International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2020): 7.803

Error Analysis in Solving Trigonometry Questions for High School Students Class X

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Abstract: ***The purpose of this study was to investigate the forms of errors made by students in solving trigonometry problems and their causes. This research method is descriptive research, with research subjects are high school students who have studied trigonometry. To find out what mistakes were made in solving trigonometry problems, students were given tests and interviewed to find out the causes of errors. The results showed that there were 16 forms of errors in solving trigonometric problems, which were further classified into three types of errors, namely conceptual errors (86.7% students), principle errors (53.3% students) and algorithm errors (43.3% students). The main cause of students making mistakes is because students do not understand the concept of trigonometry.***

Keywords: Error analysis, trigonometri, mathematic

1. Preliminary

Trigonometry is one of the materials in the high school curriculum. The fact is that many high school graduates still do not master trigonometry and Abidin (2012) said that while teaching Calculus 1, one of the prerequisite materials is trigonometry, many students have not mastered trigonometry well. The researcher interviewed a class X teacher at SMAN 1 Denpasar, that the students' test scores on trigonometry material were unsatisfactory and students considered trigonometry material to be difficult, especially on questions related to trigonometry applications. Indicators regarding three kinds of trigonometric ratios, namely sine, cosine and tangent, are considered difficult when related to application problems. For example, the problem of determining the distance of an object with a certain height, from another object if the angle of elevation or depression is known. Based on the researcher's interviews with mathematics teachers who teach trigonometry, information is obtained that students often cannot solve trigonometry problems, especially questions about their application. In addition, the teacher said that the students seemed to understand the explanation given during the lesson. If given a question that is exactly the same as the example, students can answer it correctly and if the question is changed, students are confused about solving it and many errors are seen in the solutions written by students. Therefore, the author wants to investigate what forms of errors students make in solving trigonometry problems. Thus it can be known the factors that cause the error.

In solving math problems there are stages that students do. These stages include reading the question, understanding the meaning of the question, determining the strategy for solving the problem, understanding the purpose of the question, determining the strategy for solving the problem, processing all the information known to the problem with the aim of obtaining a solution or answer to the question on the question, and writing the answer in a written form. understandable form. Failures made at different stages are shown as different errors (Watson, 1980:321).

The errors studied in this study were errors at the stage of carrying out the problem solving process (process skills). There are four things that are done in the process skill stage, namely random responses, wrong operations, faulty algorithms, and no response (Watson, 1980:321). Based on the opinion of Watson, Widdiharto and Zulmiyati above, the errors in the process skill stage studied in this study are:

a) Concept error
Concept is knowledge that involves examples of the concept. Concepts are abstract ideas that allow us to group objects into examples and non examples (Suherman, 2003:33). For example, students who understand the concept of a right triangle can distinguish a right triangle from an arbitrary triangle or an acute triangle.

b) Principle error
Principles are a series of concepts that are linked so as to provide new knowledge. If students do not have the concept used to develop the principle as an item of knowledge, then they will find it difficult to understand the principle (Hidayat, 2008: 8). This is natural because the principle contains concepts and the relationship between the concepts.

c) Algorithm error
An algorithm is a procedure for doing something. In the Mathematics Dictionary, it is stated that the algorithm is a systematic procedure for finding the answer to a problem. Errors in the algorithm mean errors that occur in the steps of solving the problem.

After examining the theories about errors in solving mathematical problems and their causes above, the researcher would like to emphasize the focus of this research. This study aims to investigate the percentage of errors at the process skill stage, especially process errors, principles and algorithms, made by students in solving trigonometry problems, and what factors are the causes.

2. Method

This study uses a descriptive qualitative approach. This research was conducted in 2021 at SMAN 1 Denpasar. The research sample was 9 students of class X SMA who have studied trigonometry, which were selected by taking three

students each from the most mistakes in concepts, principles and algorithms in solving trigonometry problems. This research was conducted in three stages, namely the preparation stage, the implementation stage and the completion stage. At the preparation stage, the researcher set a research schedule, made a grid of test questions, compiled test questions, tested test questions, tested analysis was given to research subjects, then checked test results, identified types of student errors, interviewed students and analyzed all data. obtained during the study. At the completion stage, the researcher concludes the types of errors made by students and their causes.

The data in this study are the results of students' test answers in solving trigonometry questions and interview transcripts with research subjects. The data was obtained using an unstructured test instrument and interview guide. The technique of collecting data on the results of students' answers is done by conducting written tests and interviewing research subjects.

3. Results and Discussions

Test Result Data

The test is given to students after the trigonometry material has been taught by the mathematics teacher. Based on the results of the work of 30 students in solving trigonometry problems, several errors were found by students.

There were 16 forms of errors found from the 30 students written test result sheets on trigonometry material, namely:

1) Triangle concept error
2) Error concept of right angle
3) Mistakes in using the Pythagorean theorem
4) Error in determining the solution of trigonometric equations
5) Mistakes in using trigonometric identities
6) Error in converting angles in degrees to radians
7) Errors in using trigonometric ratio formulas in right triangles
8) Error in converting angles in radians to degrees
9) Mistakes in using the concept of related angles
10) Error in determining the value of the trigonometric ratio of special angles
11) Error in using the cosine rule
12) Errors in using the concept of trigonometric ratios of angles in all quadrants
13) Error simplifying fraction form
14) Calculation error
15) Error multiplying both sides by a number
16) Error multiplying root form

The forms of errors are grouped into three types of errors, namely conceptual errors, principle errors and algorithm errors. The type of concept error is error number i and ii. The types of principle errors are errors number iii, iv, v, vii, viii, ix, x, xi, and xii. While the types of algorithm errors are xiv, xv, and xvi errors.

Based on 30 students, it is known that there are 26 students who make conceptual errors, 16 students make mistakes in principle and 13 students make algorithm errors. The following is the calculation of the percentage of students for each type of error which can be seen in Table 1.

Table 1: Percentage of Students Who Make Errors in Solving Trigonometry Problems

No	Error Type	Number of Students Doing Error	Percentage
1	Concept error	26	$\frac{26}{30} \times 100\% = 86{,}7\%$
2	Principle error	16	$\frac{16}{30} \times 100\% = 53{,}3\%$
3	Algorithm error	13	$\frac{13}{30} \times 100\% = 43{,}3\%$

The percentage of concept errors that is 86.7% is very influential on students' understanding in mastering trigonometry material. Marpaung (2018) explained that conceptual errors were found in students with high, medium and low abilities when answering math problems. However, the principle error and algorithm error of 53.3% and 43.3%, respectively, do not mean anything. Of the 10 questions given in the written test, there were students who did not answer all the questions. The most unanswered questions were numbers 4, 5, 7 and 9. There were 15 students out of 30 students who took the test only to leave their answers blank on these numbers. This means that almost all students who did not answer the question number. The next question which was also not answered by the second most students was question number 10. There were 11 students who did not answer this question.

Based on the description above, the indicators related to the questions in the previously mentioned numbers are difficult material for students. These indicators are (1) Determining the value of trigonometric ratios of angles in all quadrants; (2) Converting polar coordinates to Cartesian coordinates and vice versa; (3) Proving and using simple trigonometric identities in problem solving; (4) Draw graphs of trigonometric functions using tables and unit circles; and (5) Solve simple trigonometric equations.

Based on the data obtained from the research, it can be seen that the errors made by students are not absolute in the achievement of certain indicators. Instead, students make a lot of mistakes related to prerequisite knowledge. Errors regarding the concept of a triangle at number 9 with a question indicator that is using the rules of sine, cosine and the formula for the area of a triangle in solving problems, were carried out by 18 students. Errors regarding the concept of right angles in number 2 with the question indicator, namely determining the value of trigonometric comparisons in right triangles, were made by 8 students. Errors in using the Pythagorean theorem in number 2 were made by 6 students. Furthermore, the error in simplifying the form of fractions in number 7 with an indicator, namely solving simple trigonometric equations, was carried out by 4 students. Thus, it can be concluded that the achievement of indicators is not the main problem for students in solving problems. But many students make mistakes in their prerequisite knowledge.

Interview Result

The interview in this study aims to determine the causes of conceptual errors, principle errors and algorithm errors made by students in solving trigonometry problems. The

selection of interview subjects was carried out using a purposeful technique. Therefore, the interview subjects selected 9 students who made the most mistakes in concepts, principles and algorithms.

Interview data were analyzed by reducing, presenting and concluding data. At the data reduction stage, the researcher recorded the causes of each error made by each interview subject. Table 2 shows the results of data reduction results interview.

Table 2: Reduction of Interview Result Data

Error type	Interview subject code	Interview question number	Error cause code
Concept error	$15X_1$	3	iii
		9	iii
	$24X_1$	3	iii, iv
		5	iii
		9	iii
	$29X_1$	5	iii
		9	iii
Principle error	$17X_1$	3	ii
		5	i
		7	ii
		9	ii
	$21X_1$	1	i, ii
		2	ii
		4	i
	$25X_1$	5	ii
		7	i, iii
		10	ii, iii
Algorithm error	$4X_1$	2	i
		7	i
		9	i
	$10X_1$	2	i
		5	i
		8	i
	$13X_1$	4	i
		5	i
		7	i

Information:
1) Carelessness
2) Misunderstanding of students about a material
3) Lack of students' understanding of prerequisite knowledge
4) Misreading the question

Table 2 above shows that the cause of the error is dominated by carelessness. Of all the mistakes made by the 9 students, the factor of carelessness was experienced 13 times. Errors caused by understanding the material that were not correct were experienced 7 times. Errors caused by students not understanding the prerequisite knowledge were experienced 9 times. Meanwhile, errors caused by reading errors were only experienced 1 time.

Some of the reasons students make mistakes and why so many questions are not answered by students, including the time factor, motivation, and student readiness when the test is given.

The factors that cause student errors in solving trigonometry problems are as follows.

1) Carelessness

Carelessness is the most common excuse that students admit when asked during an interview. Students make carelessness when making miscalculations (Marpaung, 2018: 22). With In other words, students are in a hurry to solve problems. Not only is it a cause for conceptual errors, carelessness also causes students to make principle errors and algorithm errors. The reason for rushing, not being careful, wanting to finish quickly shows the student's carelessness.

2) Misunderstanding of students about a material

Most students who make mistakes in principle express that they do not understand the material being asked. There are also students who admit that they are hesitant and even often go back and forth in using or remembering the formulas used in solving problems. For example, converting angles in radians to degrees and vice versa. In addition, there are also students who remember the formula correctly, but did not use it correctly when solving problems. This happened to one of the students who only memorized the trigonometric comparison formula in a right triangle but could not use the formula.

3) Lack of students' knowledge of prerequisite knowledge

Prerequisite knowledge is knowledge that students must have before studying the next material. This means how important the prerequisite knowledge is. If students know the prerequisite material, students will experience errors in solving problems.

4) Misreading the questions

Mistakes in reading questions can lead to errors in solving problems. Because the information provided in the questions will be useful in getting the correct answer. This happened to one of the students, because not reading one word in the question resulted in an error in the answer. Yet that one forgotten word is important information in getting the right answer.

Of the four causes of errors above, carelessness and mistakes in reading questions are in accordance with Newman's theory (Watson, 1980; 321). That students' mistakes in solving math problems are procedural errors such as miscalculation (carelessness). Meanwhile, two other causes, such as students' misunderstanding of the prerequisite knowledge, can also lead to errors made by students in solving trigonometry problems.

4. Conclusion

In conclusion, there was a positive direct influence on mathematical connections to problem solving abilities. Also, there was a positive direct effect of mathematical communication on mathematical connection skills. In addition, there was a positive indirect effect of mathematical communication skills on problem solving abilities through mathematical connection skills. But the direct effect is not significant.

References

[1] Abidin, Z. (2012). Analisis Kesalahan MahasiswaProdi Pendidikan Matematika Fakultas Tarbiyah IAIN Ar-Raniry dalam Mata Kuliah Trigonometri dan Kalkulus I. *Jurnal Ilmiah DIDAKTIKA, XIII* (1), 183-196.
[2] Hidayat, A.S. (2008). *Diagnosa dan Remidi Kesulitan Belajar Matematika.* Disajikan pada Pendidikan dan Pelatihan Profesi Guru. Universitas Pendidikan Indonesia.
[3] Bahri, A.H., dkk. (2016). The Profile of Teacher's Understanding on Student's Mathematics Ability Based on Teacher's Teaching at SMPN 1 Gantarangkeke. *Jurnal Daya Matematis, 4* (2), 119-128.
[4] Layn, M.R., dkk. (2017). Analisis Kesalahan Siswa dalam Menyelesaikan Soal Cerita Matematika. *Jurnal Math Educator Nusantara,* 3 (2), 95-102.
[5] Watson, I. 1980. *Educational Studied in Mathematics II.* Dordrecht, Holland and Boston, U.S.A: D. Reide Publishing Co.
[6] Widdiharto, R. (2008). *Diagnosis Kesulitan Belajar Matematika SMP dan Alternatif Proses Remedinya.* Yogyakarta: Pusat Pengembangan dan Pemberdayaan Pendidik dan Tenaga KependidikanMatematika.