Edukasi
Vol. 19, No. 1 (2025) 12-19

p-ISSN 0852-0240| e-ISSN 2746-4016
https://journal.unnes.ac.id/journals/edukasi

Analysis of Students' Errors in Solving Circle Problems Based on Newman's Error Analysis

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Article info:
Submitted: January 19, 2025. Revised: February 17, 2025. Accepted: April 10, 2025.
Publish: May 20, 2024

Abstract

Background – Students' understanding of mathematical concepts, particularly in the topic of circles, remains a challenge in the learning process. Problems requiring both conceptual and procedural understanding are often not solved correctly by students, indicating errors in mathematical thinking.
Research Urgency – Error analysis is crucial to help teachers identify students' learning weaknesses. However, systematic approaches such as Newman's Error Analysis (NEA) are still rarely applied at the elementary school level, especially in the topic of circles. Therefore, this study is urgent in providing a detailed overview of the types and causes of students' errors.
Research Objectives – The purpose of the study is to describe problem skills in listening to learning Language Indonesia and describe the strategies for strengthening skills listening.
Research Method – The study used a descriptive qualitative approach, conducted at SD 050661 Kwala Bingai with 20 sixth-grade students (class VI-A) as subjects. Data was collected through written tests and analyzed based on the five stages of NEA: reading errors, comprehension errors, transformation errors, process skill errors, and final answer errors.
Research Findings – The results showed that most students made errors in the stages of comprehension, transformation, and process skills. These errors were caused by a lack of conceptual understanding, procedural mistakes, and inaccuracy in problem-solving.
Conclution - The study concludes that students' errors in solving problems related to circles stem mainly from weak conceptual and procedural understanding. Teachers need to take a more active role in identifying and addressing these errors through appropriate learning strategies.
Research Novelty/Contribution – This study contributes by applying Newman's Error Analysis as an effective diagnostic tool for identifying elementary students' mathematical errors. The results can help teachers design more targeted learning strategies to improve students' conceptual understanding, particularly in the topic of circles.

Keywords: Newman's Error Analysis, student errors, circles, conceptual understanding, process skills

Recommended citation:

Arsandy, Q., S., Meridina, R., Rahmah, R., & Fauzi, M., A. (2025). Analysis of Students' Errors in Solving Circle Problems Based on Newman's Error Analysis. *Edukasi, 19*(1), 12-19. https://doi.org/10.15294/edukasi.v19i1.24705

INTRODUCTION

In the world of education, mathematics is one of the subjects given in the learning process at the formal education level. Mathematics is always closely related to other subjects. In line with Turmadi's opinion as quoted by (Dewina dalam Kawiyah et al., 2022) that mathematics is closely related to everyday life so that students will immediately be able to apply mathematics in a context that is useful for students both in their lives and in their future work world.

Mathematics learning is a process carried out by teachers to help students learn mathematics. One aspect contained in mathematics learning is the concept. According to (Rezi dalam Kawiyah et al., 2022) students' success in learning mathematics can be seen from students' mastery of understanding concepts. Meanwhile, according to (Lestari in Kawiyah et al., 2022) mathematics learning is a process of interaction between educators and students in a learning environment that occurs systematically. So, the researcher concluded that mathematics learning emphasizes more on the systematic learning process and the concepts contained in the material taught to students must be instilled, because students' success in learning mathematics can be seen from students' mastery of understanding the concepts. The ability to understand concepts is a very important aspect in mathematics learning (Kawiyah et al., 2022). Understanding concepts is also an important foundation for solving mathematical problems and in everyday life. According to (Astriani, 2017) understanding mathematical concepts is the ability to understand and understand an abstract idea or basic principle of a mathematical object, where it is not only about remembering and knowing what is learned but also being able to express it in another form that is easy to understand and apply it in solving a mathematical problem.

In the process of learning mathematics, many students have difficulty solving math problems. Because many students think that mathematics is a difficult subject. Learning mathematics is not only required to master the concepts in mathematics, but students are also required to be able to apply concepts in solving problems on the questions given. The questions given are usually in the form of story/essay questions that are usually used in schools, the essay questions referred to here are questions that are closely related to everyday life which are presented in the form of descriptions that can be solved using arithmetic skills. In this case, the researcher will discuss the concept of a circle in mathematics. According to Kristanto et al. (2022) "a circle is a collection of all points on a plane that have the same distance from a certain point". In a circle, the center point plays an important role because it is usually used as the name of the circle itself. The radius is a line that connects the center point to any point along the arc of the circle.

Another important element is the diameter, which is a straight line that stretches from one point on the circle to another and must pass through the center of the circle. In addition, the circle has an arc, which is part of the circumference of the circle (Kristanto et al., 2022). A sector of a circle is part of the area in a circle that is bounded by two radii. The two radii form an angle at the center of the circle, which is called the central angle (Tosho, 2022). All of these elements are part of the interrelated elements of a circle and form the basic structure of a circle as a whole. The concept of a circle is not only the basis for understanding advanced topics, such as curved-sided geometric shapes, but also has applications in everyday life. We can find various objects around us that are circular, such as bicycle wheels, plates, and games like hula hoops. Mastery of the concept of a circle is one indicator of success in understanding the essence of mathematics as a whole (Noerhasmalina et al., 2021).

In addition to solving circle problems, students are also required to be able to apply problem-solving strategies to find a solution. Problem solving is an effort to find solutions to mathematical problems using the concepts and methods obtained. To improve problem-solving skills, it is necessary to develop students' skills in understanding problems, designing mathematical models, solving

p-ISSN 0852-0240| e-ISSN 2746-4016
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problems according to plan, and communicating the solutions obtained (Fauziah et al., 2022). According to Lubur (2021) "problem solving is a very important part of the mathematics curriculum, this is because students will gain experience in using the knowledge and skills, they have to solve non-routine problems". The problem-solving process is always related to a particular approach or strategy used. Therefore, the selection of appropriate methods, procedures, and strategies is an important aspect in mathematics learning that is oriented towards problem solving (Rachmawati, 2021).

The problem of the low level of errors in the concept of circles in mathematics that occurred in class VI-A of SD 050661 Kwala Bingai in the 2024/2025 academic year. Students' low abilities lie in their understanding of mathematical concepts. Previous research by Tall and Razali found that errors in understanding concepts were the most common mistakes made by students in solving mathematics problems. (Indriani, 2018). Based on the description that has been put forward above, the researcher is interested in knowing the students' conceptual understanding ability by conducting a study entitled "Analysis of Students' Errors in Solving Circle Problems Based on Newman's Error Analysis (NEA)".

METHODS

This research method uses qualitative descriptive research. According to Arikunto (2019) descriptive research is research that is intended to investigate conditions, circumstances or other things that have been mentioned, the results of which are presented in the form of a research report (May, 2023). This research was conducted at SD 050661 Kwala Bingai on May 3, 2025. The sampling technique used was Purposive Sampling. Purposive sampling is a way to get a sample by selecting a sample among the population according to what the researcher wants. In this technique, the researcher chooses a purposive sample with a subjective purpose. The selection of this "purposeful sample" was carried out because the researcher may have understood that the information needed can be obtained from a particular target group that is able to provide the desired information (Asrulla et al., 2023).

The research subjects were 20 class VI-A students. The researcher chose subjects who represented each level of Newman's procedure in solving circle problems. The data collection technique used in this study was to provide questions or tests to students after which they would be corrected by the researcher. The questions given to students were descriptive questions. The researcher used data analysis techniques in the form of data reduction, data presentation, and drawing conclusions. At the data reduction stage, the researcher made corrections or analysis of the test results. The researcher classified the types of errors made by students in solving mathematical descriptive problems based on the Newman Procedure. In presenting the data, a written description of the data is presented. At the conclusion drawing stage, the researcher verified the accuracy of the results through observation data that had been carried out (Atika et al., 2023).

RESULTS AND DISCUSSION

This section presents the findings of the study based on the analysis of students' errors in solving circle-related mathematical problems using Newman's Error Analysis (NEA). The analysis involved 20 sixth-grade students from SD 050661 Kwala Bingai who were given descriptive written test questions. The types of errors were categorized according to the five stages of Newman's procedure: reading errors, comprehension errors, transformation errors, process skill errors, and encoding errors. The data were tabulated and further elaborated through descriptive analysis of selected student responses to highlight the characteristics and patterns of the errors encountered.

The results show that most students made errors in the stages of comprehension, transformation, and process skills. This indicates that while students generally had no difficulty reading the problems,

many struggled to fully understand the problem statements and to convert them into appropriate mathematical models. Inaccuracies in computation further contributed to errors in the final answers. These findings, align with previous research, suggest that a lack of conceptual understanding and insufficient problem-solving strategies are major contributing factors. Therefore, this discussion also considers the possible causes of these errors and provides educational implications that can guide teachers in improving students' mathematical understanding and communication, particularly in the topic of circles.

The following are the results of the student error test in solving circle problems based on the Newman procedure.

Table 1. results of the student error test based on the Newman procedure.

STUDENT	Newman's procedural error criteria				
	1	2	3	4	5
S1	b	b, e	b, e	e	a, b, c, d, e
S2	b, e		b, c	d, e	b
S3		b	c, d, e	b	c, d
S4	b	b, c e	a, b, d,	d, e	c, d, e
S5			d		
S6	b	b, e	b e	b, c, d,	e
S7		d, e	a, b, c,	b, c, e	b, c, d, e
S8		b	e		c, d, e
S9				b	c, d
S10	e	a, b, c, d, e	b, d, e	c, d	a, b, c, d, e
S11	c	b	c	c, d, e	b, c
S12	c			e	b
S13		c, d, e	c, d	d, e	a, b, c, d, e
S14	d	d, e	d, e	b, d, e	c, d, e
S15	b, c	c, d, e	a, b, d, e	a, d, e	b
S16	b, c, d	b, e		e	a, b, c, d, e
S17	c, d, e	b, c	b	d, e	b, c
S18					
S19	b, c, d, e	a, b, d, e		e	d, e
S20	b, c, d, e	d, e	c, d, e d, e	a, b, c, d, e	a, b, c, d, e

Information:
a : Reading errors
b : Comprehension errors
c : Transformation errors
d : Process skill errors
e : Final result errors

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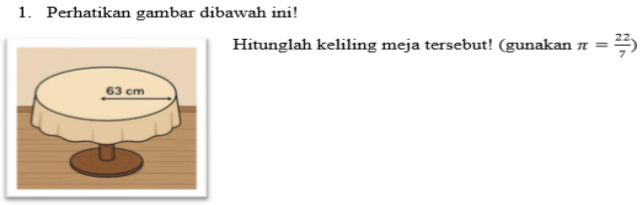
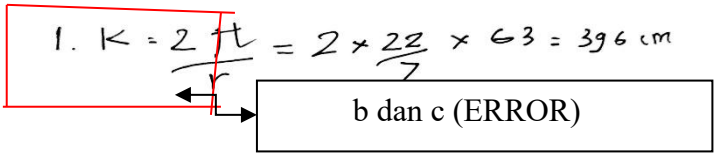
Student Test Result Data

The following are the results of student errors which are divided into reading errors, comprehension errors, transformation errors, process skill errors and final result errors based on the Newman procedure. From the tests conducted by 20 subjects, the researcher describes the test results based on the error criteria of several different students.

Question Number 1

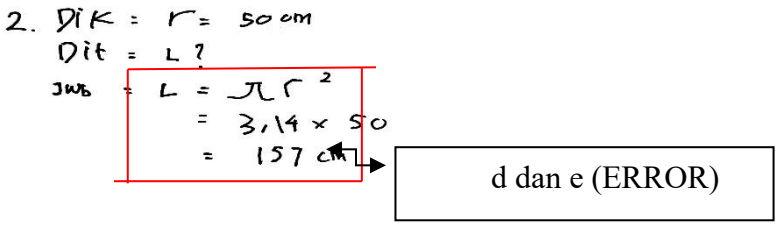


Student answer results



Based on the results of the description of the answers of the 15th student out of 20 students, there were comprehension errors and transformation errors. The 15th student made a comprehension error when completing the question where the 15th student did not write what was known or what was asked in the question, which indicates that the student did not fully understand the intent of the question. Meanwhile, the transformation error made by the 15th student was writing a formula that should be the radius multiplied but the 15th student wrote it divided.

Ouestion Number 2

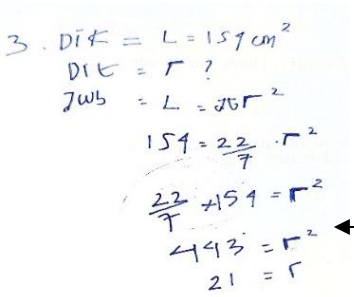


Based on the results of the answers, it was found that the 20th student made a process skill error where the student made a mistake in multiplication. The 20th student had written the formula correctly, but the student was still wrong in the multiplication process, which should be 3.14 × 50 × 50 but this student only wrote and calculated 3.14 × 50. This error then had an impact on the final answer writing stage (encoding errors) because the final answer written was incorrect due to the incomplete calculation process.

Question Number 3

3. Sebuah lingkaran memiliki luas 154 cm^2. Hitung panjang jari-jari lingkaran tersebut! (gunakan $\pi = \frac{22}{7}$)

Student answer result



c, d, dan e

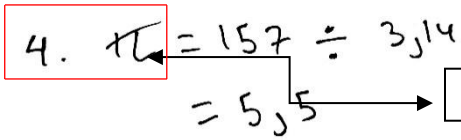
Based on the results of the answers of the 3rd student out of 20 students, transformation errors, process skill errors and comprehension errors and errors in writing the final answer (encoding errors) were found. The 3rd student made a transformation error, namely in the process of moving the segments, where it should have been written 7/22, but the student wrote 22/7 instead. So the process skill errors are also incorrect because the student's multiplication results are wrong, and the writing of the final answer (encoding errors) is also wrong.

Question Number 4

4. Perhatikan gambar berikut!

Andi mengukur keliling roda sepeda dan mendapatkan hasilnya 157 cm. Berapa diameter roda tersebut? (gunakan $\pi = 3{,}14$)

Student answer results



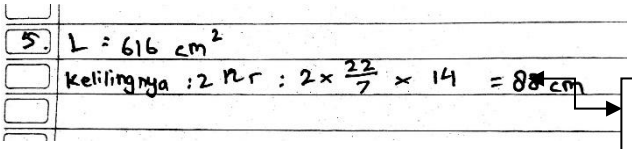
b, c, d, e

Based on the results of the description of the answers of the 6th student out of 20 students, it was found that there were errors in understanding, errors in transformation, errors in process skills, and errors in writing the final answer. When completing the question, based on the results, it was found that the 6th student made errors in understanding (comprehension errors) where he could not write what was known and what was asked from the question. In addition, the 6th student also made errors in transformation (transformation errors), namely the 6th student could not make a mathematical model of the given question, it should be written as circumference = π × d. Then, the 6th student made errors in process skills (process skill errors) where he was still wrong in making what was actually sought from the question because he wrote π = 157 / (3.14) when it should be d = 157/(3.14.) Then, this 6th student also made errors in writing the final answer (encoding errors), which should be the correct answer is 88 cm not 5.5.

Question Number 5

5. Luas sebuah lingkaran adalah 616 cm². Tentukan berapa Keliling lingkarannya! (gunakan $\pi = \frac{22}{7}$)

Student answer results



b (ERROR)

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Based on the results of the description of the answers, student 12th only made errors in understanding (comprehension errors) where he did not write down what was known and asked from the questions given, but the final results and operations were correct.

Based on the results of the study, according to Zakaria in (Hadaming, 2022) "errors often occur in solving mathematical problems both in writing and orally. Mistakes in solving mathematical story problems come from students' mistakes in solving the problems presented. Mistakes in solving story problems are generally related to the inability to imagine the problem in reality or in terms of understanding. To determine the type of student error in solving mathematical problems, Newman's theory can be used. The Newman procedure was developed by Anne Newman, a mathematics teacher from Australia, and was first introduced in 1977 (Panjaitan, 2023). One of the theories used to identify and analyze student errors in solving mathematical problems is Newman's Error Analysis (NEA). The steps in analyzing errors based on Newman's theory are divided into five stages, namely: (1) errors in reading questions (reading errors), (2) errors in understanding the contents of the questions (comprehension errors), (3) errors when changing questions into mathematical form (transformation errors), (4) errors in applying solution procedures (process skill errors), and (5) errors in writing or presenting the final answer (encoding errors) (Ismiasih, 2023).

Indicators of types of student errors according to Newman's theory are: (1) reading errors, namely students cannot read words, symbols, or numbers that are keywords in the question; (2) comprehension errors, namely students cannot understand the meaning of the problem as a whole, students cannot write what is known from the question, and students cannot write what is asked from the question; (3) transformation errors, namely students cannot determine mathematical operations or a series of operations to solve the problem correctly, and students cannot create a mathematical model of the problem presented; (4) process skill errors, namely students do not know the procedure for solving the problem correctly even though the formula has been determined correctly, students cannot perform the arithmetic operations that will be used to work on the problem, and students do not find the final answer based on the steps to solve the problem; (5) errors in writing the final answer (encoding errors), namely students cannot provide the answer correctly, and students cannot show the results of the problem.

Another opinion according to Ayuwirdayana in (Rian et al., 2023), there are five factors that cause errors made by students, namely first, factors causing reading errors, namely if students do not understand the meaning of the words in the question; second, factors causing errors in understanding, namely students do not understand the problem in the question so that students cannot determine what is known and what is asked; third, factors causing transformation errors, namely students have understood the question but cannot change the question into mathematical form; fourth, factors causing process skill errors, namely students cannot solve problems because students do not understand the number operation procedure in solving the question; and finally, factors causing errors in writing the final answer, namely students have carried out all the procedural steps correctly, but the habit of solving story problems without returning the model answer to the answer to the problem requested in the question.

CONCLUSION

Based on the results of the study on grade VI students of SD 050661, it is known that students still experience various types of errors in solving circle problems according to Newman's stages. The most dominant error occurs at the stage of writing the final answer (encoding error), which indicates students' difficulty in writing the final answer correctly, even though they are able to understand the problem and compile the steps for solving it. On the other hand, the fewest errors occur at the stage of reading the problem (reading error), which indicates that students are generally able to understand the information from the problem. This finding indicates that students' main weakness lies in delivering solutions completely and accurately. According to the results obtained, teachers are advised to emphasize more on practicing writing clear, coherent, and correct answers, and to get students used to checking their answers again. Further researchers are advised to explore learning models that can improve students' mathematical communication skills, especially in delivering written answers, and to further examine the effectiveness of Newman's strategy in improving understanding and solving mathematical problems.

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