
The Analysis of Students' Errors in Using Integration Techniques

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Abstract This study aims to determine the type of error that students do in solving indefinite integrals based Newman classification error. This study is a qualitative study with research subjects are students of the 2nd half of Mathematics Education Program, Faculty of Teacher Training and Education, University of Riau, who taking course Integral Calculus. The instrument used in this study is a description that contains test questions about the indefinite integral. Newman error indicator in this study is an error in reading matter, misunderstands the matter, the transformation error, error process skills, and writing errors. Based on the results of error analysis using Newman indicators obtained results that the students made a mistake in reading matter by 20%, misunderstands the matter by 21,6%, 17,6% transformation error, error process skills by 12,8%, and errors writing of 2,4%.

Keywords: Error analysis; Error indicators Newman; Integral

1. Introduction

Mathematics is a universal science that underlies the development of modern technology, have an important role in a variety of disciplines and develop the power of human thought. The rapid development in the field of information and communication technology today is based on the development of mathematics in the field of number theory, algebra, analysis, probability theory and discrete mathematics. To dominate and create future technology required a strong mastery of math early on. Adequate mastery of mathematics can be achieved through the study of mathematics.

The purpose of learning mathematics in college is to acquire basic knowledge and mindset of mathematics, in the form of: (1) well-organized scientific thinking critical, logical, and systematic, (2) trained power of reason and creativity after studying various strategies and tactics in solving calculus problems, (3) trained in designing a simple mathematical model, reasoning, formulas, and the correct method. One matter of mathematics in college who can bridge the achievement of learning goals is integral calculus.

Integral calculus is one of the compulsory subjects in Mathematics Education Study Program which has a weight of 3 credits. This course aims to equip students about the concept of integral, techniques of integration, integral transcendent function, area, volume, and integral unnatural. In integral calculus, competence which is expected to be achieved, namely: (1) understand the concept of indefinite and definit integral and adept at applying it to the solution of the problem, (2) understand the technique of integration and proficient applying it to the solution of the problem, (3) understand the concept of indefinite integral and adept at problem solving (Sholihah and Mubarak, 2016). In addition, the calculus is one of the subjects that have an important role in solving problems of mathematics, physics, chemistry, biology, technique,. Therefore, the ability of students to understand calculus is very important embedded in Mathematics Education student

But in reality based on the observation and experience of researchers has been on the ability of prospective educators or students during the courses support integral calculus, was found that the students are still experiencing an error in solving the problems given. This is due to less students understand the basic concepts. This fact is important, because the understanding of the concept of the previous result for the concept beyond comprehension. Similarly, the error prior understanding of the concept will influence the understanding of the next concept. In the integral calculus for the indefinite integral material, cases that were encountered as students made a mistake on the basic concept is not on the content of the concept of indefinite integral. Other than that, the lecture was found that most students prefer the problem is given by a lecturer / tutor in accordance with the example that has given before, so they know how to fix it, or many students are accustomed to working procedurally. This is in accordance with the opinion Sa'dijah (2006) which states that a student prefers to work on the problems or issues they already know the step of solution.

Observing the problems that occur, it is necessary to search form factors causing errors and mistakes made by the students. According to the Indonesian General Dictionary, the analysis is the investigation something event (bouquet, deeds, and so on) to say what causes the problems; while the error is a mistake, an oversight, something is wrong. Errors in the context of teaching and learning means that errors in the perception of the subjects / reproduce the learning memory. The error analysis is the investigation of the errors were committed student perceptions related to a memory material and learning.

Based on the statement of Newman in White (2010) that when the student is trying to answer a problem, then the student pass a series of obstacles in the form of stages in problem solving, which include:

- a. Reading problems (Reading)
The ability to read a person's problem is mental ability that represents what is read in accordance with the understanding. Furthermore, the reading ability of students in the face of problems that affect how students will solve the problem.
- b. Understanding the problem (Comprehension)
When a student is able to restate a problem using their own words, then the student is said to be able to understand the problem. Students must be able to express the idea of matter containing "what, why, where, when, who, and how". Furthermore, the idea represented in an unknown element, questioned, and prerequisites.
- c. Transformation problem (Transformation)
At this stage of the transformation of matter, students connect between the known with the question asked. The ability of students to transform the problem can be seen through the way students change the shape of matter into another appropriate mathematical form. Furthermore, the students were asked to choose how, techniques, or procedures to be used in the execution of a matter.
- d. Skills process (Process Skill)
Stage process skills requires students to apply problem-solving plans that have been on the stage of the transformation of matter in order to obtain the expected solution.
- e. Writing answers (Encoding)
Students are referred to have gone through the stage of writing the answers, if students can write down the solution of a problem accurately. To ensure the achievement of the capability of writing a response, students are directed to recheck their answers, and then interpret the final answer.

This study aims to determine the type of error which students in solving indefinite integrals based classification error Newman. We hope this research can be the basis for lecturers in overcoming the mistakes made by students in problem-solving indefinite integrals.

2. Methodology

This study is a qualitative research. The research was conducted from March to August 2019 in Mathematics Education Program, Faculty of Teacher Training and Education, Riau University. The subject of this research is the 2nd semester students who take courses Integral Calculus.

This study will describe the information collected on mathematics education student error analysis according to Newman's theory in solving problems indefinite integrals. The criteria for selection are the subjects in this study using purposive sampling technique, which means that a subject to be studied were selected based on consideration of researchers appropriate destination (Sugiyono, 2012). The instrument used in this study a description that contains test questions about the indefinite integral. Testing the validity of the instrument using content validity. The validity of the content is testing the validity of using the lattice about which there are indicators as benchmark and the number of the questions that have been outlined by the indicator. To further test the validity, then consulted with experts (Sugiyono, 2012). Data collection techniques used were written test. The answer from the written test then analyzed the mistakes the students were divided into 5 types of errors. Indicators to classify the mistakes done by the students can be seen in Table 1.

Table 1. Classification Code Table Error

No.	Stages in Error Analysis	Error indicator
1	Reading	<ul style="list-style-type: none"> • Unable to interpret the given problem correctly • Unable to find keywords in question • Not knowing who is going to implement measures • Write down the exact same form with the matter but did not proceed
2	Comprehension	<ul style="list-style-type: none"> • Wrong in write down what is known from the questions. • Write down other mathematical forms of matter but not meaningful • Write down other mathematical forms of matter, but there is important information will be missed
3	Transformation	<ul style="list-style-type: none"> • Do not change the information on the questions into another form that can solve problems • Change the information in question into another form that can solve the problem but is not appropriate • Have changed the information on the matter, but did not write a complete description
4	Process skill	<ul style="list-style-type: none"> • Errors in computing • Unable to continue troubleshooting procedures • Continuing the process of computing but is not appropriate because there is a mistake in concept of algebra • Careless in the process of calculation
5	Encoding	<ul style="list-style-type: none"> • Writing down the notation (negative sign, a symbol, an equal sign, and others) are not appropriate • Wrong in the meanings of answers (None or wrong in turning into an early form

3. Result and Discussion

3.1. Result

Before performing fault analysis on student answer sheet, first the researchers determine the percentage of correct answers, wrong, and do not answer to each question. The percentage of correct answers, wrong, and did not answer presented in the table below.

Table 2, Percentage Students for Each Problem

Number Problem	Right		false		No answer	
	total	Percentage	total	Percentage	total	Percentage
1	0	0%	15	60%	10	40%
2	4	16%	17	68%	4	16%
3	2	8%	15	60%	8	32%
4	4	16%	21	84%	0	0%
5	18	72%	7	28%	0	0%

From the table shows that most students answered wrong on the question number 4. Subsequently analyzed the number of students who make mistakes based on indicators Newman for each question. Recapitulation percentage yield per student response error analysis indicators can be seen in the following table.

Table 3, Percentage Error Newman Student Based Indicators for Each Question

No	Indicator	Problem No. 1	%	Problem No. 2	%	Problem No. 3	%	Problem No. 4	%	Problem No. 5	%	Average (%)
		total		total		total		total		total		
1	Read	11	44	5	20	8	32	1	4	0	0	20%
2	Understand	9	36	7	28	6	24	4	16	1	4	21.6%
3	Transformation	3	12	7	28	4	16	7	28	1	4	17.6%
4	skills process	2	8	2	8	4	16	8	16	4	16	12.8%
5	Writing notation	0	0	0	0	1	4	1	4	1	4	2.4%

The table shows that the most common mistake done by the students understand the problem lies in the indicator, followed indicator of reading matter. To see the error, the following error display one student for each indicator.

The first indicator Newman error is an error in the reading matter. The result showed that the average percentage error in the reading matter by 20%. Here is one result of the work of students in solving that made a mistake on the indicator reading matter.

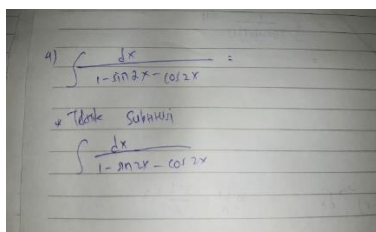


Figure 1. Examples of student answers to the indicator 1

Figure 1 shows that the error occurred because the student does not obtain the necessary information after reading the questions. Students can not find the keyword in the problem that caused the student simply rewrite the problems, then not be able to continue the settlement of a matter. This is in accordance with the opinion Clemen (Oktaviana, 2017) that the way in which students in solving problems is very influenced by the ability to read.

The second indicator Newman error is an error indicator to understand the problem. The average percentage of errors in understanding the matter based on the table that is equal to 21.6%. Below is one example of a student answers make mistakes in understanding the problem.

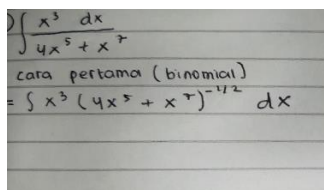


Figure 2. Examples of student answers to the indicators 2

From Figure 2 is seen that students are changing the shape of matter, but this does not mean changing the form and not the right, so that students could not continue the settlement answer questions. One of the first steps to resolve the problem number 2 is dividing the numerator and denominator by x^3 . From research conducted Amalia (2017) note that errors in understanding the problem because of confusion in understanding the problems that exist on the matter.

Newman error indicator next transformation error indicator. In the third indicator, the average percentage of the mistakes made by students at 17.6%. Examples of mistakes made by students for indicator 3, can be seen in the image below.

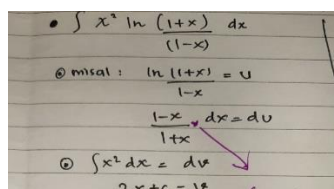


Figure 3. Examples of student answers to indicator 3

Based on Figure 3 can be seen that students are using the correct method to resolve the problem, namely the partial methods, but student got wrong when changing $\ln\left(\frac{1+x}{1-x}\right)$ to its derivatives. Results derivative u not $\left(\frac{1-x}{1+x}\right)$, but $\left(\frac{1-x}{1+x}\right) \cdot \left(\frac{1(1-x) - (-1)(1+x)}{(1-x)^2}\right)$. Supposedly, the students use the concept of the chain rule to get the correct derivative. Praktipong and Nakamura (2006) suggests that students understand the questions about but failed to do the appropriate operation in problem solving, resulting in the student got transformation error.

Indicators 4th is the skill of the process, obtaining an average error of 12.8%. Examples of student errors in process skills indicator shown in the figure below.

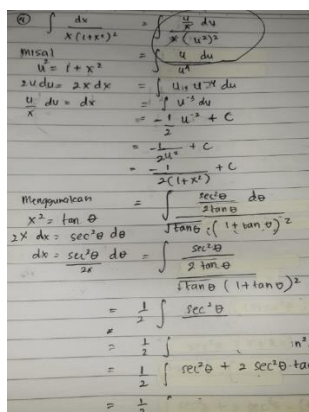


Figure 4. Examples of student response indicator 4

In this figure, it appears that the student made a mistake in the calculation process. Students have been correct in selecting methods and analogy. However, when dividing $\frac{u}{x}$ to x students got wrong student. Students write down the result as u , whereas the correct result is $\frac{u}{x^2}$. Research conducted by Sumartini (2016) states that one of the causes of errors in the skills of the process because haste to perform calculations that result in answers that are written incorrectly.

5th fault indicator is writing / notation. The average percentage of students who make mistakes on this indicator is the percentage of the smallest error is 2.4%. Examples of student errors in all five indicators can be seen in the following figure.

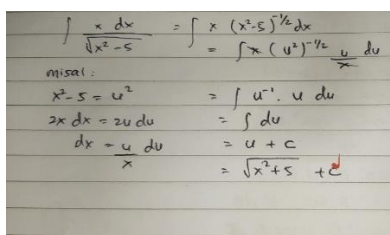


Figure 5. Examples of student answers to the indicator 5

On figures shows that when students make mistakes when substituting a u . The expected result is $\sqrt{x^2 - 5} + c$, but the students wrote $\sqrt{x^2 + 5} + c$. This error occurs because students are careless in writing notation final answer. This is in line with research conducted Darmawan (2018) who obtained the result that errors in the writing of a student due to inaccuracy and the absence of a correction back to the results of the work done.

These results indicate that the error experienced by students is most common at this stage of understanding and reading questions. Students confusion in determining the initial procedure should be done to resolve the questions. This is in line with research conducted by Rahmawati and Jewel (2018), a lot of students who have difficulty in understanding the problem, so they can not write what is known and questioned about. Research conducted by Kairuddin (2017) also obtained similar results, that is not properly interpret what the request about the most common mistakes in the student answer sheet.

By analyzing the mistakes made by students, faculty can determine the type of error and the precautions reoccurrence of the error. Junaidi, et al (2015) provides a solution to reduce errors in

answering questions via the Learning Therapy. Learning Therapy provides a way to resolve errors in each of the indicators, as follows.

1. Error indicator reading the questions can be addressed by studying the material preconditions related to the material being studied.
2. Fault indicator to understand the problem can be minimized by practicing understand the problem, for example, by understanding what is known and what is being asked about.
3. Errors on transformation indicator reduced by practicing writing the formula or method to be used so that the next job more focused.
4. Fault indicator process skills can be overcome by solving problems based on formulas and methods that have been carefully, focus, and detail.
5. Error indicator writing / notation can be avoided by familiarizing students check their answers.

3.2. Discussion

Based on student answers mistake on this study, it appears that most students experienced an error indicator and the indicator reading to understand about the matter. Therefore, we need a deeper understanding of the indefinite integral questions for students. In addition, students have more practice indefinite integrals do the problems are varied, so that confusion does not specify the procedures to be used to solve the indefinite integrals.

In this study, the researchers did not examine the effect of Learning Therapy on each error indicator Newman. Instead, to prove the impact of Learning Therapy on indefinite integral material, the need for further research that examines the influence of Learning Therapy in dealing with the error students based on indicators Newman.

4. Conclusion

Based on the results of error analysis using Newman indicators conclusion that the student made a mistake in reading matter by 20%, an error in understanding about 21.6%, 17.6% transformation error, error process skills by 12.8%, and errors writing of 2.4%. The most common mistake done by the students is a mistake to understand and read the questions, that students can not find the keyword in question and change the shape but not a significant problem.

Mistakes made by students should be addressed in an appropriate manner. One way to overcome the mistakes made by students using Learning Therapy.

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