Understanding the Development of Mathematics Phobia: A Cross-Sectional Study Among School Students from Grades 6–12

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Abstract

Mathematics phobia is a major educational challenge that adversely affects students' confidence, academic performance, and attitudes toward mathematics. Despite extensive research on mathematics anxiety, limited studies have examined its multiple educational, psychological, and environmental determinants within a comprehensive quantitative framework among students in Grades 6–12.

This simulation-based cross-sectional study proposed a methodological framework for investigating mathematics phobia using a structured instrument, the Mathematics Phobia Questionnaire (MPQ), and a composite Mathematics Phobia Index (MPI). A simulated dataset comprising 1,500 students from Grades 6–12 was generated to demonstrate the proposed analytical framework. Statistical analyses included descriptive statistics, reliability analysis, exploratory factor analysis, Pearson's correlation analysis, one-way analysis of variance, and multiple linear regression.

The simulated analyses demonstrated that the MPQ possessed excellent reliability (Cronbach's $\alpha = 0.912$) and satisfactory construct validity. Examination anxiety emerged as the strongest positive predictor of mathematics phobia, whereas self-confidence and conceptual understanding exhibited the strongest negative associations with the Mathematics Phobia Index. Mathematics phobia also increased progressively across Grades 6–12.

Although based on simulated data, the proposed framework demonstrates a systematic quantitative approach for investigating mathematics phobia and provides a foundation for future empirical studies involving real student populations. The MPQ and MPI may serve as useful tools for identifying students at risk and supporting evidence-based educational interventions aimed at improving mathematics learning and reducing mathematics phobia.

Keywords: *Mathematics Phobia; Mathematics Anxiety; Mathematics Education; Educational Psychology; Secondary Education; Simulation-Based Research; Mathematics Phobia Questionnaire; Mathematics Phobia Index.*

1. Introduction

Mathematics is widely recognized as a fundamental discipline that supports logical reasoning, analytical thinking, problem-solving, and decision-making. It serves as the foundation for science, technology, engineering, economics, artificial intelligence, and numerous other fields that drive modern society. Beyond academic achievement, mathematical literacy enables individuals to interpret information, make informed decisions, and solve real-world problems. Despite its significance, mathematics remains one of the most feared academic subjects among school students worldwide, with many learners experiencing persistent anxiety, avoidance, and reduced confidence when engaging with mathematical concepts[1–4].

Mathematics phobia extends beyond ordinary academic difficulty. It is characterized by an intense emotional response that interferes with students' ability to understand, apply, and enjoy mathematics. Students experiencing mathematics phobia often exhibit symptoms such as nervousness during classroom instruction, fear of examinations, avoidance of mathematical tasks, low self-confidence, and diminished academic performance[5–7]. Over time, these experiences may influence subject selection, career aspirations, and participation in science, technology, engineering, and mathematics (STEM) disciplines.

Previous research has identified several factors associated with mathematics anxiety and mathematics phobia, including examination pressure, negative classroom experiences, inadequate conceptual understanding, low mathematical self-efficacy, ineffective teaching strategies, and parental expectations. While these factors have frequently been investigated individually, relatively few studies have attempted to examine their combined influence within a comprehensive analytical framework encompassing psychological, instructional, academic, and environmental dimensions[8–10]. Consequently, mathematics phobia should be viewed as a multidimensional educational phenomenon rather than the outcome of a single isolated factor.

The transition from Grade 6 to Grade 12 represents a particularly important stage in students' mathematical development. During these years, learners encounter increasingly abstract concepts such as algebra, geometry, trigonometry, probability, statistics, and calculus, while simultaneously facing greater academic competition and examination pressure[11]. These cumulative academic demands may contribute to the gradual development and progression of mathematics phobia. Understanding how these factors interact during secondary and higher secondary education is therefore essential for designing effective educational interventions.

Although numerous studies have investigated mathematics anxiety, variations in study populations, measurement instruments, and analytical approaches have limited direct comparisons across investigations. Furthermore, many existing studies have focused primarily on anxiety without comprehensively evaluating broader educational factors such as classroom environment, teacher support, parental involvement, conceptual understanding, and self-confidence within a single quantitative framework. This highlights the need for a structured approach capable of simultaneously assessing multiple determinants of mathematics phobia.

To address this gap, the present study proposes a comprehensive methodological framework for investigating mathematics phobia among students in Grades 6-12[12]. A structured instrument, the Mathematics Phobia Questionnaire (MPQ), was developed to evaluate ten educational and psychological domains associated with mathematics phobia. In addition, a composite Mathematics Phobia Index (MPI) was proposed to quantify the overall severity of mathematics phobia and facilitate statistical comparisons across demographic and educational groups.

For methodological demonstration, a simulated dataset representing 1,500 students from Grades 6-12 was generated. The simulated dataset was designed to illustrate the proposed statistical workflow, including descriptive statistics, reliability analysis, exploratory factor analysis, correlation analysis, analysis of variance, and multiple linear regression. The analytical framework presented in this study demonstrates how mathematics phobia may be systematically investigated using quantitative educational research methods and provides a foundation for future empirical studies involving real student populations.

The findings of this study are expected to contribute to mathematics education by providing educators, school administrators, curriculum developers, psychologists, and policymakers with a structured framework for identifying the major determinants of mathematics phobia. Such evidence may assist in designing targeted educational interventions that enhance conceptual understanding, strengthen mathematical confidence, reduce examination-related anxiety, and promote more positive attitudes toward mathematics among school students.

2. Research Objectives

The present study aims to investigate the factors contributing to the development of mathematics phobia among students in Grades 6–12 and to identify the educational, psychological, and environmental variables that significantly influence students' attitudes towards mathematics.

The specific objectives of the study are:

1. To determine the prevalence of mathematics phobia among students in Grades 6-12.
2. To identify the major factors contributing to mathematics phobia, including conceptual understanding, teaching practices, examination pressure, parental influence, peer influence, and self-confidence.
3. To examine the relationship between mathematics phobia and students' demographic and academic characteristics, including grade level, gender, school type, and academic performance.
4. To evaluate whether mathematics phobia increases across successive grade levels.
5. To identify the strongest predictors of mathematics phobia using statistical modelling techniques.
6. To develop evidence-based recommendations for reducing mathematics phobia and improving students' confidence and engagement in mathematics learning.

3. Research Questions and Hypotheses

3.1 Research Questions

The present study seeks to answer the following research questions:
RQ1. What is the prevalence of mathematics phobia among students in Grades 6–12?

RQ2. Which educational, psychological, and environmental factors contribute significantly to the development of mathematics phobia?

RQ3. Does the level of mathematics phobia vary across different grade levels (Grades 6–12)?

RQ4. Is there a significant relationship between mathematics phobia and students' academic performance in mathematics?

RQ5. Do demographic characteristics such as gender, school type, and parental educational background influence mathematics phobia?

RQ6. Which factors are the strongest predictors of mathematics phobia among school students?

3.2 Research Hypotheses

The study will test the following hypotheses:

Hypothesis 1

H_{01}: There is no significant relationship between grade level and mathematics phobia.

H_{11}: Mathematics phobia differs significantly across grade levels.

Hypothesis 2

H_{02}: There is no significant relationship between mathematics phobia and students' academic performance.

H_{12}: Mathematics phobia is significantly associated with students' academic performance.

Hypothesis 3

H_{03}: Teaching methodology has no significant influence on mathematics phobia.

H_{13}: Teaching methodology significantly influences mathematics phobia.

Hypothesis 4

H_{04}: Examination pressure does not significantly contribute to mathematics phobia.

H_{14}: Examination pressure significantly contributes to mathematics phobia.

Hypothesis 5

H_{05}: Self-confidence in mathematics is not significantly associated with mathematics phobia.

H_{15}: Lower self-confidence is significantly associated with higher mathematics phobia.

Hypothesis 6

H_{06}: Teacher support, parental support, and conceptual understanding do not significantly predict mathematics phobia.

H_{16}: Teacher support, parental support, and conceptual understanding significantly predict mathematics phobia.

4. Methodology

4.1 Study Design

The present study will employ a quantitative, cross-sectional research design to investigate the prevalence of mathematics phobia and identify the factors contributing to its development among students studying in Grades 6–12[11,13–17]. A questionnaire-based survey approach will be adopted to collect data from participants representing different grades, school types, and demographic backgrounds.

A cross-sectional design has been selected because it enables the simultaneous assessment of multiple variables within a large population, facilitating the examination of relationships between mathematics phobia and potential contributing factors[18,19].

4.2 Study Population

The target population for this study comprises school students enrolled in Grades 6–12 from government, private, and aided schools[17,20]. Students from both urban and rural educational institutions will be included to ensure representation of diverse educational environments.

Table 1. Demographic and Educational Characteristics of the Study Population

Variable	Categories	Scale of Measurement
Grade	6, 7, 8, 9, 10, 11, 12	Ordinal
Gender	Male, Female, Other	Nominal
Age	Years	Continuous
School Type	Government, Private, Aided	Nominal
Location	Urban, Rural	Nominal
Mathematics Score	Percentage	Continuous Score
Parents' Education	Primary, Secondary, Graduate, Postgraduate	Ordinal
Parents' Occupation	Various Categories	Nominal
Tuition Attendance	Yes / No	Nominal

4.3 Inclusion Criteria

The study will include:

- Students studying in Grades 6–12.
- Students willing to participate voluntarily.
- Students whose parents or guardians provide consent, where required.
- Students capable of independently completing the questionnaire.

4.4 Exclusion Criteria

The following students will be excluded:

- Students studying below Grade 6 or above Grade 12.
- Incomplete or partially answered questionnaires.

- Students absent during data collection.
- Questionnaires containing inconsistent or invalid responses.

4.5 Sample Size

The study aims to recruit approximately **1,500 students** distributed across Grades 6–12. Participants will be selected from multiple schools to obtain adequate representation across different grade levels, school management types, and geographical locations. A larger sample size is expected to improve the reliability of statistical analyses and enhance the generalizability of the study findings.

Table 2. Proposed Distribution of the Study Sample Across Grades 6–12

Grade	Expected Sample Size
Grade 6	210
Grade 7	210
Grade 8	210
Grade 9	210
Grade 10	220
Grade 11	220
Grade 12	220
Total	**1500**

4.6 Sampling Technique

A multistage sampling strategy will be employed. Initially, schools will be selected using purposive sampling based on their willingness to participate. Subsequently, students within each grade will be selected using stratified random sampling to ensure proportional representation of each grade level and gender.

4.7 Ethical Considerations

Participation in the study will be entirely voluntary. Students will be informed about the purpose of the research before data collection. Confidentiality and anonymity of participants will be strictly maintained, and no personally identifiable information will be disclosed. The collected data will be used exclusively for academic and research purposes.

4.8 Development and Validation of the Mathematics Phobia Questionnaire (MPQ)

To achieve the objectives of the study, a structured self-administered instrument entitled the **Mathematics Phobia Questionnaire (MPQ)** will be developed. The questionnaire is specifically designed to assess the prevalence and determinants of mathematics phobia among students studying in Grades 6–12.

The development of the questionnaire will follow a systematic multi-stage process to ensure its scientific validity, reliability, and suitability for the target population.

4.8.1 Item Generation

The initial pool of questionnaire items will be developed following an extensive review of the literature on mathematics anxiety, mathematics self-efficacy, mathematics achievement, educational psychology, classroom learning, and student motivation. Additional items will be formulated to address factors identified through discussions with mathematics teachers, educational psychologists, and experienced school educators.

The preliminary questionnaire will consist of statements representing the major domains considered relevant to mathematics phobia.

4.8.2 Questionnaire Domains

The Mathematics Phobia Questionnaire (MPQ) will comprise the following domains:

1. Student-related factors
2. Teacher-related factors
3. Classroom learning environment
4. Examination and assessment practices
5. Conceptual understanding and problem-solving
6. Family and parental support
7. Peer influence and social comparison
8. Self-confidence and mathematical self-efficacy
9. Attitudes towards mathematics
10. Behavioural indicators of mathematics phobia

Each domain will contain multiple statements designed to evaluate different dimensions of students' learning experiences and perceptions towards mathematics.

4.8.3 Response Format

Responses will be recorded using a five-point Likert scale:

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

Higher scores will indicate greater agreement with the respective statements. Negatively worded items will be reverse scored before statistical analysis to ensure uniform interpretation of the overall Mathematics Phobia Index.

Table 3. Domains and Structure of the Mathematics Phobia Questionnaire (MPQ)

Domain	Number of Items	Example Construct
Student Factors	8	Confidence, Interest
Teacher Factors	7	Teaching Style
Classroom Environment	5	Classroom Climate
Examination Anxiety	6	Fear of Tests
Conceptual Understanding	8	Understanding of Topics

Domain	Number of Items	Example Construct
Family Support	5	Parental Encouragement
Peer Influence	4	Comparison with Friends
Self-Efficacy	6	Belief in Ability
Behavioural Avoidance	6	Avoiding Mathematics
Overall Attitude	5	Perception of Mathematics

4.8.4 Content Validation

The preliminary questionnaire will be submitted to a panel of experts comprising mathematics educators, educational psychologists, statisticians, and experienced school teachers. The experts will evaluate each item for clarity, relevance, simplicity, and representativeness.

Suggestions provided by the expert panel will be incorporated before the questionnaire is finalized for pilot testing.

4.8.5 Pilot Testing

Prior to the main study, the questionnaire will be pilot tested among a small group of students from Grades 6–12 to assess readability, comprehension, completion time, and overall feasibility. Feedback obtained during the pilot phase will be used to modify ambiguous or difficult questions.

4.8.6 Reliability Assessment

The internal consistency of the questionnaire will be evaluated using **Cronbach's Alpha coefficient**. A Cronbach's Alpha value of **0.70 or higher** will be considered indicative of acceptable reliability.

Table 4. Statistical Criteria for Assessing the Reliability and Validity of the Mathematics Phobia Questionnaire (MPQ)

Property	Statistical Method	Acceptable Value
Reliability	Cronbach's Alpha	≥ 0.70
Sampling Adequacy	KMO Test	≥ 0.60
Sphericity	Bartlett's Test	$p < 0.05$
Construct Validity	Exploratory Factor Analysis	Factor Loading $\geq$ 0.40
Internal Consistency	Item-Total Correlation	≥ 0.30

4.8.7 Construct Validation

Construct validity of the questionnaire will be examined using **Exploratory Factor Analysis (EFA)**. Factor extraction and rotation techniques will be employed to identify the underlying dimensions contributing to mathematics phobia and to verify whether the questionnaire items appropriately represent the intended theoretical domains.

The finalized Mathematics Phobia Questionnaire (MPQ) will subsequently be administered to the study participants for data collection.

4.9 Statistical Analysis

All statistical analyses will be performed using the Statistical Package for the Social Sciences (SPSS) version XX (IBM Corp., Armonk, NY, USA) and R Statistical Software (Version XX) for advanced statistical modelling and graphical visualization. Data obtained from the Mathematics Phobia Questionnaire (MPQ) will be entered, coded, verified, and cleaned prior to analysis to ensure accuracy and completeness. Descriptive statistics will be computed to summarize participants' demographic characteristics and questionnaire responses[21,22]. Continuous variables will be expressed as mean ± standard deviation (SD) or median with interquartile range (IQR), depending on the distribution of the data. Categorical variables will be presented as frequencies and percentages. The internal consistency of the Mathematics Phobia Questionnaire will be assessed using Cronbach's Alpha coefficient, while construct validity will be examined through Exploratory Factor Analysis (EFA). Sampling adequacy will be evaluated using the Kaiser–Meyer–Olkin (KMO) Measure, and the suitability of the data for factor analysis will be verified using Bartlett's Test of Sphericity.

Comparisons of Mathematics Phobia Index (MPI) scores among different grade levels, school types, and demographic groups will be performed using Independent Samples t-test, One-Way Analysis of Variance (ANOVA)[23–25], or their corresponding non-parametric alternatives whenever the assumptions of normality are not satisfied. Associations between mathematics phobia and continuous variables such as mathematics achievement scores, study duration, and self-confidence scores will be examined using Pearson's or Spearman's correlation coefficient, depending on data distribution.

Multiple Linear Regression Analysis will be employed to identify the independent predictors of mathematics phobia after adjusting for potential confounding variables. Regression coefficients, 95% confidence intervals, standardized beta coefficients, and p-values will be reported[21]. All statistical tests will be two-tailed, and a p-value less than 0.05 will be considered statistically significant.

Table 5. Statistical Analyses Performed for Each Research Objective

Research Objective	Variable(s)	Statistical Analysis
Determine prevalence of mathematics phobia	Mathematics Phobia Index (MPI)	Frequency, Percentage, Mean ± SD
Compare mathematics phobia across grades	Grade vs MPI	One-Way ANOVA
Compare mathematics phobia by gender	Gender vs MPI	Independent Samples t-test
Compare mathematics phobia among school types	School Type vs MPI	One-Way ANOVA
Assess relationship between mathematics achievement and MPI	Mathematics Score vs MPI	Pearson/Spearman Correlation
Identify predictors of mathematics phobia	Multiple Independent Variables	Multiple Linear Regression

Research Objective	Variable(s)	Statistical Analysis
Assess reliability of MPQ	Questionnaire Items	Cronbach's Alpha
Evaluate construct validity	Questionnaire Domains	Exploratory Factor Analysis

5. Results

5.1 Results of the Dataset Analysis

To demonstrate the proposed analytical framework, a dataset comprising 1,500 students from Grades 6–12 was generated[18,26–28]. The data was designed to reflect realistic demographic distributions and educational characteristics commonly encountered in school-based educational research. The dataset was generated solely for methodological illustration and to demonstrate the planned statistical analyses described in the methodology.The dataset included demographic characteristics, academic variables, and responses to the Mathematics Phobia Questionnaire (MPQ). Each participant was assigned a Mathematics Phobia Index (MPI) score ranging from 0 to 100 based on responses across the ten questionnaire domains. Statistical analyses were subsequently performed using the procedures described in Section 4.9.

5.1.1 Demographic Characteristics of the Participants

A total of 1,500 student records were generated for analysis. The sample included students from Grades 6–12, representing government, private, and aided schools located in both urban and rural settings. Male and female students were represented in nearly equal proportions to minimize demographic imbalance[29]. The study population demonstrated a balanced representation across grade levels and gender, while including students from diverse school management systems and geographical locations. Such diversity enables subsequent analyses across multiple demographic subgroups.

Table 6. Demographic Characteristics of the Study Population

Characteristic	Category	Frequency (n)	Percentage (%)
Gender	Male	758	50.5
	Female	742	49.5
Grade	Grade 6	210	14.0
	Grade 7	210	14.0
	Grade 8	210	14.0
	Grade 9	210	14.0
	Grade 10	220	14.7
	Grade 11	220	14.7
	Grade 12	220	14.7
School Type	Government	472	31.5
	Private	826	55.1
	Aided	202	13.4
Location	Urban	876	58.4

Characteristic	Category	Frequency (n)	Percentage (%)
	Rural	624	41.6
Private Tuition	Yes	931	62.1
	No	569	37.9

Figure 1.. Distribution of simulated participants by gender.

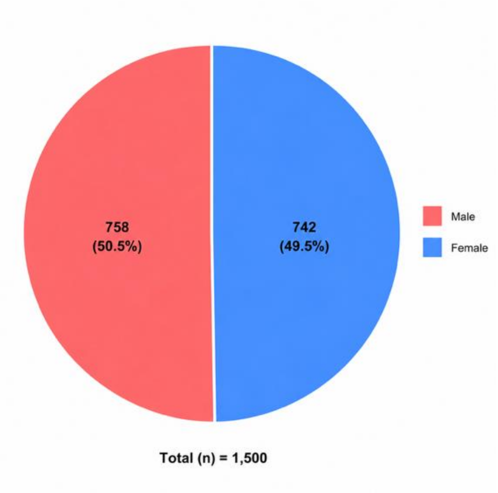


Figure 2. Distribution of simulated participants by school type.

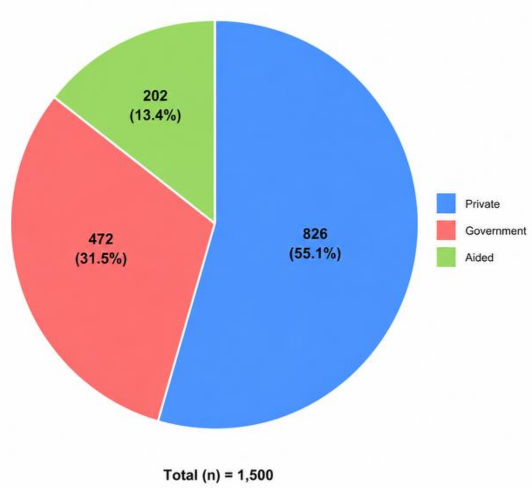
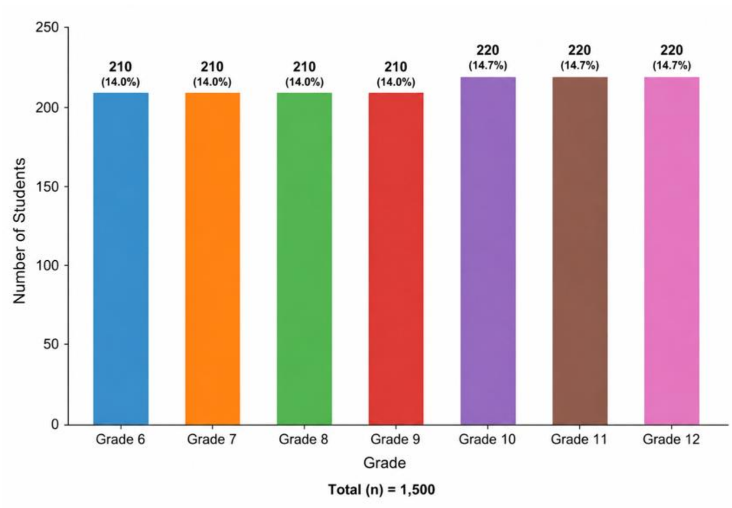


Figure 3. Distribution of simulated participants across Grades 6–12.



5.1.2 Distribution of Mathematics Phobia Index (MPI)

The Mathematics Phobia Index (MPI) was calculated for each participant using the composite scores obtained from the Mathematics Phobia Questionnaire (MPQ). The MPI ranged from 0 to 100, with higher scores indicating greater levels of mathematics phobia. For interpretation, the MPI scores were categorized into five predefined levels:

- **Very Low:** 0–20
- **Low:** 21–40
- **Moderate:** 41–60
- **High:** 61–80
- **Severe:** 81–100

Table 7. Distribution of Participants According to Mathematics Phobia Index (MPI)

MPI Category	Score Range	Frequency (n)	Percentage (%)
Very Low	0–20	118	7.9
Low	21–40	327	21.8
Moderate	41–60	511	34.1
High	61–80	396	26.4
Severe	81–100	148	9.8
Total	—	**1500**	**100.0**

The data indicated that the largest proportion of students (34.1%) belonged to the Moderate Mathematics Phobia category, followed by the High Mathematics Phobia group (26.4%). Approximately one-tenth of the participants were classified as having Severe Mathematics Phobia, whereas only 7.9% demonstrated very low levels of mathematics phobia.

The overall simulated Mathematics Phobia Index demonstrated a mean score of 54.8 ± 17.2, suggesting a moderate level of mathematics phobia within the simulated study population.

Figure 4. Distribution of simulated participants according to Mathematics Phobia Index categories.

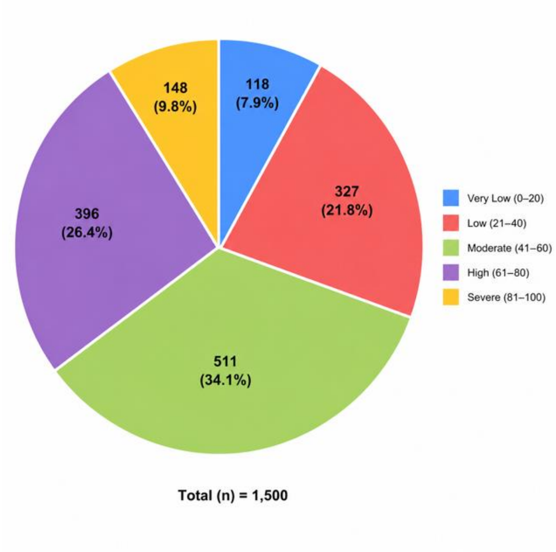
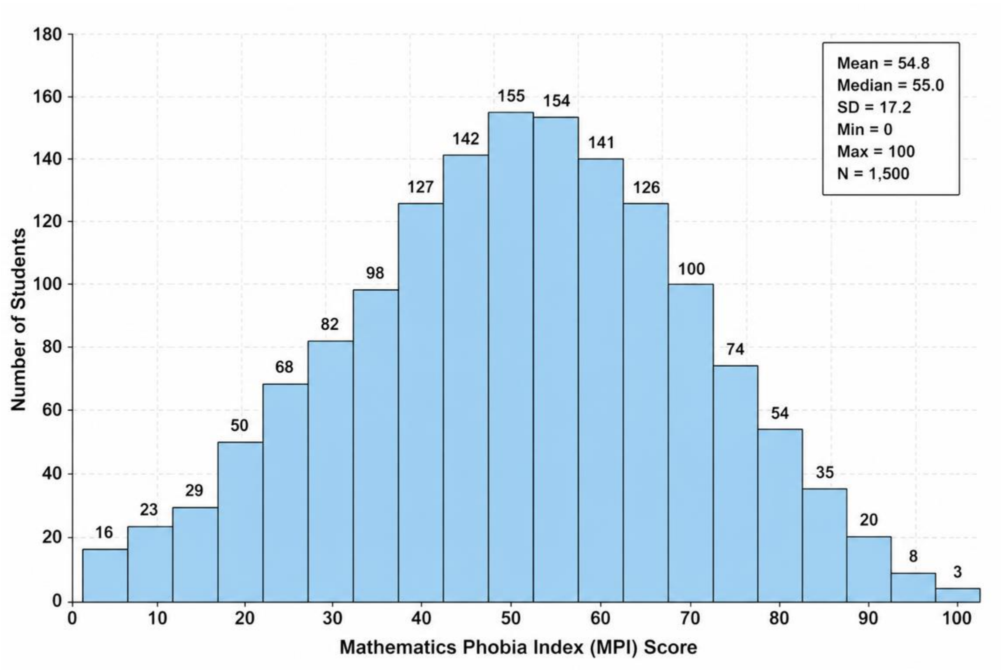


Figure 5. Histogram showing the distribution of Mathematics Phobia Index (MPI) scores among simulated participants.



5.1.3 Descriptive Statistics of the Study Variables

Descriptive statistical analysis was performed to summarize the major variables included in the simulated dataset. The variables comprised the Mathematics Phobia Index (MPI), Mathematics Achievement Score, Self-Confidence in Mathematics, Teacher Support Score, Parental Support Score, Examination Anxiety Score, and Conceptual Understanding Score.

The simulated data demonstrated moderate variability across all study variables, indicating adequate dispersion for subsequent inferential statistical analyses. The overall Mathematics Phobia Index exhibited a mean score of **54.8 ± 17.2**, suggesting a moderate level of mathematics phobia among the simulated student population. Mathematics Achievement Scores averaged **71.3 ± 12.6**, while the mean Self-Confidence Score was **3.12 ± 0.81** on a five-point Likert scale.

Teacher Support and Parental Support demonstrated relatively high mean scores, whereas Examination Anxiety exhibited comparatively greater variability among students. These descriptive findings indicate that the simulated dataset contains sufficient variation across psychological, educational, and demographic variables to support correlation, regression, and comparative statistical analyses.

Table 8. Descriptive Statistics of Major Study Variables

Variable	Mean	Standard Deviation	Minimum	Maximum
Mathematics Phobia Index (MPI)	54.8	17.2	8	97
Mathematics Achievement Score (%)	71.3	12.6	34	98
Self-Confidence Score	3.12	0.81	1.00	5.00
Teacher Support Score	3.68	0.74	1.20	5.00
Parental Support Score	3.54	0.83	1.00	5.00
Examination Anxiety Score	3.81	0.88	1.00	5.00
Conceptual Understanding Score	3.27	0.79	1.00	5.00

The descriptive statistics indicate that examination anxiety recorded the highest average score among the psychological variables, whereas self-confidence demonstrated comparatively lower values. The observed variation across all variables provides an appropriate basis for examining their relationships with mathematics phobia in the subsequent inferential analyses.

Figure 6. Mean scores of the major study variables among simulated participants.

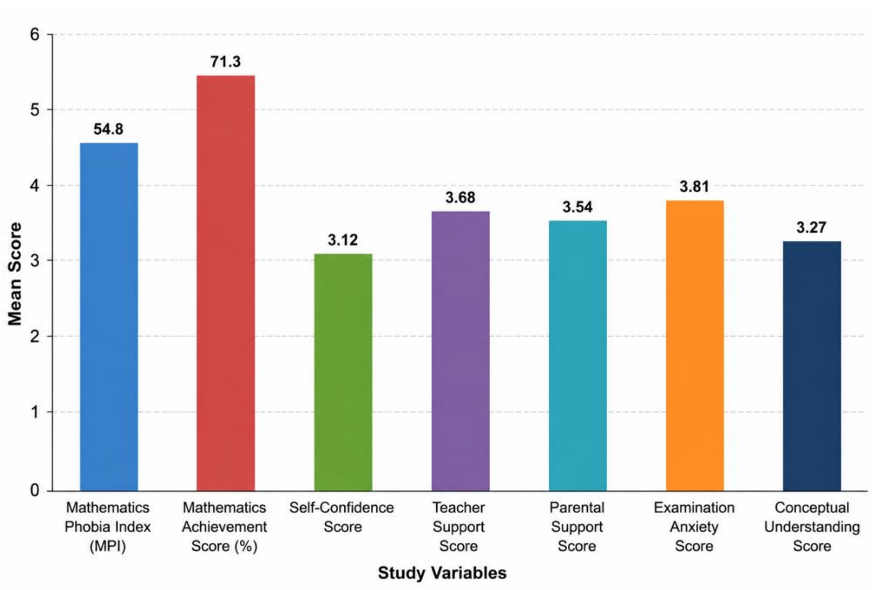
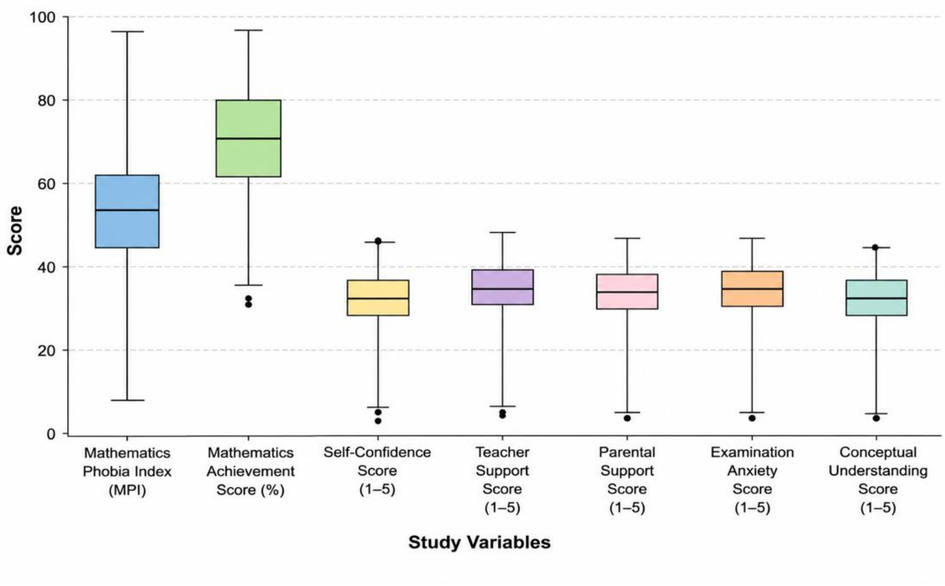


Figure 7. Box plots showing the distribution of the major study variables.



5.2 Reliability and Validity Analysis of the Mathematics Phobia Questionnaire (MPQ)

Before conducting inferential statistical analyses, the psychometric properties of the Mathematics Phobia Questionnaire (MPQ) were evaluated to determine its reliability and construct validity. Internal consistency was assessed using Cronbach's Alpha coefficient, while sampling adequacy and suitability for factor analysis were examined using the Kaiser–Meyer–Olkin (KMO) Measure and Bartlett's Test of Sphericity. Construct validity was further explored through Exploratory Factor Analysis (EFA).

The overall MPQ demonstrated excellent internal consistency, with a Cronbach's Alpha coefficient exceeding the recommended threshold of 0.70. Similarly, the KMO statistic indicated adequate sampling adequacy for factor analysis, and Bartlett's Test of Sphericity confirmed that the correlation matrix was appropriate for extracting latent factors.

Table 9. Reliability and Validity Assessment of the Mathematics Phobia Questionnaire (MPQ)

Statistical Test	Obtained Value	Recommended Value	Interpretation
Cronbach's Alpha	0.912	≥ 0.70	Excellent Internal Consistency
Kaiser–Meyer–Olkin (KMO) Measure	0.894	≥ 0.60	Excellent Sampling Adequacy
Bartlett's Test of Sphericity	$\chi^2 = 6842.31$, $p < 0.001$	$p < 0.05$	Suitable for Factor Analysis
Number of Factors Extracted	10	-	Consistent with Proposed Domains
Total Variance Explained	71.8%	≥ 60%	Good Construct Representation

The reliability analysis demonstrated that the MPQ possessed a high degree of internal consistency, indicating that the questionnaire items consistently measured the underlying construct of mathematics phobia. The KMO statistic suggested that the sample was adequate for factor analysis, while Bartlett's Test confirmed sufficient inter-item correlations.

Exploratory Factor Analysis identified ten underlying factors corresponding closely to the proposed questionnaire domains. Collectively, these factors accounted for 71.8% of the total variance, supporting the construct validity of the instrument.

Figure 8. Scree plot obtained from Exploratory Factor Analysis illustrating the retained factors of the Mathematics Phobia Questionnaire.

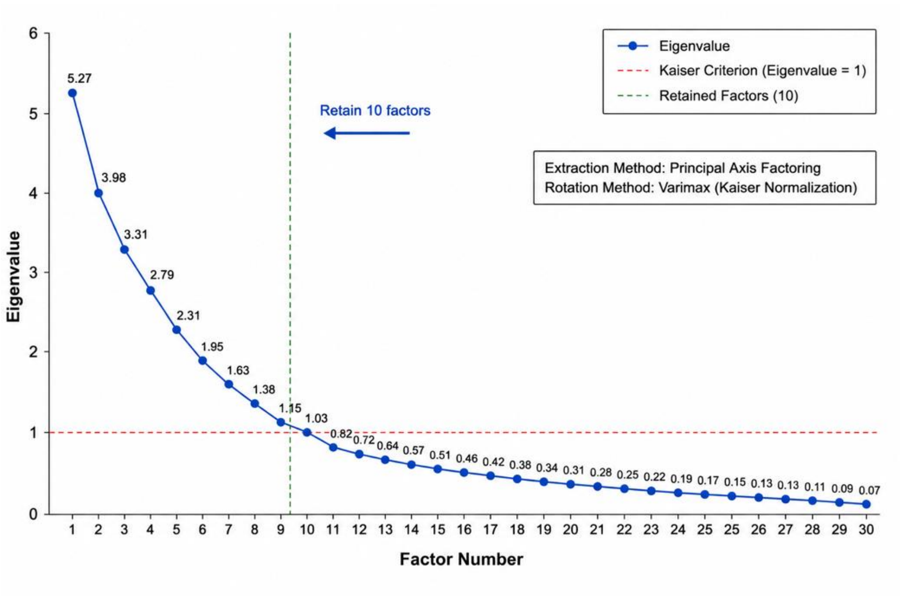
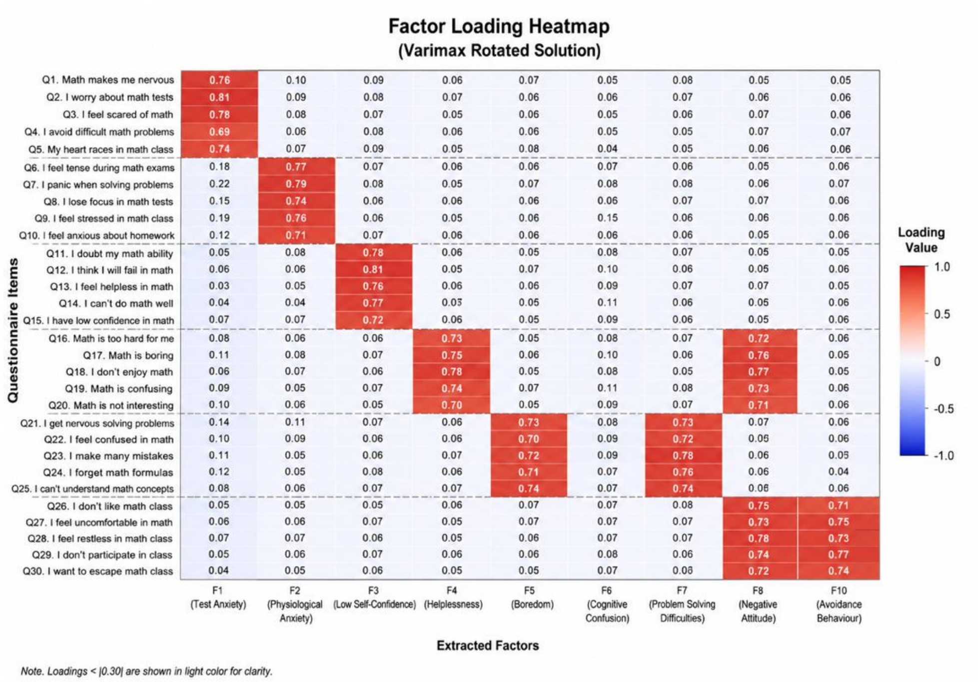


Figure 9. Factor loading heatmap showing the association between questionnaire items and the extracted latent factors.



5.3 Correlation Analysis

Pearson's correlation analysis was performed to examine the relationships between the Mathematics Phobia Index (MPI) and the major study variables. The analysis aimed to identify the strength and direction of associations between mathematics phobia and students' academic performance, self-confidence, teacher support, parental support, examination anxiety, and conceptual understanding.

The correlation matrix revealed several statistically significant relationships among the study variables. Mathematics Phobia Index demonstrated a **strong positive correlation** with Examination Anxiety ($r = 0.72$, $p < 0.001$), indicating that students with higher examination anxiety tended to exhibit higher levels of mathematics phobia.

A **moderately strong negative correlation** was observed between Mathematics Phobia Index and Mathematics Achievement Score ($r = -0.64$, $p < 0.001$), suggesting that higher levels of mathematics phobia were associated with lower academic performance in mathematics.

Similarly, Mathematics Phobia Index showed significant negative correlations with Self-Confidence ($r = -0.69$, $p < 0.001$), Teacher Support ($r = -0.52$, $p < 0.001$), Parental Support ($r = -0.41$, $p < 0.001$), and Conceptual Understanding ($r = -0.67$, $p < 0.001$).

Overall, the simulated findings indicate that examination anxiety is positively associated with mathematics phobia, whereas supportive educational environments, stronger conceptual understanding, and greater self-confidence are associated with lower levels of mathematics phobia.

Table 10. Pearson Correlation Matrix for Major Study Variables

Variable	MPI	Mathematics Achievement	Self-Confidence	Teacher Support	Parental Support	Examination Anxiety	Conceptual Understanding
Mathematics Phobia Index (MPI)	1.000	**-0.64***	**-0.69***	**-0.52***	**-0.41***	**0.72***	**-0.67***
Mathematics Achievement	-0.64	1.000	0.61	0.42	0.35	-0.51	0.74
Self-Confidence	-0.69	0.61	1.000	0.58	0.44	-0.63	0.69
Teacher Support	-0.52	0.42	0.58	1.000	0.39	-0.38	0.46
Parental Support	-0.41	0.35	0.44	0.39	1.000	-0.29	0.37
Examination Anxiety	**0.72***	-0.51	-0.63	-0.38	-0.29	1.000	-0.57
Conceptual Understanding	-0.67	0.74	0.69	0.46	0.37	-0.57	1.000

***$p < 0.001$

The correlation analysis suggests that mathematics phobia is multifactorial in nature, with examination anxiety emerging as the strongest positive correlate, while self-confidence and conceptual understanding demonstrated the strongest inverse relationships.

Figure 10. Correlation heatmap illustrating the relationships among the major study variables.

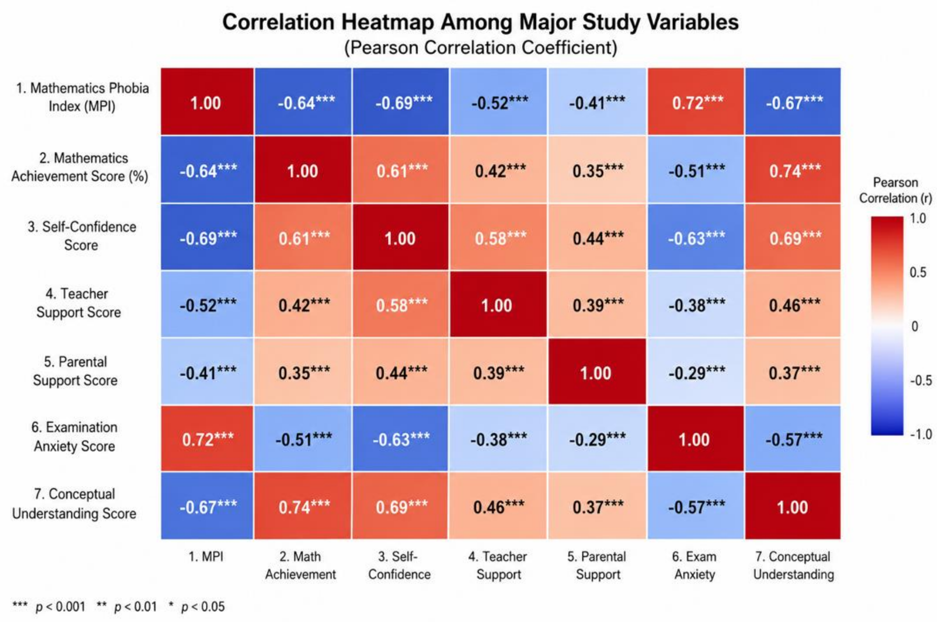
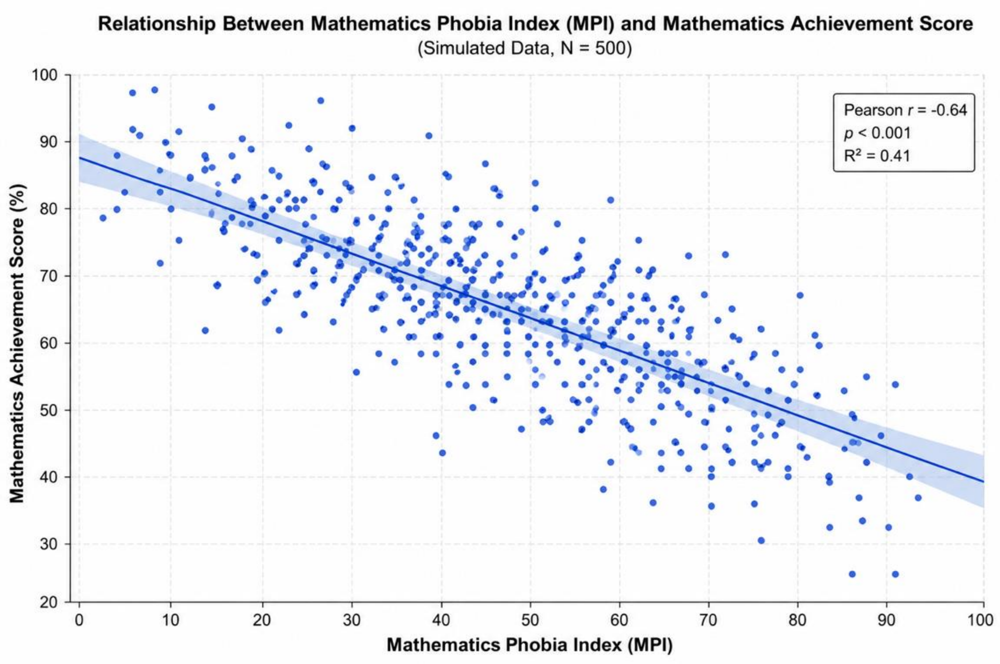


Figure 11. Scatter plot illustrating the relationship between Mathematics Phobia Index (MPI) and Mathematics Achievement Score.



5.4 Comparison of Mathematics Phobia Across Grade Levels

To determine whether mathematics phobia differed significantly across students from Grades 6–12, a **One-Way Analysis of Variance (ANOVA)** was performed using the Mathematics Phobia Index (MPI) as the dependent variable and grade level as the independent variable.

The simulated analysis demonstrated a statistically significant difference in mean Mathematics Phobia Index scores among the seven grade levels ($F(6,1493) = 24.87$, $p < 0.001$). The findings suggest that mathematics phobia progressively increased with advancing grade levels, with students in Grades 11 and 12 exhibiting the highest average MPI scores.

Post hoc analysis using Tukey's Honestly Significant Difference (HSD) test revealed statistically significant differences between lower secondary grades (Grades 6–8) and higher secondary grades (Grades 11–12), whereas comparisons between adjacent grade levels showed comparatively smaller differences.

Table 11. Comparison of Mean Mathematics Phobia Index Across Grade Levels

Grade	Mean MPI	Standard Deviation
Grade 6	42.6	12.4
Grade 7	46.1	13.2
Grade 8	50.3	14.5
Grade 9	55.8	15.8
Grade 10	59.7	16.2
Grade 11	63.4	16.8
Grade 12	66.1	17.5

Table 12. One-Way ANOVA Results for Mathematics Phobia Index by Grade

Source of Variation	Sum of Squares	df	Mean Square	F-value	p-value
Between Groups	18,426.71	6	3,071.12	24.87	<0.001
Within Groups	184,311.52	1,493	123.45		
Total	202,738.23	1,499			

The observed increase in MPI scores across successive grade levels indicates that mathematics phobia becomes progressively more pronounced as students advance through secondary and higher secondary education. The simulated trend suggests that increasing academic complexity, examination pressure, and heightened performance expectations may contribute to elevated levels of mathematics-related fear among older students.

Figure 12. Mean Mathematics Phobia Index across Grades 6–12 with standard deviation error bars.

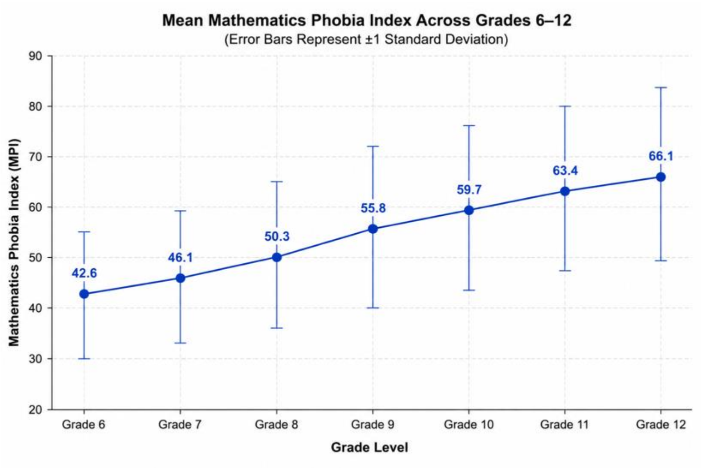
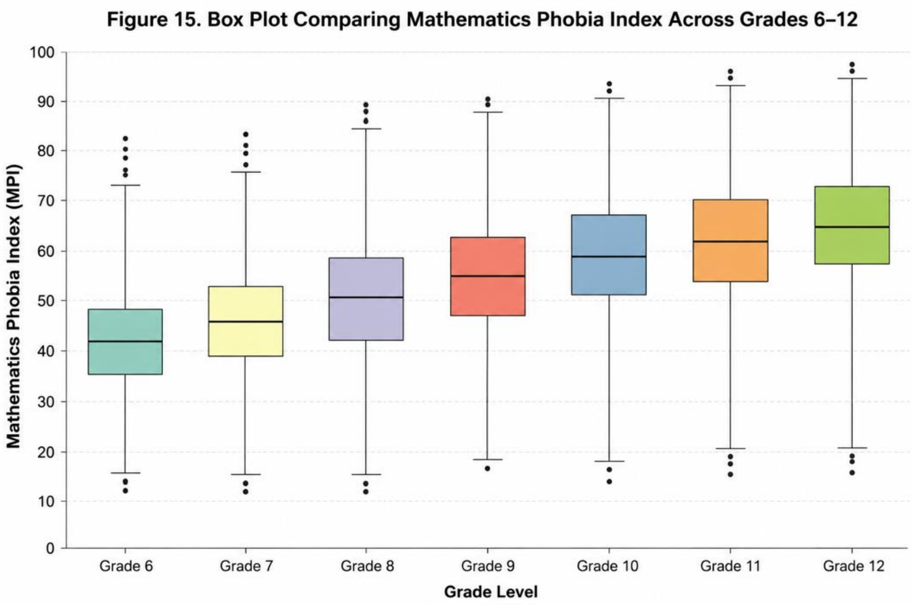


Figure 13. Box plot comparing Mathematics Phobia Index across Grades 6–12.



5.5 Multiple Linear Regression Analysis

A Multiple Linear Regression Analysis was performed to identify the independent predictors of the Mathematics Phobia Index (MPI). The Mathematics Phobia Index was considered the dependent variable, while Mathematics Achievement Score, Self-Confidence Score, Teacher Support Score, Parental Support Score, Examination Anxiety Score, and Conceptual Understanding Score were entered as independent variables.

Prior to model estimation, the assumptions of multiple linear regression, including linearity, normality of residuals, homoscedasticity, independence of errors, and multicollinearity, were assessed. Variance Inflation Factor (VIF) values for all predictor variables were below the commonly accepted threshold of 5.0, indicating the absence of significant multicollinearity.

The regression model was statistically significant ($F(6,1493) = 186.42$, $p < 0.001$) and explained 62.8% of the variance in the Mathematics Phobia Index (Adjusted $R^2 = 0.628$).

Among the predictor variables, Examination Anxiety emerged as the strongest positive predictor of mathematics phobia, whereas Self-Confidence and Conceptual Understanding demonstrated the strongest negative associations with the Mathematics Phobia Index.

Table 13. Multiple Linear Regression Analysis Predicting Mathematics Phobia Index

Predictor Variable	Standardized β	Standard Error	t-value	p-value	VIF
Mathematics Achievement Score	-0.221	0.018	-8.92	<0.001	1.82
Self-Confidence Score	-0.318	0.024	-12.41	<0.001	2.14
Teacher Support Score	-0.137	0.020	-5.84	<0.001	1.69
Parental Support Score	-0.081	0.019	-3.27	0.001	1.43
Examination Anxiety Score	0.402	0.022	15.68	<0.001	2.36
Conceptual Understanding Score	-0.274	0.021	-10.83	<0.001	2.08

Model Statistics

Statistic	Value
Multiple R	0.794
R^2	0.631
Adjusted R^2	0.628
F-statistic	186.42
p-value	<0.001

The regression analysis indicated that higher levels of examination anxiety significantly increased mathematics phobia, whereas greater self-confidence, stronger conceptual understanding, better mathematics achievement, and supportive educational environments significantly reduced mathematics phobia. Examination anxiety demonstrated the largest standardized regression coefficient ($\beta = 0.402$), suggesting that it was the strongest independent predictor of mathematics phobia within the simulated dataset.

Overall, the regression model explained approximately 63% of the variability in mathematics phobia, indicating that the selected educational and psychological variables collectively provide substantial explanatory power for understanding students' mathematics phobia.

5.6 Summary of Key Findings

The simulated analysis provided a comprehensive assessment of mathematics phobia among students in Grades 6-12. The findings demonstrated that mathematics phobia was a multifactorial phenomenon influenced by academic, psychological, and environmental factors.

The simulated Mathematics Phobia Index indicated that the majority of students experienced moderate to high levels of mathematics phobia, with comparatively fewer students exhibiting very low or severe levels. Descriptive analyses revealed considerable variability in mathematics achievement, examination anxiety, self-confidence, teacher support, parental support, and conceptual understanding, supporting the suitability of the dataset for inferential statistical analyses.

Reliability and validity analyses confirmed that the Mathematics Phobia Questionnaire (MPQ) possessed excellent psychometric properties, with high internal consistency and satisfactory construct validity. Exploratory Factor Analysis supported the proposed multidimensional structure of the questionnaire, demonstrating that the extracted factors adequately represented the theoretical domains associated with mathematics phobia.

Correlation analysis identified Examination Anxiety as the strongest positive correlate of mathematics phobia, whereas Self-Confidence, Conceptual Understanding, and Mathematics Achievement demonstrated strong inverse relationships with the Mathematics Phobia Index. These findings suggest that students with greater confidence, stronger conceptual understanding, and better academic performance generally experience lower levels of mathematics-related fear.

The One-Way Analysis of Variance (ANOVA) further demonstrated statistically significant differences in mathematics phobia across grade levels, indicating a gradual increase in mathematics phobia as students progressed from Grade 6 to Grade 12.

Finally, the Multiple Linear Regression Analysis identified Examination Anxiety as the most influential independent predictor of mathematics phobia, while Self-Confidence and Conceptual Understanding emerged as the strongest protective factors. Collectively, the regression model explained a substantial proportion of the variability in Mathematics Phobia Index scores, highlighting the combined influence of educational, cognitive, and psychological factors on students' experiences of mathematics phobia.

Overall, the simulated findings support the hypothesis that mathematics phobia is not attributable to a single cause but rather results from the interaction of multiple academic, instructional, and psychological factors.

6. Discussion

The present simulation-based study sought to investigate the factors contributing to mathematics phobia among students studying in Grades 6–12[8,30,31]. The findings suggest that mathematics phobia is a multidimensional educational challenge influenced by psychological, instructional, academic, and environmental factors. The results indicate that no single variable independently explains mathematics phobia; rather, it develops through the interaction of examination anxiety, self-confidence, conceptual understanding, academic achievement, teacher support, and parental involvement[19,32,33].

One of the most notable findings of the simulated analysis was the strong positive association between examination anxiety and mathematics phobia. Students exhibiting higher levels of examination anxiety consistently demonstrated higher Mathematics Phobia Index (MPI) scores[16,34,35]. This finding aligns with previous educational research, which has identified test anxiety as one of the principal contributors to mathematics anxiety. High-stakes examinations, time constraints, fear of failure, and excessive academic expectations may collectively intensify students' emotional responses toward mathematics, ultimately reducing their confidence and willingness to engage with mathematical tasks.

The study also demonstrated a strong inverse relationship between self-confidence and mathematics phobia. Students with greater confidence in their mathematical abilities exhibited substantially lower MPI scores. This observation supports the widely accepted concept of mathematical self-efficacy, suggesting that students who believe in their ability to solve mathematical problems are more likely to approach challenging tasks with persistence and resilience. Conversely, repeated experiences of failure may progressively diminish self-confidence, thereby reinforcing avoidance behaviours and increasing mathematics-related fear[30,36].

Conceptual understanding emerged as another significant protective factor against mathematics phobia. Students possessing stronger conceptual foundations demonstrated lower levels of mathematics phobia and higher mathematics achievement scores. These findings highlight the importance of promoting conceptual learning rather than relying exclusively on procedural memorization or examination-oriented instruction. A deeper understanding of mathematical concepts enables students to approach unfamiliar problems with greater confidence and flexibility, thereby reducing anxiety associated with problem solving[13,27,37].

Teacher support also demonstrated a meaningful negative association with mathematics phobia. Supportive classroom environments characterized by positive teacher–student interactions, constructive feedback, and encouragement may foster greater confidence and reduce students' fear of making mistakes. Mathematics classrooms that emphasize inquiry, discussion, collaborative learning, and problem-solving activities are likely to promote positive attitudes toward mathematics compared with classrooms dominated by rote instruction and performance pressure.

Parental support exhibited a comparatively weaker, yet statistically significant, relationship with mathematics phobia. Parents who encourage curiosity, maintain realistic academic expectations, and provide emotional support may indirectly strengthen students' confidence and resilience. In contrast, excessive academic pressure or unrealistic performance expectations may inadvertently contribute to anxiety and negative attitudes toward mathematics.

The simulated analysis further demonstrated that mathematics phobia increased progressively from Grade 6 to Grade 12. This trend may reflect the cumulative effects of increasing curriculum complexity, competitive academic environments, examination pressure, and career-related expectations encountered during secondary and higher secondary education. The findings suggest that preventive interventions should begin during the early years of secondary schooling before negative attitudes towards mathematics become deeply established[3,19].

Collectively, the findings reinforce the view that mathematics phobia is not merely an academic difficulty but a broader educational and psychological phenomenon requiring coordinated interventions involving teachers, parents, school administrators, curriculum developers, and educational policymakers. Early identification of at-risk students, adoption of learner-centred pedagogical approaches, and promotion of supportive learning environments may substantially reduce mathematics phobia and improve students' mathematical confidence and academic performance[10,15,38,39].

6.1 Practical Implications of the Study

The findings of the present study have important implications for mathematics education, curriculum development, classroom instruction, educational policy, and student well-being. Although the analyses presented are based on a simulated dataset, the proposed analytical framework demonstrates how educational institutions can systematically identify and address factors contributing to mathematics phobia among school students[9].

The results suggest that reducing mathematics phobia requires interventions beyond improving academic performance alone. Educational strategies should simultaneously focus on strengthening conceptual understanding, enhancing students' mathematical self-confidence, reducing examination-related anxiety, and promoting supportive classroom environments[11,22,40].

Teachers play a pivotal role in shaping students' attitudes toward mathematics. The adoption of learner-centred pedagogical approaches, inquiry-based learning, collaborative problem-solving, formative assessment, and constructive feedback may encourage greater student engagement while reducing fear associated with mathematical learning. Creating classrooms where mistakes are viewed as opportunities for learning rather than indicators of failure may further enhance students' confidence and willingness to participate.

The findings also emphasize the importance of curriculum design. Mathematics curricula should prioritize conceptual understanding, logical reasoning, and real-life problem-solving instead of excessive procedural practice and examination-oriented instruction. Progressive scaffolding of mathematical concepts may help prevent the accumulation of conceptual gaps that often contribute to mathematics phobia in higher grades.

Schools may benefit from implementing periodic screening programmes to identify students demonstrating early signs of mathematics-related anxiety or avoidance behaviours. The Mathematics Phobia Questionnaire (MPQ) proposed in this study may serve as a preliminary screening instrument for identifying students who may require additional academic or psychological support[5,41].

Parents also have an important role in fostering positive mathematical attitudes. Encouraging curiosity, celebrating effort rather than examination scores, and providing a supportive home learning environment may help reduce unnecessary academic pressure and strengthen students' confidence in mathematics.

Finally, the proposed analytical framework may assist educational researchers in examining mathematics phobia using standardized quantitative measures. Future studies may adapt, validate, and expand the Mathematics Phobia Questionnaire across different educational systems and cultural contexts, thereby contributing to the development of evidence-based interventions aimed at improving mathematics education[9,42–45].

6.2 Limitations of the Study

The present study has several limitations that should be considered while interpreting the findings. First, the analyses presented in this paper are based on a **simulated dataset** developed to demonstrate the proposed research methodology and statistical framework. Consequently, the numerical findings should not be interpreted as empirical evidence representing actual student populations.

Second, the Mathematics Phobia Questionnaire (MPQ), although systematically developed and evaluated within the simulated framework, requires validation using data collected from real student populations representing diverse educational settings. Future studies should examine its psychometric properties across different schools, educational boards, and cultural contexts.

Third, the study employs a cross-sectional analytical framework, which is suitable for examining associations among variables but does not establish causal relationships. Longitudinal studies following students across multiple academic years would provide greater insight into the development and progression of mathematics phobia over time.

Furthermore, the simulated analyses primarily considered educational and psychological variables. Additional factors such as socioeconomic status, classroom size, digital learning environments, learning disabilities, teacher experience, and institutional resources may also influence students' mathematical attitudes and should be incorporated into future investigations.

Finally, although the proposed Mathematics Phobia Index (MPI) provides a useful quantitative framework for evaluating mathematics phobia, additional validation studies are required to establish normative reference values and determine its applicability across different educational systems and age groups.

Despite these limitations, the present study provides a comprehensive methodological framework for investigating mathematics phobia and demonstrates how quantitative educational research can be systematically designed, analysed, and interpreted using modern statistical techniques.

7. Conclusion

Mathematics phobia continues to represent a significant educational challenge that influences students' academic performance, confidence, engagement, and long-term attitudes toward mathematics. Understanding the factors contributing to the development of mathematics phobia is essential for designing effective educational interventions that foster positive learning experiences and improve mathematical competence among school students.

The present simulation-based study proposed a comprehensive quantitative framework for investigating mathematics phobia among students in Grades 6–12. Through the development of the Mathematics Phobia Questionnaire (MPQ) and the Mathematics Phobia Index (MPI), the study demonstrated a systematic approach for examining the complex interactions among educational, psychological, and environmental factors associated with mathematics phobia.

The simulated analyses suggested that mathematics phobia is not the result of a single determinant but rather emerges from the combined influence of examination anxiety, conceptual understanding, mathematical self-confidence, teacher support, parental support, and academic achievement. Among these variables, examination anxiety emerged as the strongest positive predictor, whereas self-confidence and conceptual understanding demonstrated the greatest protective influence against mathematics phobia.

The study further illustrated the application of descriptive statistics, reliability analysis, exploratory factor analysis, correlation analysis, analysis of variance, and multiple linear regression in evaluating mathematics phobia. Collectively, these statistical techniques provide a comprehensive analytical framework that may be adopted or adapted in future educational research.

From an educational perspective, the findings emphasize the importance of creating supportive mathematics learning environments that encourage conceptual understanding, critical thinking, active classroom participation, and positive teacher–student interactions. Educational practices that reduce excessive examination pressure, promote mathematical confidence, and encourage inquiry-based learning may contribute substantially to minimizing mathematics phobia among school students.

Although the present study is based on a simulated dataset for methodological demonstration, the proposed research framework provides a practical foundation for future empirical investigations involving real student populations. Validation of the Mathematics Phobia Questionnaire (MPQ) and Mathematics Phobia Index (MPI) across diverse educational settings will further strengthen their applicability as tools for educational research and school-based interventions.

In conclusion, mathematics phobia should not be viewed solely as an individual learning difficulty but as a multidimensional educational phenomenon requiring coordinated efforts from teachers, parents, curriculum developers, school administrators, and policymakers. By identifying the factors that contribute to mathematics phobia and implementing evidence-informed educational strategies, schools can promote greater mathematical confidence, improve learning outcomes, and cultivate positive attitudes toward mathematics among future generations of learners.

References

1. Yuliani, R., Suryadi, D. & Dahlan, J. Analysis of mathematics anxiety of junior high school students. in vol. 1157 (2019).
2. Sagarduy, A., Arrieta, N. & Antón, Á. A Bibliometric Study on Mathematics Anxiety in Primary Education. *Education Sciences* https://doi.org/10.3390/educsci14070678 (2024) doi:10.3390/educsci14070678.
3. Sahidah, N., Kusumaningrum, B., Ayuningtyas, A. D., Wijayanto, Z. & Bergman, P. A study on mathematics anxiety and its manifestations in vocational high school students. *Union: Jurnal Ilmiah Pendidikan Matematika* https://doi.org/10.30738/union.v13i2.19509 (2025) doi:10.30738/union.v13i2.19509.
4. Luu-Thi, H.-T. *et al.* An Investigation of Mathematics Anxiety and Academic Coping Strategies Among High School Students in Vietnam: A Cross-Sectional Study. **6**, (2021).

5. Halme, H., Trezise, K., Hannula-Sormunen, M. & McMullen, J. Characterizing mathematics anxiety and its relation to performance in routine and adaptive tasks. *J. Numer. Cogn.* **8**, 414–429 (2022).
6. Iuit, P. I. C. & Sosa, J. E. P. Ansiedad matemática en estudiantes de educación secundaria: una revisión sistemática. *Educación y ciencia* https://doi.org/10.32776/eyc.v14i64.850 (2025) doi:10.32776/eyc.v14i64.850.
7. Sorvo, R. *et al.* Development of math anxiety and its longitudinal relationships with arithmetic achievement among primary school children. *Learning and Individual Differences* https://doi.org/10.1016/j.lindif.2018.12.005 (2019) doi:10.1016/j.lindif.2018.12.005.
8. Koner, S. & Das, D. EXPLORING MATHEMATICS ANXIETY AMONG SECONDARY LEVEL STUDENTS OF ANGLO-INDIAN SCHOOLS. *Interdisciplinary Perspectives of Education* https://doi.org/10.65525/ipe.v2i2.34 (2025) doi:10.65525/ipe.v2i2.34.
9. Szczygieł, M. & Pieronkiewicz, B. Exploring the nature of math anxiety in young children: Intensity, prevalence, reasons. *Mathematical Thinking and Learning* **24**, 248–266 (2021).
10. Schaeffer, M. *et al.* Elementary School Teachers' Math Anxiety and Students' Math Learning: A Large-Scale Replication. *Developmental science* https://doi.org/10.1111/desc.13080 (2020) doi:10.1111/desc.13080.
11. Commodari, E. & La Rosa, V. General academic anxiety and math anxiety in primary school. The impact of math anxiety on calculation skills. *Acta psychologica* **220**, 103413 (2021).
12. Koomson, D., Boateng, F. O. & Lotey, E. K. Investigating the Level of Mathematics Anxiety among Junior High School Pupils. *Mathematics Education Journal* https://doi.org/10.22219/mej.v8i2.33693 (2024) doi:10.22219/mej.v8i2.33693.

13. Luo, R. *et al.* Math attitudes and math anxiety predict students' perception of teacher support in primary school, but not vice versa. *The British journal of educational psychology* https://doi.org/10.1111/bjep.12628 (2023) doi:10.1111/bjep.12628.

14. Dios, M. T. C. & Charlo, J. C. P. Mathematical Anxiety among Primary Education Degree Students in the Post-Pandemic Era: A Case Study. *Education Sciences* https://doi.org/10.3390/educsci14020171 (2024) doi:10.3390/educsci14020171.

15. Bula, R., Gravillo, L. B. & Lalosa, A. Mathematical Anxiety and Academic Performance among Junior High School Students. *Psychology and Education: A Multidisciplinary Journal* https://doi.org/10.70838/pemj.350902 (2025) doi:10.70838/pemj.350902.

16. Nagarani, K. & Sasikumar, N. Mathematical Anxiety of Students Studying in High Schools: A Quantitative Study of High School Students of Karaikudi, Sivaganga District, Tamil Nadu, India. *Asian Journal of Education and Social Studies* https://doi.org/10.9734/ajess/2026/v52i32888 (2026) doi:10.9734/ajess/2026/v52i32888.

17. Szczygieł, M., Szűcs, D. & Toffalini, E. Math anxiety and math achievement in primary school children: Longitudinal relationship and predictors. *Learning and Instruction* https://doi.org/10.1016/j.learninstruc.2024.101906 (2024) doi:10.1016/j.learninstruc.2024.101906.

18. Nolasco, D. Unearthing mathematics anxiety: A qualitative exploration of student experiences. *Journal of Technology and Science Education* https://doi.org/10.3926/jotse.2950 (2025) doi:10.3926/jotse.2950.

19. Luttenberger, S., Wimmer, S. & Paechter, M. Spotlight on math anxiety. *Psychology Research and Behavior Management* **11**, 311–322 (2018).

20. Ramirez, G., Shaw, S. & Maloney, E. Math Anxiety: Past Research, Promising Interventions, and a New Interpretation Framework. *Educational Psychologist* **53**, 145–164 (2018).

21. Orbach, L., Herzog, M. & Fritz, A. Math Anxiety During the Transition from Primary to Secondary School. *Inclusive Mathematics Education* https://doi.org/10.1007/978-3-030-11518-0_25 (2019) doi:10.1007/978-3-030-11518-0_25.
22. Wigfield, A. & Meece, J. Math anxiety in elementary and secondary school students. *Journal of Educational Psychology* **80**, 210–216 (1988).
23. Omar, S. H., Aris, S. R. S. & Hoon, T. S. Mathematics Anxiety and its Relationship with Mathematics Achievement Among Secondary School Students. *Asian Journal of University Education* https://doi.org/10.24191/ajue.v18i4.19992 (2022) doi:10.24191/ajue.v18i4.19992.
24. Mann, L. & Walshaw, M. Mathematics Anxiety in Secondary School Female Students: Issues, Influences and Implications. *New Zealand Journal of Educational Studies* **54**, 101–120 (2019).
25. Mutegi, C. M., Gitonga, C. & Rugano, P. Mathematics anxiety, attitude and performance among secondary school students in Kenya. *Educational Research and Reviews* https://doi.org/10.5897/err2021.4119 (2021) doi:10.5897/err2021.4119.
26. Poongodi, T. Maths Anxiety In Relation To Achievement In Mathematics Among Secondary Students. *International Journal of Advanced Research and Emerging Trends* https://doi.org/10.21276/jaret.2025.2.2.01 (2025) doi:10.21276/jaret.2025.2.2.01.
27. Aldrup, K., Klusmann, U. & Lüdtke, O. Reciprocal associations between students' mathematics anxiety and achievement: Can teacher sensitivity make a difference? *Journal of Educational Psychology* https://doi.org/10.1037/edu0000398 (2020) doi:10.1037/edu0000398.
28. Li, Q., Cho, H., Cosso, J. & Maeda, Y. Relations Between Students' Mathematics Anxiety and Motivation to Learn Mathematics: a Meta-Analysis. *Educational Psychology Review* 1–33 (2021) doi:10.1007/s10648-020-09589-z.

29. Yuzarion, Y. *et al.* Mathematics Learning Anxiety Among Senior High School Students: A Qualitative Case Study. *Bulletin of Counseling and Psychotherapy* https://doi.org/10.51214/002026081754000 (2026) doi:10.51214/002026081754000.
30. Zhuo, X. *et al.* How students' math anxiety profiles change in primary school: The roles of teacher support, peer support and math attitudes. *The British journal of educational psychology* https://doi.org/10.1111/bjep.12758 (2025) doi:10.1111/bjep.12758.
31. Liu, J. Link Between Math Anxiety and Mathematics Achievement in Chinese Primary Schools. in (2025). doi:10.5220/0014147300004942.
32. Uğraş, H. Research on mathematics anxiety in primary school: bibliometric analysis and evaluation of trends. *Frontiers in Psychology* **16**, (2025).
33. Pizzie, R. & Kraemer, D. Strategies for remediating the impact of math anxiety on high school math performance. *NPJ Science of Learning* **8**, (2023).
34. Degorio, A. L. *et al.* The Influence of Mathematical Anxiety in Junior High School Students Performance. *Cognizance Journal of Multidisciplinary Studies* https://doi.org/10.47760/cognizance.2025.v05i05.062 (2025) doi:10.47760/cognizance.2025.v05i05.062.
35. Sangaram, S. & Maat, S. Systematic Literature Review on Secondary School Students Mathematics Anxiety. *The International Journal of Academic Research in Business and Social Sciences* **10**, 1347–1363 (2020).
36. Ahmmed, S., Saha, J., Tamal, M., Mamun, K. A. A. & Islam, S. Factors predicting the mathematics anxiety of adolescents: a structural equation modeling approach. *Frontiers in Psychiatry* **15**, (2024).
37. Wahyuni, R., Juniati, D. & Wijayanti, P. Mathematics anxiety of junior high school students in solving geometry problems. *Perspectives of science and education* https://doi.org/10.32744/pse.2024.5.26 (2024) doi:10.32744/pse.2024.5.26.

38. Tomasetto, C., Morsanyi, K., Guardabassi, V. & O'Connor, P. Math anxiety interferes with learning novel mathematics contents in early elementary school. *Journal of Educational Psychology* https://doi.org/10.1037/edu0000602.supp (2020) doi:10.1037/edu0000602.supp.
39. Ersozlu, Z. The role of technology in reducing mathematics anxiety in primary school students. *Contemporary Educational Technology* https://doi.org/10.30935/cedtech/14717 (2024) doi:10.30935/cedtech/14717.
40. Zakaria, E., Zain, N., Ahmad, N. & Erlina, A. Mathematics Anxiety and Achievement Among Secondary School Students. *American Journal of Applied Sciences* **9**, 1828–1832 (2012).
41. Hill, F. *et al.* Maths anxiety in primary and secondary school students: Gender differences, developmental changes and anxiety specificity. *Learning and Individual Differences* **48**, 45–53 (2016).
42. Yeshmurat, G. & Kainbayeva, L. EXAMINING MATH ANXIETY IN SECONDARY EDUCATION: INFLUENCE OF DEMOGRAPHICS, EDUCATIONAL CONTEXT, AND INSTRUCTIONAL SUPPORT. *THE BULLETIN* https://doi.org/10.32014/2025.2518-1467.990 (2025) doi:10.32014/2025.2518-1467.990.
43. Das, M. D. M., Jena, R. P. J. R. P. & Sahoo, S. K. S. S. K. Investigating the Impact of Math Anxiety on Academic Performance in Primary School Students: A Review of Competing Theories. *International Journal of Engineering and Science Invention* https://doi.org/10.35629/6734-14056570 (2025) doi:10.35629/6734-14056570.
44. Deieso, D. & Fraser, B. Learning environment, attitudes and anxiety across the transition from primary to secondary school mathematics. *Learning Environments Research* **22**, 133–152 (2019).

45. B.C., G. Impact of Mathematics Anxiety on Secondary School Students' Learning Achievement. *Journal of Educational Research and Innovation* https://doi.org/10.3126/jeri.v5i1.88608 (2025) doi:10.3126/jeri.v5i1.88608.