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ANALYSIS OF STUDENT ERRORS IN SOLVING TRIGONOMETRY QUESTIONS

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ABSTRACT

This research is motivated by the large number of students' mistakes in solving trigonometry questions and aims to analyze common mistakes made by students in solving questions on trigonometry material. The type of research is descriptive research while the research method is based on literature analysis and teaching experience in the context of mathematics education. The data analysis techniques used are: data collection, data reduction, and drawing conclusions. We analyzed we analyze the results of students' work, various sources, including theses and research journals. Trigonometry is a branch of mathematics that studies the relationship between angles and sides in triangles. However, students often face difficulties in understanding and working on trigonometry problems, especially when working on questions in the form of descriptions. With a better understanding of these errors, educators are expected to be able to design more effective learning strategies to help students master trigonometry concepts well.

Keywords: Error Analysis, Student, Trigonometry,

INTRODUCTION

Mathematics is one of the important sciences in the scientific aspect. Mathematics is taught at all levels from elementary school to high school/vocational school. Mathematics is an important science to master so that you can easily understand other sciences (Junaidi & Lutfianto, 2015). Mathematics taught in secondary school is the foundation for studying mathematics at the next level. One of the materials in mathematics subjects studied in high school is trigonometry. Trigonometry is material in mathematics subjects that discusses matters related to triangles, be it length, area, circumference or angle measurements (Hidayat & Aripin, 2020). Comparison of the values of sine, cosine, and tangent at an angle as well as the difference in the sum of two angles are also discussed in trigonometry. Apart from that, trigonometry contains basic concepts or material that students have studied at previous levels, such as the Pythagorean theorem, calculating fractions, rationalizing roots, and so on (Putri, 2013).

Trigonometry is closely related to everyday life, such as measuring angles, measuring the height of objects, calculating the distance between two objects, calculating the depth of the sea, and so on. Insani

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& Kadarisma (2020) stated that trigonometry is useful for students who want to enter higher education because trigonometry is not only taught in mathematics subjects but is also taught in other branches of science such as engineering, chemistry, geography, physics and others which also use trigonometry in one of their materials.

The reality in the field is that there are still many students who make mistakes in solving problems related to trigonometry material. Based on interviews with fellow mathematics teachers, trigonometry material is a difficult material for students, where many students still make mistakes when filling in trigonometry questions. In their research, Ayu & Zanthy (2020) revealed that errors when solving questions using inaccurate formulas, no final results, and errors in calculations, these are mistakes that students often make when solving trigonometry problems. Another reason is because the process of receiving and processing information is inaccurate (Nur Aly et al., 2019). Errors in the completion process made by students in solving questions have an impact on student learning outcomes. Therefore, it is necessary to carry out an analysis to identify student errors in solving trigonometry problems.

To analyze students' errors in solving trigonometry problems, researchers used Watson's error criteria. The Waton criteria are considered capable of measuring the limits of students' intellectual abilities when working on questions (Guswanto, 2018). Watson has criteria for assessing errors in the solving process carried out by students in solving problems, including 1) incorrect data, 2) incorrect procedures, 3) missing data, 4) missing conclusions, 5) response level conflicts, 6) indirect manipulation , 7) skill hierarchy problems, and 8) errors other than the seven criteria mentioned.

One alternative to reduce the difficulties experienced by students in solving trigonometry problems, includes finding the source of errors made by students and these must be addressed immediately because students will always experience difficulties if previous errors are not corrected. Students' mistakes in solving trigonometry problems receive less attention and follow-up by mathematics teachers. Usually teachers only look at students' abilities by only looking at the final results of the tests given without looking at the types of errors made by students. Therefore, it is necessary to analyze the work of the problem solving process carried out by students to find out where errors are in the problem solving procedures and to overcome them so that the same type of error is not made again.

Based on the previous description, research related to analyzing student errors in solving trigonometry problems based on Watson's criteria is considered an important thing to do to find out the mistakes made by students, and is used to find out the causes of students making mistakes in solving problems as evaluation material for students and mathematics teachers to determine appropriate learning strategies and methods according to the situations and conditions that exist in each class. In this way, similar errors can be minimized so as to improve students' mathematics learning achievement at school.

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RESEARCH METHODS

This research uses descriptive qualitative research methods. The subjects studied were class XI MIPA 1 students at Darmaraja State High School, Sumedang Regency. In taking samples, purposive sampling technique was used. A total of 3 students were sampled with considerations based on the categorization that had been previously carried out by the researcher by being given an initial mathematical ability test, then 3 students with heterogeneous abilities were taken. This research was conducted in the odd semester of the 2023/2024 academic year. Data collection was carried out in this research using tests and field notes. The instrument used in this research is a test instrument in the form of trigonometry questions which have been researched by Wulandari & Gustell (2020). The data analysis technique used in this research is the Miles and Huberman data analysis model including data collection, data reduction, and drawing conclusions. To see students' mistakes in solving trigonometry problems, the data that has been obtained is then analyzed using Watson's criteria with error factor indicators as follows.

Table 1. Watson's Criteria

Watson's Criteria	Indicator	Reason
inappropriate data / id	• Error when placing data into variables. • Not using data that should be used.	• Students are less careful in their work. • Students do not understand the questions.
Inappropriate procedure / ip	• Using an incorrect formula. • Not writing down the steps when solving problems.	• Lack of understanding of the concept to solve the questions. • Don't know how to write down the formula steps for the problem
omitted data / od	• The data entered is incomplete.	• Less thorough in presenting the data that should be used.
omitted conclusion / oc	• When making conclusions do not use existing data.	• Lack of understanding in processing data.
response level conflict / rlc	• Not being prepared when working on questions	• Not studying before taking the test
Undiect manipulation / um	• The reasons used when solving problems are not logical.	• Confusion in interpreting the intent or meaning of the problem

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skills hierarchy problem / shp	• Making errors in calculations.	• Inaccuracy in calculating
above other / ao	Didn't write down the answer	• Do not understand the meaning of the question and lack of understanding of the concept

RESULTS AND DISCUSSION

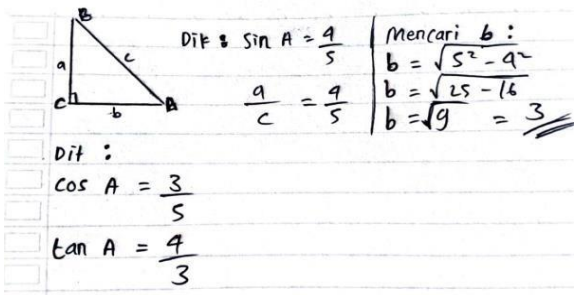
The following are the results of the analysis of students' errors in solving trigonometry problems based on Watson's criteria. After the analysis test, the location of S1, S2 and S3 students' errors in solving trigonometry questions bed on Watson's criteria is found in table 2.

Table 2.

Analysis of student errors based on Watson's criteria error categories

Error Location	**Subjek**		
	S1	**S2**	**S3**
inappropriate data / id	-	-	-
Inappropriate procedure / ip	-	■	■
omitted data / od	-	-	■
omitted conclusion / oc	■	■	■
response level conflict / rlc	-	-	-
Undiect manipulation / um	-	-	-
skills hierarchy problem / shp	-	-	■
above other / ao	-	-	-

The results obtained in table 2 show students' errors in solving trigonometry problems based on the error categories of Watson's criteria. Based on this table, S1 has a low error, S2 has a medium



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error, and S3 has a high error. The location of subject S1's error is in the omitted conclusion (oc). The location of the S2 subject's error was in the inappropriate procedure (ip), and the omitted conclusion (oc). Meanwhile, the location of the S3 subject's errors was in inappropriate procedures (ip), missing data (omitted data/od), missing conclusions (omitted conclusion/oc), and skills hierarchy problems (skills hierarchy problem/shp). The following is a description of students' mistakes in solving trigonometry problems.

Figure 2. S2 Test Results

It can be seen from the picture above that the answer from subject S1, it can be seen that S1 can do the questions correctly with the right solution procedure. Students understand the steps used to find the side of AC by using the Pythagorean theorem to get the side of b = 3. S1 also records the information contained in the question in the known and asked steps. However, there was an error in solving the S1 problem, namely not writing the answer completely and not including a conclusion from the answer obtained (oc), even though S1 had received the final mark.

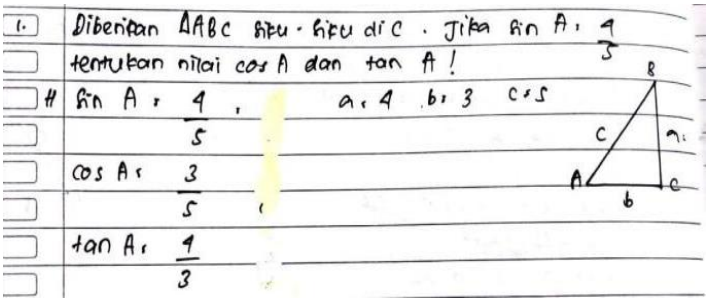

Figure 2. S2 Test Results

It can be seen from the picture above that S2's answer is S2. It can be seen that S2 can solve the question correctly, but there are visible errors. Based on the results of S2's work, it appears that S2 did not write down the steps used to solve the problem (ip). S2 does not write down the steps in finding the side of AC but immediately gets the results, then applies them to the trigonometry comparison formula to find the values of $cos\ a$ and tan a. The next error in S2's answer is that there is no conclusion from the answer that has been obtained (oc).

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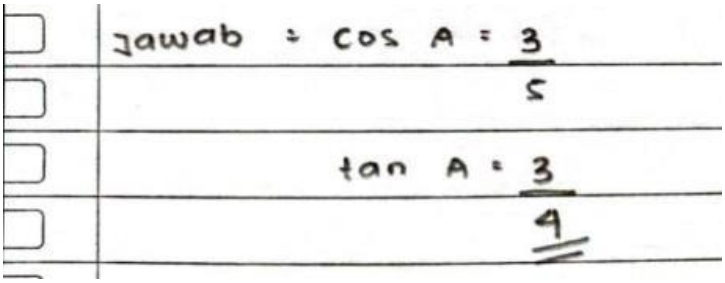

Figure 3. S3 Test Results

It can be seen from the picture above that S3's work shows that S3 was not right when solving the problems given. S3 made a mistake when working on the questions. Based on the results of S3's answer, he did not write down the steps he used in working on the problem (ip), but S3 already knew the side to be looked for, namely 3. There was missing data (od) where S3 did not write down the data known in the problem, namely $sin\ a$ = 4/ 5. Another error that S3 made was not correct in applying the trigonometric ratio formula (ip) to find the value of $tan\ a$, which can be seen in Figure 3, S3 wrote that $tan\ a$ =3/4. , even though it should be written $tan\ a$ =4/3, so students make mistakes in calculating (shp). The next error was that S3 did not write down the conclusion of the answer that had been obtained (oc).

Based on the description of the analysis that has been carried out, it was found that the inappropriate procedure (ip) error made by the student was that the student used an inappropriate formula and did not write down the steps he used in solving the problem given in the question. The factors that cause students to make this mistake are not understanding the concept of solving problems and not understanding how to write down the process of solving the steps. The results of this research are comparable to the error analysis carried out by Hartati (2019), the cause of incorrect procedural errors is not knowing the method that should be used in the process, not understanding how to write down the completion steps. Furthermore, Lestari & Nirmala (2020) revealed that the cause of inappropriate procedural errors is that students do not master the learning material, another cause is that students do not repeat lessons at home.

Then the error of missing data made by the student can be seen from the student's answer, the student did not write completely the data that should be in the answer. The factor that causes students to make this error is that students are not careful in presenting the data that should be used, which is the cause of students making errors in missing data. This is in line with the results of research by Wulandari (2016), where students were incomplete in recording all the data contained in the questions. Students wrote incompletely because they were not careful in recording all the information when solving the questions. Another contributing factor is that students tend to be in a hurry and not careful when working on questions (Mafruhah & Muchyidin, 2020).

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Furthermore, the mistake of missing conclusions made by students is where students do not write down the conclusions of what students have done in solving the problem. The factor that causes mistakes made by students to lose conclusions is the inability of students to relate previously obtained data to draw conclusions. The results of this research are in line with the results of research conducted by Nur Aly et al., (2019), the error of missing conclusions made by students was not writing a conclusion at the end of the answer, even though students had found the final result of solving the problem. According to Lestari & Nirmala (2020), the cause of errors in missing conclusions is students' carelessness in solving questions and not completing questions well. Meanwhile, according to Palayukan & Pelix (2018), the cause of missing conclusion errors is that students do not understand or are not careful when reading the questions in the questions, assuming that the final conclusion stated in sentence form does not need to be written.

CONCLUSION AND SUGGESTION

Based on the data that has been obtained, the researcher concludes that the errors made by students in solving trigonometry problems are inappropriate procedure errors (inappropriate procedure/ip), missing data (omitted data/od), missing conclusions (omitted conclusion/oc), and problems. skills hierarchy problem (shp), while no errors were found in inappropriate data (inappropriate data/id), response level conflict (rlc), indirect manipulation (undirect manipulation/um), and errors other than the seventh the above criteria (above other/ao) from the results of students' work on questions.

The causes of errors that students have made in inappropriate procedures are not understanding the concept of solving problems and not understanding how to write down the process of solving steps, students' lack of accuracy in presenting data that should be used, causing errors in missing data, errors in missing conclusions are incompetence. in linking previously known/obtained data to draw a conclusion, and errors in skill hierarchy problems are students' inaccuracy when calculating.

The research results and findings can be used as a basis for further research for researchers themselves and other researchers, besides that they can be used as evaluation material for mathematics learning and mathematics teachers. It would be better for teachers to provide more questions and also guidance in solving mathematics problems on trigonometry material so that the errors made by students when solving problems can be reduced.

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