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ANALYSIS OF STUDENTS' MATHEMATICAL UNDERSTANDING OF DERIVATIVES ALGEBRAIC FUNCTION ON ISLAMIC BOARDING HIGH SCHOOL

Sri Mulyani[1], Rama Nida Siregar[2]

[1]UIN Syekh Ali Hasan Ahmad Addary Padangsidimpuan, Jl. T. Rizal Nurdin, Km. 4,5 Sihitang, Padangsidimpuan, Indonesia.
srim91465@gmail.com
[2]UIN Syekh Ali Hasan Ahmad Addary Padangsidimpuan, Jl. T. Rizal Nurdin, Km. 4,5 Sihitang, Padangsidimpuan, Indonesia.
ramanidasiregar575@gmail.co.id

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ABSTRACT

Mathematical understanding is a critical component in learning mathematics, particularly in mastering the concept of algebraic function derivatives. This topic, included in the twelfth-grade curriculum at Islamic boarding schools, demands strong analytical thinking and the ability to apply mathematical concepts accurately. This study aims to analyze the mathematical understanding of grade XII students at Syahrani Bariah Zulkarnaen Islamic Boarding School in the context of algebraic function derivatives. The analysis focuses on three key indicators: the ability to apply mathematical objects, classify objects according to their properties, and select and use appropriate procedures or operations. The research was conducted in January 2025 and utilized qualitative methods, including observation, interviews, written tests in the form of problem-solving tasks, recordings, and documentation. The study involved three student respondents. The research process included several stages: preparation, consultation of questions with experts, implementation of data collection, result analysis, and conclusion drawing. Data were analyzed qualitatively by identifying errors and categorizing students' responses according to the indicators of mathematical understanding. The results indicate that students' mathematical understanding is generally low. This is evidenced by frequent conceptual and procedural errors, especially in the areas of selecting appropriate operations and classifying mathematical objects based on given concepts. These findings highlight the need for more adaptive and targeted instructional strategies in pesantren-based mathematics education. The study is expected to serve as a reference for educators in improving teaching methods and enhancing students' conceptual and procedural understanding.

Corresponding Author:

Sri Mulyani,
Masters Program in Mathematics Education,
Universitas Islam Negeri Syekh Ali Hasan Ahmad Addary Padangsidimpuan,
Jl. T. Rizal Nurdin, Km. 4,5 Sihitang, Padangsidimpuan, Indonesia
Email: srim91465@gmail.com

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INTRODUCTION

Mathematics is a fundamental discipline in education and plays an important role in shaping students' abilities to solve real-life problems (Rohmah et al., 2023; Siregar et al., 2020; Siregar & Prabawanto, 2021;). In addition, mathematics is also one of the main foundations in the development of science and technology (Sembiring et al., 2024). However, in many Islamic boarding schools, students' interest in learning mathematics tends to be low (Jannah & El-Yunusi, 2024; Sari et al., 2023). This is due to the difficulty in understanding the material and weak mastery of concepts, which ultimately becomes a major challenge in achieving learning goals, especially in complex materials such as derivatives of algebraic functions. Mathematical understanding is an essential aspect in learning mathematics that plays an important role in helping students build knowledge and logical, systematic, and critical thinking skills (Silvia et al., 2023; Rusmawan et al., 2024). Mathematics is not just memorizing formulas or solving calculation problems, but more than that, it involves the ability to understand concepts, principles, and procedures as a whole so that they can be applied in solving various contextual problems (Siregar, 2023). In Marini et al (2023) mathematical understanding includes the ability to recognize, interpret, and apply mathematical concepts and ideas in various situations. In other words, mathematical understanding allows students to construct the meaning of a concept, connect concepts with other concepts, and utilize these concepts in solving more complex problems (Atmaja, 2021). This understanding also reflects the extent to which students are able to think conceptually and not only focus on procedural memorization. Furthermore, this ability is very important because it plays a direct role in developing creative thinking skills, logical reasoning, and problem solving (Siregar et al., 2020; Manurung et al., 2023; Nur & Kartini, 2021). With a good understanding, students are able to connect various concepts, see patterns, and develop flexible and innovative problem-solving strategies (Siregar et al., 2022; Veronika et al., 2024). Mathematical understanding also encourages students to be able to explain mathematical ideas in their own way, develop reasonable arguments, and critically evaluate solutions (Sohilait, 2021). Therefore, a strong understanding of mathematical concepts not only improves academic competence but also fosters high-level thinking skills that are essential in facing the challenges of the 21st century.

The problem that often occurs in the field during initial observations is the low mathematical understanding of students, which is characterized by difficulty in re-explaining concepts in their own language, citing examples and non-examples, and choosing appropriate procedures in solving problems. This lack of understanding can have a direct impact on low learning outcomes and students' inability to apply mathematical knowledge in real life.

Various previous studies have shown that students' mathematical understanding abilities can be analyzed through several indicators, such as the ability to classify mathematical objects based on certain properties, the ability to choose and use appropriate procedures or algorithms, and the ability to apply concepts in problem solving (Susanto, 2022; Hayati & Marlina, 2021; Yulaistin & Roesdiana, 2022). These indicators are important to use as a basis for assessing and evaluating students' level of understanding.

Mathematical understanding is one of the key factors in successful mathematics learning (Hasanudin, & Maryati, 2023). With meaningful understanding, students are able to apply mathematical knowledge appropriately and effectively in various situations. One important component in this understanding is the ability to classify, interpret, and apply mathematical ideas (Hulu et al., 2023; Simarmata et al., 2022). However, in practice, many students have difficulty understanding the concept of derivatives, especially in solving problems and choosing the right solution strategy. Considering the importance of mathematical understanding in learning, this study focuses on examining and analyzing the extent of students' mathematical understanding, especially in derivative material in Islamic boarding schools. Derivative material began to be introduced in the second semester of class XI at the Madrasah Aliyah level, so that class XII students became the right subjects to analyze their mathematical understanding. Derivatives are one of the basic concepts in calculus that play an important role in advanced mathematics learning (Rahayu & Ishak, 2024). Derivative is a concept that shows the rate of change or slope of a function at a certain point, and has a fundamental role in understanding mathematical change (Dongoran et al., 2024). Derivatives are not only limited to the first level, but can also be developed to the second, third, and subsequent levels, although the basic principles remain the same. Although this concept is very important, students' understanding of this material is still relatively low due to limited conceptual and procedural understanding.

Although there has been a lot of research on mathematical understanding, there is still a gap in studies that specifically examine students' understanding of the material on derivative functions, especially in the context of the Islamic boarding school learning environment. The learning environment in Islamic boarding schools has its own characteristics that affect the learning process of students, and has not been widely discussed in previous studies. This study aims to fill this gap by analyzing students' mathematical understanding of the material on derivatives of algebraic functions in a more focused manner.

The purpose of this study was to analyze the mathematical understanding abilities of class XII students at the Syahrani Bariah Zulkarnaen Islamic Boarding School on the material on derivatives of algebraic functions based on the indicators of mathematical understanding that have been determined. The results of this study are expected to help educators in identifying students' learning difficulties and developing more effective learning strategies to improve students' mathematical understanding in Islamic boarding schools.

METHOD

This research was conducted in January 2025 at the Syahrani Bariah Zulkarnaen Islamic Boarding School. The selection of the research location was carried out purposively or intentionally based on certain considerations that were relevant to the research objectives, namely to observe the mathematical understanding abilities of students in the material of algebraic function derivatives. The Islamic boarding school environment was chosen because it has unique and different learning characteristics compared to formal schools in general, so it is important to know how students understand mathematical concepts in that context.

The type of research used in this study is qualitative descriptive research. This method is used to provide a comprehensive and in-depth picture of the mathematical understanding abilities of students. Qualitative descriptive research aims to describe the phenomena that are occurring at the time the research is taking place, as well as to explain and detail various aspects related to the mathematical thinking abilities of students based on certain indicators that have been previously determined.

The sample in this study was selected using a purposive sampling technique, namely sampling based on certain considerations in accordance with the research objectives. The sample consisted of three grade XII students who were selected based on the results of initial observations and recommendations from mathematics teachers. The selection of a small sample size is intended so that researchers can conduct an in-depth analysis of each student's ability to understand the material on function derivatives.

Data collection techniques in this study were carried out through several methods, namely: (1) direct observation in the learning environment to see the activities and responses of students during the learning process; (2) in-depth interviews with respondents to find out their thinking processes and understanding of the material on derivatives; (3) distributing questionnaires in the form of essay questions designed to measure indicators of mathematical understanding ability; (4) recording important data from the results of observations and interviews; and (5) documentation as supporting data, such as the results of students' work or teacher notes. All of these techniques are used in an integrated manner to obtain valid and comprehensive data.

The data analysis process is carried out through several stages, namely: (1) the preparation stage which includes determining the title, initial observations, and compiling the question instrument; (2) consulting questions with experts to ensure the feasibility and validity of the instrument; (3) the implementation stage, namely the implementation of giving questions to respondents and interviews; and (4) the analysis and drawing conclusions stage based on the results of the students' work and the data that has been collected. The indicators used in this study include: (a) the ability to apply objects, namely the ability of students to use concepts appropriately; (b) the ability to classify objects based on certain properties according to mathematical concepts; and (c) the ability to choose and use appropriate procedures or operations in solving mathematical problems.

RESULTS AND DISCUSSION

Results

This study aims to analyze the mathematical understanding ability of grade XII students on the material of algebraic function derivatives. The analysis was carried out based on three main indicators, namely: the ability to apply concepts, the ability to classify objects according to certain properties, and the ability to use and choose the right procedures or operations. Based on the results of data collection from three respondents who had been selected purposively, the learning outcome scores were obtained which are summarized in Table 1 below:

Table 1. Students' Mathematical Understanding of Derivatives Algebraic Function

Number	Name	Learning outcomes	Category
1	M	60	High
2	S	35	Medium
3	N	30	Low

1. Analysis of Students with High Category

The student named M showed a relatively good understanding of the material on algebraic function derivatives. In question number 1, she was able to solve the problem completely by explaining the steps sequentially and precisely. This shows that the student has good abilities in applying the concept of derivatives to the form of questions. In question number 2, the student was also able to use the properties of the multiplication form of functions and understand the basic concepts of derivative rules, such as the use of derivative rules from the product of multiplication functions. However, in question number 3, M had difficulty in solving questions containing a combination of multiplication and exponentiation forms. The errors that appeared were in the process of solving and applying the procedure. This shows that in the indicator of choosing and using certain procedures or operations, the student is still confused in compiling the correct steps for solving. The results of M work are shown in Figure 1 below.

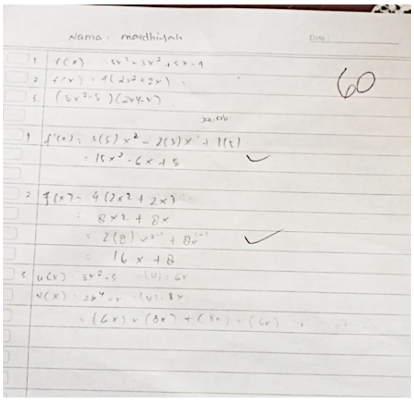

Figure 1. Results of Students' Answers (M)

The following is a complete interview script with M, adapted to the results of his analysis as a student with a high category, but still experiencing difficulties with indicators of choosing and using procedures:

P	:	*When you see a question about the derivative of a function, what is the first thing that comes to your mind?*
M	:	*I immediately think of the formula, for example if it is in the form of an exponent, then use the rule for the derivative of exponents. I also look at the form of the function first, ma'am.*
P	:	*Can you tell me how you usually solve derivative problems?*
M	:	*Usually I read the question first, look at the form of the function, then determine which rule to use. After that I work on it slowly while checking the steps again, ma'am.*
P	:	*In your opinion, what is the difference between the derivative of a regular function and a function in the form of a multiplication or exponent?*
M	:	*For regular functions, we usually use the formula directly, for example the derivative of x^3 is directly $3x^2$. But for multiplication, we have to use a special rule, like f(x)g(x), we have to differentiate one by one and then add them up, ma'am.*
P	:	*Have you ever felt sure about your answer, but it turned out to be wrong? Why do you think that is?*
M	:	*I have. Sometimes I feel like I'm right but it turns out to be wrong when I check, usually because I put the brackets in the wrong position or forgot one part of the formula, ma'am.*
P	:	*How do you differentiate between simple and complex functions?*
M	:	*Simple ones usually only have one form, like x^2 or 5x. But if complex ones have combinations, for example there are exponents then multiplied by another function, I think that's already complex, ma'am.*
P	:	*Do you know when to use the ordinary derivative rule, the multiplication rule, or the chain rule? How do you determine it?*
M	:	*I know, but sometimes I'm still confused. Usually I look at the form. If there are two functions multiplied, then use the multiplication rule. If a function is within a function, use the chain. But I still often get confused if the form is similar, ma'am.*
P	:	*Have you ever been confused when looking at a mixed form of a problem, for example a power function multiplied by another function? Can you tell me?*
M	:	*Yes, especially in question number 3 yesterday. I was confused about where to start. The problem seemed to be a combination of multiplication and exponents, and I was unsure about which formula to use first, ma'am.*
P	:	*When working on a problem, how do you determine the steps to take?*
M	:	*I first look at the form of the function, then think about which derivative rule fits. After that, I order the steps according to the formula, ma'am.*
P	:	*Do you feel like you understand the steps, or do you still often hesitate?*
M	:	*If the form is normal or the multiplication of two functions, I'm pretty sure, but if the form is combined and a bit long, I'm still unsure and afraid to skip steps, ma'am.*

P	:	*In your opinion, which part of the process of solving derivative problems is the most difficult?*
M	:	*The most difficult part is when the formulas are combined. For example, the result of the derivative of one part is multiplied by another part, I often put it in the wrong position or forget to copy everything, ma'am.*
P	:	*If you have difficulty working on derivative problems, what do you usually do?*
M	:	*I usually reread the material, then sometimes ask my friends too. If I'm still confused, I'll ask the female teacher during class, ma'am.*

Based on the interview results, it can be concluded that M has a good understanding of the basic concept of algebraic function derivatives. This can be seen from her ability to recognize the form of a function and choose the appropriate derivative rule, such as the power rule, the multiplication rule, and the chain rule. She is able to identify the difference between simple and complex functions, and understand when to use each of these rules.

However, although M is conceptually quite strong, she still shows hesitation when faced with questions with more complex combined forms, such as functions with powers multiplied by other functions. The difficulty lies in the indicator of choosing and using procedures, especially in arranging the sequence of steps in the work correctly and consistently. M admits that she is often confused when faced with questions that contain more than one derivative rule, and tends to make technical errors such as parentheses, forgetting to copy the derivative part, or the wrong position in algebraic operations.

The strategy used by M when experiencing difficulties is to reread the material, discuss with friends, and ask the teacher if she still does not understand. This shows good learning motivation, but also illustrates the need for further assistance in honing procedural skills and strategic thinking when solving more complex derivative problems. Thus, this interview confirms that even though students are in the high category, strengthening of procedural skills is still needed, especially to improve accuracy and confidence in solving combinative derivative problems.

2. Analysis of Students with Medium Category

The second student, S, obtained a moderate score. In question number 1, the student was able to complete the question and answer it correctly, indicating that she had an understanding in applying the basic concept of derivatives. However, in question number 2, she had difficulty in understanding the form of the derived function, especially in the part of the function derivative in the form of multiplication. The student failed to identify the function structure and the relationship between the existing function elements. This indicates a weakness in classifying mathematical objects based on certain properties, namely in grouping and recognizing different function forms. In question number 3, errors were again found in the advanced stage of the solution process. Although the initial understanding was correct, the student was inconsistent and lost direction in completing the next procedure. This error reflects a weakness in the indicators of use and selection of appropriate procedures or operations. Documentation of S work results can be seen in Figure 2.

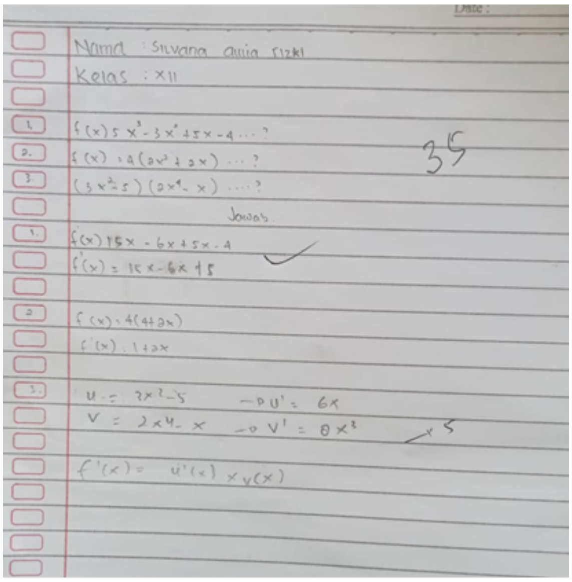

Figure 2. Results of Students' Answers (S)

Here is the complete interview script with S, who is in the moderate category. This script was compiled to dig deeper into her understanding of the algebraic function derivative material, especially in aspects that show weaknesses, namely grouping function forms and selecting procedures.

P	*:*	*When you see a question about the derivative of a function, what is the first thing that comes to your mind?*
S	*:*	*Usually I immediately remember the derivative formula, like if x^n then the derivative is n times x raised to the power of n-1. I try to remember how to do it again, ma'am.*
P	*:*	*Can you tell me how you usually solve derivative problems?*
S	*:*	*I look at the form of the function, then if I remember the formula, I immediately write it down. Sometimes I also double-check if I'm still unsure, ma'am.*
P	*:*	*In your opinion, what is the difference between the derivative of a regular function and a function that is in the form of a multiplication or exponent?*
S	*:*	*For the regular one like x^2, it's easy, but if there are two functions multiplied, I often get confused, because I can't immediately derive them one by one, ma'am.*
P	*:*	*Have you ever felt sure about the answer, but it turned out to be wrong? Why do you think that is?*
S	*:*	*Yes, sometimes I feel like I'm right, but when I check it, it turns out the order of the steps is wrong, or there's a part that I missed, ma'am.*
P	*:*	*How do you distinguish between a function that is simple and a function that is complex?*
S	*:*	*If it's simple, it's usually just one part, like x^3 or 3x. But if there are two or more functions, like multiplication or a form within a form, I consider it complex, ma'am.*
P	*:*	*Do you know when to use the ordinary derivative rule, the multiplication rule, or the chain rule? How do you determine it?*
S	*:*	*I know, but sometimes I'm confused about which one to use. Especially if the forms are similar, they often get mixed up, ma'am.*

P	:	*Have you ever been confused when looking at a mixed form of a problem, for example a power function multiplied by another function? Can you tell me?*
S	:	*Yes, I have. I don't know where to start. Sometimes I mistake the form as ordinary, but it turns out I have to use the multiplication or combination rule, ma'am.*
P	:	*When working on a problem, how do you determine the steps to take?*
S	:	*I try to remember the formula first, then I sequence the steps according to what I've learned. But if the form is difficult, I often hesitate, ma'am.*
P	:	*Do you feel like you understand the steps, or do you still often hesitate?*
S	:	*If the problem is simple, I understand it quite well. But if it's long or complicated, I still get confused and end up guessing, ma'am.*
P	:	*In your opinion, which part of the process of solving derivative problems is the most difficult?*
S	:	*The most difficult part is when arranging the steps when the form is mixed. I often get confused about which part to do first, ma'am.*
P	:	*If you have difficulty working on derivative problems, what do you usually do?*
S	:	*I usually try to look at the examples in the book again, then sometimes ask a friend or teacher if I don't understand anymore, ma'am.*

From the results of in-depth interviews, it can be concluded that S has sufficient mastery of the basic concept of derivatives, especially in simple function forms. She is able to remember the basic formula of derivatives and try to apply it directly when working on problems. This shows that the indicator of applying concepts has begun to form, although it is not yet completely stable in various problem contexts.

However, S main weakness lies in the ability to classify mathematical objects based on certain properties and the ability to choose and use the right solution procedure. She admitted that she was often confused when faced with problems with mixed forms, such as functions with powers multiplied by other functions. This confusion causes errors in determining the appropriate derivative rules, as well as the correct sequence of steps to work on.

S also revealed that she sometimes guesses the steps when faced with problems that are considered complex, because she is not sure which rule to use first. This shows that although she understands the formula individually, she is not yet fully able to integrate concepts and procedures when solving problems with more complex structures.

In overcoming difficulties, S usually tries to look back at example problems from books and ask friends or teachers, showing a willingness to learn and independent effort. However, she still needs more intensive guidance to develop a stronger conceptual understanding and strategic thinking skills in choosing mathematical procedures. Therefore, S can be further developed with a learning approach that emphasizes visualization of function forms, practice questions with a tiered structure, and gradual guidance in compiling procedures for working on complex function derivative questions.

3. Analysis of Students with Low Category

The last student, N, received the lowest score and was in the low category. Interestingly, on question number 1, she was able to answer correctly. This shows that even though her understanding is limited, she is still able to apply objects or concepts of derivatives in relatively simple questions. However, on question number 2, she failed to identify the nature of the multiplication function form, so the answer given did not comply with the rules of function derivatives. This shows a weakness in the indicator of classifying objects based on certain properties. On question number 3, the error became more significant, because the student was unable to group the function elements correctly and did not apply the solution procedure logically. She also did not show an understanding of the steps of derivatives in complex forms. This indicates a significant weakness in using and selecting procedures or operations. Figure 3 below shows the results of the student's work.

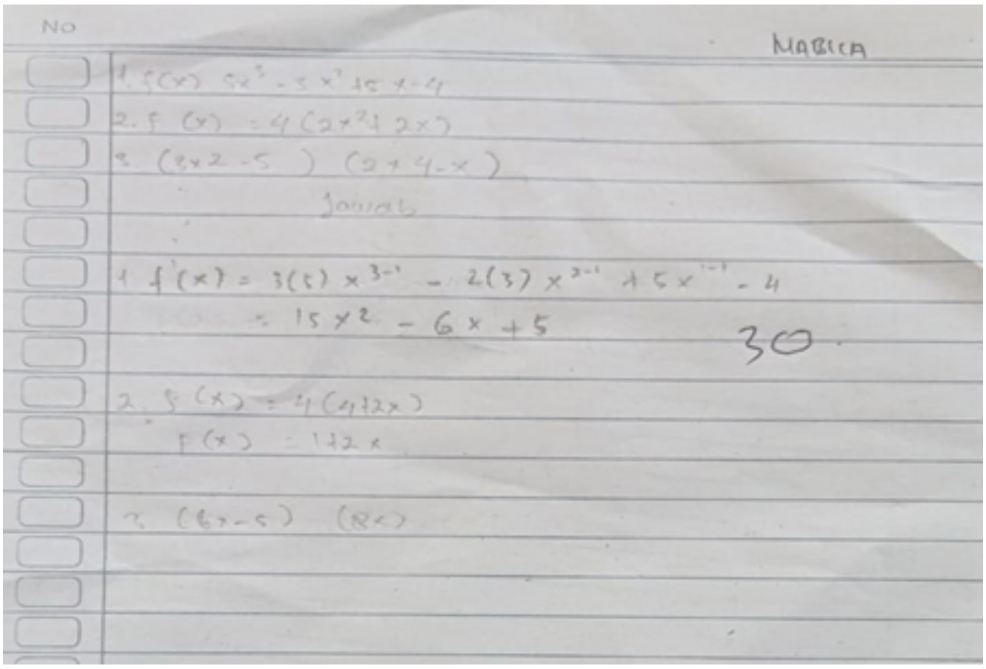

Figure 3. Results of Student's Answers (N)

The following is a complete interview script with N, a student with a low ability category in understanding the material of algebraic function derivatives. This script is designed to dig deeper into the difficulties experienced by N in three main indicators: application of concepts, classification of objects, and use of procedures.

P	:	*When you see a question about the derivative of a function, what usually comes to your mind first?*
N	:	*I think it must use a formula, but sometimes I forget which formula to use, ma'am.*
P	:	*Can you tell me how you usually solve derivative problems?*
N	:	*I try to look at the form of the problem, then sometimes I remember the formula x^n, but if the form is different, I'm confused about what to do, ma'am.*
P	:	*In your opinion, what is the difference between a regular derivative problem and one that is in the form of multiplication or a longer form?*
N	:	*The regular one is easier, just derive it. But if there is a multiplication or a longer form, I often don't understand where to start, ma'am.*
P	:	*Have you ever felt that the problem was easy, but it turned out that the answer was wrong?*
N	:	*Yes, I have. I thought I was right because it was similar to the example, but it turned out that I did it wrong, ma'am.*

P	:	*In your opinion, how do you differentiate between a simple function and a complex function?*
N	:	*The simple one is the one with only one part. The complex one usually has a multiplication sign or a form in the form, ma'am.*
P	:	*Do you know when to use the ordinary derivative formula, the multiplication rule, or other rules?*
N	:	*Sometimes I know, sometimes I don't. If the problem is like a practice problem, I can guess. But if the form is different, I'm really confused, ma'am.*
P	:	*When working on problems that are mixed in form, like there are exponents and times, do you find it difficult? Can you tell me?*
N	:	*Yes, I'm really confused. I don't know which one to derive first. Sometimes I just do it haphazardly, and then the result is wrong, ma'am.*
P	:	*When working on a problem, how do you usually determine the steps?*
N	:	*I try to remember from the examples in the book. But if it's not exactly the same, I get confused and often skip steps, ma'am.*
P	:	*Do you feel like you understand all the steps or do you still often hesitate?*
N	:	*I still often hesitate. I'm afraid of making a wrong move, and then I don't want to continue, ma'am.*
P	:	*Which part makes it most difficult for you when working on derivative problems?*
N	:	*The hardest part is when organizing the steps, especially if the form is complicated or there are combinations, ma'am.*
P	:	*If you have difficulty, what do you usually do?*
N	:	*Sometimes I ask my friends, but if my friends are also confused, I just leave them and don't continue, ma'am.*

Interviews with N showed that she had difficulty in almost all aspects of understanding the material on algebraic function derivatives. In the concept application indicator, N admitted that she often forgot formulas or was confused about choosing the right formula for the form of the problem. She only felt comfortable with simple derivative forms, but when the form of the problem started to become complex, such as containing multiplication or functions within functions, she immediately lost her way.

In terms of mathematical object classification, N has not been able to identify the function structure well. She can distinguish between simple and complex forms in general, but does not understand more deeply when and how to use certain rules such as multiplication or chain rules. This indicates that her understanding is still superficial and highly dependent on the form of the problem that is familiar or similar to the example.

The most obvious difficulty is seen in the indicator of selecting and using procedures. N has not been able to organize the work steps in a sequential and systematic manner. She often "skips" steps, or even gives up if the form of the problem does not match the examples she has seen. When experiencing difficulties, she prefers to stop working rather than looking for further solutions, which shows a low level of self-confidence and learning independence.

Overall, this interview confirms that N needs intensive guidance and a more visual, concrete, and contextual learning approach. Repeated practice with gradual variations of questions from simple to complex, as well as the use of visual aids such as function structure diagrams or colors to distinguish parts of a function, can be alternative strategies to improve her understanding and confidence in solving algebraic function derivative problems.

Based on the results of the study conducted on three grade XII students at the Syahrani Bariah Zulkarnaen Islamic Boarding School, it can be concluded that the students' mathematical understanding ability on the material of algebraic function derivatives still varies and is generally not optimal. The analysis was carried out based on three main indicators, namely: the ability to apply concepts, the ability to classify objects based on certain properties, and the ability to use and choose the right procedures or operations.

Students with a high category (M) showed good mastery in applying basic concepts and classifying mathematical objects, but still had difficulty in choosing and using the right procedures to solve problems with more complex combination forms. Students in the medium category (S) were able to apply concepts, but were still weak in understanding the structure of functions and the steps to solve them. Meanwhile, students with a low category (N) were only able to work on simple problems, while understanding more complex concepts and the use of correct procedures was still very limited.

Overall, the most dominant weaknesses lie in the indicators of the use and selection of certain procedures or operations, as well as the ability to classify mathematical objects according to their concepts. These results indicate that the learning approach in the classroom still needs to be improved, especially in helping students understand the relationship between concepts, as well as training procedural and conceptual thinking skills in solving mathematical problems.

Thus, the results of this study are expected to be evaluation materials for teachers in developing more effective and contextual learning strategies, as well as providing more focus on training students' analytical and problem-solving skills in understanding the material on derivatives of algebraic functions.

Discussions

This study aims to explore the mathematical understanding ability of grade XII students in the context of algebraic function derivative material. The results show that students' understanding is varied, with categorizations into high, medium, and low levels. These categories reflect differing cognitive abilities in mastering mathematical concepts, particularly within the unique educational setting of Islamic boarding schools (pesantren).

One of the core findings of this study is that mathematical understanding in derivative topics is significantly influenced by three interconnected indicators: the ability to apply concepts, the ability to classify mathematical objects based on their properties, and the ability to choose and use the appropriate procedures. Students who excel in one area often show competence in others, while those struggling in one aspect tend to encounter difficulties across the board. For example, student M (high category) demonstrated a good grasp of concepts but still encountered procedural confusion when solving more complex problems involving a combination of function types.

These findings align with those of Sumarmo (2010), who emphasized that mathematical understanding is not limited to conceptual knowledge but also includes procedural fluency and logical reasoning. Similar to this study, Sumarmo found that even high achieving students may experience setbacks in procedural application due to the complexity of derivative rules. Second, this study resonates with the findings of Jihad & Haris (2010), who highlighted the importance of conceptual connections in mathematics. In line with their conclusions, this research shows that merely knowing formulas does not guarantee successful problem-solving. Students must also develop the ability to recognize patterns and relationships between functions, which is often missing in students at medium and low levels (S and N). Third, compared to Syarifah (2017), who studied students in a formal school setting and concluded that classification skills are central in understanding function based problems, this study identifies a similar issue but under a different context Islamic boarding schools. It was observed that students like S and N struggled to classify mathematical objects accurately, especially when encountering compound functions. This reinforces the idea that classification is a fundamental component of mathematical literacy. Fourth, a study by Siregar et al. (2020) on procedural flexibility found that students often fail not because they lack knowledge, but because they do not know how to adapt that knowledge to varied problem structures. This directly mirrors the current study's findings, where even students with a solid grasp of basic concepts (such as M) had trouble integrating them in complex contexts, such as problems involving product or chain rules. Fifth, the research by Jannah & El-Yunusi (2024) specifically addressed the pedagogical environment in pesantren. Their study concluded that pesantren-based learning often lacks exploratory and student-centered methodologies, which are crucial for developing higher order thinking skills. The current study supports this observation, as students' difficulties seem partly rooted in a lack of exposure to diverse and interactive problem solving techniques. Despite religious and moral enrichment, mathematical instruction in pesantren is often still procedural and memorization based, which can hinder deeper understanding.

Moreover, this study introduces new dimensions by specifically contextualizing the analysis within pesantren education. Unlike formal schools where students are more frequently exposed to technology based learning or inquiry methods, students in Islamic boarding schools tend to rely heavily on traditional instruction. This aspect may further explain why even motivated students struggle with procedural decisions when faced with novel problem structures. In summary, the findings not only validate previous research but also expand the discourse by highlighting the unique challenges and educational dynamics of pesantren-based learning environments. Personalized instructional strategies, such as differentiated scaffolding and the integration of visual aids, are recommended, particularly for students with low levels of understanding. Meanwhile, enrichment programs that promote procedural flexibility and abstract reasoning could support students with higher conceptual proficiency.

Thus, this study underscores the importance of balanced development across all three indicators of mathematical understanding. Efforts to enhance procedural skills must go hand in hand with strengthening conceptual depth and classification ability. These insights can inform more effective pedagogical interventions within the pesantren context, aiming to foster comprehensive and meaningful mathematical comprehension.

CONCLUSION

Based on the results of data analysis and referring to the objectives of the study, it can be concluded that the mathematical understanding ability of class XII students at Syahrani Bariah Islamic Boarding School in understanding algebraic function derivatives is still relatively low. This is indicated by the many conceptual and procedural errors that occur, especially in two main indicators: the ability to choose and use the right procedure, and the ability to classify mathematical objects according to their properties and concepts. This study contributes to broadening the understanding of how the context of Islamic boarding school education affects mathematics learning achievement, especially in the material of algebraic function derivatives. The Islamic boarding school environment, which is different from the general approach in formal schools, presents unique challenges that impact the depth of students' conceptual understanding and procedural fluency. Scientifically, these findings strengthen the understanding that complete mathematical understanding involves not only mastery of concepts, but also strategic abilities in choosing and applying appropriate procedures. Weaknesses in one indicator can have a direct impact on overall performance in solving advanced mathematical problems. The application of these findings can be used as a basis for designing a more adaptive and contextual learning approach in the Islamic boarding school environment. Teachers are expected to be able to adjust teaching strategies to the level of students' abilities, and to pay special attention to students who are at a low level of understanding through scaffolding, visual approaches, and collaborative learning. This study also opens up space for further exploration in the realm of mathematics education in Islamic boarding schools. It is recommended that similar studies be conducted on other mathematical materials such as integrals, limits, or trigonometry, to see whether the pattern of conceptual and procedural weaknesses is consistent across topics. In addition, learning experiments based on contextual, problem-based (PBL), or technology-based approaches such as the use of interactive applications in mathematics learning can also be the focus of future research to test their effectiveness in improving students' mathematical understanding in Islamic boarding schools.

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