The Influence of Mathematical Critical Thinking Skills Based on Students' Math Anxiety

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Abstract

This research is motivated by the low ability of students to think critically mathematically, which can be influenced by various factors. One of the causes that exist in students is the emotion and attitude towards mathematics. The many concepts that are abstract, full of numbers and full of formulas make most students think mathematics is a difficult and frightening subject. So that when faced with math lessons or math problems, students will feel anxious, afraid, restless, difficult to concentrate and avoid behavior, etc. These attitudes indicate that students experience math anxiety. This study aims to determine the effect of math anxiety and its magnitude on students' mathematical critical thinking skills. The research was conducted using a quantitative approach to the type of correlation research. The sampling technique used is probability sampling with simple random sampling. The results of the study showed that the level of mathematical anxiety in students was 58%, where mathematical anxiety had an effect on students' mathematical critical thinking skills marked by the significance value obtained, namely 0.000 <0.005 so reject H0.

Key word: Mathematical Anxiety, Mathematical Critical Thinking Ability

INTRODUCTION

Today, science and technology are developing rapidly. With developments in the field of science and technology, of course, support is needed with the development of various systems, one of which is education (Retnawati). Education in general has the meaning of a life process in developing each individual to be able to live and carry on life (Alpian, Anggraeni, & Wiharti, 2019). One of the ways to develop the nation's science and technology is by learning mathematics in education. Mathematics is a useful subject

in various arts of life, so mathematics is a compulsory subject in schools. Mathematics has been introduced to students from an early age when they were at the elementary school level.

Mathematics is formed from human experience that has been analyzed so as to produce mathematical concepts that are easier for humans to understand. Mathematical concepts are interconnected with one another. However, with the many concepts that exist in mathematics, mathematics is still seen as a negative thing. This is because mathematics is abstract, full of numbers and formulas. So that everyone, especially among students consider mathematics is a subject that is difficult and scary. In learning mathematics students are required to concentrate, understand, memorize, form concepts and solve problems (Iksan, 2020). While students already think negatively about mathematics, causing them to feel anxious, afraid, restless, avoidant behavior and not confident when faced with mathematics. These feelings are an indication that students experience math anxiety.

There are several forms of symptoms of math anxiety, namely physical, cognitive and behavioral symptoms. Cognitive symptoms are in the form of not being confident with the abilities that exist in him (Stuart, 2006). In connection with the symptoms of anxiety, namely not being confident with mathematical abilities, in applying mathematical concepts or solving mathematical problems in students, hard skills are needed, which include mathematical understanding abilities, mathematical reasoning abilities, mathematical connection abilities and mathematical critical thinking abilities. Mathematical critical thinking ability is an important component in mathematics. Because mathematics is abstract in nature, full of numbers and formulas, students need to understand concepts and have the ability to think critically in solving problems related to mathematics. On the other hand what is happening now, learning mathematics that takes place in class

requires students to memorize formulas without understanding the concept, in fact mathematical concepts are important and interrelated with one another. So solving problems that demand high students' critical thinking skills makes students difficult because students' critical thinking skills are still low.

If anxiety has dominated the minds of students, it will be difficult for them to concentrate and think and always feel depressed and tend to avoid the mathematical environment. So that students find it increasingly difficult because they lose their critical thinking skills to understand mathematical concepts that can be used to solve mathematical problems. Thus the researcher is interested in conducting research entitled "the influence of mathematical critical thinking skills based on students' math anxiety"

METHODS

In this study, researchers used a quantitative approach, because they wanted to know the "title". Research with this quantitative approach uses a lot of numbers, starting from data collection, data processing to interpreting the data and when displaying the results. Quantitative research methods examine certain populations or samples, then the sampling technique is carried out randomly and the data collection uses research instruments and statistical data analysis to test hypotheses.

The data analysis process in this study uses inferential statistics. The use of inferential statistics aims to draw conclusions based on the results of research on a number of samples of a larger population. This statistical analysis is also called hypothesis testing analysis. This study uses inferential statistics with a correlational type of research. Correlation research is a research process in the form of data collection to determine whether there is a relationship and the level of relationship between two or more variables (Sukardi, 2009).

The variables of this study are divided into two, namely the independent variable and the dependent variable. The independent variable in this study is students' math anxiety. While the dependent variable in this study is students' mathematical critical thinking skills.

From the existing variables, indicators are determined, then these indicators are translated into questions or statements. The questions or statements obtained are used to facilitate the preparation of questionnaires and test instruments. In this study questionnaires and tests will be used to obtain math anxiety scores and students' mathematical critical thinking skills.

RESULTS AND DISCUSSION

The sample taken in this study was class X TBSM 3 SMKN 1 Bandung with a total of 33 students. In this study, researchers used

four stages to conduct research, namely the initial stage, the planning stage, the implementation stage, and the final stage. In the early stages the researcher asked for permission to conduct research at SMKN 1 Bandung. At the planning stage the researcher consulted with the supervising teacher regarding the class schedule that would be used in the research and indicated the math anxiety questionnaire and critical thinking skills questions that would be used in the research. At the implementation stage, questionnaires and questions were distributed to the sample class. Students are given 15 minutes to work on a math anxiety questionnaire, then students are given 45 minutes to work on tests of mathematical critical thinking skills. Then the final stage of the researcher conducted a data analysis test, namely the prerequisite test.

Instrument Test

- Validity Test

Validity test is used to determine whether the research instrument is valid or not before it is distributed to students. In this study, the instruments to be tested for validity were the math anxiety questionnaire and questions of mathematical critical thinking ability. The results of the anxiety questionnaire validity test obtained a number of 33 items with a total of N = 15 and r_{table} (sign level sig. 5%) = 0,514 indicating that out of 33 items there were 3 items that were invalid because they had $r_{count} < r_{table}$, namely items 15, 31 and 32. With thus of the 33 items used for research, namely 30 items.

The test using the help of IBM SPSS Statistics 2. The results obtained are that of the 3 questions of the critical thinking ability test instrument with N = 15 and r_{table} (sign level sig. 5%) = 0,514 on the basis of decision making $r_{count} < r_{table}$ shows that the three items are declared valid so that they can proceed to the reliability test.

- Reliability Test

The reliability test is used to measure test questions that will be used consistently to provide the same measurement results. In this test the researcher uses the basis for decision making if the value of $r_{count} < r_{table}$ then the instrument is declared reliable and if the value of $r_{count} < r_{table}$ then the instrument is declared unreliable.

Reliability Statistics

Cronbach's Alpha	N of Items
,967	30

Figure 1. The Results Of The Reliability Test Of The Mathematics Anxiety Questionnaire Instrument

Based on Figure 1, the Cronbach's Alpha value is 0.967 and the r_{table} value (sign level 5%) and N = 15 is 0.514. Thus the value of $r_{count} > r_{table}$, it can be concluded that the mathematics anxiety questionnaire instrument is stated to be reliable or constant and suitable to be used as a measuring tool for mathematics anxiety in this study.

Cronbach's Alpha	N of Items
,929	3

Figure 2. The Results Of The Reliability Test Of The Instrument For Testing The Ability To Think Critically Mathematically

Based on Figure 2, the Cronbach's Alpha value is 0.929 and the r_{table} (sign level sig. 5%) and N = 15 is 0.514. Thus the value of $r_{count} > r_{table}$, it can be concluded that the test instrument for mathematical critical thinking skills is stated to be reliable or constant and suitable to be used as a measure of mathematical anxiety in this study.

Prerequisite Test
- Descriptive Statistical Analysis

Descriptive statistical analysis was used to describe the mean, median, mode, standard deviation, variance, range, minimum and maximum of the results of the mathematics anxiety questionnaire.

ANGKET_TBSM

N	Valid	33
	Missing	0
Mean		100,06
Median		105,00
Mode		106
Std. Deviation		14,416
Variance		207,809
Range		56
Minimum		62
Maximum		118
Sum		3302

Figure 3. Results Of Descriptive Statistical Analysis Of Class X TBSM 3

Based on Figure 3, the value above the average math anxiety is 100.06, the standard deviation is 14.416, and the variance is 207.809. In addition, a maximum score of 118 and a minimum score of 62 were obtained. From this descriptive analysis, the researcher was able to determine the frequency distribution table for students' anxiety levels. According to Stuart there are 4 categories of students' anxiety levels, namely mild, moderate, severe, and panic (Stuart, 2006). The following table shows the distribution of math anxiety scores for the tbsm class divided by category.

Table 1. Category TBSM Class Math Anxiety Level

Category	Criteria	Frequency	Percentage
Mild	72-85	6	18%
Moderate	86-99	18	55%
Heavy	100-113	6	18%
Panic	114-127	3	9%

Based on table 1, there are 4 students with mild anxiety, 3 students with moderate anxiety, 19 students with severe anxiety and 7 students with panic anxiety. Thus it can be concluded that the math anxiety score of students in class X TBSM 3 SMKN 1 Bandung is in the heavy category, namely 58%.

-   Normality Test

The normality test is used to determine whether the data comes from a normally distributed population or not. The basis for making a decision on the normality test is as follows:

- If the significant value < 0,05 then the data is not normally distributed
- If the significant value is > 0,05 , the data is normally distributed

Following are the results of the normality test of the mathematical anxiety questionnaire and the results of the mathematical critical thinking ability test.

One-Sample Kolmogorov-Smirnov Test

		Unstandardized Residual
N		33
Normal Parameters[a,b]	Mean	,0000000
	Std. Deviation	5,93040904
Most Extreme Differences	Absolute	,138
	Positive	,078
	Negative	-,138
Test Statistic		,138
Asymp. Sig. (2-tailed)		,111[c]

a. Test distribution is Normal.

b. Calculated from data.

c. Lilliefors Significance Correction.

Figure 4. Normality Test Results

Based on figure 4, a significance value of 0,111 is obtained. So that the sig value of 0,111 > 0,05, it can be concluded that the mathematics anxiety questionnaire data and the results of the mathematical critical thinking ability test come from a normally distributed population.

- Linearity Test

The linearity test is a test to determine the relationship between the independent variable and the dependent variable whether it is linear or not. The basis for decision making in the linearity test is as follows:

- If the value of *Sig. deviation from linearity* > 0,05, then there is a linear relationship between the independent variable and the dependent variable.

- If the value of *Sig. deviation from linearity* < 0,05, so there is no linear relationship between the independent variable and the dependent variable.

Following are the results of the mathematical anxiety questionnaire linearity test and the results of the mathematical critical thinking ability test.

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
Kemampuan Berpikir Kritis * Kecemasan Matematika	Between Groups	(Combined)	1758,629	22	79,938	1,459	,273
		Linearity	1181,113	1	1181,113	21,556	,001
		Deviation from Linearity	577,515	21	27,501	,502	,912
	Within Groups		547,917	10	54,792		
	Total		2306,545	32			

Figure 5. Linearity Test Results

From Figure 5, the sig. of 0,912, based on the Sig. deviation from linearity 0,912 > 0,05, then there is a linear relationship between the independent variable and the dependent variable. So

the math anxiety variable has a linear relationship with mathematical critical thinking ability.

In making decisions for this linearity test, apart from using the Sig. deviation from linearity can also use the f_{count}, value. If the value of $f_{count} < f_{table}$ then there is a linear relationship between the independent variable and the dependent variable. Conversely, if the value of $f_{count} > f_{table}$ then there is no linear relationship between the independent variable and the dependent variable. From Figure 5, an f_{count} of 0.502 is obtained with a numeration db of 21 and a denominator of 10 db. The value of f_{table} = 2.76 is obtained. Thus the value of f_{count} = 0.502 < f_{table} = 2.76, then there is a linear relationship between the independent variable and the dependent variable.

Hypothesis Testing

Hypothesis testing is the process of testing something that is suspected in the population which can produce a final decision by rejecting or accepting the statement.

- H_0 = no effect of students' math anxiety on mathematical critical thinking skills in trigonometry class X TBSM 3 SMKN 1 Bandung material
- H_1 = there is an effect of students' math anxiety on mathematical critical thinking skills in trigonometry material for class X TBSM 3 SMKN 1 Bandung

The conclusion is as follows:

- If the sig value < 0.05, then reject H_0
- If the sig value > 0.05, then Accept H_1

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1181,113	1	1181,113	32,534	,000[b]
	Residual	1125,432	31	36,304		
	Total	2306,545	32			

a. Dependent Variable: Kemampuan Berpikir Kritis

b. Predictors: (Constant), Kecemasan Matematika

Figure 6. Simple Linear Regression Test Results

Based on figure 6, a significance value of 0.000 is obtained. Therefore, if the significance value is 0.000 <0.05, then reject H_0. Thus, there is an influence between students' mathematical anxiety on mathematical critical thinking skills in trigonometry material for class X TBSM 3 SMKN 1 Bandung.

To find out how much influence mathematics anxiety has on critical thinking skills, the results are presented in the following figure.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,716[a]	,512	,496	6,025

a. Predictors: (Constant), Kecemasan Matematika

b. Dependent Variable: Kemampuan Berpikir Kritis

Figure 7. The Effect Of Math Anxiety On Critical Thinking Skills

Figure 7 shows that the R value shows a simple correlation between the X and Y variables of 0.716, which means that the relationship between mathematical anxiety and critical thinking skills is 0.716. To find out how strong the relationship between the variables X and Y is by comparing the correlation value R in the following table.

Table 2. Corellation Level Between X and Y Variables

Coefficient Intervals	Corellation Level
0,00 – 0,199	Very Low
0,20 – 0,399	Low
0,40 – 0,599	Moderate
0,60 – 0,799	Strong
0,80 – 1,000	Very Strong

It can be seen that the value of R = 0.716 is located in the interval 0.60 – 0.799. It can be concluded that the correlation between math anxiety and mathematical critical thinking ability is relatively strong. Based on Figure 7 it is also obtained that the coefficient of determination or R Square is 0.512. It can be interpreted that 51.2% of the independent variable affects the dependent variable, meaning that 51.2% of math anxiety affects students' mathematical critical thinking skills. While the remaining 44.8 is influenced by other variables.

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	113,443	7,467		15,192	,000
	Kecemasan Matematika	-,421	,074	-,716	-5,704	,000

a. Dependent Variable: Kemampuan Berpikir Kritis

Figure 8. The Results Of The Regression Equation Y or X

Based on Figure 8, it is known that the constant value (a) is 113.443, while the value of mathematical anxiety (b/regression coefficient) is -0.421, so that the regression equation can be

written $\hat{Y}\ a + bX$ so that the regression equation $\hat{Y}$ = 113,442 – 0,421X is obtained. The regression equation can be translated that a constant value of 113.443 means that the consistent value of the ability to think critically mathematically is 113.443. Meanwhile, the regression coefficient X of -0.421 states that for every 1% addition to the value of mathematical anxiety, the value of mathematical critical thinking ability decreases by 0.421.

Level of math anxiety of class X TBSM 3

The level of anxiety according to Stuart is divided into 4 categories, namely mild anxiety, moderate anxiety, severe anxiety and panic (Stuart, 2006). In this TBSM class, which consisted of 33 students, there were 4 students with a percentage of 12% with mild anxiety. Mild anxiety can motivate learning and foster students' creativity, but it can also cause fatigue and fine tremors in the hands. There are 3 students with moderate anxiety with a percentage of 9%, moderate anxiety allows students to focus on important things and put aside other things so that they do something directed, but this level of anxiety causes the effect of increased heart rate and breathing, fatigue, decreased concentration, irritability and easily offended.

There are 19 students with severe anxiety with a percentage of 58%, students with this level of anxiety tend to focus on something specific and detailed, this anxiety has symptoms of not being able to sleep, dizziness, confusion and helplessness. There are 7 students with panic anxiety with a percentage of 21%, this level of anxiety is related to fear, terror because of losing control, not being able to do something even with directions, decreased ability to relate to other people, distorted perceptions, and loss of rational thinking .

Based on the data above, it can be concluded that the level of math anxiety in class X TBSM students at SMKN 1 Bandung is at the level of severe anxiety with a percentage of 58%. Severe anxiety

tends to focus on specifics and details, symptoms include excessive worry, sweating, headaches and sudden forgetfulness. This is in line with research conducted by Laili Anisatu C.M. with the title "Pengaruh Kecemasan Matematika (Math Anxiety) Terhadap Hasil Belajar Matematika Siswa Pada Materi Perbandingan Kelas VII SMP Negeri 1 Pare Kediri Tahun Ajaran 2019/2020" which shows that out of 35 students there are 2 students with a percentage of 5.7% experiencing anxiety mild, 14 students with a percentage of 40% experienced moderate anxiety, 16 students with a percentage of 45.7% experienced severe anxiety, and 3 students with a percentage of 8.6% experienced panic (Masruroh, 2015).

The Effect of Mathematical Anxiety on Mathematical Critical Thinking Ability in Trigonometry Material of Class X TBSM 3

Based on the formulation of the problem in this study, namely the presence or absence of the influence of mathematical anxiety on mathematical critical thinking skills in the trigonometry material of class X TBSM students at SMKN 1 Bandung, then for testing the hypothesis using simple regression analysis, namely by using the help of the IBM SPSS Statistics 25 program. From the results calculation of data statistical tests using the IBM SPSS Statistics 25 program obtained output whose results will be used as conclusions in the formulation of this research problem.

The output of the hypothesis test in table 4.10 can be seen that the significance value in the ANOVA table is 0.000. Based on the decision making basis, if the significance value is <0.05, then H_0 is rejected and H_1 is accepted. Significance value 0.000 <0.05. It can be concluded that "There is an Effect of Mathematical Anxiety on Mathematical Critical Thinking Ability in Trigonometry Material of Class X TBSM Students of SMKN 1 Bandung".

The results obtained in this study are in line with previous research conducted by Tsabita Fitri A.S. entitled "Pengaruh Kecemasan Matematika Terhadap Kemampuan Koneksi Matematis

Dan Hasil Belajar Pada Materi Trigonometri Siswa Kelas XI SMAN 1 Campurdarat", the results of the study showed that there was an influence of mathematical anxiety on mathematical connection abilities and learning outcomes of trigonometry material for class XI students at SMAN 1 Campurdarat (Fitria, 2020).

Mathematics anxiety occurs in various circles, especially among students, who think that mathematics is a scary and boring subject. Such students' assumptions can affect and interfere with the performance of students' cognitive functions in understanding the material and solving mathematical problems. In understanding and solving mathematical problems, students need critical thinking skills, namely interpretation, analysis, evaluation, and inference. When students experience feelings of anxiety, confusion and worry, students feel difficulties and reduce their critical thinking skills.

In connection with the above in learning activities it is necessary to pay attention to things that can reduce math anxiety and can improve students' mathematical critical thinking skills. Educators who play a role in this learning activity and interact directly with students, need to provide motivation and education that mathematics is not a difficult lesson, mathematics is a fun and easy lesson to learn, and educators also need to use strategies in learning activities. So that the negative perceptions about mathematics in the minds of students will change. By changing students' perceptions into positive perceptions about mathematics, it is possible to make students' critical thinking skills better.

The Great Effect of Mathematical Anxiety on Mathematical Critical Thinking Ability in Trigonometry Material of Class X TBSM 3

Based on the formulation of the problem in this study, namely to see how much influence math anxiety has on mathematical critical thinking skills in trigonometry material for class X TBSM

students at SMKN 1 Bandung, researchers used the help of the IBM SPSS Statistics 25 program to test the hypothesis. The coefficient that shows the magnitude of the influence caused by the independent variables in the regression analysis is called the coefficient of determination, the coefficient of determination is obtained from the square of the correlation coefficient multiplied by 100%.

From the output of the hypothesis test in table 4.15, a correlation coefficient R value of 0.716 is obtained in the interval 0.60 – 0.799, this means that it is in accordance with table 4.12. It can be concluded that the correlation between math anxiety and mathematical critical thinking ability is relatively strong.

Based on the test results using the IBM SPSS Statistics 25 program in table 4.17, the regression equation $\hat{Y}$ = 113,442 – 0,421X is obtained. A constant value of 113.443 means that the consistent value of the ability to think critically mathematically is 113.443. While the regression coefficient X is -0.421 indicating that for every 1% addition to the value of mathematical anxiety, the value of mathematical critical thinking ability decreases by 0.421.

Meanwhile, the coefficient of determination is obtained from the squared result of the correlation coefficient, namely 0.716² = 0.512, or the coefficient of determination can be seen in table 4.15. R Square value of 0.512. So the influence is 0.512 x 100% = 51.2%. Thus it can be concluded that 51.2% of the independent variable affects the dependent variable, meaning that 51.2% of math anxiety affects students' mathematical critical thinking skills. While the remaining 48.8% is influenced by other variables.

Based on the research results above, the regression coefficient is -0.421, the regression coefficient is negative. This means that math anxiety has a negative effect on students' mathematical critical thinking abilities. The negative effect here means that if math anxiety is high, students' critical thinking skills are low.

Conversely, if math anxiety is low, students' mathematical critical thinking skills are high.

The results of this study are corroborated by Ackerman's theory, D.S. and Gross, B.L which reads "The higher the students' mathematical anxiety, the lower the student's learning outcomes and the more ", this means that there is a connection with students' mathematical critical thinking abilities, because if student learning outcomes are low then the participants' mathematical thinking abilities education is also low . If students cannot meet the indicators of critical thinking skills such as interpreting, analyzing, evaluating and making inferences that are still lacking or not appropriate, the learning outcomes obtained by students will also be lacking.

The results obtained in this study are in line with previous research conducted by Evy Novia Nanda Artama, Siti Maghfirotun Amin, and Tatag Yuli Eko Siswono entitled " Pengaruh Kecemasan Matematika Terhadap Hasil Belajar Matematika Siswa" and has a negative relationship which means the higher the anxiety will affect the low learning outcomes obtained by students and the lower the anxiety will affect the high learning outcomes obtained (Artama, Amin, & Siswono, 2020). The presentation of math anxiety on mathematics learning outcomes is equal to 54.8%.

CONCLUSION

Based on data analysis and the results of the research discussion regarding the effect of math anxiety on mathematical critical thinking skills in trigonometry material for class X students of SMKN 1 Bandung, the following conclusions can be obtained.

1. The Mathematics Anxiety Level of Class X TBSM Students is 58% so it is classified as severe anxiety.
2. There is an influence of math anxiety on the ability to think critically mathematically in the trigonometry material of

class X TBSM students at SMKN 1 Bandung. This is based on the significance value obtained, namely so that it rejects .

3. The effect of math anxiety on mathematical critical thinking skills in the trigonometry material of class X TBSM students at SMKN 1 Bandung is 51.2%, while 48.8% is influenced by other variables.

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