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Error Analysis of Male and Female Students in Pythagorean Problems Based on *Newman's Error Analysis*

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Abstract
Mathematics education plays a crucial role in equipping students with logical and analytical thinking skills. One of the topics that often presents difficulties is the Pythagorean theorem. This study aims to analyze the types of errors made by male and female students in solving Pythagorean problems based on the stages of Newman's Error Analysis. A descriptive qualitative approach was employed at SMP PGRI 6 Malang, involving six selected participants from Class VIII A, consisting of three male students and three female students. Data were collected through written tests, structured interviews, and documentation, and then analyzed based on the five stages of Newman, namely reading, comprehension, transformation, process skills, and encoding. The results indicate that male students tend to make errors across almost all stages, primarily due to a lack of accuracy and a weak understanding of fundamental concepts. In contrast, female students demonstrate a significantly lower level of errors, as they are more accustomed to carefully examining the problem information before responding. Based on the findings, it was concluded that female students demonstrated better performance in solving Pythagorean problems, with only 13.3% making errors, compared to male students, of whom 46.7% made errors. Therefore, teachers are expected to design instructional strategies that are responsive to the learning characteristics of both male and female students. Therefore, teachers are expected to design learning strategies that are responsive to the differences in learning characteristics between male and female students.

Keyword: newman's error analysis, pythagorean theorem, students, mathematics

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INTRODUCTION

Mathematics is one of the scientific disciplines that plays a significant role in education. Mastery of mathematics needs to be fostered from an early age and developed across all levels of education, including higher education, so that students' competencies can grow in accordance with the demands of future scientific advancement (Marsitin, 2017). Mathematics plays a highly central role in this regard, as it is one of the fundamental sciences that holds significant importance both in everyday life and in the advancement of science and technology. It is even often referred to as the root of knowledge due to its extensive and essential contributions (Anwar, 2018). In addition, according to (Fauziyah et al., 2019), school mathematics is a subject taught at both the primary and secondary education levels. Mathematics instruction provided to students plays a crucial role in improving their academic quality. Through learning mathematics, students become

accustomed to thinking systematically and critically, while also developing their problem-solving skills.

Analysis is a cognitive process of breaking down a whole into its constituent components in order to identify the characteristics of each part, understand the relationships among them, and determine the function of each component within an integrated whole (Y Septiani, E Arribe, 2020). An error can be understood as a deviation from what is considered correct or has been previously established as a standard. Accordingly, error analysis may be defined as a systematic examination of inaccuracies found in students' written responses (Rahmania & Rahmawati, 2016). Learning difficulties experienced by students may arise from both internal and external factors, including health conditions, motivation, intelligence, as well as influences from the school, family, and broader social environment (Layn & Kahar, 2017). Administering tests on previously taught material enables teachers to evaluate students' abilities while also providing valuable feedback to assess the extent to which learners have understood the subject matter (Hasan, 2019). Once the factors contributing to these learning difficulties have been identified, the next step is to determine appropriate solutions to address the errors, thereby enhancing the effectiveness and depth of the learning process.

One relevant approach to error analysis is the Newman's Error Analysis procedure, which was first introduced in 1977 by Anne Newman. This framework proposes five stages involved in problem-solving that can be used to identify the sources of students' errors when working on descriptive or open-ended questions, namely reading, comprehension, transformation, process skills, and encoding (Suratih & Pujiastuti, 2020). Based on these stages, students' errors can be identified as reading errors, comprehension errors, transformation errors, process skill errors, and encoding errors. The application of Newman's Error Analysis provides valuable insights for educators in determining the sources and locations of students' learning difficulties, thereby enabling them to reduce the likelihood of recurring errors (Visitasari & Siswono, 2013)

Gender is also considered an important factor influencing students' ability to understand learning materials. Fundamentally, individuals are created with various differences, one of which is gender, namely male and female. Some studies suggest that male students tend to demonstrate strengths in logical, abstract, and analytical thinking, whereas female students are often associated with more holistic, imaginative, intuitive, and creative approaches to thinking (Davita & Pujiastuti, 2020). Differences in gender are associated with variations in physiological characteristics and may influence psychological aspects of learning, which in turn contribute to differences in how male and female students learn mathematics. When faced with problem-solving tasks, male and female students tend to employ different approaches and strategies in solving the problems (Nur & Palobo, 2018).

The Pythagorean Theorem describes the relationship within Euclidean geometry among the three sides of a right-angled triangle (Rahmadani, 2017). (Sholikah et al., 2024) found that, in solving Pythagorean problems from a gender perspective, male students tend to experience more obstacles and often demonstrate limited understanding of the problem context as well as difficulties in analysis. Similarly (Faisal et al., 2023). (Faisal et al., 2023) reported that students' learning outcomes in the Pythagorean theorem remain relatively low each year compared to other mathematics topics. Based on these considerations, this study focuses on examining the types of Newman's Error Analysis errors made by male and female students in solving problems related to the Pythagorean theorem. It is expected that the findings of this study will provide valuable insights for researchers, teachers, and schools in improving the quality of mathematics instruction.

METHOD

This study employed a qualitative approach with a descriptive research design. The qualitative approach was selected because it aims to address research problems that require in-depth understanding within specific temporal and situational contexts, conducted in a natural setting based on actual field conditions without any manipulation (Arifin, 2019). The descriptive design is intended to examine existing conditions, situations, or phenomena, with the findings presented in the form of a research report (Sudiono, 2017).This study does not aim to test particular hypotheses; rather, it seeks to describe phenomena "as they are" concerning certain variables, conditions, or occurrences, while also allowing for an interpretation of the underlying meanings behind these facts (Zellatifanny & Mudjiyanto, 2018). Although non-experimental in nature, the findings of this study remain valuable as they can provide a strong basis for well-founded arguments.

The data sources in this study are classified into two categories, namely primary and secondary data sources (Handayani, 2020). Primary data were obtained from research informants selected based on their roles and competencies, as they were considered capable of representing the issues under investigation. Meanwhile, secondary data refer to sources that are not directly obtained from the research subjects, including books, documents, journal articles, theses, as well as survey results conducted at SMP PGRI 6 Malang, which serve to support and complement the primary data.

Appropriate data collection techniques are essential for producing highly credible data (Sugiyono, 2022). In this study, data were collected using three techniques. First, a written test was administered to obtain data on the types of errors made by students in solving problems related to the Pythagorean Theorem, based on the stages of Newman's Error Analysis from a gender perspective. The instrument was subsequently validated by a mathematics education lecturer from Universitas PGRI Kanjuruhan Malang and a mathematics teacher at SMP PGRI 6 Malang. Second, structured interviews were conducted as a form of in-depth exploration after participants completed the written test, utilizing interview guidelines and students' written responses as references to better understand the nuances of their answers. Third, documentation was employed to strengthen the research findings, including photographs of the learning activities and records of students' work as evidence of the research implementation.

Data analysis is the process of systematically organizing and examining records obtained from observations, interviews, and other sources in order to enhance understanding of the case under investigation and present the findings to others, followed by an effort to interpret the meaning of each finding (Rijali, 2019). (Nurfajriani, 2014). More specifically, technique triangulation was used to examine the credibility of the data by cross-verifying information obtained from the same source through different methods (Alfansyur & Mariyani, 2020).

The research procedure was organized into three main stages. First, the preparation stage included conducting preliminary observations at SMP PGRI 6 Malang, obtaining research permission, developing instruments on the Pythagorean Theorem, validating the instruments, and preparing the necessary research materials. Second, the implementation stage involved establishing rapport with the students, selecting 10 male and 10 female students, from which 6 students from each group were chosen as research samples, administering the written test, evaluating students' responses based on the stages of Newman's Error Analysis, conducting structured interviews, and documenting the entire process. Third, the final stage consisted of analyzing all collected data, interpreting students' work, and drawing conclusions based on the stages of Newman's error analysis.

RESULT AND DISCUSSION

According to (Khusniawati et al., 2019) in solving problems, students are expected to understand the problem-solving process and become proficient in selecting and identifying relevant conditions and concepts, seeking generalizations, formulating solution strategies, and organizing previously acquired skills.A written test was administered to 20 students of Class VIII A at SMP PGRI 6 Malang, consisting of 10 male and 10 female students, with a completion time of 45 minutes. Based on the results, the researcher randomly selected six subjects from the group with the higher level of performance, comprising three male and three female students, as presented in Table 1.

Table 1. Student's Written Test Results

No.	Initials	Score	Gender
1	AAA	80	Male
2	PH	85	Male
3	EAP	65	Male
4	SKD	65	Female
5	DP	100	Female
6	JMP	98	Femele

After the written test was completed, the researcher analyzed each student's work. In this study, analysis refers to the process of breaking down problems into their smallest units (Y Septiani, E Arribe, 2020), particularly through examining deviations or inaccuracies in students' written responses (Rahmania & Rahmawati, 2016). The analysis was conducted based on the five stages of Newman's Error Analysis, which include reading, comprehension, transformation, process skills, and encoding. In addition, according to (Marsitin, 2018)mathematical reasoning ability is indicated by several aspects, including making analogies and generalizations, providing explanations through the use of models, and applying patterns and relationships to analyze mathematical situations.

Analysis of Written Test Results and Interviews of Male Students.

Subject AAA did not exhibit any errors across all stages of Newman's Error Analysis in Question 1 (Figure 1). However, in Question 2, AAA proceeded directly to the calculation without stating the formula, resulting in transformation and encoding errors. In Question 3, the expression $\sqrt{225 - 144}$ appeared without a clear explanation of its origin, leading to errors in transformation, process skills, and encoding (Figure 2).

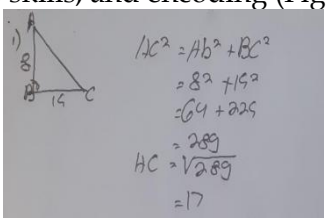

Figure 1. AAA's Work on Question Number 1

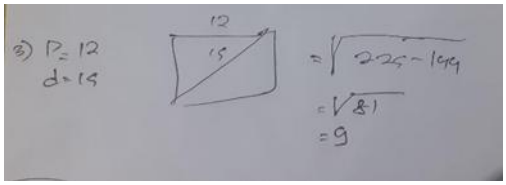

Figure 2. AAA's Work on Question Number 3

The following are the results of the interview with subject AAA:

Researcher : How do you understand the basic concept of the Pythagorean Theorem?
AAA : I understand it by studying the topic in class, following the teacher's explanations and guidance.
Researcher : When solving Pythagorean problems, which part do you find most difficult? Why?
AAA : At the moment, I do not find any part particularly difficult. The key is to remember the basic formulas provided in the problem.
Researcher : What steps do you take to solve Pythagorean problems?
AAA : I identify the sides of the triangle, such as the hypotenuse and the base, and then apply the appropriate formula.
Researcher : When you make mistakes while solving Pythagorean problems, are you usually aware of them?
AAA : Yes, I realize it when I cannot arrive at a correct answer.
Researcher : Are there specific mistakes you often make when solving Pythagorean problems?
AAA : Yes, I sometimes make mistakes when calculating squares of numbers.
Researcher : How do you overcome or learn from the mistakes you make in solving mathematics problems, particularly those related to the Pythagorean theorem?
AAA : I usually redo the problem or review the formula again.

Based on the interview, AAA acknowledged that the errors most frequently made occur when calculating the squares of numbers in the Pythagorean Theorem, and these are typically addressed by reworking the problems or revisiting the relevant formulas.The triangulation results indicate that AAA demonstrated errors in transformation, process skills, and encoding according to the Newman's Error Analysis.

Subject PH, in Question 1, demonstrated an encoding error by failing to include the appropriate unit in the final answer. In Question 2, the formula shifted abruptly from $a^2+b^2=c^2$ to $BC^2=10^2+24^2=C^2$ indicating errors in comprehension, transformation, process skills, and encoding (Figure 3). In Question 3, PH exhibited only a transformation error.

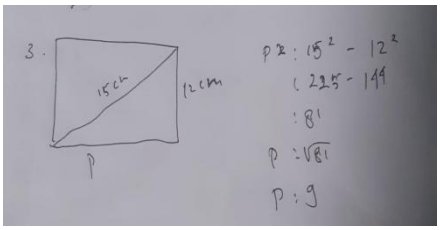

Figure 3. PH's Work on Question Number 2

The following are the results of the interview with subject PH:

Researcher : How do you understand the basic concept of the Pythagorean Theorem?
PH : The concept I understand involves determining the length of the hypotenuse in a right-angled triangle based on the lengths of the other sides.
Researcher : When solving Pythagorean problems, which part do you find most difficult? Why?
PH : The most difficult part for me is identifying the sides of the right-angled triangle and ensuring the correct use of the formula.
Researcher : What steps do you take to solve Pythagorean problems?
PH : First, I identify the sides of the triangle, then I look for example problems, and finally I apply the formula $a^2+b^2=c^2$.
Researcher : When you make mistakes while solving Pythagorean problems, are you usually aware of them?
PH : Not always, but I try to learn from those mistakes.
Researcher : Are there specific mistakes you often make when solving Pythagorean problems?
PH : The mistakes I make are usually related to algebraic calculations.
Researcher : How do you overcome or learn from the mistakes you make in solving mathematics problems, particularly those related to the Pythagorean theorem?
PH : I practice consistently, look for example problems, and repeat the exercises.

Based on the interview, PH acknowledged that the most frequent errors occur in algebraic operations, and these are addressed through consistent practice. The triangulation results indicate that PH demonstrated errors across all stages of Newman's Error Analysis, as accumulated from the three problems.

Subject EAP exhibited the highest level of errors among all participants. In Questions 1 and 3, EAP made errors at all stages of Newman's Error Analysis, ranging from reading to encoding (Figures 4 and 5). In Question 2, EAP demonstrated only a transformation error.

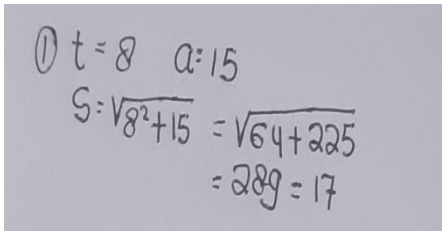

Figure 4. EAP's Work on Question Number 1

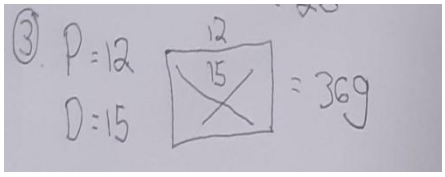

Figure 5. EAP's Work on Question Number 3

The following are the results of the interview with subject EAP:

Researcher : How do you understand the basic concept of the Pythagorean Theorem?
EAP : I am unable to explain it because I do not fully understand the concept.
Researcher : When solving Pythagorean problems, which part do you find most difficult? Why?
EAP : In my opinion, the most difficult part is determining the appropriate formula, as I tend to struggle with memorization.
Researcher : What steps do you take to solve Pythagorean problems?
EAP : At the very least, I try to carry out the calculations.
Researcher : When you make mistakes while solving Pythagorean problems, are you usually aware of them?
EAP : I am usually not aware of them until my work is evaluated by the teacher.
Researcher : Are there specific mistakes you often make when solving Pythagorean problems?
EAP : The mistakes I make are usually related to the use of formulas and algebraic operations.
Researcher : How do you overcome or learn from the mistakes you make in solving mathematics problems, particularly those related to the Pythagorean Theorem?
EAP : I try to be more careful.

Based on the interview, EAP indicated an inability to explain the basic concept of the Pythagorean Theorem and reported a lack of awareness of errors until the work was evaluated by the teacher.

The triangulation results reveal that EAP exhibited errors across all stages of Newman's Error Analysis in Questions 1 and 3, while in Question 2, only a transformation error was identified.

Analysis of Written Test Results and Interviews of Femele Students.

Subject SKD did not demonstrate any errors across all stages of Newman's Error Analysis in Questions 1 and 3. However, in Question 2, errors were observed at all stages of the framework, as SKD was unable to properly interpret the question, failed to state the known information, could not perform the calculations correctly, and did not arrive at an accurate final answer (Figure 6).

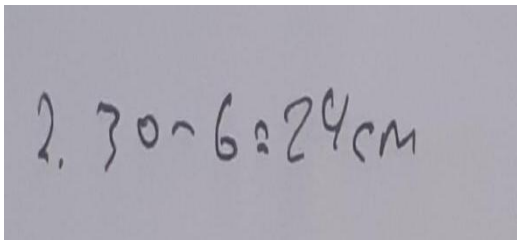

Figure 6. SKD's Work on Question Number 2

The following are the results of the interview with subject SKD:

Researcher : How do you understand the basic concept of the Pythagorean Theorem?
SKD : I begin by identifying the sides of a right-angled triangle.
Researcher : When solving Pythagorean problems, which part do you find most difficult? Why?
SKD : The most difficult part is identifying the sides of the triangle and ensuring that the correct formula is applied.
Researcher : What steps do you take to solve Pythagorean problems?
SKD : I observe and identify the sides of the triangle, then calculate the required side using the Pythagorean triple formula.
Researcher : When you make mistakes while solving Pythagorean problems, are you usually aware of them?
SKD : Sometimes I become aware of my mistakes after revisiting the problem.
Researcher : Are there specific mistakes you often make when solving Pythagorean problems?
SKD : The mistakes I make are usually basic errors in algebraic calculations.
Researcher : How do you overcome or learn from the mistakes you make in solving mathematics problems, particularly those related to the Pythagorean Theorem?
SKD : I practice diligently, look for additional problem references, and review previously completed exercises.

Based on the interview, SKD acknowledged difficulties in identifying the sides of the triangle and ensuring the correct formula is applied, with the most frequent errors occurring in algebraic calculations. The triangulation results indicate that SKD did not demonstrate any errors based on Newman's Error Analysis in Questions 1 and 3, but exhibited errors across all stages in Question 2.

Subject DP was identified as the highest-performing participant. Across all three questions, DP did not exhibit any errors at any stage of Newman's Error Analysis, as the student was able to accurately read and comprehend the problems, select the appropriate formula, perform the computations correctly, and present the final answers in a complete and accurate manner (Figure 7).

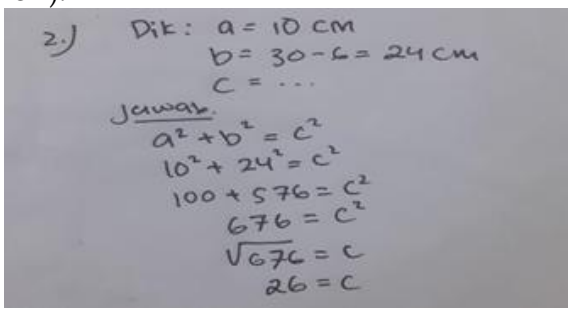

Figure 7. DP's Work on Question Number 2

The following are the results of the interview with subject PD:

Researcher : How do you understand the basic concept of the Pythagorean Theorem?
DP : I understand it by carefully listening to and comprehending the material presented by the teacher during class.
Researcher : When solving Pythagorean problems, which part do you find most difficult? Why?
DP : At present, I have not encountered any significant difficulties in solving problems related to this topic.

Researcher : What steps do you take to solve Pythagorean problems?
DP : I identify what is given and what is being asked in the problem and then solve it using the appropriate formula.
Researcher : When you make mistakes while solving Pythagorean problems, are you usually aware of them?
DP : Sometimes I am aware of my mistakes and correct them immediately before submitting my work.
Researcher : Are there specific mistakes you often make when solving Pythagorean problems?
DP : Occasionally, I make minor errors in calculations.
Researcher : How do you overcome or learn from the mistakes you make in solving mathematics problems, particularly those related to the Pythagorean Theorem?
DP : I practice extensively by working on additional problems beyond those provided by the teacher.

Based on the interview, DP reported not experiencing any significant difficulties and demonstrated a consistent habit of carefully identifying the given information and the problem requirements before attempting a solution. The triangulation results indicate that DP did not exhibit any errors across all stages of Newman's Error Analysis in all three questions.

Subject JMP did not demonstrate any errors across all stages of Newman's Error Analysis in Questions 1 and 3. However, in Question 2, JMP was unable to select the appropriate formula, resulting in a transformation error, although the computational steps and final answer were still presented correctly (Figure 8).

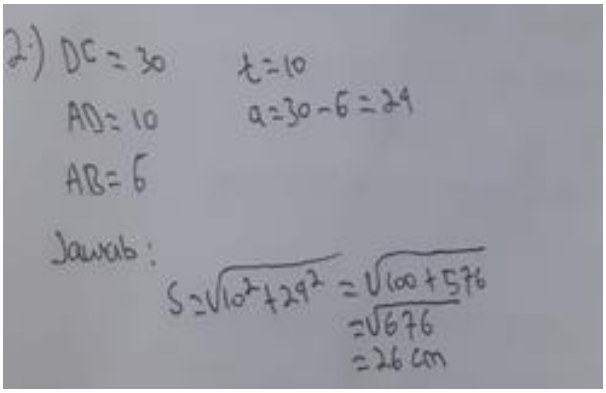

Figure 8. JMP's Work on Question Number 2

The following are the results of the interview with subject JMP:

Researcher : How do you understand the basic concept of the Pythagorean Theorem?
JMP : I understand it by paying attention to the teacher's explanations and studying from school textbooks.
Researcher : When solving Pythagorean problems, which part do you find most difficult? Why?
JMP : Most of the difficulties I encounter are related to formulas, as there are many formulas from different topics that need to be memorized.
Researcher : What steps do you take to solve Pythagorean problems?
JMP : I examine what is given and what is being asked in the problem, then select and recall the appropriate formula to use.
Researcher : When you make mistakes while solving Pythagorean problems, are you usually aware of them?
JMP : Sometimes I am not aware that I have made mistakes while solving the problems.
Researcher : Are there specific mistakes you often make when solving Pythagorean problems?
JMP : Most of my mistakes occur in the final answer and in the units I use.
Researcher : How do you overcome or learn from the mistakes you make in solving mathematics problems, particularly those related to the Pythagorean Theorem?
JMP : I practice regularly and learn from problems that have been previously discussed by the teacher.

Based on the interview, JMP acknowledged difficulties related to formulas, primarily due to the large number of formulas that must be memorized across different topics. The triangulation results indicate that JMP exhibited only a transformation error in Question 2 according to the Newman's Error Analysis.

Recapitulation of Errors for Each Newman Indicator

Table 2. Test Results for Each Error Indicator According to Newman

No.	Initial	Question	*Reading*	*Comprehension*	*Transformation*	*Process Skill*	*Encoding*
1	AAA	1	-	-	-	-	-
		2	-	-	√	-	√
		3	-	-	√	√	√
2	PH	1	-	-	-	-	√
		2	√	√	-	√	-
		3	-	-	√	-	-
3	EAP	1	√	√	√	√	√
		2	-	-	√	-	-
		3	√	√	√	√	√
4	SKD	1	-	-	-	-	-
		2	√	√	√	√	√
		3	-	-	-	-	-
5	DP	1	-	-	-	-	-
		2	-	-	-	-	-
		3	-	-	-	-	-
6	JMP	1	-	-	-	-	-
		2	-	-	√	-	-
		3	-	-	-	-	-

Note: √ = indicates an error; – = indicates no error

Table 3. Students' Error Levels According to Newman

Newman's Stages	Male	Female
Reading	Important symbols are overlooked due to a lack of carefulness, and the initial information processing is unstable	Students are able to recognize information, numbers, and symbols quickly, with consistent and accurate initial processing.
Comprehension	Students often experience difficulty in identifying what is known and what is being asked.	They are able to understand the intent of the problem well, with a stronger conceptual understanding.
Transformation	They fail to recall the appropriate formulas and have difficulty transforming verbal information into mathematical models.	They are able to recall and select appropriate formulas accurately.
Process Skill	Errors frequently occur in algebraic operations and computations due to a lack of accuracy.	Their calculations are stable, careful, and accurate throughout the algebraic solution process.
Encoding	The final answer or units are incorrectly written, and no rechecking process is performed.	The final answers are correct and well-presented.

DISCUSSION

Reading

Reading ability in mathematics is not merely limited to pronouncing text, but also includes the ability to interpret symbols and key terms presented in a problem. As stated by (Visitasari & Siswono, 2013), when students attempt to solve problem-based questions, they go through a series of problem-solving stages, one of which is the reading stage that requires the ability to recognize mathematical symbols and terms. Reading errors in this study were found in PH, EAP, and SKD, whereas AAA, DP, and JMP did not exhibit errors at this stage. EAP was unable to interpret key terms in questions number 1 and number 3,

which consequently led to failure in all subsequent stages. In contrast, DP and JMP were able to read and interpret all questions accurately, reflecting more consistent initial information processing among female students.

Comprehension

The comprehension stage requires students to understand the meaning of all words and symbols in a problem so that they are able to restate the problem in their own words (Visitasari & Siswono, 2013).Comprehension errors were found in PH, EAP, and SKD, while AAA, DP, and JMP did not exhibit errors at this stage. In question number 2, PH inserted numerical values in the solution process without being able to explain their origin, which serves as a strong indicator of weak problem comprehension. EAP did not even write any part of the known information in questions number 1 and number 3. This difference is also influenced by gender characteristics, where female students tend to be more careful and thorough in understanding problem information compared to male students (Davita & Pujiastuti, 2020)

Transformation

Transformation errors occur when students fail to convert problem information into an appropriate mathematical model, including the selection of suitable methods, procedures, or solution strategies (Visitasari & Siswono, 2013).The Pythagorean topic itself is closely related to Euclidean geometry and the relationship among the three sides of a right triangle (Rahmadani et al., 2018), making the ability to transform problems into the formula $a^2+b^2=c^2$ highly crucial. This stage showed the highest frequency of errors, as they were found in AAA, PH, EAP, SKD, and JMP, while only DP did not exhibit any transformation errors in all questions. This condition is in line with (Hodiyanto, 2014), who argues that male students, despite having more developed abstract thinking abilities, are not necessarily able to express these ideas accurately in mathematical models. As a result, transformation errors become a dominant obstacle for them.

Process Skill

The process skills stage involves the ability to implement a problem-solving plan derived from the transformation stage in order to produce the desired solution (Visitasari & Siswono, 2013). Errors at this stage were found in AAA, PH, EAP, and SKD, while DP and JMP did not exhibit any errors. In question number 3, AAA was unable to explain the origin of the numerical values used in the calculations. Meanwhile, EAP, in questions number 1 and number 3, was unable to perform the computations correctly as a whole. This difference reflects the findings of (Siswandi et al., 2016), which suggest that although male students generally demonstrate better abstract thinking abilities, female students such as DP and JMP tend to show more stable and accurate performance in the execution of computations**.**

Encoding

The encoding stage refers to the stage at which students are considered successful if they are able to write the required final answer accurately (Visitasari & Siswono, 2013). Errors at this stage were found in AAA, PH, EAP, and SKD, while DP and JMP did not exhibit any encoding errors in any of the questions. PH did not include the appropriate unit notation in the final answer for question number 1. AAA failed to clearly present the formula, resulting in incomplete notation in questions number 2 and number 3. EAP consistently failed to provide conclusions that corresponded to the questions asked.
In contrast, DP and JMP were able to write the final answers accurately, including proper notation and units, for all questions.

Overall, the findings of this study reveal a pattern that differs from previous theoretical assumptions. (Davita & Pujiastuti, 2020),(Hodiyanto, 2014) , and (Siswandi et al., 2016) generally position male students as individuals with stronger logical and analytical abilities, while female students are considered to be more careful and meticulous. When faced with problem-solving-based questions, male and female students indeed demonstrate different tendencies in problem-solving approaches, (Faisal et al., 2023) and gender differences also influence psychological differences in learning mathematics (Mulyanti et al., 2018). However, the results of this study indicate that female students exhibit significantly lower error rates, particularly in the transformation and encoding stages. Factors such as carefulness, structured learning habits, and attention to detail have been shown to contribute more substantially to the success of female students. Therefore, persistence and discipline in the learning process are crucial determinants of success, which are no less important than cognitive ability alone(Rohmah, 2020).

CONCLUSION

Based on the results of the analysis, male and female students exhibit different patterns of errors in solving Pythagorean problems according to the stages of Newman's Error Analysis. Male students tend to make errors at almost all stages, including reading, comprehension, transformation, process skills, and encoding, which are mainly caused by a lack of carefulness and weak understanding of fundamental concepts. In contrast, female students demonstrate significantly lower error rates, as they are more accustomed to carefully examining problem information before attempting to solve it. As a result, their solution processes tend to be more systematic and accurate. Mathematics teachers are therefore expected to design instructional strategies that take into account the differences in learning characteristics between male and female students, particularly in the topic of the Pythagorean theorem. A more structured approach should be provided for male students, especially in developing habits such as identifying given information, selecting appropriate formulas, and rechecking final answers. On the other hand, female students should be encouraged to build greater confidence when dealing with more complex problems. Future research is recommended to involve a broader range of participants so that the findings can be generalized more widely.

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