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# Analysis Of Student Errors In Solving Intgral Questions For Grade XII IPS 1 At MAS YMPI Tanjungbalai

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***Abstract***

*This research has a purpose to analyze students' errors in solving problems combined to integral calculus in Grade XII IPS 1. This is a descriptive study with a qualitative approach. The research subjects has 30 students and 3 mathematics teachers. The instruments used are tests (reliability coefficient V=0.76) and questionnaires (reliability coefficient V=0.68). Data is collected with four methods: 1) students are asked to complete a descriptive test on integral calculus in 5 questions on a worksheet, 2) collecting and analyzing some of the students' answers, 3) interviewing with some students who face difficulties, and 4) interviewing teachers. The research instruments used include a descriptive test on integral calculus, interview worksheets for students and mathematics teachers. Data analysis is carried out in three stages: 1) identifying and categorizing students' errors in answering the questions, 2) analyzing students' errors, and 3) examining the correlation between students' test results and the results of interviews with students and teachers. The results of the study show that out of 30 students who took the test, 12 or 40% of the students did not meet the passing criteria (KKM = 70), 7 or 23.3% of the students made errors in understanding basic integral concepts, 12 or 40% of the students made errors in applying principles, and 13 or 43.3% of the students made errors in solving problems in text questions. From the questionnaire and interview results, it has been found that 16 or 53.3% of the students are mostly influenced by internal factors, and 11 or 36.6% of the students are mostly influenced by external factors.*

***Keywords: Error Analysis, Integral Calculus***

## INTRODUCTION

The interference of learning can become a serious obstacle to a child, particularly when the affected skills, such as mathematics, are crucial in the modern world (Benavides-varela et al., 2020). Mathematics is a fundamental science that plays a significant role in the development of science and technology (Jabnabillah, 2022b). The subject of mathematics is the most important one for students to study in school and play a vital role in shaping human thought processes (Rindiani et al., 2023) reasoning process strategic and systematic reasoning and problem-solving skills (Phonapichat et al., 2014). Teacher assessment of mathematical understanding is considered to have a multidimensional structure and place a central place in mathematics education (Görgüt & Dede, 2022).

In this context, mathematics education aims to equip students with logical, analytical, systematic, critical, and creative thinking abilities (Syam, 2020). Mathematics learning is an exact science that requires understanding rather than memorization (Suswigi & Zanthy, 2019). One of the mathematical subjects that requires understanding is integral calculus (Jabnabillah, 2022a).

Many students perceive integral calculus as a difficult subject. This is accordance with research (Hasbi, 2019) which shows that many high school students face difficulties in solving calculus problems, including integral calculus. In mathematics, a fundamental understanding of mathematical concepts must be mastered by students. According to research (Baweleng et al., 2023), most students are unable to grasp mathematical concepts, leading to difficulties and errors in solving mathematical problems. According to (Lim, 2023), fractions are an important basic concept, and many middle school students do not understand the concept of fractions.

(Sumantri & Irmayanti, 2023) emphasize the importance of error analysis, stating that in the learning process, teachers must genuinely analyze student errors, try to understand these errors, explain what the students experience, and identify the causes of these errors. Errors are a systematic deviation from the correct answer (Suryani & Jufri, 2021). Error analysis is a means to identify and classify errors in a particular pattern (Sari, 2023). According to (Hayati, 2023), mathematical error classification can be divided into three categories: 1) errors in concept application, 2) errors in principle application, and 3) errors in solving verbal problems.

Similar research has been conducted by (Kurniawati et al., 2020) , (Amelia & Yadrika, 2019) and (Hayati, 2023), who generally found that students encounter difficulties in solving integral problems and have revealed errors in concepts, facts, principles, and operations. However, the distinction in my research is that, in addition to analyzing errors in understanding concepts, an analysis of errors in principles and problem-solving has also been done. Therefore, a more in-depth study is necessary to explain the specific learning difficulties in mathematics experienced by students in integral calculus.

## RESEARCH METHODS

Research Method This study is a descriptive research with a qualitative approach. Descriptive research aims to describe, summarize various conditions, situations, or become social phenomena that exists in society and become the subject of research, presenting the reality as a feature, characteristic, nature, model, sign, or description of a specific condition, situation, or phenomenon (Zulaika & Febrilia, 2019). The qualitative approach was chosen because the researcher wanted to describe and depict the phenomena related to the characteristics, qualities, and relationships between activities. Thus, the qualitative approach is suitable for uncovering various central phenomena that arise in this study.

This research was conducted at MAS YMPI Tanjungbalai. The research subjects consisted of 30 students selected using simple random sampling and 3 mathematics teachers. The research instruments used were descriptive tests on integral calculus with the following indicators: 1) Students are able to solve indefinite integrals with negative powers, 2) students can solve indefinite integrals using substitution, 3) Students are able to complete certain integrals, and 4) students can apply the concept of integrals to solve real-life problems. Besides tests, the research instruments included questionnaires for students and interview sheets for mathematics teachers. The validity of the test and questionnaire instruments was assessed using construct validity by one expert from the faculty and two experts from the mathematics teacher community. The Aiken's $V = \frac{\sum s}{n(c-1)}$ formula was used to calculate the validity coefficient (Hayati, 2023), which resulted in 0,76 for the questionnaire and 0,68 for the test instrument, indicating both instruments are valid.

The research process includes five steps: 1) students are required to complete a descriptive test on integral calculus consisting of 5 questions, 2) several student answers are selected for analysis, 3) a questionnaire on learning difficulties is given to the students, 4) interviews are conducted with some students experiencing difficulties, and 5) interviews are conducted with teachers. Data analysis is carried out in three stages: 1) identifying and categorizing student errors in answering questions, 2) analyzing student errors, and 3) examining the correlation between student test results and the results of interviews with students and teachers.

## RESULT AND DISCUSSION

Based on the recapitulation of students' test scores and the school's minimum passing criteria (KKM) set at 70, there are still many students who did not pass, specifically 12 out of 30 students.

**Table 1 Final Results of Students' Integral Material Test.**

| Range of value | Frequency | Presentation | Category |
|---|---|---|---|
| 91-100 | 0 | 0% | Very high |
| 76 -90 | 6 | 20% | High |
| 61-75 | 12 | 41% | Medium |
| 51-60 | 8 | 27% | Low |
| 0-50 | 4 | 14% | Very low |
| **Amount** | 30 | 100% | |

Based on the mistakes made by students in solving integral problems, from the 30 students, the research team selected 12 students for the analysis of their answer results. The selected students are S1, S4, S5, S8, S10, S13, S16, S18, S21, S25, S28, and S30. The results of the test data, questionnaires, and interviews will be compared to draw conclusions in the form of good data regarding the mistakes students made and the factors that caused them.

One of the mistakes made by the students is a :

- **Misunderstanding of basic concepts**.

Out of 30 students, 7 or 23,3% of the students made errors in understanding fundamental integral concepts. Here is an example of a misconception in integral concepts when given question number 1, which reads:

**Question 1**: Determine the result of $\int \frac{3}{x^4} dx$

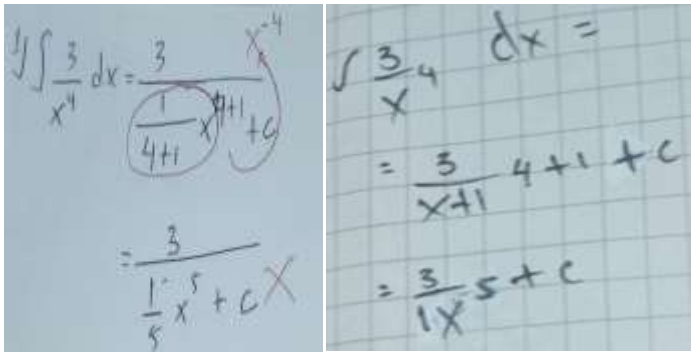

**Figure 1, answer to question number 1, S1 and S4**

Based on the students' answers above, it can be seen that students do not understand the basic concept of integration. According to (Rahma & Khabibah, 2022), a low understanding of concepts about a subject often leads to students making mistakes in solving problems. The mistakes made by the students in answering the above questions indicate that the students had misconceptions about using the indefinite integral formula.

In the question, students were asked to determine the result of the integral using the indefinite integral formula for functions with negative exponents. However, the students made a mistake by directly attempting to solve the problem without changing it to a negative exponent form. The correct form to convert it to should have been $\int 3x^{-4} dx$, and then it could be solved

using the integral formula.

**Table 2 showing the results of the questionnaire regarding the misconceptions made.**

| No | Instrument point | Answer of student | | | |
|---|---|---|---|---|---|
| | | Yes | Persentation | No | persentation |
| 1 | I write the formula while finishing the mathematic test | 23 | 77% | 7 | 23% |
| 2 | I am difficult to use the formula when the test is different | 17 | 57% | 13 | 43% |
| 3 | I am difficult to use the concept learned already | 11 | 37% | 19 | 67% |
| 4 | I understand every basic concepts learned already | 16 | 53% | 14 | 47% |
| 5 | I am happy to memorise without using the mathematic concepts | 8 | 27% | 22 | 23% |

From the questionnaire, it is evidece that many students still struggle when they face with problems that differ from the examples provided by the teacher. They also find it challenging to apply the concepts they have learned. Through interviews with teachers, the main factor identified is their lack of understanding of prerequisite integral material, such as fraction operations. Research conducted by (Maharani, 2023) also found that students often struggle with solving problems related to fractions due to insufficient practice in solving algebraic fraction operations like addition, subtraction, multiplication, and division.

- **Errors in principle use skills**

One of the areas where students make mistakes is in the application of mathematical principles. Out of 30 students, 12 students, or 40%, make mistakes in applying mathematical principles. Here is an example of student errors when answering questions 2, 3, 4, and 5.

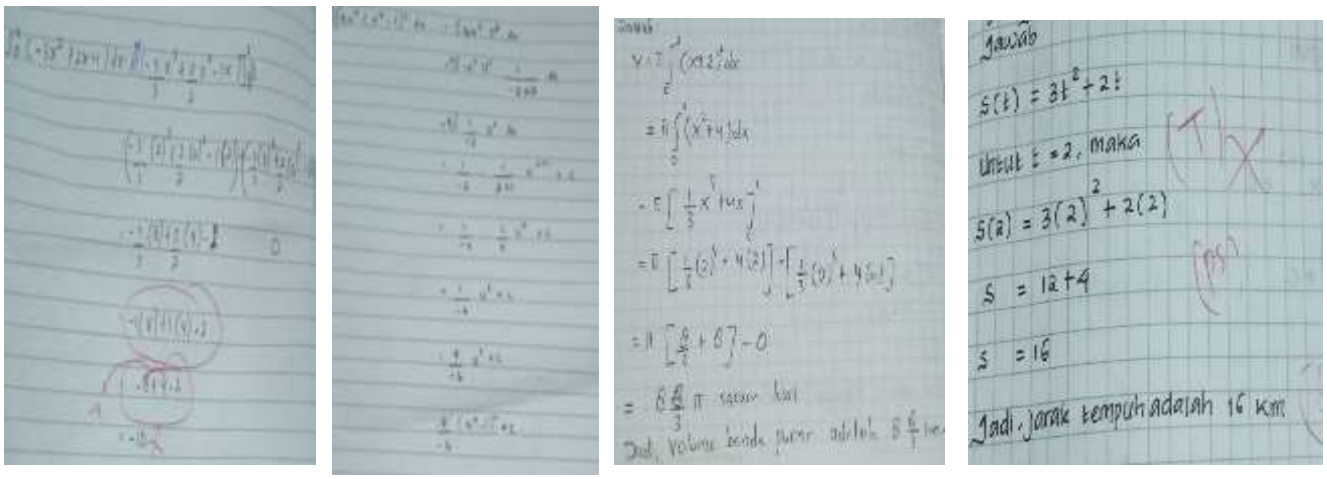


**Figure 2:** Answers to Questions 2, 3, 4, and 5 by Students S13, S18, S21, S25

Based on Figure 2, it is evident that some of the research subjects or students are still facing difficulties in applying mathematical principles, particularly when solving mathematical problems. From the answers provided by students to questions 2, 3, 4, and 5, the following errors were observed: In the answer to question 2, it is apparent that the student made a mistake due to

lack of attention to detail in calculations, leading to an incorrect final answer. For question 3, the student made an error in solving an integral by substitution. They failed to make the necessary assumptions for finding the differential (derivative) and made errors in the calculations. In question 4, the student made a mistake related to exponent forms, which led to an incorrect final result. Question 5 saw a mistake where the student did not integrate the variable correctly, failed to follow the required steps, and substituted the wrong value. The correct substitution should have been t = 5, and there were errors in the calculations.

To gain a deeper understanding of these mistakes, please refer to the questionnaire results in Table 3.

**Table 3:** Questionnaire Results on Errors in Applying Mathematical Principle

| **No** | **Instrument point** | **Answer of student** | | | |
|---|---|---|---|---|---|
| | | **Yes** | **Persentation** | **No** | **Persentation** |
| 1 | I am careful in finishing the mathematic test | 22 | 73% | 8 | 27% |
| 2 | I check back the answer before being collected to the teacher | 25 | 83% | 5 | 17% |
| 3 | I am hurry to answer the mathematic test | 5 | 17% | 25 | 83% |
| 4 | I am difficult to look at the steps of doing the mathematic test | 16 | 53% | 14 | 47% |
| 5 | I am difficult to use in finishing the mathematic test | 24 | 80% | 6 | 20% |

Student errors are often attributed to a lack of attentiveness when working on problems. This is further supported by the questionnaire results, which indicate that 24 out of 30 students, or 80%, make mistakes in their mathematical problem-solving. These errors are primarily a result of students lacking proficiency in applying mathematical principles.

- **Errors in Problem-Solving for Word Problems**

Out of 30 students, 13 students, or 43%, make mistakes when solving word problems. In Figure 3, student errors in answering questions 4 and 5 are illustrated. Here is an example of a student's mistake:

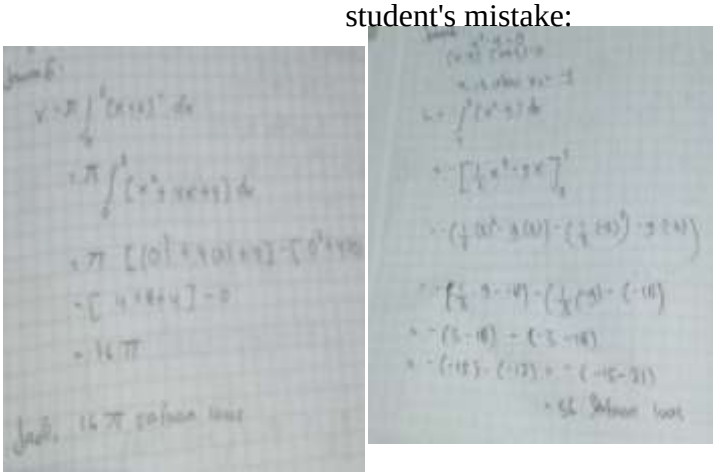

**Figure 3**: **Answers to Question 4 by Student S28 and Question 5 by Student S30**

In question 4, it is evident that the student made a mistake by not explicitly writing down what is known and what is asked in the problem. Right from the initial step, the student made an error by not integrating the variable correctly, leading to an incorrect final result. In question 5, the student did not complete the problem correctly due to lack of attention to detail in the exponent form, resulting in an incorrect final answer.

Questionnaire results and interviews with mathematics teachers indicate that some students struggle with comprehending the problems presented to them. According to the findings of the same research by (Rahmi et al., 2020) when students are asked to solve word problems, none of the students interpret the problem presented, such as identifying what is known and what is asked. Instead, they immediately attempt to solve the problem without prior exploration. This serves as evidence that students' initial abilities are essential for teachers to consider when designing integral learning within the classroom.

**Table 4**: **Questionnaire Results on Errors in Problem-Solving**

| No | Instrument point | Answer of student | | | |
|---|---|---|---|---|---|
| | | Yes | Persentation | No | persentation |
| 1 | I attempt to finish math test in essay till the end | 18 | 60% | 12 | 40% |
| 2 | I am difficult to use counting in finishing math test | 13 | 43% | 17 | 57% |
| 3 | I use the best strategy to finish the math test | 22 | 73% | 8 | 23% |
| 4 | I am difficult to finish the math test in the text test | 76 | 53% | 24 | 47% |
| 5 | I interprete the understand and comprehend what the test asks | 14 | 47% | 53 | 20% |

As for the factors that contribute to students experiencing difficulties in learning mathematics, these can be observed in the results of the following questionnaire:

**Table 5: Results of the Student Questionnaire on Internal Factors**

| No | Instrument point | Answer of student | | | |
|---|---|---|---|---|---|
| | | Yes | Persentation | No | Persentation |
| 1 | Mathematics is the interesting and challanging lesson | 25 | 83% | 5 | 17% |
| 2 | I attempt to finish the math test without being ordered by the teacher | 12 | 40% | 18 | 60% |
| 3 | I always read the math book before studying at school | 7 | 73% | 23 | 23% |
| 4 | Mathematics lesson is difficult to understand | 17 | 53% | 13 | 47% |
| 5 | I am feeling confused in finishing integral question | 23 | 47% | 7 | 20% |
| 6 | I often uncome in math lesson because of being sick | 4 | 13% | 26 | 87% |

From the table above, it is evident that intrinsic factors are highly correlated with students' test results, one of which is when asked whether they practice exercises without being instructed by the teacher. Eighteen students, or 60%, answered 'no.' These research findings align closely with the study conducted by (Wutsqo, 2021), who stated that students face difficulties in learning because they seldom practice exercises related to indefinite integral applications in algebraic functions.

Furthermore, from the questionnaire results, it is evident that when asked about their perception of mathematics, 17 students, or 57%, found mathematics to be a challenging subject. Additionally, 23 students, or 77%, reported experiencing confusion when studying mathematics. In interviews with teachers, it was revealed that the dominant factor is the low motivation of students to learn mathematics.

On the external factors side, the findings can be observed in the following table.

**Table 6: Results of the Student Questionnaire on External Factors**

| No | Instrument Point | Answer of Student | | | |
|---|---|---|---|---|---|
| | | Yes | Persentation | No | Persentation |
| 1 | Teacher uses the media and props in teaching mathematics | 10 | 33% | 20 | 67% |
| 2 | School deserves the Math book | 30 | 100% | 0 | 0% |
| 3 | The class is comfortable to study | 28 | 93% | 2 | 7% |
| 4 | I study in the house with the parent | 3 | 10% | 27 | 90% |

From the table above, it is evident that 20 students, or 67%, answered "No" when asked about the media and tools used by the teacher. Additionally, 27 students, or 90%, reported that they were not accompanied by their parents during the learning process at home. This indicates that environmental factors, particularly at home, are highly correlated with students' test results. This observation aligns with the findings of (Setiawan, 2020) who stated that external factors affecting students' learning difficulties include crowded or less conducive classroom conditions, students' involvement in extracurricular activities outside of school hours, and a less supportive community environment.

After analyzing the questionnaire results and conducting interviews with teachers, it was found that 16 students, or 53.33%, were predominantly influenced by internal factors, while 11 students, or 36.67%, were predominantly influenced by external factors.

## CONCLUSION

In conclusion, based on the analysis of test data, questionnaires, and interviews regarding students' errors in solving integrals in the 12th-grade IPS1 MAS YMPI class, the following conclusions can be written:

1. Out of the 30 students who were tested, 12 students, or 40%, did not meet the minimum passing grade (KKM) of 70. Among them, 7 students, or 23.3%, made errors in understanding basic integral concepts, 12 students, or 40%, made errors in applying mathematical principles, and 13 students, or 43.3%, made errors in solving word problems.
2. Based on the questionnaire results and interviews, it was found that 16 students, or 53.3%, were predominantly influenced by internal factors, while 11 students, or 36.6%, were predominantly influenced by external factors.

From these conclusions, the researcher recommends that every teacher should continuously provide innovative and appropriate strategies for each lesson to minimize students' errors in solving problems.

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