(JIML) JOURNAL OF INNOVATIVE MATHEMATICS LEARNING
Volume 8, No. 1, March 2025

P-ISSN 2621-4733
E-ISSN 2621-4741

https://dx.doi.org/10.22460/jiml.v8i1.p27152

ANALYSIS OF STUDENTS' ERRORS IN SOLVING ALGEBRAIC FUNCTION LIMIT PROBLEMS BASED ON BLOOM'S TAXONOMY

Sakdiah[1], Rama Nida Siregar[2]

[1]UIN Syekh Ali Hasan Ahmad Addary Padangsidimpuan, Jl. T. Rizal Nurdin, Km. 4,5 Sihitang, Padangsidimpuan, Indonesia.
sakdiahnasution57@gmail.com

[2]UIN Syekh Ali Hasan Ahmad Addary Padangsidimpuan, Jl. T. Rizal Nurdin, Km. 4,5 Sihitang, Padangsidimpuan, Indonesia.
ramanidasiregar575@gmail.co.id

ARTICLE INFO

Article history:

Received Jan 17, 2025
Revised Feb 22, 2025
Accepted Mar 27, 2025

Keywords:

Students' Errors
Algebraic Function Limits
Bloom's Taxonomy
Problem Solving

ABSTRACT

Understanding mathematical concepts is a fundamental component in effective mathematics learning. When students lack conceptual understanding, their ability to solve problems accurately such as in the topic of algebraic function limits is significantly hindered. This study aims to identify the causes of students' incorrect answers in solving limit problems of algebraic functions based on Bloom's Taxonomy. A qualitative descriptive research method was employed to explore this issue. Data were collected using a written test consisting of three essay questions constructed to represent different levels of Bloom's Taxonomy, followed by brief interviews with selected students. The research involved Grade 11 students who had previously studied the limit of algebraic functions. The students' answers were analyzed to classify types of errors and identify patterns related to specific cognitive levels. The results indicated that all students answered correctly at the C1 and C2 levels (remembering and understanding). However, at the C3 and C4 levels (applying and analyzing), students commonly made Encoding Errors and Transformation Errors. At the higher cognitive levels C5 and C6 (evaluating and creating) Process Skills Errors and Comprehension Errors were more prevalent. These findings suggest that students struggle more as the cognitive demands of questions increase, indicating a lack of problem solving practice and insufficient exposure to high level thinking tasks. In conclusion, strengthening instructional strategies that target higher order thinking skills is necessary to help students develop deeper mathematical understanding.

Corresponding Author:
Sakdiah,
Masters Program in Mathematics Education,
UIN Syekh Ali Hasan Ahmad Addary Padangsidimpuan,
Jl. T. Rizal Nurdin, Km. 4,5 Sihitang, Padangsidimpuan, Indonesia
Email: sakdiahnasution57@gmail.com

How to Cite:

Sakdiah, S., & Siregar, R. N. (2025). Analysis of Students' Errors in Solving Algebraic Fuction Limit Problems based on Bloom's Taxonomy. *JIML*, 8(1), 160-172.

INTRODUCTION

Mathematics is a fundamental science that plays an essential role in the development of science and technology. It is closely associated with formulas and calculations (Manalu et al., 2019), and is widely used to solve real-life problems that we often encounter in daily life (Sholihah & Mahmudi, 2015). Additionally, mathematics helps students develop structured thinking patterns (Surat, 2016). Thus, learning mathematics is crucial for students (Wiliawanto et al., 2019). As an exact science, mathematics requires more understanding than memorization (Suswigi & Zanthy, 2019). In mathematics, it is very closely related to problem-solving abilities and students' conceptual understanding (Siregar et al., 2022; Siregar, 2023). Problem solving is one of the important competencies in mathematics learning because it involves critical, logical, and creative thinking skills in finding solutions to problems faced (Nurlelah et al., 2023; Siregar et al., 2022). This problem-solving ability not only helps students in solving math problems, but also in dealing with various real-life situations that require rational and systematic decision-making (Firmansyah et al., 2025). In the problem-solving process, students are required to understand the problem, design a solution strategy, implement the strategy, and review the results obtained (Siregar et al., 2024). However, various studies show that many students still have difficulty solving math problems due to a lack of conceptual understanding, inappropriate solution strategies, and low high-level thinking skills (Silvia & Hendriana, 2023; Hazim et al., 2024; Rusmawan, et al., 2024; Gunawan & Yuspriati, 2024). Therefore, the assessment of problem-solving abilities and mathematical understanding is an aspect that needs to be emphasized in mathematics learning in schools. One of the topics in mathematics that really requires conceptual understanding in solving problems is the concept of limits, especially the limits of algebraic functions. The limits of algebraic functions is a fundamental topic taught in high school, particularly in grade XI. Understanding the concept of limits is necessary because it serves as the basis for mastering more complex topics such as derivatives and integrals (Hartono & Noto, 2017). The application of limits is not only found in mathematics but also widely used in physics, engineering, and other fields (Ghozi & Hilmansyah, 2018). In learning mathematics, conceptual understanding allows students to relate and apply concepts accurately and efficiently in solving problems (Maharani et al., 2013). However, many students still struggle with this, as shown in several studies (Rachman & Saripudin, 2020; Yuliani et al., 2018; Damayanti et al., 2017).

Errors in solving mathematical problems are often indicators of weak conceptual understanding. These errors arise due to a lack of strategy in problem-solving, especially in interpreting problems, choosing appropriate methods, and carrying out procedures correctly (Fitriani & Yuliani, 2016; Ario & Asra, 2018). Observations at MAN Tapanuli Selatan show that students often make mistakes in solving limit problems, particularly algebraic limits, due to poor conceptual grasp, as evidenced by their low performance in daily mathematics assessments.

Newman's Error Analysis provides a comprehensive framework for analyzing students' problem-solving errors, categorizing them into five types: reading errors, comprehension errors, transformation errors, process skills errors, and encoding errors (Karnasih, 2015; Jha, 2012; Singh et al., 2010). These categories help identify specific weaknesses in students' cognitive processes during problem-solving. Table 1 below outlines the indicators of each type of error:

Table 1. Factors and Indicators of Student Errors

Error Type	Indicators
Reading Error	Students cannot interpret words, symbols, or terms in the question.
Comprehension Error	Students fail to identify all the given information accurately.
Transformation Error	Students cannot translate information into mathematical models or formulas.
Process Skills Error	Students do not know the procedures or steps to solve the problem.

Encoding Error	Students cannot reach or state the correct final answer.

Previous studies (Agnesti & Amelia, 2020; Aulia & Kartini, 2021; Manalu & Zanthy, 2020; Septiahani et al., 2020) have explored student errors in solving math problems, while others have focused on conceptual understanding (Kurniadi et al., 2020; Munasiah, 2021; Radiusman, 2020; Wijaya et al., 2018). However, this study differs in terms of analysis technique, research subject, topic focus, and research setting. Unlike prior studies, this research employs Bloom's Taxonomy as a cognitive framework to analyze students' errors according to different levels of thinking—from applying (C3), analyzing (C4), evaluating (C5), to creating (C6).

The purpose of this study is to describe and analyze the types and percentages of students' errors in solving algebraic function limit problems based on Bloom's Taxonomy levels. This study aims to provide deeper insight into students' conceptual misunderstandings and propose instructional improvements that address these cognitive errors.

METHOD

This study uses a qualitative approach method with a qualitative descriptive research type. The form of analysis is in the form of qualitative data analysis presented in the form of descriptive words and does not use hypotheses (Anugrah & Pujiastuti, 2020). The study was conducted at MAN Tapanuli Selatan Class XI semester 1. The determination of the subjects of this study used purposive sampling based on the research objectives obtained criteria that were used as references in the data source. In this study, the researcher took 10 students as sampling subjects with different levels of understanding of mathematics. The research instrument was a written test containing 3 essay questions on the limit of algebraic functions that were made according to the cognitive domain of Bloom's taxonomy. Question item 1 contains indicators of questions defining and interpreting the limit of algebraic functions (C1 and C2). Question item 2 contains indicators of questions calculating and examining the results of the limit of algebraic functions (C3 and C4). Question item number 3 contains indicators of questions validating and reconstructing so that students need to prove the results of the limit of algebraic functions (C5 and C6). After being given a written test, interviews were conducted with students to validate the answers given. The instrument used was adopted from previous research by Melinda, 2017 and Wibowo, 2015. The instrument has been tested in advance so that the questions are suitable for use.

Data analysis was carried out based on the results of the students' work who were the subjects of the study. The implementation of this study consisted of three stages, namely the preparation stage, the implementation stage, and the data analysis stage. In the preparation stage, the researcher collected questions on the limits of algebraic functions that were suitable for testing. After the questions were collected, the implementation stage was carried out, namely the researcher gave written test questions to students. Then interviews were conducted with students regarding the results of the written test answers to validate students' abilities. In the final stage, the results of the students' written tests were presented with a summary in the form of a table containing the students' initials and the percentage of scores from each student's answers on each question item. Then from the table it was analyzed to draw a conclusion.

Data collection techniques used tests and observations. The test was carried out by giving students conceptual understanding questions. Meanwhile, observations were carried out based on the teacher's explanation of the conditions of mathematics learning in the classroom and based on the data on the students' daily mathematics test scores given by the teacher. The test research instrument consists of 3 descriptive questions on the material of algebraic function limits which refer to the mathematical concept understanding ability test questions. In this study, it refers to the concept understanding indicators by Juliana and Zanthy (2020) which are explained in Table 2 below.

Table 2. Questions and Indicators of Conceptual Understanding Ability in the Material on Limits of Algebraic Functions

Question Number	Question Items	Indicators of Mathematical Concept Understanding Ability
1	If $\lim_{x \to a^+} f(x) = \lim_{a^-} f(x) = L$ So the value $\lim_{x \to a} f(x) = L$	• Define concepts in writing. (C1 and C2)
2	The value of $\lim_{x \to 3} \frac{3x^2 - 8x - 3}{2x - 6}$	• Calculate and examine the results of the limits of algebraic functions. (C3 and C4)
3	Prove that $\lim_{x \to 0} \frac{\tan x}{x} = 1$	• validate and reconstruct so that students need to prove the results of the limits of algebraic functions. (C5 and C6)

RESULTS AND DISCUSSION

Results

This study aims to identify students' abilities in solving algebraic function limit problems based on Bloom's taxonomy levels, and to determine the types of errors made by students in the process of solving the problem. In question number one, the results obtained from ten students who were made into subjects were able to answer correctly, where question number one was a question about the concept of algebraic function limits with levels in Bloom's taxonomy, namely at levels C1 and C2. For question number 2, which is about calculating and examining limit results with levels in Bloom's taxonomy, namely at levels C3 and C4, various answers were obtained, 6 students were able to answer correctly, namely on behalf of (siti sarah, lili putri, wulan safitri, khoirul adjam, rezki ramadhani and desti aulia). Other students got less than perfect answers on behalf of (salika Olivia, Indah juliana, seri aini and mawaddah bara). Of the four students, the error was in the final answer, not understanding how to substitute the value of x for its limit function and not being careful in calculating the multiplication to substitute the value of x.

For question number 3, it contains indicators of validating and reconstructing questions so that students need to prove the results of the limits of algebraic functions with levels in Bloom's taxonomy, namely levels C5 and C6, obtained from 10 students only 3 students answered correctly (on behalf of Siti Sarah, Wulan Safitri and Khoirul Adjam) there are several students who do not understand the limit theorem for trigonometric functions so that they are overwhelmed in finding the final result of the question.

To better understand the causes of errors in answering these questions, researchers have interviewed students who answered incorrectly, and obtained several answers from these students where the obstacles lie so that the questions given cannot be answered correctly.

The following are the results of interviews with researchers with several students who answered the questions tested incorrectly.

on number 2 which is about calculating and examining the limit results with levels in bloom's taxonomy, namely at levels C3 and C4, there are 4 students who have not found the right answer. To find out the cause of the wrong answer, here are the results of an interview with a student who answered incorrectly named IJ.

P	:	*In number 2 why did you answer wrong in the part of substituting the value of x=3 into the function equation? Doesn't substituting mean replacing each value of x in the function with 3?*
IJ	:	*Sorry ma'am I was wrong, because because I still don't understand the problem of the limit of this algebraic function, I should only need to replace the value of x with a value that is close to it.*
P	:	*Okay, fine, if you encounter a problem like that, it's a good idea to look at and study the steps to solve it in the book and if necessary, you can watch on YouTube how to solve problems like that.*
IJ	:	*Okay ma'am, I'll try.*

From the results of the short interview above, it was found that the cause of the student's incorrect answer was Transformation Error, namely that students were unable to create a mathematical model from the information obtained. The following are IJ's answers:

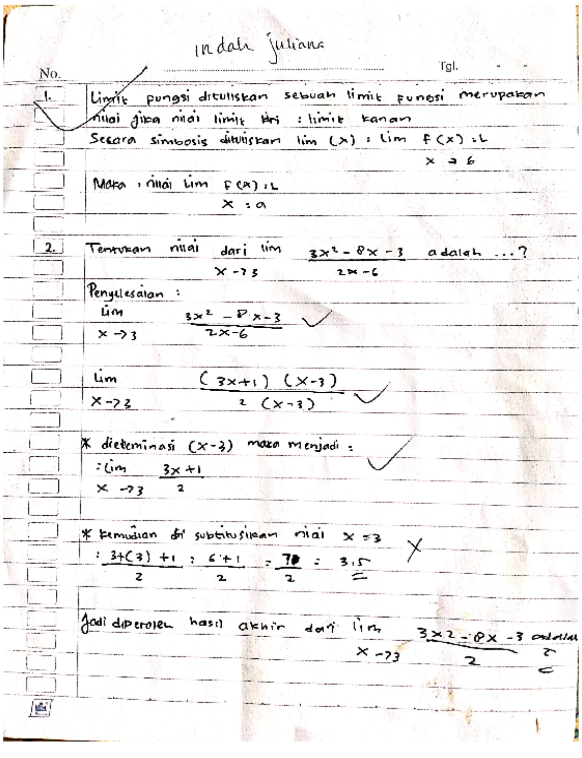
indah juliana
No. Tgl.
1. Limit pungsi ditutiskan sebuah limit punosi merupakan nilai jika nilai limit kri : limit kanan
Secara simbosis dituliskan lim (x) : lim f(x) : L
x → 6
Maka : nilai lim f(x) : L
x : a
2. Tentukan nilai dari $\lim_{x \to 3} \frac{3x^2 - 8x - 3}{2x - 6}$ adalah ...?
Penyelesaian :
$\lim_{x \to 3} \frac{3x^2 - 8 \cdot x - 3}{2x - 6}$
$\lim_{x \to 3} \frac{(3x+1)(x-3)}{2(x-3)}$
* dieleminasi (x-3) maka menjadi :
: $\lim_{x \to 3} \frac{3x+1}{2}$
* kemudian di subtitusikan nilai x = 3
: $\frac{3+(3)+1}{2}$: $\frac{6+1}{2}$ = $\frac{7}{2}$: 3,5
Jadi diperoleh hasil akhir dari $\lim_{x \to 3} \frac{3x^2 - 8x - 3}{2}$ adalah ...

Figure 1. IJ's Answer Indicating Transformation Error in Solving Algebraic Limit Problem

For the same question, a student named SA also answered incorrectly in her final result. To find out the cause of the error, here is an excerpt from a short interview with the student:

P	:	*in question number 2, you have done the steps to answer the question correctly and according to the rules, you have been able to substitute the value that is close to x, namely 3, into its algebraic function, but unfortunately in the final result your answer is wrong, why is that, son?*

SA	:	*Yes, ma'am, I'm sorry I was wrong because I made a slight mistake in the final calculation, namely the division of the algebraic function, ma'am.*
P	:	*Next time be careful, son, because the final result is the result that is expected to be accurate based on the question instructions.*
SA	:	*Yes, ma'am, next time I will be more careful, ma'am.*
P	:	*To be more proficient in calculating algebraic operations, we must often discuss questions related to this, you can also visit YouTube channels that discuss similar problems.*
SA	:	*Okay, ma'am, thank you for your input and suggestions, ma'am.*

From the results of the short interview, it was found that the cause of the student's error in the question was Encoding Error, namely the student could not show the final answer to the problem solving correctly. Here are the Results of SA's Answers:

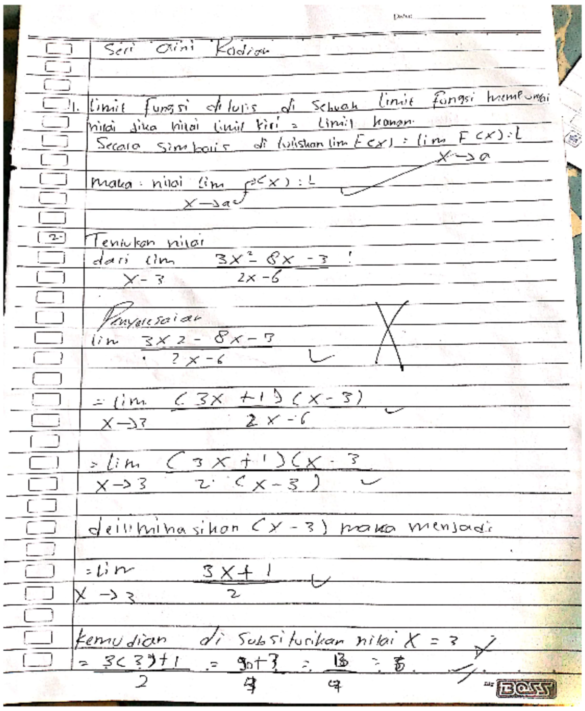

Figure 2. SA's Answer Indicating Transformation Error in Solving Algebraic Limit Problem

After other students whose answers were wrong on question number 2 were corrected, the cause of the student's error was Encoding Error, namely the student was unable to show the final answer to the solution of the problem correctly and Transformation Error, namely the student was unable to create a mathematical model from the information obtained.

Then for question number 3, the question is validating and reconstructing so that students need to prove the results of the limit of algebraic functions with levels in Bloom's taxonomy, namely levels C5 and C6. In this question, students are asked to prove the limit of trigonometric functions. Where in question number 3 there are 7 students who answered incorrectly.

To find out the cause of student errors, here is an excerpt from an interview with students who answered incorrectly, including LW.

P	:	*For question number 3, what obstacles did you face that made your answer less than perfect.*
LW	:	*Yes ma'am, I'm sorry ma'am, actually I don't really understand the purpose of the question ma'am.*
P	:	*But in question number 3, the question instructions are quite clear, son, they only ask you to prove the truth of the equation of the question.*
LW	:	*Yes ma'am, to prove it I was confused in the first step ma'am.*
P	:	*The question is about the limit of a trigonometric function, the first thing we have to master is the concept of trigonometric limits that we have learned before, son.*
LW	:	*Okay ma'am, I will study it again.*
P	:	*Okay ma'am, it would be good if you also practice solving similar questions to strengthen your conceptual knowledge.*
LW	:	*Yes ma'am, thank you for your advice and input ma'am.*
P	:	*Okay ma'am, good luck, I hope you get maximum results.*
LW	:	*Okay ma'am, I will try.*

From the results of a brief interview with the student, the cause of the wrong answer in number 3 is the Process skills error, namely the student does not know the procedure or steps used to solve the problem correctly. So the student is confused about what steps to do first, which results in the final answer being automatically wrong. Here are the results of LW's answers:

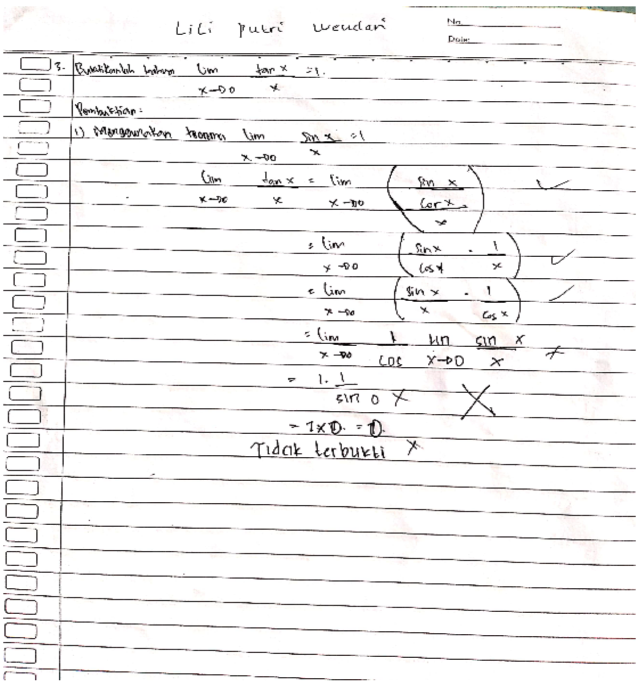

Figure 3. LW's Answer Indicating Transformation Error in Solving Algebraic Limit Problem

Apart from LW, there was also a student named DA who gave the wrong answer. The following is an excerpt from a short interview with DA:

P	:	*Ananda Mawaddah, why is the answer to number 3 incorrect, son?" Are there any obstacles?*
DA	:	*I'm sorry ma'am, in question number 3 I don't quite understand the instructions for the question, ma'am.*
P	:	*Isn't it quite clear in the question that the instructions for the question are to prove the truth of the limit equation of trigonometric functions?*
DA	:	*Yes ma'am, I will be more careful in understanding the instructions for the questions in the next exercise, ma'am.*
P	:	*Okay, son, it's a good idea for you to study questions like this again, you can look at the textbook, or there are also many examples of similar questions on proving the limit equation of trigonometric functions on the internet.*
DA	:	*Okay ma'am, thank you for your advice, ma'am, I will try to study it again, ma'am.*
P	:	*Good luck studying again, son, if you still have obstacles, you can ask me.*
DA	:	*Okay ma'am.*

From the results of a brief interview with DA students, it was found that the cause of the error in question number 3 which is at level 5 in Bloom's taxonomy with the operational verb Proving is Comprehension Error, namely students do not understand what information is known in the question completely so that students do not understand the instructions for the question. Here are DA's answers:

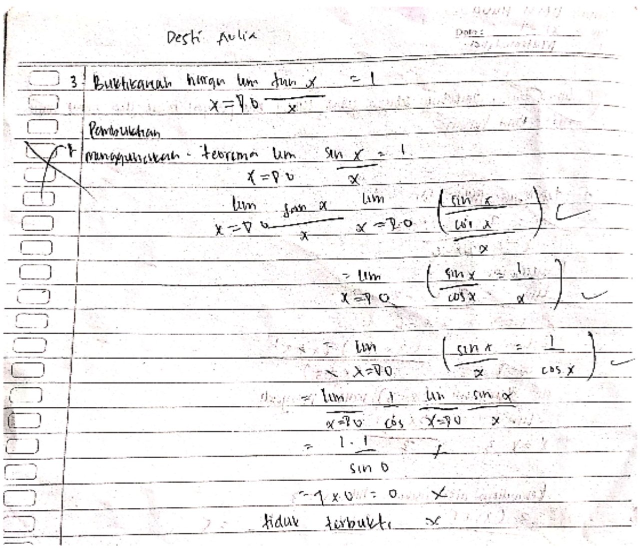

Figure 4. DA's Answer Indicating Transformation Error in Solving Algebraic Limit Problem

After conducting interviews with other students who answered incorrectly on question number 3, it was found that the cause of their errors was also Process skills error, namely students do not know the procedures or steps used to solve the question correctly and Comprehension Error, namely students do not understand what information is known in the question completely so that students do not understand the question instructions.

Thus the results of a brief interview with students who gave incorrect answers to each number with different levels of Bloom's taxonomy. Several causes of student errors were found, namely Transformation Error, Encoding Error, Process skills error and Comprehension Error.

Based on the results of the analysis, it was found that in question number one which is at levels C1 and C2, namely the level of remembering and understanding, all of the ten students who were the subjects of the study were able to answer the question correctly. This shows that at the basic cognitive level, students have a fairly good understanding of the basic concept of the limit of algebraic functions. This is different from question number two which is at levels C3 and C4 (applying and analyzing), where there is diversity in the results of students' answers. Six students, namely SS, LPW, WS, KA, RR, and DA managed to answer this question correctly, while the other four students SO, IJ, SA, and MB made mistakes, especially in the value substitution and final calculation stages. Based on the interviews conducted, two main types of errors were found in this question, namely Transformation Error, as experienced by IJ who had difficulty forming a mathematical model from the information in the question, and Encoding Error as experienced by SA who although understanding the steps of the work, made mistakes in the final result due to inaccuracy in the calculation. Furthermore, in question number three which is at levels C5 and C6, namely evaluating and creating, students are asked to validate and reconstruct by proving the limits of trigonometric functions. As a result, only three students, namely SS, WS, and KA were able to provide correct and complete answers. Meanwhile, seven other students experienced difficulties caused by two types of errors, namely Process Skills Error, as experienced by LPW who did not understand the procedure or steps in solving the question, and Comprehension Error, as in DA who did not understand the information contained in the question and experienced confusion in understanding the instructions given. When compared to previous studies that tend to show that students' errors occur more in the procedural aspect, this study actually reveals that students also face difficulties in the conceptual understanding aspect and translating information into mathematical form. This finding indicates that the learning approach based on Bloom's taxonomy still needs to be strengthened, especially at higher cognitive levels (C5 and C6), so that students are not only able to remember and understand concepts, but also able to apply, analyze, evaluate, and create solutions independently and systematically.

Discussions

The findings of this study highlight the complexity of students' cognitive engagement in solving problems related to algebraic function limits, especially when analyzed based on Bloom's taxonomy. Although mastery of lower-level thinking skills such as remembering and understanding (C1 and C2) was found to be quite high among students, there were striking differences as the cognitive level of the problem increased. At levels C3 and C4 applying and analyzing students began to show frequent errors, and their performance declined significantly at levels C5 and C6, which require the ability to evaluate and create. This finding is in line with the opinion that students often have difficulty applying concepts that have been learned in unfamiliar contexts (Anderson & Krathwohl, 2001). A deeper exploration of the types of errors revealed several patterns. Students who made Transformation Errors had difficulty in transforming verbal or symbolic problems into mathematical models. This indicates a weakness in symbolic representation skills, which are essential abilities in algebraic reasoning (Herman et al., 2024). On the other hand, Encoding Error, an error in providing the correct final answer even though the procedure used is correct, indicates a problem in the accuracy of the calculation and computational accuracy, as discussed in previous research (Poetry et al., 2024).

More striking difficulties occur at levels C5 and C6, where the questions require validation and argumentation related to the limits of trigonometric functions. Students not only lack understanding of limit theorems, but also show Process Skills Error, namely the inability to choose the right problem-solving strategy. In addition, Comprehension Error was also found when students misunderstood the structure of the question or the instructions given. This type of error is very important to note because it shows weaknesses in cognitive understanding as well as metacognitive regulation, as emphasized by Schoenfeld who emphasized the importance of strategic thinking and understanding in solving mathematical problems (Purnomo, 2021).

Unlike previous studies that generally only focus on procedural fluency (Maulani et al., 2021; Novitasari & Pujiastuti, 2020; Nurhayati et al., 2021), this study reveals that students' difficulties cover various cognitive domains. The error analysis conducted not only classifies what is wrong but also explores the reasons behind the errors. In particular, this study shows that not enough attention has been paid to the development of higher-order thinking skills and reflective problem solving in mathematics classes.

The significance of these findings lies in their implications for teaching strategies. Learning strategies need to be adjusted not only to build students' procedural skills but also to develop conceptual understanding, problem representation skills, and strategic planning. Active learning techniques, such as inquiry-based learning and problem-based instruction, can be a solution, as they have been shown to improve higher-order thinking skills and student engagement (Putri et al., 2024).

In conclusion, this discussion confirms that although basic knowledge in mathematics is very important, it is not enough. To produce learners who are able to deal with complex and unfamiliar mathematics problems, there needs to be a shift towards teaching practices that challenge students to think critically, reflectively, and creatively. Future research could focus on developing interventions that target specific types of errors and assess their effectiveness in improving student learning outcomes across cognitive domains according to Bloom's taxonomy.

CONCLUSION

Based on the research objectives to identify students' abilities in solving algebraic function limit problems based on Bloom's Taxonomy levels and the types of errors made by students, it can be concluded that students' abilities vary greatly depending on the cognitive level tested. In questions with levels C1 and C2 which test the ability to remember and understand the basic concept of algebraic function limits, all students (10 out of 10) were able to answer correctly. This shows that basic conceptual knowledge has been mastered well by students. However, at levels C3 and C4, which require the ability to apply and analyze, it was found that only 6 out of 10 students were able to answer correctly. The other four students made errors that can be classified as Transformation Error (inability to form a mathematical model from the information given) and Encoding Error (error in producing the final answer even though the steps are correct).

Furthermore, at the highest levels, namely C5 and C6 which emphasize evaluation and creation, students experience greater difficulties. Only 3 out of 10 students managed to answer correctly, while the rest showed errors such as Process Skills Error (not understanding the solution procedure) and Comprehension Error (inability to understand the contents and instructions of the question as a whole). The results of this study indicate that the higher the cognitive level required in the questions based on Bloom's Taxonomy, the greater the level of errors made by students. This indicates the need to improve learning strategies that not only focus on mastering basic concepts, but also on developing high-level thinking skills, including analysis, synthesis, and evaluation skills.

This study contributes to the development of mathematics education by providing a concrete picture of the challenges faced by students in solving algebraic function limit problems. These results can be used by teachers to design more effective learning, especially at a high cognitive level, through approaches such as problem-based learning and conceptual understanding-based learning. For further development, it is recommended to conduct further research that tests the effectiveness of learning interventions specifically designed to address the types of errors found, as well as expanding the sample so that the results are more representative in general.

ACKNOWLEDGMENTS

The researcher would like to express his sincere gratitude to all individuals and institutions who have contributed to the completion of this research entitled "Analysis of Students' Errors in Solving Limit Problems of Algebraic Functions Based on Bloom's Taxonomy." Special thanks are given to the mathematics teachers and students who actively participated in this research and willingly shared their time and thoughts. Finally, the greatest appreciation is given to all parties who have helped so that the research data can be collected properly until the end.

REFERENCES

Anderson, L. W., & Krathwohl, D. R. (2001). *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom’s Taxonomy of Educational Objectives*. Longman

Arifani, N. H., As’ari, A. R., & Abadyo. (2016). Analisis kesalahan siswa dalam menyelesaikan soal matematika TIMSS menurut teori Newman: Studi kasus pada siswa kelas VIII SMP Negeri 1 Tanjungbumi Bangkalan. *Seminar Nasional Matematika Dan Pendidikan Matematika UNY*, 1(3), 443–448. http://seminar.uny.ac.id/semnasmatematika

Aulia, J., & Kartini. (2021). Analisis kesalahan siswa dalam menyelesaikan soal cerita pada materi himpunan bagi siswa kelas VII SMP/MTs. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 5(1), 484. https://doi.org/10.31004/cendekia.v5i1.280

Az Zahra, S. J. (2019). Analisis kesalahan siswa dalam menyelesaikan soal cerita SPLTV berdasarkan tahapan Newman. *Jurnal Pembelajaran Matematika Inovatif*, 2(2), 364–373. https://journal.ikipsiliwangi.ac.id/index.php/jpmi/article/view/2390

Damayanti, N. W., Mayangsari, S. N., & Mahardika, L. T. (2017). Analisis kesalahan siswa dalam pemahaman konsep operasi hitung pada pecahan. *Edutic - Scientific Journal of Informatics Education*, 4(1), 1–7. https://doi.org/10.21107/edutic.v4i1.3389

Firmansyah, F., Mujib, A., Siregar, R. N., & Mathelinea, D. (2025). Electronic modul contextual learning in mathematics: analizing its impact on student self-efficacy and problem solving abilities. *Jurnal Ilmiah Ilmu Terapan Universitas Jambi*, *9*(2), 495-512. https://doi.org/10.22437/jiituj.v9i2.42554

Gunawan, M., & Yuspriati, D. N. (2024). Analysis of Mathematical Problem Solving Ability of XI Class Vocational Students on Composition Function Material. *(JIML) Journal Of Innovative Mathematics Learning*, *7*(1), 76-83. https://doi.org/10.22460/jiml.v7i1.19360

Hazim, M., Yuliani, A., & Setiawan, W. (2024). The Implementation of Project Based Learning to Improve Students’ Mathematical Understanding and Learning Interest on Junior High School. *(JIML) Journal Of Innovative Mathematics Learning*, *7*(3), 293-302. https://doi.org/10.22460/jiml.v7i3.19850

Herman, T., Andini, M., Nurhanifah, N., & Wulandari, I. (2024). *Kemampuan Berpikir Matematis: Berpikir Relasional, Berpikir Fungsional dan Berpikir Kritis*. Indonesia Emas Group.

Jabnabillah, F. (2022). Analisis kesalahan siswa dalam menyelesaikan soal pemahaman konsep pada materi integral. *Jurnal Ilmu Sosial dan Pendidikan (JISIP)*, 6(2), 74–82. https://doi.org/10.36312/jisip.v6i2.3084

Maulani, M., Alipatan, M., & Khotimah, H. (2021). Kesulitan belajar matematika siswa kelas X ditinjau dari taksonomi bloom revisi ranah kognitif. *Kompetensi*, *14*(1), 40-51. https://doi.org/10.36277/kompetensi.v14i1.44

Malihatuddarojah, D., & Prahmana, R. C. I. (2019). Analisis kesalahan siswa dalam menyelesaikan permasalahan operasi bentuk aljabar. *Jurnal Pendidikan Matematika*, 13(1), 1–8. https://doi.org/10.22342/jpm.13.1.6668.1-8

Nurhanifah, S., et al. (2023). Analisis kesalahan siswa menyelesaikan permasalahan limit fungsi aljabar berdasarkan taksonomi Bloom dan gaya belajar. *Jurnal Pendidikan dan Ilmu Pengetahuan*, 23(3), 115–126. https://doi.org/10.30651/didaktis.v23i3.13393

Novitasari, D., & Pujiastuti, H. (2020). Analisis pemahaman konsep mahasiswa pada materi analisis real berdasarkan taksonomi Bloom ditinjau dari ranah kognitif. *Maju*, *7*(2), 504952.

Nurhayati, E., Nurfauziah, P., & Fitriani, N. (2021). Analisis kesulitan siswa kelas ix dalam memahami materi sistem persamaan linear dua variabel (spldv) dalam pembelajaran daring. *JPMI (Jurnal Pembelajaran Matematika Inovatif)*, *4*(6), 1609-1620. https://doi.org/10.22460/jpmi.v4i6.p%25p

Nurlelah, S., Hendriana, H., & Fitrianna, A. Y. (2023). The implementation of scientific approach to increase mathematical problem solving ability on junior high school students. *(JIML) Journal Of Innovative Mathematics Learning*, *6*(3), 178-185. https://doi.org/10.22460/jiml.v6i3.17580

Poetry, A. S., Prihatiningtyas, N. C., & Hedriana, E. C. (2024). Analisis kesalahan siswa dalam menyelesaikan soal cerita matematika berdasarkan teori nolting. *Jurnal Holistika*, *8*(2), 11-18. https://doi.org/10.24853/holistika.8.2.11-18

Purnomo, D. (2021). *Pola dan perubahan metakognisi dalam pemecahan masalah matematis*. Media Nusa Creative (MNC Publishing).

Putri, R. D., Rahmawati, R., Pujiati, P., & Hestiningtyas, W. (2024). Penerapan Inductive Approach untuk Meningkatkan Efektivitas Pembelajaran Berbasis Indikator Berpikir Kritis Siswa. *Nuwo Abdimas*, *3*(2), 95-104. http://e-jurnal.fkip.unila.ac.id/index.php/nuwo/article/view/762

Radiusman. (2020). Studi literasi: Pemahaman konsep siswa pada pembelajaran matematika. *FIBONACCI: Jurnal Pendidikan Matematika Dan Matematika*, 6(1), 1–8. https://doi.org/10.24853/fbc.6.1.1-8

Ruseffendi, E. T. (2010). *Pengajaran matematika modern untuk guru SD dan SLTP*. Tarsito.

Rusmawan, R., Putra, H. D., & Hendriana, H. (2024). Improving Junior High School Student's Mathematical Understanding Ability using Discovery Learning Model on Relation and Function Material. *(JIML) Journal Of Innovative Mathematics Learning*, *7*(1), 42-56. https://doi.org/10.22460/jiml.v7i1.18499

Salido, A., Misu, L., & Salam, M. (2014). Analisis kesalahan siswa dalam menyelesaikan soal-soal matematika materi pokok limit fungsi pada siswa kelas XI IPA 2 SMA Negeri 5 Kendari. *Jurnal Penelitian Pendidikan Matematika*, 2(1), 1–13. http://dx.doi.org/10.36709/jppm.v2i1.3072

Silvia, S., Fitrianna, A. Y., & Hendriana, H. (2023). The Implementation of Scientific Approach to Improve Mathematical Understanding Ability on Junior High School Students. *(JIML) Journal Of Innovative Mathematics Learning*, *6*(3), 194-201. https://doi.org/10.22460/jiml.v6i3.17615

Siregar, R. N., Suryadi, D., Prabawanto, S., & Mujib, A. (2022). Improving student learning: mathematical reasoning ability through a realistic mathematic education. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *11*(4), 2698-2713. https://doi.org/10.24127/ajpm.v11i4.6250

Siregar, R. N., Suryadi, D., Prabawanto, S., & Mujib, A. (2022). Cognitive flexibility of students in solving mathematical problems: A phenomenology study. *Kreano, Jurnal Matematika Kreatif-Inovatif*, *13*(2), 355-369. https://doi.org/10.15294/kreano.v13i2.40220

Siregar, R. N. (2023). *Kemampuan Cognitive Flexibility Dan Self-Efficacy Peserta Didik Dalam Pemecahan Masalah Matematis* (Doctoral dissertation, Universitas Pendidikan Indonesia). http://repository.upi.edu/id/eprint/105061

Siregar, R. N., Suryadi, D., Prabawanto, S., & Mujib, A. (2024). Improving Mathematical Problem-Solving Abilities through Think Pair Share Learning Using Autograph. *KnE Social Sciences*, 468-481. https://doi.org/10.18502/kss.v9i8.15583