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The Effects of Mathematics Anxiety on Students' Mathematics Learning Outcomes

Karina Nurwijayanti
Universitas Teknologi Mataram

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Abstract
This study aims to determine the effect of mathematical anxiety on mathematics learning outcomes. This research is quantitative research. This study's population was comprised of all 3rd-semester Informatics Engineering students, totaling 139 people across four classes. Based on the existing population, 77 students were sampled in this study, which were taken using simple random sampling. Mathematics anxiety data were obtained from questionnaires, and mathematics learning outcomes were obtained from documentation, which were then analyzed using inferential analysis with simple linear regression. This study concludes that mathematics anxiety has a negative effect on mathematics learning outcomes with a regression equation of Y=130.997-0.961X and a coefficient of determination of 0.860. This means that 86% of students' mathematics learning outcomes are influenced by mathematics anxiety. The higher the mathematics anxiety, the lower the students' mathematics learning outcomes will be, and the lower the mathematics anxiety, the higher the students' mathematics learning outcomes will be.

Corresponding Author:
Karina Nurwijayanti
Universitas Teknologi Mataram

1. INTRODUCTION

Mathematics is essential for students in college because it helps them think critically and understand other disciplines. First, mathematics serves as a tool for solving academic and everyday problems.This aligns with the perspective that mathematics is not merely about numbers and formulas but also represents a systematic and logical way of thinking (Bakrin, 2023). In higher education, students are expected to develop critical and analytical thinking skills through mathematics learning, which is highly relevant across various fields of study, including science, technology, and social sciences (Jannah, 2024). Research shows that constructing and understanding mathematical proofs is key to success in mathematics studies and related disciplines (Hamdani et al., 2020). Therefore, mathematics education at the university level not only focuses on mastering techniques but also on developing critical and creative thinking skills (Desmawati & Farida, 2018).

Finally, all disciplines rely on mathematics. Good mathematical skills allow students to apply mathematical concepts in broader contexts, which enhances their understanding of more complex material (Kamil, 2023; Pratamawati, 2020). Therefore, mastery of mathematics in college is essential to prepare students to face workplace and everyday problems. In other words, mathematics is necessary for college students. Mathematics not only helps solve problems, but also builds critical thinking and understanding of other disciplines.

Student learning outcomes are one indicator of the success of mathematics learning. Good learning outcomes indicate that students understand concepts, can solve problems, and are more creative in mathematics. Good learning outcomes also suggest that students understand and apply mathematical concepts in a broader context. Learning outcomes, or learning achievement, indicate how well a student participates in the learning process. According to Ngapa (2023), learning outcomes are evidence of the success of a person's learning efforts, including the maximum achievement students achieve in terms of their ability to understand the subject being studied. This shows that learning outcomes are measured by the final grade and the student's learning process. Academic grades, ability to complete tasks, and participation in learning activities are some indicators that can be used to measure learning outcomes.

Often, students' mathematics learning outcomes in college do not meet expectations, as many studies show that students show poor results in this subject. Mathematics anxiety experienced by students is one of the factors that contribute to these poor results. Research indicates that students often perceive mathematics as a complex and burdensome subject, leading them to give up and switch to other fields of study that are considered easier (Nasution et al., 2022). Low mathematics achievement among students can be caused by various factors related to cognitive and affective aspects. Various components related to cognitive and affective elements can cause poor mathematics learning outcomes in students. The cognitive aspect is related to students' ability to understand and process mathematical information, while the affective element is related to students' emotions and perceptions of mathematics learning.

Affective factors such as students' motivation, anxiety, and attitudes toward mathematics can influence how well they understand and apply mathematical concepts. Research shows that students with a positive attitude and high motivation tend to achieve better learning outcomes compared to those who experience anxiety or lack self-confidence (Sari et al., 2019; Hasanah, 2023). Affective, especially mathematics learning anxiety, affects students' learning outcomes. Excessive fear can prevent students from concentrating and understanding the material well. According to Mulyana et al. (Mulyana et al., 2021), low anxiety levels are positively correlated with better learning outcomes.

Research by Auliya emphasizes that math anxiety is closely related to students' mathematical understanding, with students experiencing high anxiety tending to have lower comprehension (Auliya, 2016). Students experiencing math anxiety often feel stressed when facing exams or assignments, which can reduce their concentration and ability to think critically in solving mathematical problems.

Mathematics anxiety is an emotional condition characterized by tension, fear, and discomfort experienced by individuals when faced with mathematics-related situations. This definition includes various elements, such as emotional reactions resulting from bad mathematics learning experiences, which can negatively impact a person's ability to learn further (Julya, 2022; Tasya, 2023). According to Setiawan, mathematics anxiety can be classified into several levels, ranging from mild to severe anxiety, all of which can influence how students interact with mathematical material (Setiawan, 2024).

Students often experience math anxiety when they face challenging tasks, such as solving math problems or taking exams. This aligns with Freedman's idea, which states that math anxiety is an emotional reaction to mathematics that stems from previous bad experiences (Tasya, 2023). This anxiety can disrupt students' concentration, reduce motivation, and even hinder their ability to solve mathematical problems (Andaresta, 2024; Rizki et al., 2019). These fears do not only arise during exams; they can also occur in everyday learning, such as when students work in groups or provide problem solutions to their classmates (Dzulfikar, 2016). Therefore, it is essential to understand and address mathematics anxiety so that students can learn more effectively and achieve better outcomes in mathematics. Mathematics anxiety is a complex phenomenon involving emotional and cognitive aspects and can significantly impact students' learning experiences in mathematics (Dewi & Pujiastuti, 2020; Berliana & Adirakasiwi, 2021).

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Mathematics anxiety is a complex phenomenon influenced by various components or indicators, namely cognitive, affective, and somatic. Each element contributes to the anxiety experienced by students when dealing with mathematical tasks.

a) Cognitive Component

Cognitive anxiety is related to how students process information and think about mathematics. Students with cognitive anxiety often lack confidence in their mathematical abilities, struggle to concentrate, and have an excessive fear of making mistakes (Mulyana et al., 2021; Sholichah, 2022). Research shows that a lack of self-belief and mathematical competence can lead to stress during learning, which, in turn, hampers their understanding of the material (Zahra & Haerudin, 2023; Nuraeni, 2023). Cognitive anxiety may also cause students to avoid mathematics situations, exacerbating their lack of understanding (Kartikasari & Kurniasari, 2021).

b) Affective Component

The affective aspect of mathematics anxiety encompasses the emotions and feelings students experience while learning mathematics. This anxiety can stem from negative past experiences, such as exam failures or insufficient support from teachers and peers (Sholichah, 2022; Syahbana, 2024). Students with negative attitudes toward mathematics are more likely to experience higher anxiety levels, which disrupt their learning process (Machmud et al., 2022). Studies suggest positive attitudes and high motivation can help reduce mathematics anxiety and improve students' academic performance (Hikmah, 2023).

c) Somatic Component

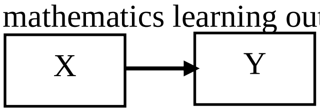
Somatic anxiety refers to the physical reactions students experience in stressful mathematical situations. Symptoms may include a rapid heartbeat, sweating, or nausea (Nuraeni, 2023; Fatma & Noviarni, 2022). Research indicates that somatic anxiety can worsen students' learning experiences, as physical symptoms can divert their attention from the task at hand (Wahyuningsih, 2023). These physical reactions often make students uncomfortable and hinder their concentration, negatively impacting their academic performance (Hastuti et al., 2021).

Finally, the three components—cognitive, affective, and somatic—work together and contribute to the mathematics anxiety that students face. Understanding and addressing these aspects is essential to help them reduce their anxiety and improve their mathematics learning outcomes (Siagian et al., 2022; Nurkarim, 2024). Based on the explanation above, the researcher aims to determine whether mathematics anxiety affects college students' learning outcomes.

2. RESEARCH METHODS

This research is quantitative. The method used in this study is ex post facto, where the researcher does not control the independent variable directly, or the existence of the variable has occurred. The population of this study was all informatics engineering students in semester 3rd in the academic year 2024/2025.

The variables used in this study are independent variables and dependent variables. The independent variable in this study is mathematics anxiety (X). At the same time, the dependent variable in this study is students' mathematics learning outcomes (Y). Research design:



This study's population comprised all 3rd-semester Informatics Engineering students, totaling 139 people across four classes. Based on the existing population, 77 students were the sample in this study, which was taken using simple random sampling. A simple random sampling technique is carried out randomly from population members without considering the overall level.

The study used questionnaires and documentation for data collection. The questionnaire method was implemented by giving students who were the research samples a questionnaire about mathematics anxiety.

Table 1. Blueprint of the Mathematics Anxiety Questionnaire

Variable	Aspect	Indicators
Mathematics Anxiety	Cognitive	a. Difficulty concentrating
		b. Lack of confidence
		c. Self-perceived ability
		d. Fear of failure
	Affective	a. Nervounsness
		b. Lack of enjoyment
		c. Anxiety
	Physiological (Somatic)	a. Nausea
		b. Cold Sweating
		c. Palpitations
		d. Headache

The questionnaire has four answer choices: Strongly Agree (SS), Agree (S), Disagree (TS), and Strongly Disagree (STS). Each positive question is given a score of 4, 3, 2, and 1, while each negative question is given a score of 1, 2, 3, and 4.

Table 2. Scoring for the Mathematics Anxiety Questionnaire

Nature	Response Options			
	Strongly Agree (SS)	Agree (S)	Disagree (TS)	Strongly Disagree (STS)
Positive (+)	4	3	2	1
Negative(-)	1	2	3	4

Meanwhile, the documentation method of collecting odd-semester mid-term exam scores for discrete mathematics courses is used to measure student learning outcomes or learning achievements on campus.

This study uses inferential analysis as a data analysis technique. The inferential analysis used is simple linear regression analysis, which is a method used to determine the effect of independent variables (math anxiety) on dependent variables (math learning outcomes).

The classical assumption test is performed first before a simple linear regression analysis. This test is performed to see whether the data in the study is normally distributed and whether there is a deviation. The tests performed in the classical assumption test are the normality, linearity, heteroscedasticity, and autocorrelation tests.

3. RESULTS AND DISCUSSION

3.1.Research Results

The characteristics of the research sample can be described from the results of descriptive analysis based on the variables of mathematics anxiety and student learning outcomes, as shown in Table 3, through the average score, standard deviation, minimum value, and maximum value.

Table 3. Descriptive Statistics

Variable	$\bar{X}$	SD	Min	Max
X (Mathematics Anxiety)	56.73	5.61	40	73
Y (Learning Outcomes)	76.48	5.82	62	89

Kolomogorov-Smirnov (with a significance level of 0.05) was used to test the normality of the results of the mathematics anxiety questionnaire and mathematics learning outcomes. The residual normality test aims to determine whether the residual or interfering variables in the regression model are normally distributed.

Table 4. Normality Test Results

	Unstandardized Residual
Asymp. Sig. (2-tailed)	.200[c,d]

a. Test distribution is Normal.
b. Calculated from data.
c. Lilliefors Significance Correction.
d. This is a lower bound of the true significance.

In Table 4, information is obtained in the Asymp. Sig (2-tailed) row of 0.200. This study's significance level (α) is 5% or 0.05. If the sig value > α, then the regression model is normally distributed. The Sig value is 0.200> α , then the regression model is normally distributed. Thus, the normality assumption test is met so that it can be continued to the linearity test for the linearity of the relationship between mathematics anxiety and mathematics learning outcomes.

Table 5. Results of Linearity Test of Regression

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.628	1.641		2.211	.030
	Mathematics Anxiety	-.035	.029	-.139	-1.212	.229

a. Dependent Variable: ABSRES

Table 5 shows the Sig. A deviation from Linearity value of 0.746 > 0.05 means that the mathematics anxiety variable has a linear relationship with the learning outcome variable, so the linearity test assumption is met. The data can be used for the next stage, namely determining the regression equation.

Table 6. Heteroscedasticity Test Results

			Sum of Squares	df	Mean Square	F	Sig.
Learning Outcomes * Mathematics Anxiety	Between Groups	(Combined)	2299.604	23	99.983	19.367	.000
		Linearity	2212.185	1	2212.185	428.504	.000
		Deviation from Linearity	87.420	22	3.974	.770	.746
	Within Groups		273.617	53	5.163		
	Total		2573.221	76			

The heteroscedasticity test is used to determine whether there is a difference between the variance and residual of one observation to another observation in a simple linear regression model. The data will have no heteroscedasticity if the coefficient column has a significant value of more than 0.05. The results of the heteroscedasticity test above show that the significance value is 0.229 > 0.05, so there is no heteroscedasticity.

The autocorrelation test is conducted to test whether there is a correlation between errors that appear in the data sorted by time in the simple linear regression model. This study performed the autocorrelation test using the Durbin-Watson (DW) test. The results of the autocorrelation test are shown in the following table:

Table 7. Autocorrelation Test Results

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.927[a]	.860	.858	2.19404	1.885

a. Predictors: (Constant), Mathematics Anxiety
b. Dependent Variable: Learning Outcomes

Based on the table above, the Durbin-Watson value is 1.885. Furthermore, it will be compared with the dU and dL values in the Durbin-Watson table at a significance of 5% or 0.05 with ($k: N$), k is the number of independent variables, while N is the number of samples, so in this study $k = 1$ and $N = 77$, so $(k: N) = (1: 77)$. In the Durbin Watson table for $(1: 77)$ the values $dL = 1.6036$ and $dU = 1.6561$ are obtained. Because $dL < DW > dU$ and $dL < (4 - DW) > dU$, so there is no autocorrelation in this research or regression model.

Table 8. Regression Equation

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	130.997	2.555		51.264	.000
	Mathematics Anxiety	-.961	.045	-.927	-21.437	.000

a. Dependent Variable: Learning Outcomes

From Table 8, a simple linear regression equation can be obtained $y = 130.997 - 0.961x$. In addition to the simple linear regression equation, Table 8 can also be used to test hypotheses. Hypothesis testing is used to show the effect of mathematics anxiety on mathematics learning outcomes. The hypotheses tested are:

H_0: There is no significant effect between mathematics anxiety and mathematics learning outcomes.

H_1: There is a significant effect between mathematics anxiety and mathematics learning outcomes.

Hypothesis testing criteria:
If the $Sig.value > 0.05$ then H_0 is accepted.
If the $Sig.value \leq 0.05$ then H_0 is rejected.

Table 8 also shows that the significant value of the mathematics anxiety variable (X) is 0.000 <0.05. This means that H_0 is rejected and H_1 is accepted. So, it can be said that there is a significant influence between mathematics anxiety and mathematics learning outcomes. Every one-unit increase in mathematics anxiety has a decreasing impact on mathematics learning outcomes of -0.961. This means a negative influence exists between mathematics anxiety and mathematics learning outcomes. The higher the students' mathematics anxiety, the lower the mathematics learning outcomes, and vice versa. There is a negative influence between mathematics anxiety and mathematics learning outcomes.

Table 9. Coefficient of Determination

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.927[a]	.860	.858	2.19404

a. Predictors: (Constant), Kecemasan Matematika (Anxiety Score
b. Dependent Variable: Matematika (Math Score)

To determine the magnitude of the influence of mathematics anxiety on mathematics learning outcomes, the coefficient of determination is used. Table 9 shows that the coefficient of determination is 0.860, meaning that the relationship between mathematics anxiety and mathematics learning outcomes is 86%, and the remaining 14% is determined by other variables not analyzed in this study

3.2.Discussion

The research results show that the significant value of the mathematics anxiety variable (X) is 0.000 <0.05. This means that H_0 is rejected and H_1 is accepted. So, it can be said that mathematics anxiety significantly influences learning outcomes. The research results shows that the coefficient of determination is 0.860, meaning that the relationship between mathematics anxiety and mathematics learning outcomes is 86% .

This study concludes that mathematics anxiety has a negative effect on mathematics learning outcomes with a regression equation of $y = 130.997 - 0.961x$. Every one-unit increase in mathematics anxiety has a decreasing impact on mathematics learning outcomes of -0.961. This means a negative influence exists between mathematics anxiety and mathematics learning outcomes. Mathematics anxiety, which is often recognized as a disruptive psychological factor, can hinder students' ability to learn and achieve in this field. Previous studies have shown that high anxiety can lead to decreased academic performance, especially in the context of mathematics, which is often considered a source of stress for many students (Onoshakpokaiye, 2024; Daker et al., 2021; Jamieson et al., 2021).

In addition, students' math anxiety can be categorized into three main categories: somatic, affective, and cognitive. These three elements significantly influence students' math learning outcomes. Factors such as lack of self-confidence, difficulty concentrating, and inability to complete math tasks are the cognitive parts of math anxiety. According to research, students who experience cognitive anxiety tend to have difficulty understanding and solving math problems, which in turn results in poorer learning outcomes (Sholichah, 2022; Wardani, 2022).

The affective aspects of math anxiety, such as nervousness, restlessness, and lack of interest in mathematics, greatly affect students' learning outcomes. This anxiety can interfere with students' learning process and affect their academic achievement in mathematics. Negative emotions, such as nervousness and restlessness, can interfere with students' ability to concentrate and process information (Mansor, 2023; Julya, 2022).

Finally, students often experience somatic symptoms such as nausea, sweating, heart palpitations, and headaches when facing mathematical situations. Studies show these physical symptoms can interfere with students' concentration and academic performance. Ultimately, this can hurt students' learning outcomes (Mulyana et al., 2021; Nuraeni, 2023)

The results of this study indicate that psychological factors that affect student learning outcomes are very important in higher education. Educational institutions should create programs that help students master mathematics, manage anxiety, and increase their self-confidence (Balogun et al., 2017; Jamieson et al., 2016). Therefore, students' mathematics learning outcomes can be improved with a holistic approach that includes academic and psychological aspects.

4. CONCLUSIONS

The results of the study showed a significant influence between mathematics anxiety and mathematics learning outcomes. So, it is suggested that educators or lecturers create interesting and enjoyable learning experiences that can reduce students' mathematics anxiety. The results of this study are expected to provide the development of learning methods that can reduce mathematics anxiety. Further research can be conducted on the factors causing low student learning outcomes other than mathematics anxiety.

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