ANALYSIS OF STUDENT ERRORS IN SOLVING TRIGONOMETRIC FUNCTION LIMIT

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Abstract

Every student can make mistakes with the same or different types of questions given. Various factors, both internal and external, cause students to make these mistakes. Several types of errors commonly made by students consist of conceptual errors, principal errors, and procedural errors. This research is qualitative research with a descriptive method, aimed at finding out the types of errors made by class. The research consisted of 3 students. Data collection techniques in this research are tests and interviews. After the students were given the test, 3 students were selected to be used as research subjects. Next, the researcher conducted interviews with 3 research subjects to find out the factors that caused students to make mistakes. The result show that the mistakes made by students are conceptual errors, principles errors and procedural errors. conceptual errors and procedural errors. The dominant conceptual errors made by research subjects are errors in determining how to solve the limits of trigonometric functions and errors in carrying out operations. Mistakes made by students in solving trigonometric function limit problems are caused by various factors. The dominant factor that causes students to make conceptual errors is that students do not understand the concept of limits, while the dominant factor that causes students to make procedural errors is errors in carrying out calculations.

Keywords: Student Errors, Limit of Trigonometry Function

Abstrak

Setiap siswa memiliki peluang untuk melakukan kesalahan dengan jenis yang sama ataupun berbeda dari setiap soal yang diberikan. Berbagai faktor baik intenal maupun ekternal yang menyebabkan siswa melakukan kesalahan tersebut. Beberapa jenis kesalahan yang biasa dilakukan oleh siswa terdiri atas kesalahan konsep, kesalahan prinsip, dan kesalahan prosedur. Penelitian ini adalah penelitian kualitatif dengan metode dekskriptif, bertujuan untuk mengetahui jenis−jenis kesalahan yang dilakukan siswa kelas XI IPA SMA dalam menyelesaikan soal limit fungsi trigonometri dan untuk mengetahui faktor−faktor yang menyebabkan siswa melakukan kesalahan konsep, kesalahan prinsip dan kesalahan prosedur, dengan subjek penelitian berjumlah 3 siswa. Teknik pengumpulan data dalam penelitian ini adalah tes dan wawancara. Setelah siswa diberikan tes maka selanjutnya terpilih 3 siswa yang dijadikan sebagai subjek penelitian. Selanjutnya peneliti melakukan wawancara terhadap 3 subjek penelitan untuk mengetahui faktor−faktor yang menyebabkan siswa melakukan kesalahan. Kesalahan yang dilakukan siswa adalah kesalahan konsep, kesalahan prinsip dan kesalahan prosedur. kesalahan konsep dan kesalahan prosedur. Kesalahan konsep dominan dilakukan subjek penelitian adalah kesalahan dalam menentukan cara penyelesaian limit fungsi trigonometri dan kesalahan dalam melakukan operasi. Kesalahan yang dilakukan siswa dalam menyelesaikan soal limit fungsi trigonometri disebabkan oleh berbagai faktor. Faktor dominan yang menyebabkan siswa melakukan kesalahan konsep adalah siswa kurang memahami konsep limit sedangkan Faktor dominan yang menyebabkan siswa melakukan kesalahan prosedur adalah salah dalam melakukan perhitungan.

Keywords: Kesalahan siswa, Limit Fungsi Trigonometry

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Mathematics education has an important role because mathematics is a basic science that is widely applied in all fields (Satriani & Usman, 2018). By studying mathematics, students can develop the ability to think logically, systematically, and carefully. Based on this, students need mathematics

learning in various fields. For this reason, mathematics learning for students must be optimized so that students can utilize what they have learned. Mathematics has an important role in several other fields of science. (Wibowo, 2016).

Calculus is a branch of mathematics that has a fairly broad scope, including the concepts of limits, derivatives, integrals, and infinite series (Satriani et al., 2020). Calculus is considered a very important branch of knowledge not only in the field of science but is also often widely applied in the fields of economics, engineering, and so on. One of the important materials in calculus is the limits of trigonometric functions. The material on limits of trigonometry functions is one part that is still difficult for students to understand. There are still many students who experience errors in solving questions. An error in completing a question is a mistake that deviates from the correct answer and the cause of the error is determined by the student's competence (Deki, 2023). Based on observations, it was found that when working on trigonometric function limit questions, students made mistakes when solving trigonometric function limit questions. Mistakes made by students are errors in answering questions and errors in writing the final results. Through interviews with subject teachers, students still find it difficult to solve questions related to limits of trigonometric functions and students make mistakes in solving problems in the form of writing down trigonometric function formulas incorrectly and students do not understand the material related to limits of trigonometric functions.

Haryono explained that errors in solving mathematics problems were conceptual errors and non-conceptual errors (Amir, 2015). Conceptual errors are errors caused by students in interpreting concepts or errors in applying them. Meanwhile, non-concept errors are errors in procedures and errors in using principles. The types of student errors are fact errors, principles errors, concept errors, and operational errors (Kepa & Ramli, 2021). Meanwhile, Kastolan separates the types of errors in the form of conceptual errors and procedural errors (Amir, 2015).

Every student makes mistakes of the same or different type in each question given. Previous research conducted by (Adhim & Amin, 2019);(Salido et al., 2014) revealed that the types of students' errors in solving trigonometric function limit problems were; conceptual errors, principle errors, and procedural errors. Conceptual errors are student errors related to concepts in solving problems. Principle errors are students' mistakes in applying mathematical formulas related to the material on limits of trigonometric functions. The cause of students' errors when solving trigonometric function questions was the students' inability to determine the correct formula to solve trigonometry problems (Andriani et al., 2017; Wahid et al., 2021; Ferdiansyah et al., 2022; Satriani et al., 2020). Suryana et al (2019) stated that the reason why students make mistakes when solving trigonometric function limits questions is due to many factors, including low ability to understand the material on trigonometric function limits, students are too hasty in solving problems, students do not know the formulas to be used. in solving problems and students make mistakes in determining how to solve problems regarding the limits of trigonometric functions. The novelty of this research compared to previous studies is that the last

research studied more about the factors that cause student errors. In contrast, this research not only examines the factors that cause student errors but also examines the types of errors experienced by students in their studies and solved linear problems of trigonometric functions. Apart from that, there is not much research that examines students' errors in the material on limits of trigonometric functions. From this, this research aims to find out the types of mistakes made by students in solving trigonometric function limit problems and to find out the factors that cause students to make conceptual errors, principles errors, and procedural errors.

METHOD

This research uses descriptive qualitative research, namely research that naturally describes the facts that occur to the research subject. The research subjects consisted of three people who were selected based on the results of the diagnostic tests obtained for in-depth interviews. The consideration for choosing these three subjects was because they were subjects who represented students who were assessed as having made several types of errors after a diagnostic test was carried out. Apart from that, the subjects could also communicate well so they could explain the reasons why these errors occurred. The data sources in this research are adjusted to the research focus and research objectives, namely secondary data originating from documents in the form of journals, books, theses, and other documents and primary data originating from student test results, and interview results with students who are research subjects and teachers as well as observation results. Data collection instruments used student learning outcomes tests, observation sheets, and interviews. Data was analyzed using three stages, namely data reduction, data display, and data verification stage. The data analysis technique in this research is a data reduction technique in the form of analyzing the results of student answers to identify types of student errors in solving trigonometric function limit problems, grouping the errors found into conceptual errors, principles errors, and procedural errors that are adjusted to each indicator. errors, classifying students into three types of errors based on the type of error they made, then the data is presented in the form of narrative text, then presented in the form of pictures and tables to make it easier to understand, and finally draws conclusions in the form of summarizing the data results that have been obtained from the previous process. Testing the validity of the data uses the triangulation method to find the suitability of the test, observation, and interview data.

RESULTS AND DISCUSSION

Exposure Data for Subject 1 (S1)

The following is the form of the question.

$$\text{Determine the value of } \lim_{x \to 0} \frac{x \tan 4x}{\sin^2 x}!$$

S1's answer to the question above can be seen as follows:

Figure 1. The S1's answer in answering the question.

Based on Figure 1, S1 seems to have made mistakes from the start in solving the questions. S1's first error was that the subject did not factor $x \tan 4x$ into $x \times \tan 4x$. S1's second error was that the subject did not factor $sin^2 x$. Based on the results of the interview, information was obtained on the reason why not factoring because S1 did not know about the concept of factoring. S1's third error was that the subject was wrong in determining how to solve the problem. S1's fourth error was the subject's error in writing the formula $sin^2 x$ equals 4. This error was an error in writing the trigonometric function formulas. S1's fifth error was that the subject omitted x in $x \tan 4x$ and immediately carried out the division operation 4/4 = 2 This error was an incomplete error in writing the answer. Based on test and interview results data, the errors made by S1 in answering the questions above were conceptual errors, principles errors, and procedural errors. Conceptual errors made by S1 were errors in determining how to solve problems regarding the limits of trigonometric functions and errors in understanding the concept of factoring methods. The principles error made by S1 was writing the trigonometric function formula incorrectly and writing the answer incompletely. The procedural error made by S1 was an error in carrying out the operation in solving the problem.

Exposure Data for Subject 2 (S2)

The answer to the same question as the previous subject by the second subject can be seen in the image below.

Figure 2. The S2's answer in answering the question.

Based on Figure 2, you can see several mistakes made by students, namely S3's first mistake was an error in writing the limit symbol. S2 does not write the limit symbol at $\frac{x \tan 4x}{sin^2 x}$. Repeated errors are written down at the next stage $\frac{x \tan 4x}{\sin x \sin x}$. Repeated errors are written in the next stage $\frac{x}{\sin x}$ and $\frac{\tan 4x}{\sin x}$. S2's error in not writing the limit symbol is an error in writing the limit symbol. This error is a procedural

error. S2's second mistake was carrying out the operation incorrectly. S2's error when solving $\lim\limits_{x\to 0}\dfrac{x}{\sin x}$ and $\lim\limits_{x\to 0}\dfrac{\tan 4x}{\sin x}$ where S2 wrote the next move with $\dfrac{1}{1}$. S2's error in writing the continuation of the answer $\dfrac{x}{\sin x}\times\dfrac{\tan 4x}{\sin x}$ is an error in carrying out the operation. Errors in carrying out operations are procedural errors. The consideration for choosing these three subjects was because they were subjects who represented students who were assessed as having made several types of errors after a diagnostic test was carried out. Apart from that, the subjects could also communicate well so they could explain the reasons why these errors occurred. Based on the test results and interview results, the error made by S2 in answering the question above was a procedural error. The procedural errors made by S2 were errors in writing the limit symbol and errors in carrying out operations.

Exposure Data for Subject 3 (S3)

The answer to the same question as the previous subject by the second subject can be seen in the image below.

Figure 2. The S3's answer in answering the question.

Based on Figure 3, you can see several mistakes made by students, including the first mistake is that S3 did not write the limit symbol on $\dfrac{x\tan 4x}{\sin^2 x}$. The second error is that S3 does not write the limit symbols on $\dfrac{x}{\sin x}$ and $\dfrac{\tan 6x}{\sin x}$. The third error is that S3 reduces $\dfrac{x\tan 4x}{\sin x\sin x}$ to $\dfrac{x}{\sin x}$ and $\dfrac{\tan 6x}{\sin x}$. These errors are errors in writing the limit symbol and errors in carrying out operations. This error falls into the category of procedural error. Based on the results of the interview, information was obtained regarding the student's error in not writing the limit symbol in his answer because the student did not know the importance of writing this symbol, so S3 assumed that even though he did not write the limit symbol, the answer was still correct. Meanwhile, due to an operation error when writing $\dfrac{x\tan 4x}{\sin x\sin x}$ to $\dfrac{x}{\sin x}$ and

$\frac{\tan 6x}{\sin x}$, information was obtained that S3 incorrectly wrote the value 6 which should be 4.

Of the three subjects above, the errors made by students are predominantly conceptual and procedural. Conceptual errors are the most crucial type of error that occurs when solving mathematics problems (Ferdiansyah et al., 2022). Errors in determining how to solve trigonometric function limit problems are relevant to the results of research conducted by Adhim & Amin (2019) which concluded that the types of conceptual errors made by students were in the form of incorrect concepts about the mathematical models used in solving problems. Errors in determining how to solve the limits of trigonometric functions are following the results of research conducted by Salido et al. (2014) which concluded that the cause of students making conceptual errors was that students did not understand the concept of determining the limit values of ladder functions. The error in determining how to solve the limits of trigonometric functions is in line with research conducted by Sumedi & Bennu (2020) which concluded that the conceptual error made by students was that students were unable to solve the problem. In subject 1 who did not do factoring, it is relevant to the results of research conducted by Manibuy (2014) which concluded that the type of conceptual error made by KMT students was misunderstanding the concept of factoring. The factor that causes subjects to make conceptual errors is that students do not understand the concepts involved in solving trigonometric function limit problems. These factors cause the subject to make mistakes in factoring. The factor of students not understanding the concepts involved in solving trigonometric function limit problems is in line with the results of research conducted by Andriani et al. (2017), which concluded that the cause of students making conceptual errors came from themselves (internal factors) in the form of not understanding the concepts properly. correctly. Meanwhile, procedural errors seen in S1, S2, and S3 are predominantly seen as errors in carrying out operations. The factor is that students are not careful in writing answers relevant to the results of research conducted by Adhim & Amin (2019) which concludes that the factor causing students to make mistakes is that the subject is wrong in writing the conclusion according to the conclusion requested in the question. It is also in line with the previous studies that procedural errors made by students were mistakes in writing that (Sumedi & Bennu, 2020; Wahid et al., 2021; Rahmania & Rahmawati, 2016).

CONCLUSION

The conclusion that can be obtained from the research above is that several types of errors are seen to be made by students in solving trigonometric function limit problems, including students making conceptual errors and procedural errors. The dominant conceptual errors made by research subjects are errors in determining how to solve the limits of trigonometric functions and errors in carrying out operations. Mistakes made by students in solving trigonometric function limit problems are caused by various factors. The dominant factor that causes students to make conceptual errors is that students do not understand the concept of limits, while the dominant factor that causes students to make procedural

errors is errors in carrying out calculations. To minimize the errors that occur in students when solving trigonometric function limit questions, it is necessary to provide lots of exercises such as question banks which contain a variety of questions that can hone students' abilities in solving similar or modified problems related to trigonometry material.

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