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Analysis of Students' Errors in Applying the Newman Procedure at SMKN 2, Kediri City

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ABSTRACT

This study was motivated by students' low ability to solve problems related to the Pythagorean theorem. The study aims to describe the types of errors students make when applying the Pythagorean theorem and their underlying causes using the Newman procedure. The study was conducted at SMKN 2 Kota Kediri using a qualitative descriptive method. The research subjects were 10th-grade students selected based on their ability levels. Data analysis was conducted based on the stages of the Newman procedure, namely: reading errors (0%), comprehension errors (5.56%), transformation errors (5.56%), process skill errors (8.33%), and answer-writing errors (69.44%). The results indicate that the most prevalent errors made by students occurred during the answer-writing stage, followed by errors in understanding the problem and writing the final answer.

Keywords: Analysis, errors, Pythagorean theorem, Newman procedure.

INTRODUCTION

Mathematics is a highly essential and useful science for every individual. This discipline has been developed since ancient times by mathematicians from around the world as a tool for solving problems, ranging from simple to more complex ones. Even in daily life, mathematics always plays a significant role (Permadi et al., 2021) .

According to Skemp in 1987, mathematics is a way to use our minds that can rapidly enhance our thinking abilities. Mathematics is widely recognized as an essential tool for science, technology, and commerce, as well as for entering many professions (Nurulwati, 2026) . From the following statements, it can be concluded that mathematics is an important subject to study because the progression of time and the increasingly rapid advancement of Science and Technology (S&T) today are driving people worldwide—particularly in Indonesia—to keep pace with these developments (Dari & Jatmiko, 2024) .

Mathematics plays a role in preparing students to cope with evolving circumstances through the fundamental practices of critical, rational, and careful thinking, as well as enabling them to apply mathematical thinking both in studying various fields of science and in their daily lives. Cockrof states that: "We believe that all these perceptions of the usefulness of mathematics arise from the fact that mathematics provides a means of communication that is powerful, concise, and unambiguous" (Rahmaini & Ogylva Chandra, 2024) . This statement highlights the necessity for students to study mathematics because it serves as a highly effective, precise, and unambiguous means of communication.

This is reinforced by the results of the 2011 TIMSS survey regarding students' average proficiency in mathematics. The survey

results showed that Indonesian students' mathematics proficiency ranked 38th out of 42 participating countries with a score of 386, while the international average was 467.4. Data from the 2015 TIMSS results showed that Indonesia ranked 44th out of 49 participating countries with a score of 397, and the international average was 504. 5 Although there was an 11-point increase from the previous year, a score below 400 places Indonesia in the low-achievement category according to the TIMSS international scale (HASANAH, 2023) .

Mathematics is a universal science that underpins the development of modern science and technology, advancing human thinking and analytical skills (Zahro et al., 2023) . Mathematics is classified as an abstract subject; therefore, the process of learning mathematics requires serious attention from all parties, including teachers, the school environment, parents, and the home environment (Haris, 2023) . Starting in elementary school, mathematics is taught to all students. This is intended to equip students with competencies in logical, analytical, systematic, critical, innovative, and creative thinking, as well as the ability to collaborate. These competencies are necessary so that students can acquire, manage, and utilize information to lead better lives in an ever-changing, uncertain, and highly competitive world. Mathematics plays a crucial role in problem-solving across all areas of life (Saputra, 2024) . Its ability to translate various phenomena of life into the language of mathematics makes it a foundational science that everyone must master. One of the most important branches of mathematics to study is the Pythagorean Theorem (Daulay, 2023) . The concept of the Pythagorean Theorem is one of the instructional topics capable of enhancing students' reasoning skills. In studying the Pythagorean Theorem, students will learn how to analyze problems, provide arguments supporting the solution steps, and draw logical conclusions to arrive at the correct answer (Anasis & Alyani, 2021) .

Pythagoras was a Greek mathematician and philosopher who lived from 582 to 496 BCE. As a mathematician, he discovered that the square of the length of the hypotenuse of a right triangle is equal to the sum of the squares of the lengths of the other two sides. In recognition of his contributions, this theorem is named the Pythagorean theorem (Amri & Sunda, 2024).

Students' learning errors will impact their learning outcomes because good academic achievement can result from learning experiences both in and out of school, as well as from the students' commitment and effort in learning (Fauziah & Puspitasari, 2022) . This also applies to learning mathematics; therefore, it is important for teachers to address students' errors in mathematics. Newman divides the five stages of error analysis into two groups of obstacles faced by students in solving problems (Febryana et al., 2023) : The first obstacle is a problem with linguistic fluency or language skills and conceptual understanding, which corresponds to the level of simple reading and understanding the meaning of a problem. These challenges are associated with the stages of reading and comprehending the meaning of a problem. The second challenge involves mathematical processing, which consists of transformation, process skills, and encoding the answer (HESSY, 2023).

Based on the explanation outlined above, the author is interested in analyzing students' errors in solving mathematical problems—since errors serve as the basis for improvement—and in analyzing these abilities using the Newman procedure. To address this issue, the author has titled this study "Analysis of Students' Mathematical Errors Using the Newman Procedure."

MATERIALS & METHODS

The research method and approach used by the researcher is quantitative descriptive. Quantitative descriptive research is a statistical analysis used to describe, summarize, and analyze data to provide a

clear picture of the existing data, thereby facilitating decision-making based on the available data (Subhaktiyasa et al., 2023) . It is a method for grouping objects or documents. These objects are grouped or classified based on certain characteristics or content to facilitate necessary searches (Ramdhan et al., 2022) . In line with this view, the researcher used the clustering method because the researcher wanted to group students based on the level of learning difficulty they experienced.

The first step in this research is to identify the existing problem (Hidayat et al., 2025) . Problem identification is conducted to determine which issue will be addressed in the study. This problem identification serves as the foundation for establishing the background of the issue and concluding that this specific problem will be the main focus of the study (Ikhlas et al., 2023) . The problem the researcher will address is the errors made by 10th-grade students in solving Pythagorean theorem problems (Rina & Bernard, 2021) .

In this study, the researcher administered a test to students to identify related problems, using existing references and sources. The references and sources used as a basis for this study include books, journals, conference proceedings, and previous studies that address the same topic or employ the same methodology.

The next step in initiating the research was to collect data. The results of the test questions, supported by interview findings, were used by the researchers in the study.

After collecting data from the research sample, the researcher then conducted data analysis. The data analysis steps performed by the researcher in cases of multicollinearity included dendrogram creation, student analysis, and discriminant analysis. After the results of the data analysis are evaluated, the findings and conclusions of the study will be derived (Rosyada & Utari, 2024) . In this section, the research findings will be explained in detail so that readers can fully understand the results.

RESULTS

a. Students' Error Test Results (Pythagorean Theorem) Question No. 1

Based on the results of the error test on solving Pythagorean Theorem problems, the researchers analyzed the data obtained from the students' test responses, yielding the following results.

PROBLEM 1. Ladder and Wall.

A painter wants to set up a ladder to paint the wall of a house. The base of the ladder is 6 m from the wall, and the height of the ladder leaning against the wall reaches 8 m. How long is the ladder the painter used?

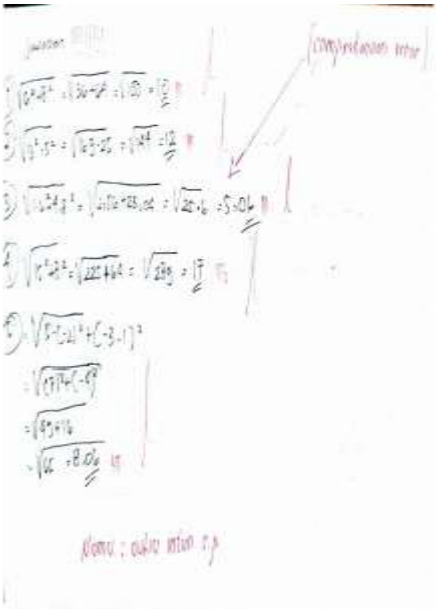
Based on the results of the correction of students' test answers, it was found that students' errors in solving problems involving the application of the Pythagorean theorem occurred only at four stages of the Newman procedure, namely comprehension errors, transformation errors, process skill errors, and encoding errors. No reading errors were found in the students' answers, as all students were able to read and recognize the information, symbols, and mathematical terms in the problem well.

Reading errors by number of students	Percentage	0%

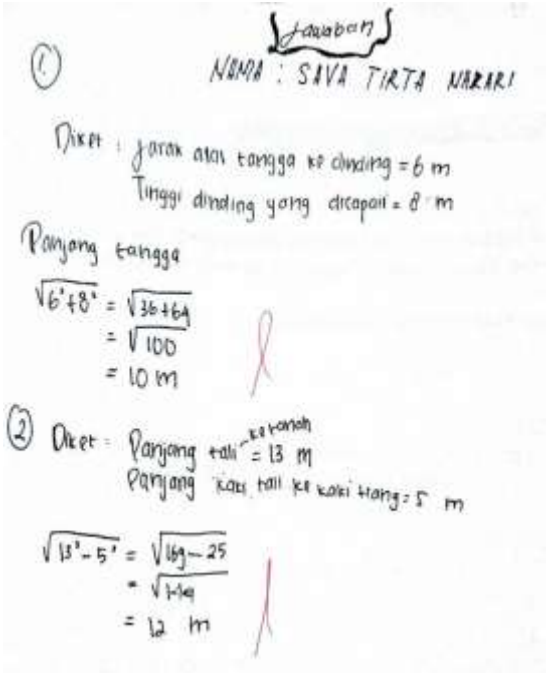
PROBLEM 2. Pole and Rope.

A flagpole is tied to the ground with a rope to prevent it from falling over. The length of the rope from the top of the pole to the ground is 13 m, and the distance from the ground to the base of the pole is 5 m.

How tall is the flagpole?



Source: Student work



Source: Student work

Comprehension Errors

A comprehension error is characterized by a student's inability to grasp the intent of the problem, such as failing to write down what is given and what is being asked. Research findings indicate that a significant number of students make errors at this stage. Students tend to jump straight into calculations without understanding the information provided in the problem.

Comprehension	2	$\frac{2}{36}$ x100% = 5.56%

PROBLEM 3. Ladder Against a Wall

A person leans a ladder against a wall with the base of the ladder 1.6 m from the wall. The top of the ladder touches the wall at a height of 4.8 m. How long is the wall?

Source: Students' work

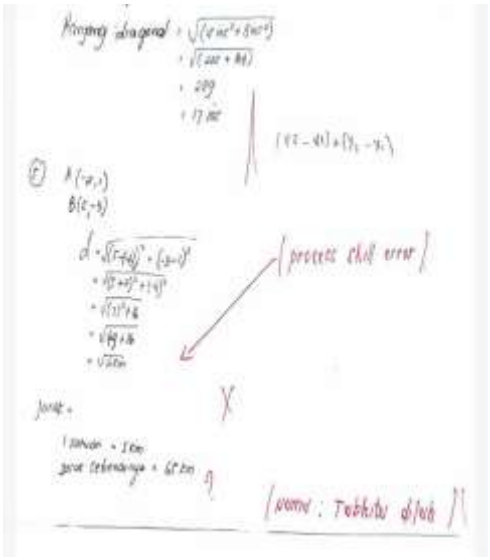
Transformation Errors

A transformation error occurs when a student is unable to convert a problem into an appropriate mathematical model. At this stage, a common mistake is the incorrect application of the Pythagorean theorem, such as incorrectly identifying the hypotenuse or incorrectly squaring each side.

Transformation	2	$\frac{2}{36}$ x100% = 5.56%

PROBLEM 4. Flat-Screen TV

A rectangular television has a length of 15 inches and a width of 8 inches. What is the length of the screen's diagonal?



Source: student work

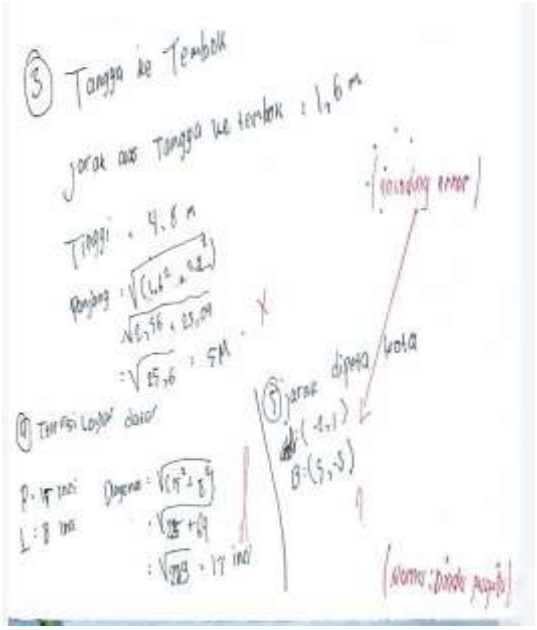
Process Skill Errors

Process skill errors are mistakes made during arithmetic operations. Based on research findings, these are the most common errors made by students. Examples of such errors include mistakes in squaring numbers, addition errors, and errors in taking square roots.

Process Skills	3	$\frac{3}{36}$ x 100% = 8.33%

PROBLEM 5. Distance on a Map

On a city coordinate map, Andi's house is located at point A (-2,1) and his school is at point B (5, -3). What is the actual distance between Andi's house and his school if one unit on the map represents 1 KM?



Source: Student's work

Final Answer Writing Errors (Encoding Errors)

An error in writing the final answer occurs when a student has performed the calculation steps correctly but writes the final answer incorrectly. These errors include failing to include the unit, writing a result that does not match the context of the problem, or failing to provide a final conclusion.

Encoding	25	$\frac{25}{36}$ x 100% = 69.44%

DATA PERCENTAGE

percentage = $\frac{\text{number of students who made a mistake}}{\text{total number of students}} \times 100\%$

Type of error Number of students Percentage

Reading	-	-
Comprehension	2	$\frac{2}{34}\ x\ 100\% = 5{,}56\%$
transformation	2	$\frac{2}{34}\ x\ 100\% = 5{,}56\%$
Process skills	3	$\frac{3}{34}\ x\ 100\% = 8{,}33\%$
Encoding	25	$\frac{25}{34}\ x\ 100\% = 69{,}44\%$

Based on the analysis of the answers from 34 students using the Newman procedure, the most common error was "encoding error" (the final answer was not written correctly), at 69.44%. This indicates that students still have difficulty completing the final part of the problem.

DISCUSSION

Based on the research findings, it can be concluded that students' errors in applying the Pythagorean theorem occurred at every stage of the Newman procedure. This suggests that students' errors stem not only from their computational skills but also from their ability to understand and model problems. (Bete et al., 2023) found that students' errors in the Pythagorean theorem occurred at all stages of the Newman procedure, from reading the problem to writing the final answer.

The relatively low rate of reading errors indicates that most students were able to read the problems well. However, there were still students who were not careful enough when reading mathematical symbols, which affected the subsequent steps in solving the problems. (Sianipar et al., 2025) , which states that reading errors arise because students lack an understanding of the mathematical terms and units used in word problems.

Errors in understanding the problem indicate that students have not fully grasped the basic concepts of the Pythagorean theorem and the intent of the given problem. This aligns with learning practices that tend to emphasize memorizing formulas over conceptual understanding. (Ahmadi et al., 2024) , which found that students often fail to select the correct formula when converting word problems into mathematical models

These transformation errors indicate that students have difficulty identifying the sides of a right triangle and selecting the appropriate formula. This highlights the need for instruction that emphasizes visual understanding and the geometric concepts underlying the Pythagorean theorem.

Process-skill errors were the most prevalent type of error, indicating that students' arithmetic skills still need improvement. These errors may also be influenced by a lack of varied practice problems. (Annisa & Kartini, 2021) found that process-skill errors accounted for the highest percentage because students were still not thorough enough in performing arithmetic operations and applying mathematical formulas.

Meanwhile, errors in writing the final answer indicate that students are not accustomed to presenting answers completely and systematically. Therefore, teachers need to encourage students to write down the final conclusion and pay attention to units in each answer. (Laimeheriwa et al., 2025) , which shows that students often neglect to write the final conclusion even though the calculation process was performed correctly.

Based on this discussion, it can be concluded that error analysis using the Newman procedure is effective for identifying where students make mistakes when solving Pythagorean problems. The results of this study are expected to serve as evaluation material for teachers in designing more appropriate learning strategies to minimize student errors in the future. (Sawu et al., 2021) states that error analysis based on the Newman procedure can help teachers understand students' learning errors in greater detail, thereby enabling the design of more effective learning strategies.

CONCLUSION

Based on the results of this study on the analysis of students' errors in applying the Pythagorean theorem using the Newman procedure among 10th-grade students at SMKN 2 Kota Kediri, it can be concluded that students still make various types of errors when solving Pythagorean theorem problems. The errors identified include comprehension errors, transformation errors, process skill errors, and encoding errors.

Comprehension errors occur because students are not yet able to accurately

identify the given and unknown information. Transformation errors arise because students lack a thorough understanding of the Pythagorean theorem when determining the sides of a right triangle. Process skill errors are caused by students' weaknesses in performing arithmetic operations, while encoding errors occur due to students' lack of precision in presenting the final result in accordance with the question.

Declaration by Authors
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