

The Influence of Mathematics Anxiety on Mathematical Abstraction Abilities with Self-Concept as a Mediator Variable

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Abstract:

This study aims to determine whether mathematics anxiety affects mathematical abstract ability, with self-concept acting as a mediator variable. The research type is survey research with a quantitative approach. The study was conducted at SMA Negeri Kandat. The population of this research consists of all 12th-grade students at SMA Negeri Kandat. The sampling technique used was simple random sampling, with a sample size of 100 students from the 12th grade of SMA Negeri Kandat. Data collection techniques included test methods involving the administration of mathematical abstraction ability tests and non-test methods using a mathematics anxiety scale. Data analysis was conducted using descriptive and inferential statistical analysis, which comprised prerequisite tests and hypothesis testing. The data collection procedure began with administering the mathematics anxiety and self-concept scales to the research sample. The next stage involved conducting mathematical abstraction ability tests on the research sample. The results of the study indicate that (1) mathematics anxiety among 12th-grade students at SMA Negeri Kandat affects students' mathematical abstraction ability by 30.6%, (2) there is an influence of mathematics anxiety on students' self-concept by 25.5%, (3) there is no influence of self-concept on student's mathematical abstraction ability by 37%, and (4) self-concept can serve as a mediator variable between mathematics anxiety and student's mathematical abstraction ability. These findings were obtained based on questionnaires and mathematical abstraction ability tests conducted with the students.

Keywords: *mathematical anxiety; self-concept; mathematical abstraction ability.*

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Introduction

Thinking is one of the main activities in education. By thinking, students will be able to achieve success in learning. The thinking process in learning mathematics is known as mathematical thinking ability. Mathematical thinking can facilitate the formation of good mathematics learning skills and enable the achievement of mathematics education goals (Nurhikmayati 2017). According to Sumarmo, the term mathematical thinking can be interpreted as a way of thinking regarding mathematical processes (doing mathematics) or a way of thinking about completing mathematical tasks, both simple and complex. Therefore, students at every level of education must have the ability to think mathematically to achieve success in learning mathematics (Nurhikmayati 2017).

The ability to think in mathematical abstraction is one of the important abilities in mathematics education (Suwanto, Tobondo, and Riskiningtyas 2017). Based on Tall's opinion (Suryana 2012) abstraction is depicting a certain situation as a thinkable concept through a construction. Furthermore, the concepts that have been thought about can be applied in the context of higher and more complicated thinking. According to Adelia, abstraction is an important basic step in mathematics because through abstraction skills, students can develop mathematical concepts in their minds by utilizing the initial knowledge they have (Nurrahmah, Rochmad, and Isnarto 2021). Mathematical abstraction abilities have a huge influence because they allow us to describe situations or problems in a mathematical context (Islam, Susilawati, and Sugilar 2021).

Mathematics is often considered a difficult subject. Learning difficulties experienced by students can be caused by various factors, both internal factors (which come from within the student, such as talent, interest, motivation, self-concept, etc.) and external factors (which come from outside the student, such as the environment at home and surrounding areas) (Andinny 2015). One factor that influences students' understanding of mathematical abstraction abilities is self-concept. According to (Magfirah, Rahman, and Sulasteri 2015), self-concept is how a person sees themselves, which comes from a collection of beliefs and attitudes towards themselves. Students with a positive self-concept tend to act more positively in learning, the tasks given by the teacher will be completed with full responsibility, and they will use learning obstacles as challenges and will be able to motivate them to learn (Alamsyah 2016).

If students have a negative self-concept, anxiety will arise in them. The anxiety that often arises in students when facing mathematics subjects is known as mathematics anxiety. Students who experience math anxiety often tend to avoid situations where they have to study and complete math assignments. Mathematics anxiety must be taken seriously, because student's difficulties in overcoming this subject can lead to their incompetence, create fear of mathematics, and ultimately result in a decrease in their learning outcomes and achievements in this subject (Handayani 2016). According to Habibi and Suparman, mathematics anxiety is a psychological condition involving individual beliefs which include fear, the urge to avoid, and difficulty remembering mathematics learning. This also leads to a loss of self-confidence in facing mathematics subjects, which in turn makes them tend to avoid all situations related to mathematics and results in a decrease in self-confidence in these subjects (Harefa, Lase, and Zega 2023).

Based on the results of previous research, it shows that there is a significant influence between self-concept and critical thinking skills in the context of mathematics (Mawarni and Purnama 2022). These findings confirm that the higher the level of self-concept that students have, the higher their ability to think critically in solving mathematical problems. This reflects a positive relationship between self-concept and critical thinking abilities in the mathematics domain, where increasing self-concept can have a positive impact on the development of

student's mathematical critical thinking abilities. In addition, research conducted by (Handayani 2016) states a positive and significant relationship between student's self-concept (which includes self-confidence, positive perceptions about themselves, and an optimistic view of their mathematical abilities) and understanding of mathematical concepts. That is, the higher the level of student's self-concept in terms of these factors, the higher their ability to understand and master mathematical concepts.

The difference between this research and previous research is the dependent variable: the student's mathematical abstraction abilities. Research on mathematical abstraction abilities is still rarely researched. In one study, there was no research involving the variables of students' self-concept, mathematics anxiety, and mathematical abstraction abilities. Especially the self-concept variable as a mediator variable. The following is the conceptual framework for this research

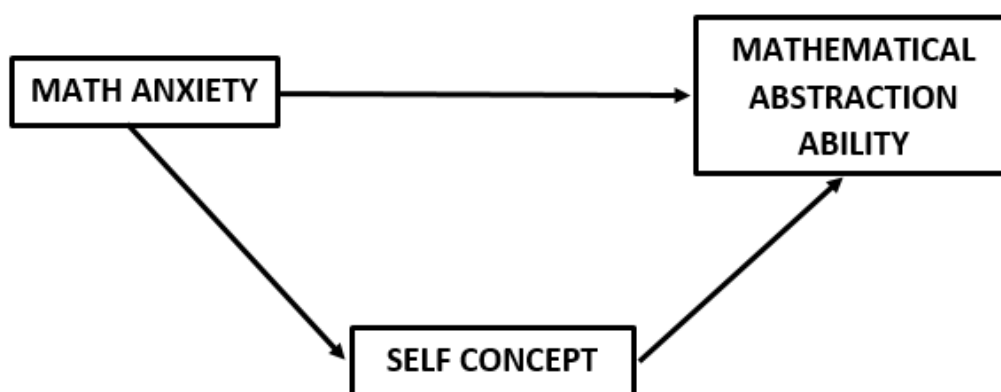


Figure 1. Copceptual Framework

Based on this explanation, the researcher plans to conduct a study that aims to overcome the problems previously explained, which relate to students' self-concept and anxiety as one of the factors that influence students' mathematical abstraction abilities. Researchers want to understand more deeply and measure how students' levels of self-concept and anxiety contribute to their abstraction abilities in understanding and mastering mathematical concepts. This research will be entitled "The Effect of Mathematics Anxiety on Mathematical Abstraction Ability with Self-Concept as a Mediator Variable."

Methods

This research is quantitative research with a survey method. The sampling technique used is simple random sampling. The sample used in this research was 100 class XII students at SMA Negeri Kandat Kediri. The research instruments used were testing and non-test instruments. The test instrument is a questionnaire consisting of several favourable and unfavourable statement items by the variable indicators of mathematics anxiety and the self-concept variable. Meanwhile, the test instrument is a question sheet with a description or essay type to measure student's mathematical abstraction abilities.

The data analysis techniques used are descriptive statistics and inferential statistics. Descriptive statistics are used to describe questionnaire and test data, while inferential statistics are used to test prerequisites and hypotheses. The prerequisite tests in this research consist of normality tests and linearity tests. Hypothesis testing consists of linear regression tests and Sobel tests. The linear regression test functions to see the influence of the independent variable on the dependent variable; in this case, the independent variable is mathematics anxiety and self-concept, while the dependent variable is mathematical abstraction ability. The Sobel test in data analysis plays a role in proving the self-concept variable as a mediator

of the relationship between the mathematical anxiety variable and mathematical abstraction abilities. All data will be analyzed using SPSS software.

Results and Discussion

In this research, researchers used three independent variables: mediator variables and dependent variables. Mathematics anxiety (X) is the independent variable, mathematical abstraction ability (Y) is the dependent variable, and self-concept (M) is the mediator variable. For this reason, the researcher will describe the data on each variable in this section.

Table 1. Data Description

Variable	Hypothetical Score				Empirical Score			
	Min	Maks	Mean	Std. Dev	Min	Maks	Mean	Std. Dev
Math. Anxiety	11	44	27.5	5.5	23	36	27.77	2.29
Math. Abstraction Ability	33.3	100	66.6	11.11	33.3	88.9	57.1	12.2
Self Concept	23	92	57.5	11.5	49	78	62.8	5.81

Source: SPSS Software

Based on Table 1, it can be concluded that the mathematics anxiety questionnaire distributed to 100 students obtained an average of 27.77, a minimum score of 23, and a maximum score of 36. The mathematical abstract ability test distributed to 100 students obtained an average of 57.11, a minimum score of 33.33, and the maximum value is 88.9. Apart from that, the self-concept questionnaire distributed to 100 students obtained an average of 62.8, a minimum score of 49, and a maximum score of 78.

In this research, the normality test is a test carried out to determine whether the data distribution follows a normal distribution pattern or not (Sintia, Pasarella, and Nohe 2022). In this study, the normality test was carried out using Kolmogorov-Smirnov with the SPSS 25 application.

Table 2. Result of the Normality Test

		AnxietyMath_ MathAbstractAbility	SelfConcept_Mat hAbstractAbility
N		100	100
Normal Parameters ^{a,b}	Mean	.0000000	.0000000
	Std. Deviation	2.51142232	7.07880578
Most Extreme Differences	Absolute	.069	.067
	Positive	.069	.067
	Negative	-.043	-.051
Test Statistic		.069	.067
Asymp. Sig. (2-tailed)		.200 ^{c,d}	.200 ^{c,d}

Source: SPSS Software

Based on the presentation in table 2, it can be seen that the *sig* value is 0.20. Because the *sig* value (0.200) is greater than the value of *alpha* (0.05) or $0.200 > 0.05$, according to the H_0 test criteria it is accepted and can be concluded that the data is normally distributed.

The linearity test aims to determine whether the relationship between the independent and dependent variables is linear. The linear relationship can be positive (in the same direction) or negative (not in the same direction).

Table 3. Results of the Linearity Test of The Independent Variable Mathematics Anxiety with the Dependent Variable Mathematical Abstract Ability

			F	Sig.
MathAbstract	Between	(Combined)	3.922	.000
Ability *	Groups	Linearity	44.556	.000
MathAnxiety		Deviation from	1.213	.279
		Linearity		
		Within Groups		
		Total		

Source: SPSS Software

Based on Table 3, the Deviation from Linearity value shows a figure of 0.053, which means the linearity test has been fulfilled because $0.279 > 0.05$. In this study, the independent variable, mathematics anxiety, and the dependent variable, mathematical abstraction ability, have a linear relationship.

Table 4. Results of the Linearity Test of the Independent Variable Self-Concept with the Dependent Variable Mathematical Abstraction Ability.

			F	Sig.
MathAbstrac	Between	(Combined)	2.307	.002
tAbility *	Groups	Linearity	52.576	.000
SelfConcept		Deviation from	.736	.828
		Linearity		
		Within Groups		
		Total		

Source: SPSS Software

Based on Table 4, the Deviation from Linearity value shows a figure of 0.172, which means the linearity test has been fulfilled because $0.828 > 0.05$. Thus, it can be concluded that the independent variable self-concept and the dependent variable mathematical abstraction ability in this research have a linear relationship. The following are the results of the linearity test of the independent variable mathematics anxiety with the dependent variable self-concept.

Table 5. Results of the Linearity Test of the Independent Variable Mathematics Anxiety with the Dependent Variable Self-Concept.

			F	Sig.
SelfConcept	Between	(Combined)	3.486	.000
*	Groups	Linearity	35.394	.000
MathAnxiety		Deviation from	1.359	.188
		Linearity		
		Within Groups		
		Total		

Source: SPSS Software

Based on Table 5, the Deviation from the Linearity value shows a figure of 0.117, which means the linearity test has been fulfilled because 0.88 is greater than 0.05. Thus, it can be concluded that the independent variable, mathematics anxiety and the dependent variable, self-concept, in this study, have a linear relationship.

The next test is the hypothesis test, conducted using linear regression and the Sobel test. The results are as follows:

The first hypothesis test is analyzing the data using simple regression using the SPSS 25 application with the following hypothesis:

H_0 : There is no influence of mathematics anxiety on the mathematical abstraction abilities

H_1 : There is an influence of mathematics anxiety on the mathematical abstraction abilities

Table 6. Linear Regression Test Results for Mathematics Anxiety on Mathematical Abstraction Ability

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	146.789	1	146.789	43.151	.000 ^b
Residual	333.371	98	3.402		
Total	480.160	99			

Source: SPSS Software

Based on Table 6, it is known that the significance value is $0.000 < 0.05$, which means that H_0 is rejected, or in other words, mathematics anxiety (X) influences mathematical abstraction abilities (Y).

Table 7. Model Summary of Mathematics Anxiety on Mathematical Abstraction Ability

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.553 ^a	.306	.299	1.84438

Source: SPSS Software

Based on Table 7, it is known that the correlation (R) is 0.553 and the *R Square* is 0.306 or 30.6%. This figure shows that the influence of mathematics anxiety on mathematical abstraction abilities is 30.6%, while the remaining 69.4% is influenced by other factors. For example, if a student's level of mathematical anxiety is high, then their mathematical abstraction ability will be low. Students feel anxious when working on mathematics problems, so their mathematical abstraction ability scores will be low.

The second hypothesis test is analyzing the data using simple regression using the SPSS 25 application with the following hypothesis:

H_0 : There is no influence of mathematics anxiety on the self-concept

H_1 : There is an influence of mathematics anxiety on the self-concept

Table 8. Linear Regression Tests for Mathematics Anxiety on Self-Concept

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	1520.697	1	1520.697	33.551	.000 ^b
Residual	4441.893	98	45.325		
Total	5962.590	99			

Source: SPSS Software

Based on Table 8, it is known that the significance value is $0.000 < 0.05$, which means that H_0 is rejected, or in other words, mathematics anxiety (X) influences the student's self-concept (M).

Table 9. Summary Models of Mathematics Anxiety on Self-Concept

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.505 ^a	.255	.247	6.73242

Source: SPSS Software

Based on Table 9, it is known that the correlation (R) is 0.505 and the R Square is 0.255 or 25.5%. This figure shows that the influence of mathematics anxiety on self-concept is 25.5%, while the remaining 74.5% is influenced by other factors. If the student's level of mathematics anxiety is high, then the student's level of self-concept is low. Students who feel anxious when working on mathematics problems will have a low self-concept.

The third hypothesis test is analyzing the data utilizing simple regression using the SPSS 25 application with the following hypothesis:

H_0 : There is no influence of self-concept on the mathematical abstraction abilities of class XII students at SMA Negeri Kandat

H_1 : There is an influence of self-concept on the mathematical abstraction abilities of class XII students at SMA Negeri Kandat

Table 10. Linear Regression Tests of Self-Concept on Mathematical Abstraction Ability

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	177.622	1	177.622	57.536	.000 ^b
	Residual	302.538	98	3.087		
	Total	480.160	99			

Source: SPSS Software

Based on Table 10, it is known that the significance value is $0.000 < 0.05$, which means that H_0 is rejected, or in other words, self-concept (M) influences mathematical abstraction abilities (Y).

Table 11. Model Summary of Self-Concept on Mathematical Abstraction Ability

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.608 ^a	.370	.363	1.75702

Source: SPSS Software

Based on Table 11, it is known that the correlation (R) is 0.608 and the R Square is 0.370 or 37%. This figure shows that the influence of self-concept on mathematical abstraction abilities is 37%, while the remaining 63% is influenced by other factors. If the student's level of self-concept is high, then the value of the student's mathematical abstraction ability will also be high. Students who have maximum self-concept will also have maximum mathematical abstraction ability scores.

The fourth hypothesis test analyses the data with the help of the Sobel Test Calculation for the Significance of the Mediation application. The hypothesis is:

H_0 : There is no influence of anxiety on mathematical abstraction abilities with self-concept as the mediator variable

H_1 : There is an influence of anxiety on mathematical abstraction abilities with self-concept as a mediator variable

Table 12. Results of Path A Analysis (Effect of Mathematics Anxiety (X) on Mathematical Abstraction Ability (Y))

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	21.786	1.761		12.369	21.786
	X	-.393	.060	-.553	-6.569	-.393

Source: SPSS Software

The results of the regression analysis in Table 12, testing the relationship between mathematics anxiety (X) and mathematical abstraction ability (Y), show a t_{count} value of 6,569 which is greater than the t_{table} 1,664 (t_{count} 6,569 > t_{table} 1,664). The unstandardized coefficients in Table B are used as coefficient values (A) to calculate the direct effect test later, and the standardized error is used as coefficient values (SA).

Table 13. Path B Analysis (Influence of Self-Concept as a Mediator Variable)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	9.600	2.875		3.339	9.600
	X	-.235	.062	-.330	-3.785	-.235
	M	.125	.025	.442	5.066	.125

Source: SPSS Software

The results of the regression analysis in Table 13 test the relationship between mathematics anxiety (X) and mathematical abstraction ability (Y) by entering the self-concept variable (M) into the regression.

If we observe the relationship between mathematics anxiety, it shows that the t_{count} 3,785 which is greater than the t_{table} 1,664 (t_{count} 3,785 > t_{table} 1,664). This means that mathematics anxiety on mathematical abstraction abilities has a significant influence.

If we observe the relationship between self-concept, it shows a t_{value} 5.066 which is greater than the t_{table} of 1.664 (t_{count} 5.066 > t_{table} 1.664), then self-concept on mathematical abstraction ability shows a significant influence.

The unstandardized coefficients in Table B for the mediator variable are used as coefficient values (B) to calculate the direct effect test later. Standardized Error is used as coefficient values (SB).

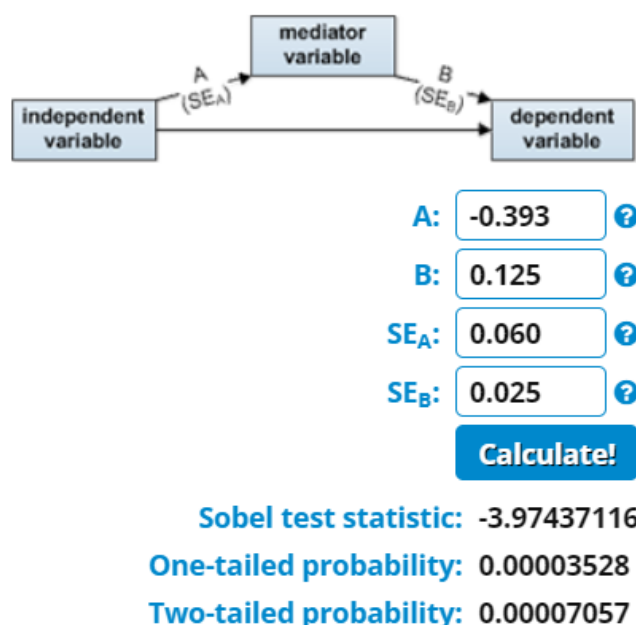


Figure 2. Result Online Sobel Test Research Data Processed Via <http://www.danielsoper.com/> in 2024

Based on the T-test, an Online Sobel Test was carried out, and the Sobel Test Statistics value was minus 3.97, which was more than the t sub table (t sub count, 3.97 greater than t sub

table, 1.664). This means that self-concept can mediate between mathematical anxiety and mathematical abstraction ability.

So, it can be concluded that H_0 is rejected and H_1 is accepted. In other words, anxiety influences mathematical abstraction abilities, with self-concept as the mediator variable. This can be seen from the high level of students' mathematical anxiety, which lowers the value of students' mathematical abstraction abilities. His self-concept also influences a high level of mathematics anxiety. Therefore, self-concept can be a mediator variable.

Analysis

Based on the research results, the influence of mathematics anxiety on mathematical abstraction abilities is 30.6%, while the remaining 69.4% is influenced by other factors. This is supported by research (Juliyanti and Pujiastuti 2020) which states that there is a significant influence between mathematical anxiety and students' partial mathematics learning outcomes, meaning that to get high mathematics learning outcomes, students must suppress or control their anxiety. Apart from that, research conducted by (Handayani 2016) also stated that there was a significant direct effect of student anxiety on understanding mathematical concepts of 0.699.

The mathematics anxiety and self-concept questionnaire instruments were distributed to 100 Kandat State High School class XII students. Calculations were carried out using the SPSS 25 application to determine the influence of mathematics anxiety on students' self-concept. Based on the research results, the influence of mathematics anxiety on self-concept was 25.5% while the remaining 74.5% was influenced by other factors.

Based on the research results, the influence of self-concept on mathematical abstraction abilities is 37%, while the remaining 63% is influenced by other factors. The results of this research support the results of research conducted by (Fatmala 2022) which states that there is an influence between self-concept on students' mathematical representation abilities of 18.2%, while the remaining 81.8% is influenced by other variables. Apart from that, research conducted by (Putri et al. 2023) states that there is a significant influence of self-concept on learning outcomes with a correlation coefficient of 0.755. A positive self-concept can build self-confidence, which, of course, can positively influence student learning outcomes.

Based on the calculation results, it was found that mathematics anxiety influenced students' mathematical abstraction abilities, which was mediated by the self-concept of class XII students at SMA Negeri Kandat. In this research, assisted by the Sobel test using the Sobel Test Calculation for Significance of Mediation application based on the T-test, the Online Sobel Test was carried out, and the Sobel Test Statistics value was 3.97, which was more than the t_{table} (t_{count} 3.97 > t_{tabel} 1.664) which means the concept of self can be a mediator variable between mathematics anxiety and self-concept.

Conclusion

Based on research conducted by researchers regarding the influence of mathematics anxiety on student's mathematical abstraction abilities with self-concept as a mediator variable, it can be concluded that:

1. Mathematics anxiety has an influence on students' mathematical abstraction abilities in class XII students at SMAN Kandat. The influence of mathematics anxiety on mathematical abstraction abilities is 30.6%, while the remaining 69.4% is influenced by other factors.
2. Self-concept influences the mathematical abstraction abilities of class XII students at SMAN Kandat. The influence of self-concept on student's mathematical abstraction abilities is 25.5%, while the remaining 74.5% is influenced by other factors.
3. Mathematics anxiety influences the self-concept of class XII students at SMAN Kandat. The influence of mathematics anxiety on student's self-concept is 37%, while the remaining 63% is influenced by other factors.

4. Mathematics anxiety influences students' mathematical abstraction abilities, mediated by self-concept. This can be seen in the Sobel Test Statistics value -1.087 , where the value is less than the t-table ($t_{count} 3.97 > t_{tabel} 1.664$), which means that self-concept can be a mediator variable between mathematics anxiety and self-concept.

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