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Mastery of Trigonometry Material and Its Effect on Students' Ability to Solving Three Dimensional Problems

Nisa Triyatul Fitri[1], Arif Muchyidin[2], Reza Oktiana Akbar[2]
[1]SMP Binaul Ummah Kuningan, Indonesia
[2]IAIN Syekh Nurjati Cirebon, Indonesia

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ABSTRACT

This study aims to describe whether or not mastery of trigonometry affects students' ability to solve geometric problems in class X at SMAN Kadugede. The form of research used in this study is a quantitative research method. The research design used in this study is a one-shot case study, meaning that the treatment is applied to one experimental group, and then the dependent variable is measured. This design aims to determine a variable's effect on other variables effectively. The data collection instrument used was a test of mastery of trigonometric material and students' abilities in solving three-dimensional space problems. The population in this study was 253 students of class X; in this study, the authors took samples using the cluster random sampling technique with the object sampled in this study, namely class X 4, as many as 34 students at SMA Negeri 1 Kadugede. Analysis of the research data using linear regression test. Mastery of trigonometry material significantly influences mastery of three-dimensional space material. This is indicated by a significant value of 0.000 < 0.05 and the regression equation obtained is Y = 11.435 + 0.758 . The equation means that the ability to solve geometrical problems increases or increases by 0.758 times the mastery of trigonometry material, while the constant value of 11.435 states that if students do not have mastery of trigonometry material, then the ability to solve three-dimensional space problems is shallow. The results of the statistical test showed that there was an effect of mastery of trigonometry material on students' ability to solve three-dimensional problems.

Corresponding Author:

Nisa Triyatul Fitri
SMP Binaul Ummah Kuningan, Indonesia
Email: nisatriyatul@gmail.com

1. INTRODUCTION

The rapid development of the times indirectly demands the existence of Human Resources that are ready to compete. Education, in this case, science, must be mastered to improve human resources' quality. Humans, the primary educational actors, must make reasonable learning efforts to improve their abilities. This is inseparable from the educational paradigm that develops in managing the process and student learning outcomes as an integral part of the education system. Without ignoring the importance of the success that has been achieved, especially in formal education, a fundamental problem arises that dramatically affects the essence of the educational institution, namely the low tendency and poor quality of education [1].

When viewed from the Human Development Index (HDI) compared to other countries, in 2020, the quality of our country's Human Resources is on the order of 107 out of 189 countries worldwide. This ranking is the third rank in ASEAN countries after Malaysia is ranked 62 and Thailand, ranked 79th. The human resource development index is part of an indicator of the low quality of education. The most important thing is to take constructive steps to anticipate these problems from all parties, teachers who go directly to the field, and policy developers [1]–[5]. This step is taken so that the process and results of education for the community's growth and development can be accounted for. One is that students can have critical, creative, systematic, and logical thinking, which can be developed through mathematics education. This is possible because mathematics has a structure with solid and clear linkages and a consistent mindset [6].

Mathematics subjects based on the Minister of National Education objectives above are sequential, graded, and sustainable subjects. This means that the material given to students is the basic concept which is the foundation for the delivery of the next concept. Mastering early mathematical concepts in students opens the way for the delivery of different mathematical concepts so that students will find it easier to understand them in the following material. In addition, if students master the material well, they can solve various variations of math problems, making it easier to solve math problems related to everyday life. The number of errors students make in working on the questions can indicate the extent of student mastery of the material [7]–[11].

According to Utomo [12], mastery of the material is the ability of students to capture the meaning of certain natural phenomena through observation, where the analysis of the results of the observations is built and stored in the minds of students as stored memory and one day can be recalled through tests. A person is said to master the material if he understands it correctly so that he can explain it again according to his knowledge and not change its meaning. Therefore, mastery of the material is one of the essential aspects that must be applied to measure students' cognitive abilities.

Cognitive ability in trigonometry material is a subject matter that uses many concepts that will continue to develop and are not rote material, so if students have not mastered the concept of the previous material, it is feared that they will experience difficulties in the following material, such as polyhedra. The subject matter of polyhedra for class X students is the position of points, lines, or fields in the wake, the distance in the wake, and the angle in the wake. Material related to the material polyhedra is trigonometry.

When viewed from the ability of students at SMAN 1 Kadugede, one of the schools in Kuningan Regency, students at this school belong to the category of intelligent students. The relatively high score indicates this on the entrance test to the school. When viewed from the students' input, they should not have much difficulty understanding the subject matter of mathematics. However, the observations in class X showed that most students still had difficulties understanding the three-dimensional subject matter. Meanwhile, students' success in learning mathematics can be measured from students' understanding of learning mathematics and utilizing that understanding to solve mathematical problems and other problems in life, which are the application of mathematics [13]–[18].

Based on interviews with mathematics teachers at SMA Negeri 1 Kadugede, Kuningan Regency, it was obtained that there are still many students who have difficulty learning the material of angles in building spaces. This can be seen from the results of their daily tests from 34 students who took the test; 70% of students' scores were still below the KKM standard (Minimum Completeness Criteria) with a set value of 72 with the determination of KKM based on student intake, carrying capacity and complexity. This problem is possible because understanding trigonometry and spatial figures' angles have not been mastered perfectly. Nevertheless, other problems were also found: students who mastered trigonometry could not solve problems in determining angles in shapes, but those who did not master trigonometry were quite able to solve problems in determining angles in shapes. Meanwhile, according to some students of class X, mathematics is not so complicated for some students to accept. Some students like mathematics, but this is not necessarily the case in the material of building space. Students who are said to like mathematics may not necessarily be able to master other mathematical materials, such as three-dimensional material. The three-dimensional material requires precision and accuracy as described above; in determining the shape's angle, mastery of the previous material is needed, namely trigonometry material.

2. METHOD

This study aims to determine the effect of mastery of trigonometry on students' ability to solve three-dimensional space problems. The research method used in this research is quantitative research. The research design used in this study is ex-post facto, where a series of independent variables occurs when the researcher begins to observe the dependent variable [19]. Natsir can explain the main characteristics in ex-post facto research [20], i.e., there is no control over the variables. Variables are seen as they are. Arikunto [21] further explains this; in this study, the researcher did not start the process from the beginning but immediately took the results.

This study seeks to find out whether there is an effect of mastery of trigonometry on students' ability to solve three-dimensional problems. This study has two independent variables (X) and a dependent variable (Y). The independent variable in this study is the mastery of trigonometry material, while the dependent variable is the student's ability to solve three-dimensional problems. The data collection instrument used to measure variable X (Mastery of Trigonometric Material) and variable Y (Students' Ability in Solving Three Dimensional Space Problems) was a test. A test is a series of questions or exercises used to measure the skills, knowledge, abilities, or talents of an individual or group [21]. This test was conducted to obtain data on students' ability to solve three-dimensional space problems after students had mastered the trigonometry material. The test instrument is given as an essay (description).

The test of mastery of trigonometry material is ten questions, and the test of students' ability to solve three-dimensional space problems is 12 questions. the population in this study was 253 class X students at SMA Negeri 1 Kadugede. Sampling was carried out using a cluster random sampling technique which went through two stages, namely random sampling without regard to the strata that existed in the population, this sampling technique was carried out in two stages, namely the first to determine the regional sample, and the next stage to determine the sample. Individuals are taken randomly [22]. Therefore, the researcher randomly took one class from the seven existing classes. The object sampled in this study is class X-4, as many as 34 students at SMA Negeri 1 Kadugede, Kuningan.

3. RESULTS AND DISCUSSION

3.1. Results

This data analysis was conducted to prove the research hypothesis, namely to prove whether there is an influence between mastery of trigonometry material on the ability to solve three-dimensional space problems. The results of the description of the respondent's data in this study include test score data filled in by the research respondents regarding trigonometry and three-dimensional space material.

a. Data Variable X (Mastery of Trigonometric Material)

The researcher used tests as a data collection instrument to determine the mastery of trigonometry material. The test consists of 10 items. In data processing, the researchers changed the raw data into standard data using a 0-100 scale rating, meaning that students' highest score was 100 and the lowest score was 0. From the results of the test distribution, the following data were obtained:

Table 1. Descriptive Statistics of Trigonometric Material Test Results

N	Valid	34
	Missing	0
Mean		71.8824
Median		74.0000
Mode		74.00
Std. Deviation		6.54941
Variance		42.895
Range		32.00
Minimum		32.00
Maximum		86.00

Based on calculations with the help of the SPSS program, it is known that the average value (mean) of the Trigonometry material test is 71.9706. Then it can be categorized as "good" mastery of trigonometric material; the minimum score is 54, while the maximum is 89. Furthermore, the standard deviation is 6.76213, and the variance is 45,726. To find out the size of each indicator from the total calculation, the following will interpret the test results of each indicator that has been achieved by class X students of SMAN 1 Kadugede regarding mastery of trigonometry as follows:

Table 2. Recapitulation of Trigonometric Mastery Test Results

No	Indicator	Percentage	Interpretation
1	Determining the value and size of the trigonometric ratio angle	61%	Good
2	Calculates trigonometric ratio values of particular angles	75%	Good
3	Calculate the side lengths of any triangle using the sine and cosine rules.	76%	Good
4	Apply the formula for the area of a triangle to solve problems in everyday life.	85%	Very good
	Average	74%	Good

The data above shows that determining the value and magnitude of trigonometric comparison angles, calculating the value of particular angle trigonometric ratios, calculating the side lengths of any triangle using the sine and cosine rules, and applying the formula for the area of a triangle to solve problems in everyday life by 74%. It can be interpreted that the learning mastery of class X students of SMAN 1 Kadugede towards trigonometry material is in a suitable category.

b. Data Variable Y (Ability to Solve Three Dimensional Space Problems)

To find out the mastery of the three-dimensional space material, the researchers used a test as an instrument for testing the data. The test consists of 10 items. In data processing, the researchers changed the raw data into standard data using a scale of 0 – 100, meaning that the student's highest score was 100 and the lowest score was 0. From the results of the distribution of the test, the following data were obtained:

Table 3. Descriptive Statistics Test of Students' Ability to Solve Three Dimensional Problems

N	Valid	34
	Missing	0
Mean		79.8824
Median		80.0000
Mode		80.00
Std. Deviation		6,89209
Variance		47.501
Range		38.00
Minimum		62.00
Maximum		100.00

Based on calculations using the SPSS program, it is known that the average value (mean) is 79.882. So it can be categorized as mastery of three-dimensional space material as "very good." The minimum value is 62, while the maximum value is 100. Furthermore, the standard deviation is 6.8921, and the variance is 47.501. To find out the size of each indicator from the total calculation, the following will interpret the test results of each indicator that has been achieved by class X students of SMAN 1 Kadugede regarding mastery of trigonometry as follows:

Table 4. Recapitulation of Ability Test Results for Solving Three Dimensional Space Problems

No	Indicator	Percentage	Interpretation
1	Determine the position of points, lines, and planes in three-dimensional space	76%	Good
2	Determine the distance from a point to a line and from a point to a plane in three-dimensional space	78%	Good
3	Determine the measure of the angle between a line and a plane and between two planes in three-dimensional space	83%	Very good
	Average	79%	Good

The data above shows that determining the value and magnitude of trigonometric comparison angles, calculating particular trigonometric ratios, calculating the side lengths of any triangle using the sine and cosine rules, and applying the formula for the area of a triangle to solve problems in everyday life is 79%. It can be interpreted that the learning mastery of class X students of SMAN 1 Kadugede towards trigonometry material is in a suitable category.

c. Regression Linear

Regression linearity is used to determine whether the regression is linear or non-linear. The regression linearity was obtained with the help of the SPSS program, and the following results were obtained:

Table 5. Regression linearity test

ANOVA

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1043.875	12	86.990	3.928	.003
Within Groups	465.095	21	22.147		
Total	1508.971	33			

Based on the table 5 above, it can be seen that the significance value for Linearity is 0.003. Because the significance is less than 0.05, it can be concluded that there is a linear relationship between the variables of mastery of trigonometry material and three-dimensional space material.

Table 6. Regression equation

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	11.435	8.832		1.295	.025
	VAR X	.758	.110	.772	6.879	.000

a. Dependent Variable: VAR Y

Table 6 above shows the regression sought for the value of sig. from constant $0.025 < 0.05$ and the value of sig. Variable X is $0.000 < 0.05$, so the correct equation for the two parables is $y = 11.435 + 0.758x$, with Y being students' ability to solve three-dimensional space problems and x being mastery of trigonometry. The equation means that the ability to solve three-dimensional space problems increases or increases by 0.758 times the mastery of trigonometry material. In contrast, the constant value of 11.435 states that if students do not have mastery of trigonometry material, then the ability to solve geometrical problems is shallow.

3.2. Discussion

After obtaining data from field research and data processing that has been carried out, the results of statistical calculations are obtained. Data analysis begins with analyzing whether each sample from the population is normally distributed or not. The normality test results showed that the data were normally distributed because the significance value was more significant than 0.005, namely 0.428 for trigonometry and 0.481 for three-dimensional space. Next is the homogeneity test. The homogeneity test was carried out with the help of SPSS software using Levene's test statistic with a significance level of 0.05. The homogeneity test results obtained a significance value of 0.055. Because the significance is more significant than 0.055, it can be concluded that the data has the same variance or is homogeneous.

Mastery of trigonometry material in class X SMAN 1 Kadugede is categorized as "enough." This is indicated by the highest score of 100 and the lowest score of 54. The trigonometry material test in class X4 has an average score of 71.97. Likewise, the ability to master three-dimensional space material is categorized as "high" because the average value of the three-dimensional space material mastery test is 79.88. This is indicated by the highest score of 100 and the lowest score of 69, meaning that some students can understand three-dimensional space well, although some students still do not understand the material of three-dimensional space.

Mastery of trigonometry material significantly influences mastery of three-dimensional space material. This is indicated by the measurement results showing that students' ability in trigonometry material has Linearity that follows students' mastery of three-dimensional space material with a significant value of $0.000 <0.05$, meaning that mastery of trigonometry material influences mastery of three-dimensional space material.

Based on the test results, the regression equation used to predict the effect of mastery of trigonometric material on three-dimensional space material is $Y = 11.435 + 0.758$. The equation means that the ability to solve geometrical problems increases or increases by 0.758 times the mastery of trigonometry material, while the constant value of 11.435 states that if students do not have mastery of trigonometry material, then the ability to solve three-dimensional space problems is deficient.

Statistical tests show that mastery of trigonometry material affects students' ability to solve three-dimensional problems. This shows that theory is suitable for the facts of learning at school. The importance of students' mastery in the subject area they are pursuing will affect students' ability to acquire knowledge. This result is in line with the statement which states that mastery of the material is defined as the ability of students to understand the meaning scientifically, both in theory and in its application in everyday life [23]. Talking about three-dimensional space, almost all of the objects that exist in everyday life are three-dimensional forms. So when we discuss the material, we are discussing the application of a theory. This is supported by Dahar's opinion, which states that mastery of the material includes application in daily life, and Abror's opinion, which states that mastery of the material also includes deepening/application of the field of study.

The results of statistical tests show that there is an effect of mastery of trigonometry on the ability to solve three-dimensional problems. The ability to solve three-dimensional problems requires mastery of trigonometry material. This is in line with Marhijanto's opinion [24] that the level of a student's ability to solve math problems describes the extent to which students' understanding of the material has been taught. Therefore, trigonometry is one of the prerequisites for solving three-dimensional space problems. The higher the mastery of trigonometry material, the higher the students' ability to solve three-dimensional space problems. Solving problems is an important activity in mathematics. This has become the hallmark of learning mathematics, and students have to practice many math problems. Practice solving problems can deepen mastery of mathematical material and make students skilled. It is even expected that students can apply it to various problems they face [25]. Mastery of the basic trigonometry concepts is necessary to understand the following more complicated concept, namely the three-dimensional concept. This is because a concept is prepared based on the previous concept and will be the basis for subsequent concepts, so a wrong understanding of a concept will result in a misunderstanding of the following material.

4. CONCLUSION

Based on the results of the research described, analyzed, and discussed following the provisions, research on the effect of mastery of trigonometry material on students' ability to solve three-dimensional space problems in class X SMAN 1 Kadugede concluded that mastery of trigonometry material has an average of 71.97. Based on the test results criteria, the average value of mastery of trigonometry material for class X students of SMAN 1 Kadugede, Kuningan Regency, belongs to the category of moderate mastery. Mastery of three-dimensional space material has an average of 79.88. Based on the test results criteria, the average value of mastery of three-dimensional space material is included in the high category.

Based on the test results, the regression equation used to predict the effect of mastery of trigonometric material on three-dimensional space material is $Y = 11.435 + 0.758$. The equation means that the ability to solve geometrical problems increases or increases by 0.758 times the mastery of trigonometric material. At the same time, the constant value of 11.435 states that if students do not have mastery of trigonometric material, then the ability to solve geometrical problems is shallow. The results of statistical tests show that mastery of trigonometry material affects students' ability to solve three-dimensional space problems. This shows that theory is suitable for the facts of learning at school. Students must master the trigonometry material first in order to be able to solve three-dimensional space problems.

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