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Analysis of Students' Mathematical Concept Understanding Ability in Understanding Trigonometry Material for Class XI Senior High School

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ABSTRACT

One of the goals of learning mathematics is that students must be able to understand mathematical concepts. At one high school in Kediri, class XI students did not understand mathematical concepts. The low ability to understand mathematical concepts is proven by the majority of students not being able to reformulate the solution to the problem given. Therefore, the aim of this research is to examine the ability to understand mathematical concepts of class XI students in solving problems related to trigonometry material. In this research, qualitative descriptive methods were used. Simple Random Sampling technique that researchers use to select research subjects. The students involved in the research were 23 students who were in class Furthermore, the non-test instrument takes the form of an unstructured interview to find out students' difficulties. The mathematical concept understanding ability rubric is used to analyze the mathematical concept understanding ability test. The research results show that the average understanding of the concept is categorized as sufficient at 64.50. Causal factors that also influence students' low percentage of understanding of mathematical concepts are lack of concentration in learning, irregular study habits and less interesting learning methods.

Keywords: *Concept Understanding, Mathematics, Trigonometry*

INTRODUCTION

Mathematics as a fundamental branch of science in studying logic, deduction and analysis, has a significant role in developing students' intellectual abilities [1]–[3]. Scientific disciplines do not just provide knowledge about numbers and calculations, but also train students to think rationally, develop problem-solving abilities, and improve analytical skills [4], [5]. According to [6], [7] underlines that in the world of education, mathematics not only functions as a tool to measure students' academic abilities, but also as a means to train creativity, explore problem solving, and foster critical thinking patterns in students. Mathematics not only sharpens academic abilities, but also develops students' intellectual abilities and thinking skills in solving challenges and facing complexity in various areas of life [6], [8]. Thus, mathematics becomes an important foundation that forms a holistic and sustainable framework for students' thinking.

One of the goals of learning mathematics is for students to understand mathematical concepts, understand the relationships between concepts, and be able to use concepts and algorithms efficiently, flexibly, accurately and precisely to solve problems [9], [10]. Students who understand the concept well will better understand closed mathematical concepts [11], [12]. In this way, teachers and students collaborate to achieve one of the goals of mathematics learning better than before.

It cannot be denied that, the process of learning mathematics is full of challenges and complexity [13], [14]. Students' understanding of mathematical concepts is very important in the mathematics learning process [15]. Teachers are expected to be able to explain how concepts relate to each other in a material. In learning mathematics, the ability to understand concepts helps students acquire other basic abilities [16]. To achieve this goal, teachers are expected to be able to plan the mathematics learning process well.

Trigonometry is a mathematics subject that students study in high school. According to [17] trigonometry material is often a challenge for most high school students. This is because trigonometry is one of the most important chapters of mathematics which causes its own difficulties for students. Trigonometric angles, sine, cosine, and tangent are often considered difficult to understand and make students afraid [18]. Some students feel intimidated and not confident in studying trigonometry material, thereby creating a gap between the expected understanding and the conditions in the learning field [19]. In addition, it can be more difficult to understand and apply trigonometry material in particular if you have difficulty connecting trigonometry concepts to everyday life.

As shown by [20], the trigonometry comparison material in right triangles is still below the KKM (Minimum Completeness Criteria), namely 75. This shows that trigonometry material is often considered difficult for students. The main factor that causes students' difficulties in trigonometry material is students' tendency to memorize formulas without understanding the fundamental concepts related to them. Students' lack of conceptual understanding causes a decline in student learning outcomes [21]. Based on the explanation above, researchers want to conduct research on how students understand mathematical concepts regarding trigonometry material.

MATERIALS & METHODS

This research is qualitative research that uses a descriptive approach. A qualitative approach is a scientific method used to collect data for a specific purpose. This research was carried out in January 2024. The selection of research subjects was carried out using purposive sampling , which is a technique for sampling data sources with certain considerations [22]. This research was conducted on students in class XI at One High School in Kediri City with research subjects consisting of 23 students.

The aim of this research is to find out how well students understand mathematical concepts in trigonometry material taught in class XI One High School in Kediri City. Data collection was carried out through interviews and tests. Based on [23] states that a test is a collection of tasks that must be completed to assess a student's abilities. To assess students' ability to understand mathematical concepts, this research used a description test consisting of five questions adapted to each indicator of understanding mathematical concepts. The process is as follows: the researcher gives a test sheet containing detailed questions, assesses students' answers, and then calculates what percentage of students understand mathematical concepts well according to the indicators. Next, the conceptual understanding ability test scoring guidelines will be used to analyze the test data.

To complete research data, interviews are required. The interviews conducted in this research were conducted in an unstructured

manner. Students are interviewed after completing the questions.

Concept understanding ability indicators are used to assess students' concept understanding abilities. The criteria for assessing the ability to understand mathematical concepts after being modified from [24] can be seen in table 1.

Table 1. Guidelines for scoring the ability to understand mathematical concepts

Concept Understanding Indicator	Information	Score
Using, utilizing, and selecting a particular procedure or operation	Blank answer	0
	Unable to use, utilize, and choose procedures or operations	1
	Can use, utilize, and choose procedures or operations but there are still many mistakes	2
	Can use, utilize, and choose procedures or operations but not yet correctly	3
	Can use, utilize, and choose procedures or operations appropriately	4
Develop necessary conditions/sufficient conditions of a concept	Blank answer	0
	Cannot use or choose the procedure or operation used	1
	Can use or choose the procedure or operation used but there are still many errors	2
	Can use or choose the procedure or operation used but it is still not appropriate	3
	Can use or choose the procedures or operations used appropriately	4
Apply concepts or algorithms in problem solving	Blank answer	0
	Unable to apply formulas according to procedures in solving problem solving problems	1
	Can apply formulas according to procedures in solving problem solving problems but there are still many errors	2
	Can apply formulas according to procedures in solving problem solving problems but not yet correctly	3
	Can apply formulas according to procedures in solving problem solving problems correctly	4

RESULT AND DISCUSSION

This research involved students in class XI One of High School in Kediri City during the even semester of the 2023/2024 academic year. The aim of this research is to analyze students' level of understanding of mathematical concepts when solving trigonometry problems. There were 23 students involved in the research. To find out what students think, this research uses description questions and interviews. There are five questions arranged based on indicators of conceptual understanding, which cover trigonometry material.

The results of the trigonometry material test showed an average result of 64.5; median 60; mode 77; minimum 20; and a maximum of 92. After getting the test scores, researchers grouped students' abilities into three categories: High (T), Medium (S), and Low (R). Based on data analysis, it was found that there were 4 students in the high category or 17%, 14 students in the medium category or 61%, and 5 students in the low category or 22%. This shows that the conceptual understanding of class XI One High School students in Kediri City in solving trigonometry problems is classified as moderate or average.

The level of student achievement towards indicators of ability to understand mathematical concepts based on the results of the test of ability to understand mathematical concepts is shown in Figure 1.

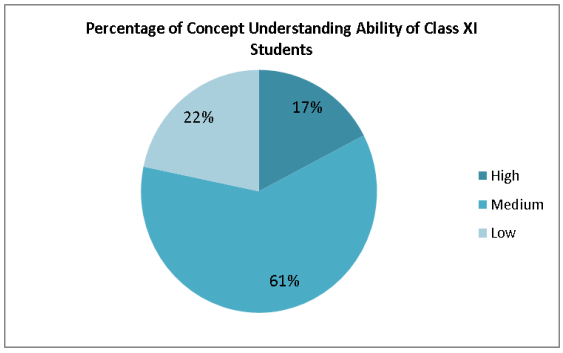

Figure 1 Results of Class XI Students' Concept Understanding Ability Test

Data obtained from the analysis of concept understanding abilities shows that students can understand students' mathematical concepts which can be seen from the indicators Using, utilizing, and selecting certain procedures or operations, Developing necessary/sufficient conditions for a concept, Applying concepts or algorithms in problem solving. A rubric for assessing the ability to understand concepts with a scale of 0, 1, 2, 3 and 4 is used to assess each indicator of concept understanding. Student results for each indicator are shown as follows.

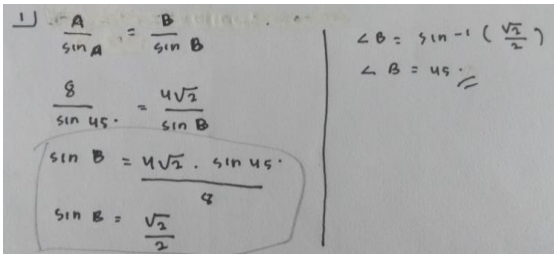

Figure 2 Answer to question number 1 by first subject (S1)

Analysis

Based on Figure 2, the results of the answers to question no. 1 by first subject (S1) shows that the student can use, utilize, and choose certain procedures or operations. It can be seen that students are able to use, utilize and select certain procedures or operations by entering values $\alpha, \sin A, \beta, \sin B$, but students do not write the complete formula for the sine rule for triangles. It can be seen from the test results that students correctly entered the sine rule formula for triangles using trigonometry.

Apart from using, exploiting and selecting certain procedures or operations, in question number 1 there is an indicator for developing necessary/sufficient conditions for a concept. In this indicator, students are able to develop necessary/sufficient conditions for a concept but are not yet equipped with a triangular plane illustrator. Then, in the indicator of applying concepts or algorithms in solving problems, there are errors. It can be seen from the calculation of the results of $4\sqrt{2} \times \sin 45°$ S1's answer $\sqrt{2}$, the result should be $4\sqrt{2} \times \frac{\sqrt{2}}{2} = 4$ that this error causes errors in subsequent calculations which result in the final answer obtained being wrong. Thus, these students have not been able to apply algorithm concepts in problem solving.

Based on the results of interviews with students with wrong answers, it was stated that when working on the questions the students already knew how to use the formula for the sine rule in triangles, but in the calculations the students had difficulty calculating $4\sqrt{2} \times \sin 45°$ which has a root sign in it. Agree with the statement **[25]** that students will be mistaken if they cannot make the right formula.

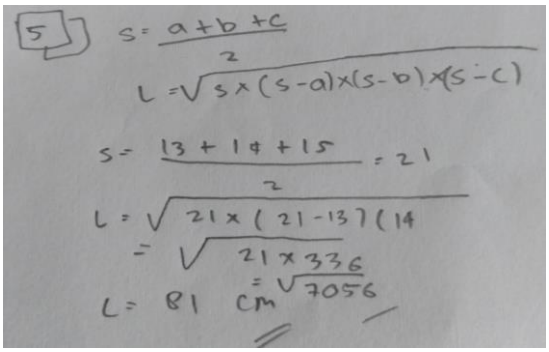

Figure 3 Answer to question no. 5 by Second subject (S2)

Analysis

Based on Figure 3, the results of answer no. 5 by Second Subject (S2) shows that the student can use, utilize, and choose certain procedures or operations. This shows that students are able to use, utilize, and select certain procedures or operations by entering values a, b and c. It can be seen from the test results that students enter values in the formula s correctly, but for the formula for the area of a triangle, the value entered into the formula is not correct.

Apart from using, utilizing, and selecting certain procedures or operations, in question number 5 there is an indicator of developing necessary/sufficient conditions for a concept. In this indicator, students are able to develop necessary/sufficient conditions for a concept but are not yet equipped with an illustrator for flat triangles and there was

an error entering the value into the formula. Then, in the indicator of applying concepts or algorithms in solving problems, there are errors. It can be seen from the calculation of the area of a triangle that students should enter the value of $\sqrt{s \times (s-a) \times (s-b) \times (s-c)}$but the student has not entered all the values that need to be entered into the triangle formula, this error causes errors in subsequent calculations which result in the final answer obtained being wrong. Thus, these students have not been able to apply algorithm concepts in problem solving.

Based on the results of interviews with students with incorrect answers, it was stated that when working on the questions the students already knew how to use the formula for the area of a triangle if they knew the values or lengths of the three sides of the triangle, but in the calculations the students experienced a calculation error which resulted in an error in the final result of the answer. Agree with statement **[25]** that students will be mistaken if they cannot make the right formula.

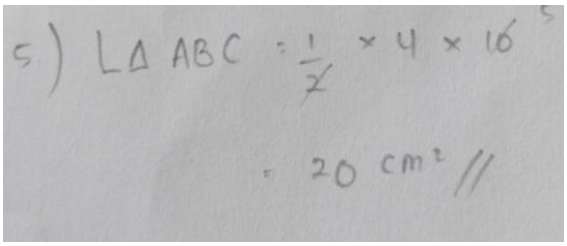

Figure 4 Answer to question no. 5 by Third subject (S3)

Analysis

Based on Figure 4, the results of the answers to question no. 5 by Third subject (S3) shows that the student has not been able to use, utilize, and choose certain procedures or operations. This shows that students are not yet able to use, utilize and choose certain procedures or operations. It can be seen from the test results that students use the triangle formula which does not meet the criteria for the question indicators.

Students also cannot develop the necessary/sufficient conditions for a concept so that the indicator of applying a concept or algorithm in solving problems also causes errors.

Based on the results of interviews with students with wrong answers, students were not careful when interpreting questions because students were in a hurry when doing them. As in Ananda's research which shows that of the total answers, students experienced conceptual errors amounting to 33.33%, this error was because students did not know what the question was in the question so the resulting solution was wrong **[26]**.

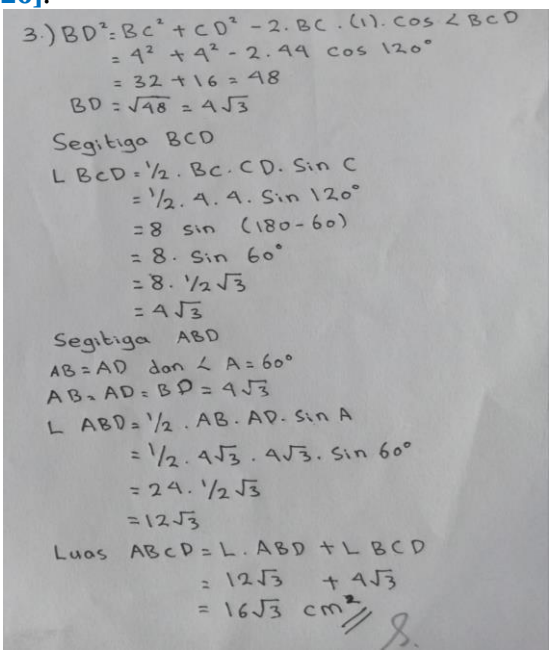

Figure 5 Answer to question no. 3 by Four Subject (S4)

Based on Figure 5, the results of the answers to question no. 3 by Four Subject (S4) shows that the student can use, utilize, and choose certain procedures or operations well and correctly. This shows that students are able to use, utilize and select certain procedures or operations by entering numbers into formulas correctly. It can be seen from the test results that students correctly entered the formula for the sine rule, the cosine rule and were able to determine the area of a rectangular shape from two triangular shapes formed using trigonometry.

Apart from using, exploiting and selecting certain procedures or operations, in question

number 3 there is an indicator for developing necessary/sufficient conditions for a concept. In this indicator, students are able to develop necessary/sufficient conditions for a concept but are not yet equipped with a triangular plane illustrator. Then in the indicator of applying concepts or algorithms in problem solving, students are able to apply concepts or algorithms in solving problems well and correctly. In this way, students are declared good at mastering these indicators.

CONCLUSION

Based on the results of the analysis of students' answers to each question item above, it shows that the ability to understand mathematical concepts of class XI students at one of the high schools in Kediri City is still categorized as sufficient. This is based on the students' answers as a whole not meeting the criteria for understanding the concept, with an average percentage of 64.5. Of the 3 indicators of understanding the concept of mathematical problems used in this research, namely the indicators of Using, utilizing, and selecting certain procedures or operations; Developing necessary conditions/sufficient conditions for a concept; Students have mastered the concept or algorithm in solving problems, although students are still found to be unable to master this indicator. Students have difficulty understanding what is known and being asked in the problem, changing prose questions into mathematical sentences, and students also experience problems when implementing the concept of algorithmic solving and determining how to solve mathematical problems. The factors that influence the low percentage of students' understanding of mathematical concepts are students' lack of concentration in learning, irregular study habits and the learning methods used are less interesting.

Declaration by Authors

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