Tarbawi: Jurnal Ilmu Pendidikan
p-ISSN:1858-1080|e-ISSN: 2615-6547
Vol. 20, No. 2, December 2024, 208-220

Newman's Error Analysis (NEA) in Solving Computational Thinking Problems on Indefinite Integral Material

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Abstract. *The initial abilities of students in the Integral Calculus course reveal that many have not yet grasped the fundamental concepts of integration. Out of 20 students given integral problems, only 6 students (30%) were able to answer correctly, while 14 students (70%) made errors. These errors in the Calculus course need to be analyzed further to assist lecturers and students in identifying weaknesses in the learning process and address or at least reduce similar mistakes in the future. This study employs a descriptive qualitative approach, with 20 second-semester students from the Mathematics Education program at IAIN Lhokseumawe as the research subjects. The findings indicate that students with very high and high computational thinking skills did not make errors compared to those with moderate, low, and low computational thinking skills. Students with moderate computational thinking skills tended to make errors in processing and answer writing. In contrast, students with low and very low computational thinking skills more frequently encountered transformation, processing, and answer-writing errors. Transformation errors occur when students make mistakes in calculations or during the process skill stage. These errors are often caused by students' difficulty structuring solution steps, leading to misunderstanding the problems. Most students were also unable to reformulate the problems into forms suitable for the appropriate solution method, resulting in their inability to proceed with the calculations. Based on the error analysis using Newman's Error Analysis (NEA) method, the most common types identified were transformation, processing, and answer-writing errors.*

Keywords: *Computational Thinking Ability, Indefinite Integral, Newman's Error Analysis*

INTRODUCTION

The 21st-century learning paradigm focuses on improving competence, literacy, character, and thinking skills. (Arifin, 2017; Fityana, I. N., Sarwanto, 2017). During the learning process, students are expected to be able to solve problems using skills such as communication, collaboration, critical thinking, innovation, and creativity. (Amanah, P. D., Harjono, A., & Gunada, 2017). This aligns with the 21st-century learning objectives, which prepare students to face challenges in life. (Aliftika, O., Purwanto, Utari, 2019). The development of technology and information in the 21st century has been linked to learning. (Arif Widodo, Dyah Indraswati, Deni Sutisna, 2020; Dewi, K. P., & Purwanti, 2019). Therefore, students need to master various skills, including learning and innovation skills, knowledge of media and information technology, and skills related to life and career. (Zubaidah, 2016). Learning and innovation skills refer to learners' ability to think creatively, solve problems, communicate and cooperate, and create something new. Learners are expected to master the ability to filter and process data and use technology to help them in their work. In addition, life and career skills are linked to learning and innovation skills.

The ability to solve or resolve a problem is one of the mathematical abilities that students must have. Problem-solving skills can improve critical thinking and help students understand and solve problems. (Putri, L. F., & Manoy, 2013; Rahmawati, A., & Warmi, 2022). Students will have difficulty solving problems if they do not have good problem-solving skills. (Wahyu, H., & Sariningsih, 2018). According to Rosmawati et al. (2018), Problem-solving is an essential stage in the mathematics curriculum and is the first step students must take to solve various problems they face. Students must be able to understand and analyze data and make appropriate strategies to solve mathematical problems.

21st-century skills include problem-solving, critical thinking, collaboration, and communication. How people think about problems or issues and take action to solve them is one way to achieve the goals of 21st-century education. (Setyautami, 2020)To face today's challenges, students must be able to solve problems with computational thinking. However, learning mathematics is always monotonous. It includes teachers explaining the material, checking students' assignments, and giving homework to students. As a result, students are less eager to improve their computational thinking, which decreases their computational thinking ability. (Budiarti, 2022).

21st-century skills, such as problem-solving, critical thinking, collaboration, and communication, are essential for achieving educational goals in this era. One approach to fostering these skills is teaching students to think critically about problems and take practical actions to solve them. (Setyautami, 2020). To address these challenges, students must develop computational thinking abilities, which can help them solve problems more effectively. However, mathematics education often feels monotonous, relying on traditional methods such as teacher-led explanations, assignment reviews, and homework tasks. This approach tends to demotivate students, hindering the development of their computational thinking skills and ultimately leading to a decline in the quality of these abilities. (Budiarti, 2022)Faced with the challenges of the 21st century, prospective mathematics teachers must master a range of competencies that empower students to acquire and apply knowledge, collaborate effectively, and grow as individuals capable of adapting and thinking critically in the future. (Eliza, 2023).

Computational thinking, crucial in developing students' mathematical skills, is essential to 21st-century education. However, research by Ostian et al., (2024) Reveals that students' computational thinking abilities remain significantly low. Among 25 students studied, only 11% demonstrated a high level of proficiency, while the majority (75%) exhibited moderate skills, and 14% fell into the low category. Although most students in Grade VII.1 could identify indicators such as decomposition, pattern recognition, algorithmic thinking, and abstraction, only a few could apply these concepts correctly in problem-solving contexts. This finding underscores the need for more effective strategies to enhance student's understanding and application of computational thinking concepts. By fostering a deeper grasp of these skills, students can achieve higher-order and more structured thinking, enabling them to solve mathematical problems more effectively. (M. Gunawan Supiarmo, 2021).

Computational thinking ability, also known as computational thinking ability, is a 21st-century skill that supports mathematical thinking. Computational thinking is a way of thinking about solving problems by incorporating the solving of those problems into computer algorithms. Computational thinking can help students in making decisions and solving mathematical problems. School curricula in some developed countries have been updated to allow students to learn mathematics early on. This is based on the belief that computational thinking can help students learn to think systematically, logically, and structurally. (M. Gunawan Supiarmo, 2021).

One of the courses in the mathematics education study program at IAIN Lhokseumawe is integral calculus. This course combines material from several additional courses, such as differential calculus, calculus of many variables, differential equations, mathematical statistics, and others. High computational thinking skills are required to understand and solve problems related to the topic. Monariska (2019) stated that "integral" is an essential operation in integral calculus. Integrals are widely used to solve problems in various fields, such as curve length, volume, population estimates, and effort. They are also essential in many areas of science and industry. Critical theories usually begin in high school; due to their intrinsic complexity, integral calculations often require an infinite process of solving. As a result, many learners face difficulties when learning them. Learners will make many mistakes when solving problems. According to the results of initial interviews and observations made during the lecture, the integral calculus course is one of the most challenging courses for students to understand. This is because it requires a deep understanding of concepts and an accurate grasp of the subject studied in high school. It is essential for lecturers proficient in this course to identify students' errors when learning the material.

According to the results of Iriani (2022) Research, namely (1) High ability students made mistakes at the process skills stage because they did not receive practice problems using the partial method; (2) High ability students made mistakes at the transformation stage because they incorrectly substituted the values obtained at the permissiveness stage; and (3) High ability students made mistakes at the process skills stage because they could not simplify the terms containing the x variable. Very low-ability students made errors at various stages. They made errors at the reading stage. They could not read the symbol "∫, "errors at the comprehension stage because they did not understand the meaning of dy and could not determine the term to be generalized, mistakes at the transformation stage because they could not change the form of the problem to fit the formula of the substitution and partial methods, and errors at the process stage because they did not understand the steps of the substitution and partial methods.

Hajizah (2019) It also highlighted that students made errors using different indicator approaches. For instance, students incorrectly determined indefinite integrals using the substitution method in 51.16% of cases, the partial method in 30.23% of cases, the trigonometric substitution method in 23.26% of cases, and the method of rationalizing the integrand in 48.84% of cases. These findings align with Rusyda's (2022) The research identified that the most frequent errors in Newman's Error Analysis (NEA) were related to coding, process, and transformation skills. Therefore, instructors must address these issues by incorporating non-routine problems and tasks that involve Higher-Order Thinking Skills (HOTS).

Maths problems are usually description problems. Problems like this are still quite complex for most learners to solve. Learners who have difficulty solving problems can make mistakes when trying to solve them. Lecturers can use Newman's Error Analysis (NEA) to determine how learners solve problems. NEA explains the errors learners make when solving problems. The results of this study can be used to assess the improvement of learning quality. (Cahyaningtyas, O., Rahardi, R., & Irawati, 2021).

Lisa et al. (2023) Findings related to students' difficulties in solving computational thinking (CT) questions regarding the problem-solving pattern, difficulties when asked how to solve the problem, and difficulties when determining and concluding from the problem. Based on the results of the initial ability of integral calculus lectures, it is found that there are still many students who do not understand the basic concepts of integral. Of the 20 students given integral problems, 6 could answer the questions correctly, and 14 made mistakes. This means that 30% of students are doing the problem correctly, and 70% are making mistakes. Then, when interviewed, most students answered that they had forgotten the basic integral concept, even though they had been taught it in high school. The basic idea of the integral is something that students must understand when working on problems in the integral calculus course. Other findings were found by Lisa et al. (2024) The high computational thinking ability indicators that can be completed perfectly are decomposition, pattern recognition, algorithm thinking, and generalization/abstraction. With moderate computational thinking ability, students can solve perfectly for decomposition and pattern recognition indicators. However, indicators of thinking algorithms and generalization/abstraction are still less precise. Low computational thinking ability has been able to measure decomposition indicators. However, for pattern recognition indicators, thinking algorithms are still less precise in solving, while generalization/abstraction indicators do not answer.

The errors experienced by students in the Calculus course need to be analyzed further. This is intended to help lecturers and students identify the weaknesses of the learning process and overcome or at least reduce subsequent errors so that the same mistakes do not occur in the future.

There are many kinds of analysis methods to determine student error types. One of them is by using Newman's analysis method. Newmon suggests that 5 types of errors are often made by students in the process of solving problems, namely 1) Reading errors, 2) Understanding errors, 3) Transformation errors, 4) Processing ability errors, and 5) Answer writing errors. These errors occur because students are in a hurry to solve problems and lack motivation to give their best effort (Veena Kapur, 2018; Wardhani, T. A. W., & Argaswari, 2022). Jamal (2018) also stated that compared to other methods, Newman's method has the highest level of credibility.

The results of the above opinions suggest that educators highly recommend analysis to find out how credible their students are in the computational thinking process. The analysis method can clearly explain the types of errors that learners often make when solving problems. Learners must be responsible for the problem-solving process. (Kania, 2019). In the process, learners are expected to produce valid evidence by making reasonable opinions and arguments. (Ekayanti, 2017).

In this research, no one has discussed how computational thinking skills on indeterminate integral material. So, there needs to be further discussion about how the computational thinking ability of students. Based on the description above, researchers are interested in research to conduct a study entitled "Analysis of Student Errors in Completing Computational Thinking Skills on Indeterminate Integral Material Based on Newman's Error Analysis (NEA)." Based on the research context described above, the author intends to analyze the types of errors, error tendencies, and causes of students' mistakes in completing computational thinking skills on indeterminate integral material.

METHOD

This research will use descriptive qualitative research. Descriptive qualitative research aims to provide a structured, clear, and concrete description of the computational thinking ability of students studying mathematics on indefinite integral material. This research aims to describe the errors made by students in solving computational thinking problems of indeterminate integrals based on Newman's Error Analysis (NEA) indicators. The NEA indicators referred to in this study are as follows: (1) Reading errors: These are errors made by students when they read information, both words and symbols, which they know and then asked in the problem; (2) Understanding errors: These are errors made by students after they have correctly read the information in the problem, but they are unable to understand the information, either words or symbols, that they already know, (3) Transformation errors are errors made by students after they have correctly understood the problem but are unable to find the formula, properties, or steps needed to solve it, (4) Processing ability errors are errors that occur when students have found the right formula, properties, or steps to solve the problem but fail to carry out the procedure correctly, (5) Answer Writing errors: Students make mistakes after performing the procedure correctly, but cannot write the answer correctly. (A. Newman, 1983; M. A. Newman, 1977).

This research was conducted from 19 February to 31 March 2024 at the Mathematics Education Study Program, FTIK IAIN Lhokseumawe. Twenty students who attended integral calculus lectures in the academic year 2023/2024 were selected as research subjects using purposive sampling, which means taking samples based on specific considerations. (Sugiyono, 2015). The choice of subjects was made through purposive sampling based on the following considerations: (1) each subject represents the category of high, medium, or low initial mathematics ability after the description question test; (2) each subject is given indefinite integral material; (3) each subject can communicate well; and (4) each subject does not feel pressured or forced. Before administering the test to students, validity and reliability tests were conducted on the computational thinking ability test items.

This study employs several complementary techniques for data collection. First, essay-type tests assess students' ability to solve indefinite integral problems, considering the five NEA indicators. Additionally, semi-structured interviews are conducted to explore the reasons behind the students' mistakes, allowing the researcher to understand the thought processes involved when students tackle the problems. Documentation is also utilized to record test results, interview transcripts, and other supporting data, such as students' academic backgrounds, which provide further context for the analysis of the study.

Based on the analysis using IBM SPSS Statistics 25, the validity values for each test item were as follows: item 1a scored 0.758, item 1b scored 0.583, item 1c scored 0.695, item 1d scored 0.715, and item 1e scored 0.838. With a sample size of 20, the r-table value was 0.444. Since the r-calculated values for all test items were more significant than the r-table value, and the significance (sig. 2-tailed) values were less than 0.05, all test items were deemed valid. Additionally, the reliability test resulted in a Cronbach's Alpha value of 0.782, which exceeded the minimum threshold of 0.6, confirming that the test items were reliable for use in measurement. Subsequently, out of 20 students in the research population, three subjects were selected based on their levels of computational thinking ability. The chosen subjects included one student with moderate computational thinking ability, one with a low level, and one with a very low level. The details of the research subjects based on their computational thinking ability levels are presented in Table 1.

Table 1. Research Subjects Based on The Level of Computational Thinking Ability

No.	Subject	Value	Ability Level
1.	S3	65	Medium
2.	S8	55	Low
3.	S18	35	Very Low

Furthermore, based on the results of the answer correction, the researcher divided the students into five groups: very high, high, medium, low, and very low. There were no errors for the very high and high levels of computational thinking ability, so the researcher selected only three students who made the most errors on all five questions and all types of errors. Data collection through computational thinking tests and unstructured interviews were used to collect data. The test is a description question with five questions; computational thinking ability in indeterminate integral material indicates the questions used. The test was conducted to obtain data on errors, while the interview was conducted to explore the causes of errors.

The research used three data analysis techniques. (Sugiyono, 2008): data reduction, data presentation, and conclusion drawing. Triangulation of methods ensures the validity of the data collected by researchers. By looking at how students solve problems, researchers can identify the types of errors they make. This research uses the triangulation method to ensure the validity of the data. According to Yenusi, Mumu, and Tanujaya (2019), triangulation is a data-checking method in which something different from the data is used to check or compare it with the data. This research uses time triangulation by conducting interviews and observations on research subjects at various times or situations. If the test results show different data, the trial should be repeated repeatedly until you get the correct confidence.

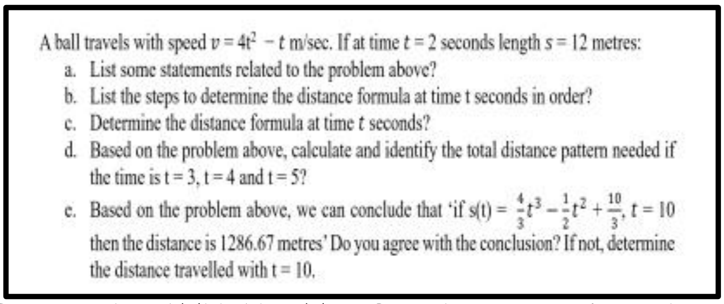
FINDINGS

This study aims to analyze students' errors in solving computational thinking skills questions on indefinite integral material based on NEA indicators. Twenty students solved computational thinking skills problems on indefinite integral material. One problem with five issues related to indeterminate integral material is given. Table 2 below shows the value of student answer correction results based on NEA indicators.

Table 2. Test Results of Students' Computational Thinking Ability Based on NEA Indicators

Subject	Value	Category	Subject	Value	Category
S1	90	Very High	S11	70	Medium
S2	40	Very Low	S12	40	Very Low
S3	65	Medium	S13	55	Low
S4	40	Very Low	S14	35	Very Low
S5	50	Very Low	S15	40	Very Low
S6	55	Low	S16	45	Very Low
S7	60	Low	S17	65	Medium
S8	55	Low	S18	35	Very Low
S9	40	Very Low	S19	45	Very Low
S10	40	Very Low	S20	40	Very Low

Table 2 shows the test results of students' computational thinking ability based on NEA indicators with very high, high, medium, low, and very low categories. The question of computational thinking ability on indefinite integral material given can be seen in Figure 1 below.



A ball travels with speed $v = 4t^2 - t$ m/sec. If at time $t = 2$ seconds length $s = 12$ metres:

a. List some statements related to the problem above?
b. List the steps to determine the distance formula at time t seconds in order?
c. Determine the distance formula at time t seconds?
d. Based on the problem above, calculate and identify the total distance pattern needed if the time is t = 3, t = 4 and t = 5?
e. Based on the problem above, we can conclude that 'if $s(t) = \frac{4}{3}t^3 - \frac{1}{2}t^2 + \frac{10}{3}$, $t = 10$ then the distance is 1286.67 metres' Do you agree with the conclusion? If not, determine the distance travelled with t = 10.

Figure 1. Computational Thinking Test Questions For Indeterminate Integrals

The question in Figure 1 measures computational thinking ability on indeterminate integral material based on computational thinking indicators. According to the results of the indeterminate integral computational thinking ability test in Table 1, the IAIN Lhokseumawe mathematics education study program students are grouped into five groups based on computational thinking ability. Table 2 shows the range of student scores.

Table 3. Student Score Range

Ability Level	Score Range	Number of Students
Very high	$x \geq 80.83$	1
High	$71.67 \leq x < 80.83$	0
Medium	$62.50 \leq x < 71.67$	3
Low	$53.33 \leq x < 62.50$	4
Very Low	$x < 53.33$	12

Based on Table 3 for the test results of computational thinking ability of Indeterminate Integral, students of IAIN Lhokseumawe mathematics education study program who obtained a very high level of ability only 1 student, high level of ability does not exist, medium level of ability as many as 3 students, low level of ability as many as 4 students and very low level of ability as many as 12 students. The following will present the results of answers and interviews for errors made by students based on indicators of Newman's error types based on ability level, which can be seen in Table 4.

Table 4. Newman's Error Types Based on Computational Thinking Ability Level

No.	Type of Error	Number of Students				
		Very High	High	Medium	Low	Very Low
1.	Reading error	0	0	0	0	0
2.	Comprehension error	0	0	0	0	0
3.	Transformation error	0	0	0	1	2
4.	Process skill error	0	0	1	1	4
5.	Encoding error	0	0	2	2	6

Based on Table 4, for errors in reading, the problem (reading error) and comprehension error (comprehension error) obtained for the level of ability is very high, high, medium, low, and very low, and did not make mistakes. As for the transformation error obtained from the test results of computational thinking ability of Indeterminate Integral of mathematics education study program students, IAIN Lhokseumawe for the level of ability is very high, high, and moderate did not make mistakes. In contrast, the level of ability is low for 1 student, and very low; 2 students make mistakes in transformation errors. The answer results can be seen in Figure 2 below.

The solution steps determine the distance formula at time t sequentially:

Distance formula = $S = v \times t$

$$S = (4t^2 - t)t = 4t^3 - t^2 = 4(2)^3 - (2)^2 = 4(8) - 4 = 32 - 4 = 28$$

$$V = 4t^2 - t = 4\int t^2 - \int t = 4\int \frac{1}{2+1}t^{2+1} - \int \frac{1}{1+1}t^{1+1} = 4\int \frac{1}{3}t^3 - \int \frac{1}{2}t^2 + C = \frac{4}{3}t^3 - \frac{1}{2}t^2$$

The first step is to calculate the speed $V = 4t^2 - t$ to determine the distance s, $V = 4(2)^2 - (2) = 4 \times 4 - 2 = 14$

Figure 2. Answers of S8 and S18

From Figure 2, the results of the answers and interviews of S8 and S18 to measure computational thinking algorithm indicators, S8 has a low ability to answer mistakenly in determining the steps of completion and which steps take precedence in solving the problem; this can be seen S8 did not mention the steps of completion but immediately used the distance formula, for the Abstraction indicator S8 was wrong in determining the distance formula which should be $V = 4t^2 - t$ Integrated to obtain the intended distance formula so that it was wrong in determining the mathematical model. S18, who had a very low ability, did the same thing. S18 was incorrect in determining the steps of solving and which steps took precedence in solving the problem; it can be seen that S18 immediately calculated the speed by using the formula V and entered t = 2; for the Abstraction indicator, S18 mistakenly used the formula to solve the problem so that it was wrong in determining the mathematical model.

The process skill error is obtained from the test results of the computational thinking ability of Indeterminate Integral of mathematics education study program students of IAIN Lhokseumawe. The very high ability level and high did not make mistakes, while the medium ability level, as many as 1 student; low ability level, as many as 1 student; and very low ability level, as many as 4 students made process skill errors. The answer results can be seen in Figure 3 below.

$$V = 4t^2 - t = 4\int t^2 - \int t = 4\int \frac{1}{2+1}t^{2+1} - \int \frac{1}{1+1}t^{1+1} = 4\int \frac{1}{3}t^3 - \int \frac{1}{2}t^2 + C = \frac{4}{3}t^3 - \frac{1}{2}t^2$$

Find the formula for the distance at time t seconds:

Answer: $V = 4t^2 - \frac{tm}{det}$ terhadap waktu

$$s(t) = t^3 - \frac{t^2}{2}$$

Distance at t = 3, t = 4 and t = 5

$$s(t) = t^3 - \frac{t^2}{2}$$

$s(t = 3) = 19{,}5\ meter$

$s(t = 4) = 56\ meter$

$s(t = 5) = 105\ meter$

$$V = 4t^2 - t = 4\int t^2 - \int t = 4\int \frac{1}{2+1}t^{2+1} - \int \frac{1}{1+1}t^{1+1} = 4\int \frac{1}{3}t^3 - \int \frac{1}{2}t^2 + C = \frac{4}{3}t^3 - \frac{1}{2}t^2$$

Figure 3. Answer Results S3, S18 and S18

Based on Figure 3, the results of answers and interviews S3, S8, and S18 to measure computational thinking indicators of pattern recognition with questions based on the problem above: Calculate and identify the total pattern of the distance required if the time is t = 3, t = 4, and t = 5. S3, who has moderate ability, answered incorrectly due to errors in determining the distance formula. The answer above shows that S3 is wrong in completing the integral. $4t^2 - t$ Integrating does not use the concept of integral that should and does not determine the value of C, resulting in the distance being missed when determining the time t = 3, t = 4, and t = 5. S8 also did the same thing and was unable to answer erroneously due to errors in determining the distance formula. The answer above shows that S8 is wrong in completing the integral. $4t^2 - t$ When integrating, it does not use the concept of integral and does not determine the value of C, resulting in deciding the distance with time t = 3, t = 4, and t = 5 unanswered. The same thing was also done by S18, who has a very low ability to answer erroneously due to errors in determining the distance formula. The answer above shows that S18 did not define the integral. $4t^2 - t$ when determining the distance with time t = 3, t = 4 and t = 5 it was wrong in the solution.

Based on the results of the interview, it is known that the cause of the mistakes made by students is that they consider it difficult to make the steps of completion, so they are wrong in understanding the problem; most students cannot change the form of the problem to match the method that should be used, this causes students not to continue the calculation process. Based on the interview, it is known that the cause of students making process skill errors is that they cannot integrate the problem. Students do not understand how to solve problems because they do not understand the concept of integrals.

Encoding error is obtained from the test results of the computational thinking ability of Indeterminate Integral of mathematics education program students IAIN Lhokseumawe for very high ability level and did not make mistakes. In contrast, the medium ability level 2 students, low ability level 2 students, and very low ability level 4 students made encoding errors. The answer results can be seen in Figure 4 below.

Based on the above problem, it can be concluded that, If $s(t) = \frac{4}{3}t^3 - \frac{1}{2}t^2 + \frac{10}{3}, t = 10$ then the distance is 1286 meters. Do you agree with the conclusion? If not, determine the distance traveled with t=10.

$$\frac{4}{3}t^3 - \frac{1}{2}t^2 + \frac{10}{3}$$
$$\frac{4}{3}10^3 - \frac{1}{2}10^2 + \frac{10}{3}$$
$$\frac{4}{3}1000 - \frac{1}{2}100 + \frac{10}{3}$$
$$\frac{4000}{3} - 50 + \frac{10}{3}$$
$$\frac{4000}{3} - \frac{150}{3} + \frac{10}{3}$$
$$\frac{4840}{3} = 1613{,}33$$

I disagree with your conclusion, because if $s(t) = \frac{4}{3}t^3 - \frac{1}{2}t^2 + \frac{10}{3}, t = 10$, then the distance is 1613,33 m

$t = 10$ $\quad s(10) = \frac{4}{3}(10)^3 - \frac{1}{2}(10)^2 + \frac{10}{3} = \frac{4}{3}(1000) - \frac{1}{2}(100) + \frac{10}{3} = \frac{4000}{3} - \frac{100}{2} + \frac{10}{3} = \frac{4000}{3} - 500 + \frac{10}{3} = \frac{4000-1500+10}{3} = \frac{2.510}{3} = 836{,}67$ meter

Figure 4. Answers of S3 and S8

Based on Figure 4, the results of S3 and S8 answers and interviews to measure computational thinking evaluation indicators with questions based on the problem above, it can be concluded that "if s(t) = $\frac{4}{3}t^3 - \frac{1}{2}t^2 + \frac{10}{3}$, t = 10, then the distance is 1286.67 meters." Do you agree with the conclusion drawn? If not, determine the distance traveled with t = 10. S3, who has medium ability, answered by using the steps using the correct distance formula, but the final calculation was wrong when adding and subtracting fractions, namely $= \frac{4000}{3} - \frac{150}{3} + \frac{10}{3} = \frac{4840}{3}$ should be $= \frac{3860}{3}$ So, it was wrong to conclude. Similarly, S8, who had low ability, answered using the steps using the correct distance formula, but the final calculation when adding and subtracting fractions was wrong. $= \frac{4000}{3} - \frac{100}{2} + \frac{10}{3} = \frac{4000}{3} - 500 + \frac{10}{3} = \frac{2510}{3}$ should have been $= \frac{3860}{3}$The conclusion was wrong. Figure 5 shows another result obtained by S18, who has very low ability.

Not,

$$s(10) = \frac{4}{3}(10)^3 - \frac{1}{2}(10)^2 = \frac{4}{3}(1000) - \frac{1}{2}(100) = \frac{4000}{3} - \frac{100}{2} = \frac{4000}{3} - 50 = \frac{4000}{3} - \frac{100}{3} = \frac{3800}{3} = 1283{,}33$$

Figure 5. Answers of S18

Based on Figure 5 of S18 answers and interview results to measure computational thinking evaluation indicators with questions based on the problem above, it can be concluded that "if s(t) = $\frac{4}{3}t^3 - \frac{1}{2}t^2 + \frac{10}{3}$, t = 10, then the distance is 1286.67 meters." Do you agree with the conclusion drawn? If not, determine the distance traveled with t = 10. S18, who has very low ability, mistakenly used the correct distance formula so that the final calculation was wrong, which resulted in the wrong conclusion. Based on the interview results, the cause of errors at the encoding stage is that students cannot complete the calculation process, which results in not working at this stage. The high level of errors students make at the encoding stage is due to errors made by students at previous stages of errors, such as the transformation and process skill stages. Errors made by students at the encoding stage are not the main errors but result from previous errors, namely comprehension, transformation, and process skills.

DISCUSSION

Based on the research results obtained, Newmon suggested that 5 types of errors are often made by students in the process of solving problems, namely 1) Reading errors, 2) Understanding errors,

3) Transformation errors, 4) Processing skill errors, and 5) Answer writing errors. Errors in reading problems (reading errors) and comprehension errors for high, medium, low, and very low ability levels did not make mistakes. Transformation errors for high, high, and medium ability levels did not occur. In contrast, the low ability level of 1 student and 2 students made transformation errors due to errors in determining the distance formula, which should be $V = 4t^2 - t$ Integrated to obtain the intended distance formula so that it was wrong in determining the mathematical model. Salmina conveyed the same thing. (2017): mistakes in understanding the basic understanding of the integral; 2) Errors in calculating indefinite integrals and definite integrals by using substitution integrals

The process skill error for the high and high ability levels did not make mistakes. In contrast, the medium ability level was 1 student, and the low ability level was 1 student. The very low ability level was 4 students made process skill errors, namely incorrectly completing the integral and not using the integral concept that should be and not determining the value of C, resulting in when determining the distance with time t = 3, t = 4 and t = 5 missed, incorrectly determining the distance formula, and wrong in the solution. This is because students find it challenging to complete the steps, so they misunderstand the problem; most students cannot change the form of the problem to fit the method that should be used, so students do not continue the calculation process. Because the arithmetic operation is incorrect, the students experience errors when working. (Ningsih, 2021), the same thing was also conveyed by Fitriantien (2022) Students made process errors due to a lack of accuracy in performing calculations. Therefore, there were also process skill errors and encoding errors.

Encoding errors for very high and high ability levels did not make mistakes. In contrast, the medium ability level of 2 students, low ability level of 2 students, and very low ability level of 4 students made encoding errors and answered correctly the distance formula. Still, the final calculation was wrong when adding and subtracting fractions, so it was terrible in giving conclusions and mistakenly using the correct distance formula, resulting in incorrect conclusions. Based on the interview results, the cause of errors at the encoding stage is that students cannot complete the calculation process, resulting in not working on this stage. This research is relevant to the study of Dila and Zanthy. (2020) Students' difficulties in performing calculations cause students' answers to be incorrect and challenging to conclude. The high level of errors students make at the encoding stage is due to mistakes made by students at previous error stages, such as the transformation and process skill stages. This is relevant to Yusnia's research. (2010) Errors at the encoding stage are caused by not checking the concepts used and calculations, so students are wrong or do not write the final answer. According to the research of Mulyadi, Riyadi, and Subanti, students' errors at the encoding stage are not the main errors but result from previous errors, namely comprehension, transformation, and process skills. (2015)Errors at the encoding stage occur because the subject does not know the concept; most are also caused by errors in the previous solution process, origin in writing the final answer and conclusion, and some do not provide conclusions. This is in line with Nurul Farida's research. (2015) Which states that students are not used to writing the conclusion of a question.

The implications of mathematics instruction, particularly in indefinite integrals, should be considered from multiple perspectives to enhance student learning effectiveness. One approach that can be implemented is the use of Newman's Error Analysis (NEA), which aids educators in identifying common types of errors made by students, such as mistakes in reading, understanding, transforming, processing, and writing answers. Additionally, teachers should assign non-routine tasks and problems that promote higher-order thinking Skills (HOTS) to develop students' computational thinking abilities significantly. Emphasizing the process of concept transformation is also crucial, as many students struggle to convert a problem into a solvable format. Integrating technology in learning can enhance interactivity and assist students in visualizing abstract concepts. Continuous assessment of student progress is necessary to detect errors early on, allowing educators to provide appropriate support. Furthermore, student motivation can be increased through group activities and collaboration that facilitate peer interaction and realistic projects relevant to real-world applications. Constructive feedback following evaluations is essential for helping students identify areas needing improvement and planning their learning strategies. By applying these principles, student effectiveness in learning indefinite integrals is anticipated to improve, providing a strong foundation for future academic pursuits.

CONCLUSION

Students' ability is related to the errors experienced by students when solving problems on indefinite integral material. Students with very high and high abilities did not encounter errors compared to those with medium, low, and very low skills. Moderate ability made processing ability errors and answer writing errors; low and very low ability made transformation errors, processing ability errors, and answer writing errors. Students' transformation errors are wrong in performing calculations or bad at the process skill stage because students find it challenging to make solution steps, so they are mistaken in understanding the problem; most students cannot change the form of the problem to match the method that should be used, this causes students not to continue the calculation process. Future research recommendations are expected to develop similar research with different materials so that the types of errors found are more diverse and can be followed up in providing solutions and factors that cause errors.

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