achievement.

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## 1. INTRODUCTION

Mathematics education in Jordan faces many challenges represented by the ability of teachers to create a comfortable learning environment, engage students with activities, and provide interesting math experiences for students. Many studies emphasize the importance of motivation to teach math carefully [1]. Yet, inevitably, there are levels of anxiety felt by students in learning a given subject, and this may be especially true with regards to the subject of mathematics.

Of course, this is a broad subject, but this researcher proposes to explore it by focusing on pre-secondary school students, and specifically those in seventh grade. This study will look at this issue by first reviewing what is already documented about math learning, and the anxiety that is associated with it. Having established the research background on these issues, the study questions will then be proposed, explained, and tested; and the study conclusions will be discussed.

One of the prerequisites for creativity in learning math is to develop students' motivation to learn. Costa [2] emphasizes the need for perseverance, diligence, and maintaining a high level of motivation to learn. A study by Korkmaz, Dundar, and Yaman [3] emphasizes the importance of providing 'productive' mental habits for teachers and students, so as to provide classroom environments free from fear and stress.

The National Council of Teachers of Math [4] considers the Principle of Teaching as one of the most important principles and standards of teaching and learning math. This principle emphasizes the need to provide

appropriate educational measures aimed at raising the achievement levels of math students. Specifically, this may be seen in their ability to solve mathematical problems, to master their mathematical skills to better overcome life problems, and to increase the general 21<sup>st</sup> century skills of critical thinking, communication, cooperation, and creativity.

However, there is evidence that these measures must be thoroughly addressed, now more than ever. The results of a 2015 international study pointed to a clear decline in the achievement levels of Jordan's students in math, as compared to those of students worldwide. The international study indicated that the average scores of Jordanian students in tests were lower than the general average by a difference of 114 points. This decline in math achievement resulted in eighth-grade Jordanian students being ranked 36 out of 39 countries [5].

A problem facing math learners, locally and regionally, may be the reliance on traditional instructional teaching strategies, and the lack of focus on the specific learner's activity and direct experience [6]. A teacher may often solve problems in class without the active participation of the learners. Consequently, one of the important factors affecting a student's level of mathematical anxiety is self-confidence, which has an active role in learning math. Anxiety reduces learning opportunities, thinking capacity, as well as attempts to solve mathematical problems.

Mathematical anxiety is defined by Agail [7] as the general tension and fear of situations where dealing with math and numbers is required. Wilson further defines it as a state of panic, fear, trembling, and mental distraction that appears to students when they are exposed to mathematical problems, negatively affecting their learning and academic achievement. Math anxiety usually starts at the basic stage, with the accumulation of bad experiences during the early school years. This negatively affects the learner's confidence in his or her ability to deal with mathematical problems [7]; and this naturally leads to avoidance of dealing with math in the future.

Deniz and Uldas [8] point out that math anxiety is due to three main factors, which are the environmental, mental, and personal issues of the learner. Shields [9] further states that math anxiety can be the result of many factors that may either be perceived individually, or in combination with each other. These factors are the impacts felt by the society, the family, the teacher, the teaching and evaluation method, as well as the school and classroom environment.

Vitasri et al. [10] conducted a study aimed at identifying the factors affecting math anxiety in a sample of Malaysian students at the Faculty of Engineering. The results of the study showed that this phenomenon is due to five factors: the perception that math is difficult, the repetition in courses, the large amount of writing in classes, general difficulty in understanding the subject, and the unwillingness to solve mathematical problems. Vitasri et al. noted anxiety among females more so than males. They explain that there is a relationship between math anxiety and achievement, and that students with math anxiety tend to avoid using mathematical and problem-solving skills. There have been many other studies which show that there is a negative relationship between math anxiety and achievement, such as those by Hembree [11], and Yaaqoub [12], with varying strength.

Some studies were conducted to determine the effect of math anxiety on the prediction of students' success in the subject. Ashcraft and Kirk [13] showed that students with high math anxiety levels had difficulties in solving problems, and that they were slower to perform various mathematical operations, and thus performed less efficiently in math. A study by Riika et al. [14] emphasizes the need to identify math anxiety levels in students at an early stage. The study was conducted on fifth grade students in Finland, where the results showed an inverse relationship between the level of anxiety and academic achievement. In addition, the study showed that there are two types of mathematical anxiety: anxiety related to mathematical attitudes, and anxiety related to the study of math in general.

Elizabeth et al. [15] also conducted a study on the inverse relationship between math anxiety and achievement in primary school students, and specifically those in first and second grade. The results of study showed a positive relationship between motivation and achievement— i.e., the higher the motivation, the higher the achievement. The results also showed that the level of achievement in the first grade may have a significant effect on achievement in later stages.

There has been some documentation into using various educational strategies to reduce anxiety. One such study by Mina and Mehdi [16] investigated the impact of standard cognitive behavioral therapy in reducing anxiety in math, as well as promoting self-assertion, among a sample of tenth grade students in Iran. The experimental method was used in the study, wherein the results confirmed the effectiveness of cognitive behavioral therapy in reducing anxiety and increasing self-affirmation, especially in female students.

Of course, it may be prudent to understand how other players' behaviors or actions may have an impact on a student's anxiety. Akanksha and Santha [17] conducted a study in India to investigate the relationship between the parents' anxiety with regards to math and their children's math anxiety. They found that there is a positive correlation between the parents' anxiety about math and that of their children.

In the scope of university students, Hodges et al. [18] conducted a study on the role of teachers in increasing the activity of the learner, providing classroom environments to encourage learning, and managing student anxiety appropriately. The study was conducted on Master's students enrolled in math-intensive programs, and investigated the role of using a therapeutic strategy in an acute attempt to reduce their math anxiety. The results of the study showed the effectiveness of the described strategy in reducing anxiety, and in increasing the self-efficacy of mathematical comprehension. It also showed that female math anxiety was higher than that of males. Similarly, Ciftci [19] conducted a study exploring the impact of teachers' methods to control math anxiety in a sample of university students in Turkey; and the mediating factors that may play an important role in reducing mathematical anxiety, such as gender, previous achievement level, and school year level. The results confirmed that there is a perceived impact related to a teacher's anxiety reduction method. The results also showed that there is a gender factor to the teacher's method, as results were noted more greatly in males— particularly in low-achievement groups.

Trends International Math and Science Study (TIMSS), in 2015, showed a clear decline in the performance results of students in the fourth and eighth grades, and Jordanian students scored poorly at the bottom of the list [5]. Furthermore, Jordanian student results in the high school exit test did not exceed 50% in the scientific stream in 2018; and the failure rate in the math course was high.

Almasry & Abulebdeh [20] conducted a study for the National Center for Human Resources Development (NCHRD) about the problems and difficulties faced by learners in Jordan. It was noted that there is a clear weakness in students' possession of basic skills, and their abilities for inductive and deductive thinking.

Morsi [21] suggests that math anxiety in students during exams may contribute to their poor achievement, and to their inability to think. Alanzi's study [22] confirms that there is a negative correlation between a student's academic average and the level of math anxiety— i.e., students with high scores in math had less anxiety than their peers with low scores. Also, the results of the study showed that there are differences between relative levels of anxiety, and identified those as low, middle, and high anxiety levels.

Educational literature suggests that many factors may affect learning outcomes: emotional, mental, and physical [23]. Anxiety is considered an emotional factor, and is one of the more prominently observed elements in the current era, which is why some see it as “the age of anxiety”. It is, therefore, necessary to know anxiety levels in a sample of students, and to study their relationship to academic achievement.

Hart [24] points to other factors related to students' anxiety about math, testing procedures, and concern about math classes. These include the concerns of math teachers themselves about the subject, as well as concerns about the inability of students to understand math topics. Akanksha and Santha [17] points out that another the factor associated with math anxiety, as felt by students, may be the concern of parents about math and their lack of confidence that their children are able to understand math and solve problems.

One of the most important requirements of learning is to provide a comfortable, attractive, and exciting classroom environment that provides a positive approach and a high motivation for learning. In this present study, the researcher seeks to explore the effect the level of math anxiety has on student achievement in math by pre-secondary stage students in Amman schools. The focus will be on middle-school students, specifically those in seventh grade.

Study questions: (1) What effect does the level of math anxiety have on the achievement of middle-school students in mathematics?, (2) Is there a statistically significant interaction between the level of anxiety (low, middle, high) and gender (male, female) on academic achievement in math among middle-school students?. Mathematics Anxiety: stress, general fear, and shivering in situations where math and numbers are required. This is measured by the scores obtained by the study sample on the math anxiety scale, as used in the present study. Achievement in Mathematics: Achievement refers to the set of skills, knowledge, and experience gained by the learner at the end of the academic year. In this study, it is measured practically by a seventh grade student's average at the end of the academic year, 2018/2019, in math.

This study aims to identify the level of math anxiety among middle school students in Amman, study the effect of such anxiety on their achievement, and to investigate if gender factors into the matters of math anxiety levels and achievement. That would provide insight with which to solve student problems with the subject of math, and may increase their achievement by reducing anxiety and addressing the learning difficulties students face in that subject. This study is bolstered by US National Council standards, which emphasize the need for stress- and anxiety-free classroom environments [4]. In short, the importance of this study lies with the need to understand the relationship between anxiety and achievement in math, so as to better manipulate it and activate the role of the learner and his active participation in learning. The study sample is limited to seventh-grade students in Amman, Jordan, for the academic year 2018/2019. The validity and reliability of the academic achievement is represented in the academic average of math for seventh grade students.

## 2. RESEARCH METHOD

The subjects of the study consisted of (180) seventh-grade students in Amman schools, enrolled in the 2018/2019 academic year, in the public education sector. The students were classified into three levels of anxiety (low, middle, and high), as shown in Table 1.

Table 1. Distribution of the study sample according to the level of anxiety and gender

Males				Females				Grand Total
Low	Middle	High	Total	Low	Middle	High	Total	
31	30	29	90	25	35	30	90	180

And to achieve the goals of the study, the researcher developed the Mathematics Anxiety scale, and used in this study. The aim of this tool is to measure the level of math anxiety in a sample of seventh grade students, using test paragraphs prepared in light of viewing measures in math anxiety [7, 8]. This was developed in conjunction with a review of the theoretical literature and components on anxiety, procedural definitions, measurement items, and the 18-item scale. The scale is divided into five (5) levels of measurement: strongly agree, agree, neutral, disagree, strongly disagree.

The level of anxiety is determined based on the score the student receives, where the student is considered to have low anxiety if his score on the test is (0-30), middle anxiety if his mark is (31-60), high anxiety if his mark is (61-90). To verify the face validity, the scale was presented to a group of arbitrators in the fields of psychology, methods of teaching math, and psychological counseling. Consequently, some paragraphs were amended in light of observations. Also, to verify the test reliability, the scale was applied to a survey sample of seventh-grade students, two weeks prior, and the reliability factor was (0.82).

The sample of the study is represented by seventh grade students in the schools of Amman, with a total of 180 students enrolled during the 2018/2019 academic year. The math anxiety scale was prepared and presented to the arbitrators, then applied to a prospective sample to determine its application time. The coefficient of reliability and validity were verified, and the sampled students were classified into three levels (low, middle, and high). The selected schools were honored at the end of the second semester, at which time the students' math marks for both semesters were obtained. The results of the study were analyzed, using statistical packages of SPSS programs. Suggestions and recommendations were made.

The descriptive and experimental method was used, where anxiety levels were identified in a sample of seventh-grade math students. The purpose was to study the effect of anxiety on academic achievement, as well as the factor of the student's gender and how that interacts with the level of anxiety. Data analyzed using arithmetic averages, standard deviations, multiple variance analysis (MANOVA).

## 3. RESULTS AND DISCUSSION

This study aims to investigate the effect of the math anxiety level on student mathematical achievement in middle-school, and specifically the seventh grade. To answer the first posed question: what effect does the level of math anxiety have on the achievement of middle-school students in math?

The arithmetic means and standard deviation were calculated. Table 2 shows the resultant statistics.

Table 2. The arithmetic means, number, and levels of math anxiety

Gender	Male			Female		
Levels of math anxiety	Low	Middle	High	Low	Middle	High
Number	25	35	30	31	30	29
Arithmetic means of achievement	54.96	71.65	55.00	53.67	74.16	55.79

The two-way ANOVA was used to show the differences between achievements in investigating the effect had on them by the levels of math anxiety. The Table 3 below shows those differences.

Table 3. Two-way ANOVA for differences of achievements in the three levels of math anxiety

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	13597.11 <sup>a</sup>	5	2719.42	20.52	0.000
Intercept	660518.08	1	660518.08	4984.27	0.000
Gender	20.20	1	20.20	0.15	0.697
Levels	13464.75	2	6732.37	50.80	0.000
Gender * Levels	107.19	2	53.59	0.404	0.668
Error	23058.54	174	132.52		
Total	713653.00	180			
Corrected Total	36655.66	179			

*R Squared = .371 (Adjusted R Squared = .353)*

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In the above table, we notice that there were statistically-significant differences ( $\alpha \leq 0.01$ ) between the levels of math anxiety (low, middle, and high) in achievement, where the significant value reached (0.00) confirming that math anxiety level affects achievement. Consequently, to know the differences between these levels, we used the Scheffe Test, as seen in Table 4.

Table 4. The scheffe test for significance of anxiety level differences

(I) levels	(J) levels	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
low	middle	-18.56 <sup>*</sup>	2.10	0.00	-23.74	-13.38
	high	-1.138	2.148	0.86	-6.44	4.16
middle	low	18.56 <sup>*</sup>	2.098	0.00	13.38	23.74
	high	17.42 <sup>*</sup>	2.07	0.00	12.31	22.53
high	low	1.139	2.14	0.86	-4.16	6.44
	middle	-17.42 <sup>*</sup>	2.07	0.00	-22.53	-12.31

Based on observed means. The error term is Mean Square (Error) = 132.520.

\* The mean difference is significant at the 0.05 level.

In the above table, this researcher noticed that there were no differences between low and high math anxiety in achievement. Moreover, when math anxiety is in the middle, it precipitates high achievement. Thus, it can be said that middle anxiety stands out as different to both low and high anxiety in achievement

To answer the second question: Is there a statistically significant interaction between the level of anxiety (low, middle, high) and gender (male, female) on academic achievement in math among middle-school students?

MANOVA analysis was used to explore the interaction between the levels of math anxiety and gender. As seen in Table 3, there is no interaction between the levels of math anxiety and gender in achievement, where the significance reached 0.668. Consider the following Figure 1.

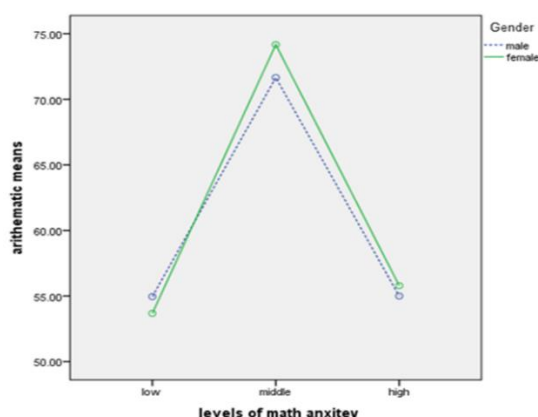


Figure 1. The interaction between the levels of math anxiety and gender in math achievement

#### 4. DISCUSSION

Deniz and Uldas [8] point out that anxiety in math may be attributed in large part to the student's environment. Similarly, parental discomfort to math may transfer in the form of anxiety to their children, on an inverse relationship between achievement in math and the level of anxiety [17, 11, 12, 2].

This study concurs with Elizabeth [15] on the inverse relationship between math anxiety and achievement. This study also suggests that to relieve math anxiety, strategies should be implemented to increase students' comfort levels towards the subject. The results of this study indicate that motivation is a significant variable to them, in order to raise their level of achievement.

National council of Teachers of mathematics (NCTM) confirms the importance of providing math programs that decreases the math anxiety, and provide classroom environment that help the students to achieve learning outcomes [25].

The researcher recommends the continual search for factors that lead to instability in math, so as mitigate them, but not erase them completely. One must understand that the availability of an average level of

anxiety may be optimal to high achievement, which, in turn, may reduce high anxiety when studying math and during tests. A controlled level of anxiety creates a positive learning environment, and provides an appropriate atmosphere to raising the efficiency of students in math, and increasing their self-confidence.

## 5. CONCLUSION

The results of this study show that for a student, both low and high anxiety levels may lead to low achievement. Conversely, moderate anxiety levels are shown to be optimal for academic achievement in math. This indicates that students must actually have some level of anxiety in order for their achievement to be high, but that it must be controlled. This control may be difficult to achieve for a variety of reasons, such as a general fear of math, a disinterest in studying it, or a lack of confidence in completing mathematical tasks. This is especially true for those who exhibit high anxiety levels towards math.

Students with low anxiety levels are typically indifferent to the study of math. They may believe that it is not useful to them, or they may not have any interest in studying it or any math-related courses in the future. This lack of interest due to a perceived low importance of math to their lives generates difficulties in its study, thus, their achievement in it.

As for the interaction between the level of anxiety and student gender, the results show that both male and female students with either high or low anxiety had generally low achievement scores, while moderate concern levels for both genders lead to higher achievement. The factors of anxiety level and gender are, therefore, independent of each other. This may disagree with some of the reviewed literature on this subject.

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