Mathematics Letters
2026, Vol. 12, No. 3, pp. 42–51
https://doi.org/10.11648/j.ml.20261203.11

SciencePG
Science Publishing Group

Research Article

Mathematics Anxiety and Student Achievement: A Mathematical-statistical Analysis

Nadia Naqvi[1, *], **Adeel Abbas**[2]

[1]Department of Mathematics, NED University of Engineering and Technology, Karachi, Pakistan
[2]KINPOE, Pakistan Institute of Engineering and Applied Sciences (PIEAS), Islamabad, Pakistan

Abstract

Students' Mathematics anxiety is one of the most significant affective factors that influence students' performance in Mathematics and other quantitative subjects. The present research is a mathematical-statistical study to investigate the relationship of mathematics anxiety and mathematics achievement. A cross-sectional quantitative design was used, based on an existing public database of 5,000 students. Mathematics anxiety was used as the independent variable, and mathematics achievement was used as the dependent variable. The Pearson correlation coefficient revealed a statistically significant negative correlation between mathematics anxiety and mathematics achievement. Regression analysis also revealed that mathematics anxiety was a statistically significant negative predictor of mathematics achievement, with the model accounting for 19.6% of the variance of mathematics achievement ($R^2 = .196$, $p < .001$). Results for the estimated regression model showed that Mathematics Achievement = 98.869 − 0.453 × Mathematics Anxiety, indicating that higher mathematics anxiety scores were associated with lower mathematics achievement scores. Additionally, the low, moderate, and high anxiety groups were compared for mathematics achievement using one-way ANOVA, which revealed a statistically significant overall difference among the three groups, $F(2, 4997) = 820.166$, $p < .001$. Tukey HSD post-hoc comparisons showed statistically significant differences between each pair of anxiety groups (low vs. moderate, low vs. high, and moderate vs. high; all $p < .001$). Students with low mathematics anxiety had the highest mean achievement scores, while students with high mathematics anxiety had the lowest mean achievement scores. The results overall suggest a consistent statistical relationship between mathematics anxiety and mathematics achievement that is negative. The study shows that the combination of correlation, regression, and group-comparison methods can present an educational research quantitative model for the anxiety–achievement relationship that can be interpreted.

Keywords

Mathematics Anxiety, Mathematics Achievement, University Students, Statistical Modeling, Linear Regression, Academic Performance, Quantitative Education, Mathematical Modeling

*Correspondence: nadianaqvi@gmail.com (Nadia Naqvi)

Received: 6 October 2026; **Accepted:** 20 October 2026; **Published:** 9 November 2026

Copyright: © The Author(s), 2026. Published by Science Publishing Group. This is an **Open Access** article, distributed under the terms of the Creative Commons Attribution 4.0 License (http://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

1. Introduction

Mathematics has been called the universal language of science, technology, engineering, economics and many other academic fields. Students can see mathematics used in a number of fields within the University, including mathematics, engineering, computing, business, economics, physics, education, statistics and research methodology. However, mathematics is also one of the subjects that many students take on fear and apprehension. Some students are embarrassed before taking a mathematics test and others feel uneasy when they have to do mathematical calculations in front of the class mates. The sight of mathematical symbols, formulas or questions with numbers can cause tension for some pupils. This emotional reaction is known as" Mathematics anxiety".

The term Maths anxiety is commonly used to indicate the stress, worry or fear experienced when confronted with mathematical tasks and situations. The distinction between mathematics anxiety and general anxiety needs to be taken into account. A student can be at relatively low levels of anxiety during their daily lives but at the same time may show relatively high levels of anxiety when handling mathematics [1]. The issue is even more significant in higher education as mathematics courses in the curriculum may impact students' academic trajectory and, in certain fields, their future academic and career decisions. Studies conducted with university students have identified mathematics anxiety as one of the significant obstacles of students in various disciplines. A scoping review in the university setting was conducted to explore how the ss [2]. A negative correlation between mathematics anxiety and mathematics achievement has been found in previous mathematics studies. There has been a recent review of the relationship between the two that reported a strong correlation between the two (in the Trends in Cognitive Sciences), along with two main explanatory models: that lower mathematical achievement leads to anxiety, and that anxiety disrupts the cognitive processes during mathematical tasks. The review also highlighted the importance of mathematics avoidance as a way to strengthen the relationship [3]. There is more recent, large-scale evidence in support of the importance of this relationship. In a 2026 study of 90 countries, a representative sample of students (9–23 years) and adults, high mathematics anxiety was found to be correlated with reduced mathematics achievement [4]. But, there is more to it than just having a relationship. A more practical question is:

Is there a simple mathematical model that allows us to quantify the relation between mathematics anxiety and mathematical achievement that can help us to understand how changes in mathematical anxiety correspond with changes in achievement? This question provides the motivation for the present study.

1.1. Research Problem and Question

Mathematics is often used by university students in courses, examinations, statistics and research methods. However, some students experience considerable anxiety when dealing with mathematics. Previous studies have been conducted which has already established a link between mathematics anxiety and mathematical performance. But more study is required to precisely quantify this relationship with a simple statistical method. Hence this research poses the following question:

To what extent does mathematics anxiety predict mathematics achievement among university students?

1.2. Research Objectives

The study has four main objectives:

1) To assess level of mathematics anxiety among the university students.
2) To find out the correlation between mathematics anxiety and mathematics achievement.
3) To determine if mathematics anxiety is a significant predictor of mathematics achievement.
4) To compare mathematics achievement of students with low, moderate and high mathematics anxiety.

1.3. Research Gap

There is ample evidence in the literature that mathematics anxiety and mathematics achievement are correlated. This correlation, however, is supported by meta-analytic and review evidence [5] and recent studies have focused on the possibility of the relationship being two-way rather than one-way [6]. But there's still a few chances. One of the main problems with the current literature is that it is often mixed together, combining students from varying educational levels. It can be useful to undertake a study that is conducted at a university level in order to get a better understanding of the phenomenon in higher education. Second, some studies focused on a psychological or educational interpretation, whereas there were relatively fewer that gave the relationship in a simple mathematical representation that is easily understood by mathematics educators and readers who are not experts in the field of psychology or education. Third, prior studies have explored mathematics anxiety in the university environment and its association with quantitative-research avoidance and achievement in academic studies. The findings from these studies indicate that mathematics anxiety can have implications for students' attitudes toward mathematical tasks engagement with quantitative work and achievement. But these relationships between university students need to be explored further with accessible and simple statistical methods. The studies are illustrative of the importance of the issue in higher education. There is still scope for a thorough study at university level which brings together:

1) A validated mathematics-anxiety measure;
2) An objective measure of mathematics achievement;
3) correlation analysis;

4) regression modeling;
5) Anxiety-level group comparisons; and
6) An interpretable mathematical representation of the anxiety-achievement relationship.

The present study addresses this gap.

1.4. Purpose of the Study

This study aims to examine the relationship between mathematics anxiety and mathematics achievement among university students and to construct a simple mathematical-statistical model describing this relationship. This study does not make the claim that anxiety is the only cause for poor mathematics performance. Rather, it's designed to provide an approximation of the strength and direction of the relationship, and to find out whether mathematics anxiety provides statistically meaningful predictive information about achievement.

2. Literature Review

Mathematics anxiety has been investigated extensively as an affective variable that could affect students' experience and performance in mathematics [7]. It is commonly defined as anxiety, fear, apprehension or unease that occurs when facing mathematical activities [1, 12, 18, 24, 26].

The Mathematics Anxiety Rating Scale (MARS) was developed as a result of early research on measuring mathematics anxiety. The original instrument was quite long, so other researchers created a shorter and modified version for educational research. These instruments have demonstrated that mathematics anxiety can be assessed as a specific psychological construct with acceptable reliability and validity [8, 17, 19, 21].

The association of mathematics anxiety and mathematical achievement has been discussed in various learning contexts. Studies with University students have found a negative relationship between mathematics anxiety and mathematics achievement. This suggests that students who experience greater levels of anxiety may perform less effectively on mathematical tasks than students with lower levels of anxiety. These results have helped to shape the perception of the relevance of students' achievement of quantitative subjects for mathematics anxiety [9].

But, anxiety in math is not only a measure of low mathematical proficiency. Students can have good Maths knowledge and skills without having confidence in their math’s, but with anxiety when doing Maths tasks, tests or quantitative work. Anxiety can manifest in a number of ways, such as a decrease in concentration, an increase in cognitive interference, a decrease in confidence, and a decrease in the ability to hold information in working memory. All these factors can constrain students' capacity to effectively use their mathematical knowledge in academic tasks [10]. Longitudinal studies with university students have also produced evidence that suggests that mathematics anxiety could have effects that extend beyond mathematical performance. After controlling for mathematical ability and other factors, studies have found links between mathematics anxiety and subsequent avoidance of STEM-related courses and poor academic achievement. This indicates that the mathematics anxiety might be correlated with students' mathematics performance and engagement in quantitative and STEM learning opportunities [11].

The literature also suggests that math anxiety affects attitude and willingness of students towards mathematics. Students with anxiety might not engage in mathematical activities, postpone preparing for mathematical tests, or have less confidence in solving quantitative problems. These patterns can potentially decrease opportunities for practice and engagement, and may also be connected to academic performance [12].

Although there is a considerable frame of literature on mathematics anxiety, a large number of studies have reported correlations, group differences, scale scores, or descriptive levels of anxiety. These methods are useful tools for describing the phenomenon, but there is potential for research that will yield an easily interpretable and simple mathematics achievement estimate that will be associated with changes in Mathematics anxiety.

Thus, the present study concentrates on the correlation between Mathematics Anxiety and Mathematics Achievement of the University Students. The purpose of the study is to measure the relationship between the two variables by using simple linear regression and to find out if mathematics anxiety has a significant effect on mathematics achievement. This method offers a simple statistical structure in which the direction, strength and explanatory value of the relationship can be explored Mathematics anxiety may develop and change over the course of formal schooling, making it important to consider students' educational experiences when examining anxiety in later academic settings [25, 26].

2.1. Mathematics Anxiety

Mathematics anxiety is anxiety experienced by students when learning mathematics, solving mathematical problems, attending mathematics classes, or taking mathematics examinations [13]. Even with the mathematical knowledge and skills, students might have difficulty focusing, remembering mathematics, and effectively using problem-solving strategies if they have mathematics anxiety. It can also affect students' confidence, motivation, and enthusiasm for mathematical activities. Thus, the mathematics anxiety is an important aspect to explore in the field of education research, especially with regard to its connection with students' academic performance and their performance in mathematics as a whole.

2.2. The Causes of Mathematics Anxiety

There are a number of personal, educational and environmental factors that can lead to mathematics anxiety. Students' anxiety may be triggered by negative learning experiences,

fear of making mistakes, mathematics examination failure and a lack of confidence in mathematical skills. Pedagogical approaches focusing on memorization, time constraints and evaluation pressure, can also exacerbate students' anxiety about math. Furthermore, teachers, parents, or peers' negative comments can develop the perception that math is tough or that only a few students are good at it. Students with prior mathematical deficiencies or difficulties in understanding mathematical concepts may also feel heightened anxiety when studying more advanced concepts. Thus, previous experiences, teaching methods, social factors, and personal beliefs in mathematical capability can all contribute to mathematics anxiety [14].

2.3. Identifying Factors that Impact Mathematics Anxiety

There are several interrelated factors that affect students' emotional responses and attitudes towards learning mathematics that are influenced by mathematics anxiety. Students' beliefs about their own competence can influence the degree of confidence and motivation they have in carrying out mathematical tasks, as well as their perceptions of the difficulty of the task. Anxiety and lack of involvement in mathematics related activities can be heightened due to negative experiences within the school and fear of failure and concerns about academic evaluation. Moreover, the classroom culture, the method of teaching and learning, and the support from teachers and family members can have an impact on students' experience with and reactions to mathematical problems. Pupils who feel they are not good at maths can be more likely to be anxious when they are presented with a challenging problem. The above factors underscore the need to gain insight into students' psychological, academic, and social experiences in studying mathematics in order to explore the possible link between mathematics anxiety and academic achievement [15].

2.4. Research Questions

The study addresses the following research questions:

RQ1: What is the level of Mathematics anxiety among university students?

RQ2: Is Mathematics anxiety significantly related to Mathematics achievement?

RQ3: To what extent does Mathematics anxiety predict mathematics achievement?

RQ4: Do students with different levels of mathematics anxiety differ in their Mathematics achievement?

2.5. Research Hypotheses

To keep the study focused, only three hypotheses are proposed.

H_1: There is a statistically significant negative relationship between Mathematics anxiety and Mathematics achievement among university students.

H_2: Mathematics anxiety significantly predicts Mathematics achievement among university students.

H_3: Mathematics achievement differs significantly among students with low, moderate, and high levels of mathematics anxiety.

These three hypotheses are sufficient to address the main research questions without unnecessarily expanding the statistical model.

3. Methodology

3.1.1. Research Design

The research design used in this study was a quantitative research design which studied how university students' Mathematics anxiety levels affect their performance in Math. The research examination focused on assessing students' Math achievement through their Math anxiety levels together with their ability to foresee their academic achievement. The research examined how students who showed different levels of math anxiety performed in their math studies. In this article the statistical methods are applied to analyze their gathered numerical data which included correlation analysis and regression analysis and statistical tests between different groups. The study applied a hypothesis-testing method to assess statistical importance of discovered relationships and predictive effects and differences between groups.

3.1.2. Data Source

This study is based on a public dataset found on Kaggle. It was downloaded from Kaggle and statistically analyzed to understand the relationship between Mathematics anxiety and academic performance .

https://www.kaggle.com/datasets/nadianaqvi/mathematics-anxiety-and-student-achievement?select=H_3.xlsx

3.1.2. Independent and Dependent Variables

The independent variable in this study is Mathematics Anxiety which represents the level of anxiety or discomfort experienced by students when they need to study Mathematics. The dependent variable is Academic Achievement, which represents students' academic performance. The research study investigates how university students' academic achievement varies because of their Mathematics anxiety levels.

1) Independent Variable: Mathematics Anxiety
2) Dependent Variable: Academic Achievement
3) Grouping Variable: Student Level (Pre and Postgraduate)

3.1.3. Mathematical Model

The research applies basic linear regression to study how Mathematics anxiety affects students' Mathematics performance. Let:

1) A_i = Mathematics achievement score of student i

2) MA_i= Mathematics anxiety score of student i.
3) The regression model is $A_i=\beta_0+\beta_1 MA_i+\epsilon_i$ Where: A_i = Mathematics achievement of student i
4) MA_i = mathematics anxiety score of student i
5) β_0 = intercept
6) β_1 = regression coefficient of mathematics anxiety
7) ϵ_i = error term

In this model the estimation of the coefficient β_1 by using the data which have gathered.

1) A negative value of β_1 indicates that higher mathematics anxiety is associated with
2) Lower Mathematics achievement, whereas a positive value would indicate a positive
3) Association. The regression analysis determine both the size and the statistical
4) Importance of β_1 during the evaluation process. The results section display the
5) Calculated coefficient together with its confidence interval and significance level which
6) Stems from the actual study data.

3.1.4. Statistical Analysis and Hypothesis Testing

IBM SPSS Statistics was used to analyze the data. The collected data were analyzed and tested using appropriate descriptive and inferential statistical analysis for relationship between Mathematics anxiety and Mathematics achievement among University students. The variables of the study were summarized using descriptive statistics like mean and standard deviation. Pearson's correlation analysis was employed to find the direction and strength of the relationship between mathematics anxiety and mathematics achievement to test H_1. To test H_2, simple linear regression analysis was used to determine whether mathematics anxiety significantly predicts mathematics achievement. One-way analysis of variance was used to find out if there were significant differences in mathematics achievement between students who had low levels of mathematics anxiety, moderate levels of mathematics anxiety, and high levels of mathematics anxiety for H_3. Due to significant results of the ANOVA, Tukey HSD (honestly significant difference) post-hoc comparisons were performed to determine which anxiety groupings differed from one another. The level of statistical significance was set at $\alpha = 0.05$.

4. Results and findings

H_1: Mathematics anxiety and mathematics achievement.
Descriptive Statistics

Table 1. *Descriptive Statistics of Mathematics Anxiety and Mathematics Achievement.*

Variable	N	Mean	Std. Deviation	Minimum	Maximum
Mathematics Anxiety	5,000	60.094	12.893	20.00	100.00
Mathematics Achievement	5,000	71.837	13.095	23.38	100.00

Table 2. *Pearson Correlation Between Mathematics Anxiety and Mathematics Achievement.*

Variables	Mathematics Anxiety	Mathematics Achievement
Mathematics Anxiety	1.000	−.427
Mathematics Achievement	−.427	1.000
Sig. (2-tailed)	—	< .001
N	5,000	5,000

Pearson correlation: $r = -0.427$, $p < .001$, $N = 5{,}000$

Interpretation

The descriptive statistics reveals that 5000 students were involved in the study. The mean mathematics anxiety score was 60.094 (SD = 12.893) and the range of scores was from 20 to 100. The mathematics score mean achievement was 71.837 (SD = 13.095) and the range was 23.38 to 100. The results give a general description of the level and variation of mathematics anxiety and achievement of the students.

The Pearson correlation analysis demonstrated that university students who experienced mathematics anxiety developed a negative association with their mathematics achievement through a statistically relevant correlation coefficient of r = −.427 which produced a p-value below .001. The data shows

that students who experience greater math anxiety achieve lower scores in their mathematics assessments. The relationship showed statistical significance because it reached the .001 level of significance.

Result: The Pearson correlation analysis showed that there was a statistically significant negative correlation between mathematics anxiety and mathematics achievement, $r = -.427$, $p < .001$. Thus, the hypothesis 1 (H_1) is accepted/supported.

H_2: Mathematics anxiety significantly predicts mathematics achievement among university students.

Table 3. *Descriptive Statistics of Mathematics Anxiety and Mathematics Achievement.*

Variable	N	Mean	Std. Deviation	Minimum	Maximum
Mathematics Anxiety	5000	60.094	12.893	0	100
Mathematics Achievement	5000	71.634	13.205	0	100

Linear Regression
Dependent Variable: Mathematics Achievement
Predictor: Mathematics Anxiety

Table 4. *Model Summary of Linear Regression Predicting Mathematics Achievement.*

Model	R	R^2	Adjusted R^2	F	Sig.
1	.443	.196	.196	1217.036	<.001

Coefficients

Table 5. *Regression Coefficients for Mathematics Anxiety Predicting Mathematics Achievement.*

Predictor	B	SE	Beta	t	Sig.
Constant	98.869	.798	—	123.827	<.001
Mathematics Anxiety	-0.453	.013	-.443	-34.886	<.001

Regression equation:
Mathematics Achievement = 98.869 − 0.453 × Mathematics Anxiety

Interpretation

University students demonstrated a mathematics anxiety average score of 60.09 (SD = 12.89) and achieved a mathematics average score of 71.63 (SD = 13.21). The research results shows that students experience different levels of Math anxiety and their Math test results vary widely. The Pearson correlation analysis showed that math anxiety created a moderate negative relationship with Math achievement which reached statistical significance ($r = -0.443$, $p < .001$). Students who experienced higher math anxiety levels showed reduced performance in their Math achievement tests. The research team performed a simple linear regression analysis to identify the impact of math anxiety on students' math achievement results. The statistical analysis of the regression model showed significant results ($F = 1217.036$, $p < .001$) while the model explained 19.6% of the variance in students' mathematics achievement results ($R^2 = .196$). The data showed that mathematics anxiety created a strong negative effect on students' mathematics achievement results ($B = -0.453$, $\beta = -0.443$, $t = -34.886$, $p < .001$). The model shows that mathematics anxiety creates a negative effect on mathematical achievement which reduces the achievement score by about 0.453 points for every one-unit increase in anxiety levels. Research results demonstrate that mathematics anxiety produces a statistically significant negative relationship with university students' mathematics achievement performance.

Result: Therefore, the hypothesis stating that mathematics anxiety significantly predicts mathematics achievement among university students is supported. H_2 is supported.

H_3: Mathematics achievement differs significantly among students with low, moderate, and high levels of mathematics anxiety.

Table 6. *Descriptive Statistics of Mathematics Achievement by Mathematics Anxiety Level.*

Anxiety Level	N	Mean	Std. Deviation
Low	1127	77.874	8.725
Moderate	2628	69.902	10.073
High	1245	61.176	11.074
Total	5000	69.932	11.573

Table 7. *One-Way ANOVA of Mathematics Achievement Across Mathematics Anxiety Groups.*

ANOVA	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	165716.363	2	82858.181	820.166	< .001
Within Groups	504827.658	4997	101.026		
Total	670544.021	4999			

Result: $F(2, 4997) = 820.166$, $p < .001$. The one-way ANOVA indicated a statistically significant overall difference in mathematics achievement among the three anxiety groups.

Table 8. *Tukey HSD Post-Hoc Comparisons of Mathematics Achievement Across Anxiety Groups.*

Comparison	Mean Difference	SE	q	Adjusted p	Decision
Low vs. Moderate	7.972	0.253	31.502	< .001	Significant
Low vs. High	16.698	0.292	57.142	< .001	Significant
Moderate vs. High	8.726	0.245	35.685	< .001	Significant

Note: Tukey HSD/Tukey-Kramer post-hoc comparisons used the ANOVA mean square error (MSE = 101.026) and df = 4997. Each of three pairwise comparisons was significant at the $\alpha = .05$ level.

Interpretation: One-way ANOVA was used to see if there was any difference in the mathematics achievement of the students in the low, moderate and high anxiety groups. Analysis showed that overall the three anxiety categories differed statistically, $F(2, 4997) = 820.166$, $p < .001$. The students with low mathematics anxiety had the highest average achievement score (77.87, SD = 8.73), the students with moderate mathematics anxiety had achieved score of average 69.90 (SD = 10.07), the students with high mathematics anxiety had achieved score of average 61.18 (SD = 11.07).

4. Result

The data support H_3 as $p < .001$; mathematics achievement is significantly different among students with low, moderate, and high levels of mathematics anxiety. Tukey HSD post-hoc comparisons also revealed that there were statistically significant differences between the three pairs (low versus moderate, low versus high, and moderate versus high, all $p < .001$).

5. Discussion

The present study investigated the relationship between the mathematics anxiety and mathematics achievement of the university students via a mathematical-statistical approach. The study focused on three main aspects: the relationship between mathematics anxiety and achievement, the predictive role of mathematics anxiety, and differences in achievement across

different levels of mathematics anxiety. The results support the "statistical evidence" that the students in the dataset have a negative association between mathematics anxiety and mathematics achievement [4, 6, 13, 16, 22, 23].

For H_1, it was found that there was a statistically significant negative correlation between mathematics anxiety and mathematics achievement. The Pearson correlation analysis revealed that students with higher mathematics anxiety had lower level of mathematics achievement. This result is consistent with prior studies that indicated that mathematics anxiety correlates with decreased performance on mathematics-related activities. A possible reason is: that anxiety can impact a student's concentration, working memory, confidence, and ability to effectively use what they have learned in their mathematical knowledge when completing academic tasks. The relationship found in the present study should, however, be interpreted as an association, since the data was collected cross sectionally, and no conclusions regarding a direct effect of mathematics anxiety on lower achievement can be drawn.

The results for H_2 also showed that mathematics anxiety was a significant predictor of mathematics achievement. The simple linear regression was statistically significant, $F(1, 4998) = 1217.036$, $p < .001$ and accounted for about 19.6% of the variance ($R^2 = .196$) in mathematics achievement. The regression coefficient for mathematics anxiety was negative ($B = -0.453$), with higher mathematics anxiety levels being related to lower predicted mathematics achievement. It is found that the relationship between Mathematics Achievement and Mathematics Anxiety can be described using a simple regression equation: $\textit{Mathematics Achievement} = 98.869 - 0.453 \times \textit{Mathematics Anxiety}$. The model is therefore an easily accessible means of quantifying the relationship between the two variables.

The results for H_3 were statistically significant because it showed that students with low, moderate, and high mathematics anxiety levels had different mathematics achievement results. The mean achievement score for the low anxiety group was the highest, moderate anxiety group was the next highest, and the high anxiety group had the lowest mean achievement score. The overall result of the one-way ANOVA was statistically significant, $F(2, 4997) = 820.166$, $p < .001$. Results of Tukey HSD post-hoc comparisons revealed that all pairs of the anxiety groups were significantly different from each other (low vs. moderate, $p < .001$; low vs. high, $p < .001$; and moderate vs. high, $p < .001$). This is a common pattern as seen in the correlation and regression data, which showed a negative correlation.

Overall, results from the three hypotheses indicate a consistent pattern: that is, higher mathematics anxiety was related to lower mathematics achievement on the study sample. The results also illustrate the value of applying both correlation and regression analysis and the group-comparison method in the study of educational data sets. The direction and strength of the relationship is identified by correlation, regression is a quantitative prediction model and ANOVA can be used to compare achievement on the various anxiety levels.

The results should be viewed with the caveat of limitations of the study, however. The data sets were not collected specifically for the current study, but rather were taken from a publicly available source, the Kaggle data set. Furthermore, the cross-sectional design does not enable conclusions to be drawn about causal direction. There may also be a relationship between mathematics anxiety and lower achievement, and lower achievement can lead to higher mathematics anxiety. Achievement might be influenced by other factors (such as mathematical preparation, motivation, and confidence, teaching methods, study habits and socioeconomic status).

As a whole, the results give statistical evidence for a meaningful negative correlation between mathematics anxiety and mathematics achievement for the students included in the data set. This relationship can be explained and quantified in a relatively simple framework in the field of higher education using the mathematical-statistical approach.

6. Conclusion

In this study, correlation, simple linear regression, and one-way ANOVA were used to investigate the relationship between mathematics anxiety and mathematics achievement among university students. The results showed that mathematics achievement was negatively correlated with mathematics anxiety. The correlation analysis demonstrated a statistically significant negative relationship between mathematics anxiety and mathematics achievement. The regression analysis also revealed that mathematics anxiety was a statistically significant predictor of mathematics achievement, accounting for about 19.6% of the variance in mathematics achievement. The regression equation was used to represent the relationship between anxiety and achievement in a simple mathematical equation. The ANOVA results revealed a statistically significant overall difference in mathematics achievement among the low, moderate, and high mathematics-anxiety groups. Tukey HSD post-hoc comparisons confirmed statistically significant differences between each pair of anxiety groups (all $p < .001$). The mean achievement of students with low mathematics anxiety was the highest, whereas students with high mathematics anxiety had the lowest mean achievement. In general, the statistical results supported all three hypotheses. In conclusion, the study reveals that mathematics anxiety is a significant variable that needs to be explored along with mathematics achievement in university students. The results, however, are only statistical associations and should not be viewed as causation. Longitudinal or experimental study designs could yield more definitive evidence on the direction and mechanisms of this association.

7. Recommendations

Based on the findings of the study, the following recommendations are proposed:

Early identification of students with high levels of mathematics anxiety should be considered in universities, and a supportive learning environment should be created that allows students to ask questions, make mistakes without fear, and engage in mathematical activities. Problem-based learning, cooperative learning, real-life examples, and scaffolding from easy to hard problem-based tasks can be beneficial in developing students' confidence and interest. Academic support and mentoring, and, if available, counselling, should be provided for students with significant mathematics anxiety. Math anxiety should also be recognized as a possible correlate of academic achievement, and teachers should be provided professional development on effective teaching strategies. Other variables like mathematical self-efficacy, motivation, prior achievement, study habits, teaching methods, and socioeconomic backgrounds should be studied in the future, and further research should investigate the relationship between changes in mathematics anxiety and achievement through longitudinal studies. Finally, larger and more diverse samples from universities from various regions and disciplines should be used in future studies to enhance generalizability. Future studies with additional group structures may apply appropriate post-hoc procedures following significant ANOVA results Previous research has examined interventions designed to reduce mathematics anxiety, including structured therapeutic and skill-based approaches, while meta-analytic evidence has also evaluated the potential of educational games and other intervention strategies [18, 20, 27, 28].

Abbreviations

MA	Mathematics Anxiety
AA	Academic Achievement
SD	Standard Deviation
M	Mean
N	Sample Size
r	Pearson Correlation Coefficient
p	Significance Level
R2	Adjusted Coefficient of Determination

Author Contributions

Nadia Naqvi: Conceptualization, Formal Analysis, Investigation, Methodology, Project administration, Resources, Software, Validation, Visualization, Writing – original draft

Adeel Abbas: Data curation, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Hembree, R. (1990). The nature, effects, and relief of mathematics anxiety. *Journal for research in mathematics education, 21*(1), 33-46.

[2] Ashcraft, M. H., & Kirk, E. P. (2001). The relationships among working memory, math anxiety, and performance. *Journal of Experimental Psychology: General, 130*(2), 224–237.

[3] Skagerlund, K., Östergren, R., Västfjäll, D., & Träff, U. (2019). How does mathematics anxiety impair mathematical abilities? Investigating the link between math anxiety, working memory, and number processing. *PLOS ONE, 14*(1), e0211283.

[4] Brunner, M., Preckel, F., Götz, T., Lüdtke, O., & Keller, L. (2026). High math anxiety is associated with lower math achievement across 90 countries: An individual participant data meta-analysis of representative student and adult samples. *Psychological Bulletin, 152*(2), 207–253. https://doi.org/10.1037/bul0000514

[5] Vos, H., Marinova, M., De León, S. C., Sasanguie, D., & Reynvoet, B. (2023). Gender differences in young adults' mathematical performance: Examining the contribution of working memory, math anxiety and gender-related stereotypes. *Learning and Individual Differences, 102*, 102255.

[6] Finell, J., Sammallahti, E., Korhonen, J., Eklöf, H., & Jonsson, B. (2022). Working memory and its mediating role on the relationship of math anxiety and math performance: A meta-analysis. *Frontiers n Psychology, 12*, 798090.

[7] Ashcraft, M. H., & Moore, A. M. (2009). Mathematics anxiety and the affective drop in performance. *Journal of Psychoeducational Assessment, 27*(3), 197–205.

[8] Suinn, R. M., Taylor, S., & Edwards, R. W. (1988). Suinn Mathematics Anxiety Rating Scale for Elementary School Students (MARS-E): Psychometric and normative data. *Educational and Psychological Measurement, 48*(4), 979–986.

[9] Barroso, C., Ganley, C. M., McGraw, A. L., Geer, E. A., Hart, S. A., & Daucourt, M. C. (2021). A meta-analysis of the relation between math anxiety and math achievement. *Psychological Bulletin, 147*(2), 134–168. https://doi.org/10.1037/bul0000307

[10] Daker, R. J., Gattas, S. U., Sokolowski, H. M., Green, A. E., & Lyons, I. M. (2021). First-year students' math anxiety predicts STEM avoidance and underperformance throughout university, independently of math ability. *npj Science of Learning, 6*(1), Article 17.

[11] Finn, J. D., & Zimmer, K. S. (2012). Student engagement: What is it? Why does it matter? In S. L. Christenson, A. L. Reschly, & C. Wylie (Eds.), *Handbook of research on student engagement* (pp. 97–131). Springer.

[12] Maloney, E. A. (2016). Math anxiety: Causes, consequences, and remediation. In K. R. Wentzel & D. B. Miele (Eds.), *Handbook of motivation at school* (2nd ed., pp. 408–423). Routledge.

[13] Bessant, K. C. (1995). Factors associated with types of mathematics anxiety in college students. *Journal for Research in Mathematics Education, 26*(4), 327–345.

[14] Mammarella, I. C., Caviola, S., Giofrè, D., & Szűcs, D. (2019). *Mathematics anxiety: What is known and what is still to be learned*. Routledge.

[15] Ma, X. (1999). A meta-analysis of the relationship between anxiety toward mathematics and achievement in mathematics. *Journal for Research in Mathematics Education, 30*(5), 520–540.

[16] Ma, X., & Xu, J. (2004). The causal ordering of mathematics anxiety and mathematics achievement: A longitudinal panel analysis. *Journal of Adolescence, 27*(2), 165–179. https://doi.org/10.1016/j.adolescence.2003.11.003

[17] Núñez-Peña, M. I., Guilera, G., & Suárez-Pellicioni, M. (2014). The single-item math anxiety scale: An alternative way of measuring mathematical anxiety. *Personality and Individual Differences, 60*, 125–127.

[18] Ramirez, G., Shaw, S. T., & Maloney, E. A. (2018). Math anxiety: Past research, promising interventions, and a new interpretation framework. *Educational Psychologist, 53*(3), 145–164.

[19] Richardson, F. C., & Suinn, R. M. (1972). The Mathematics Anxiety Rating Scale: Psychometric data. *Journal of Counseling Psychology, 19*(6), 551–554. https://doi.org/10.1037/h0033456

[20] Sammallahti, E., Finell, J., Jonsson, B., & Korhonen, J. (2023). A meta-analysis of math anxiety interventions. *Journal of Numerical Cognition, 9*(2), 346–362.

[21] Suinn, R. M., Edie, C. A., Nicoletti, J., & Spinelli, P. R. (1972). The MARS, a measure of mathematics anxiety: Psychometric data. *Journal of Clinical Psychology, 28*(3), 373–375.

[22] Wang, Z., Lukowski, S. L., Hart, S. A., Lyons, I. M., Thompson, L. A., Kovas, Y., Mazzocco, M. M. M., & Petrill, S. A. (2015). Is math anxiety always associated with lower math learning outcomes? A meta-analysis of the relationship between math anxiety and mathematics performance. *Psychological Bulletin, 141*(3), 538–564.

[23] Wang, Z., Shakeshaft, N., Schofield, K., & Maloney, E. A. (2021). Mathematics anxiety and mathematical achievement: A longitudinal study of reciprocal relations. *Learning and Individual Differences, 91*, 102060.

[24] Beilock, S. L., & Maloney, E. A. (2015). Math anxiety: A factor in math achievement not to be ignored. *Policy Insights from the Behavioral and Brain Sciences, 2*(1), 4–12.

[25] Eden, C., Heine, A., & Jacobs, A. M. (2013). Mathematics anxiety and its development in the course of formal schooling—A review. *Psychology, 4*(6B), 27–35. https://doi.org/10.4236/psych.2013.46A2005

[26] Maloney, E. A., & Beilock, S. L. (2012). Math anxiety: Who has it, why it develops, and how to guard against it. *Trends in Cognitive Sciences, 16*(8), 404–406.

[27] Codding, R. S., Goodridge, A. E., Hill, E., Kromminga, K., Chehayeb, R., Volpe, R. J., & Scheman, N. (2023). Meta-analysis of skill-based and therapeutic interventions to address math anxiety. *Journal of School Psychology, 100*, 101229.

[28] Dondio, P., Gusev, V., & Rocha, M. (2023). Do games reduce maths anxiety? A meta-analysis. *Computers & Education, 194*, 104650.