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ANALYSIS OF STUDENT DIFFICULTIES IN SOLVING QUESTIONS UNDERSTANDING MATHEMATICS CONCEPTS IN GEOMETRY MATERIALS

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Abstract. Although geometry is important in mathematics education, many students have difficulty understanding and applying its concepts, which can affect their academic performance. This study analyzes students' difficulties in solving problems related to understanding elementary school geometry concepts. Assessment of the concept understanding aspect aims to decide the extent of students' ability in understanding mathematical concepts with indicators of the causes of students making mistakes in solving problems based on the Newman procedure: a) reading errors; b) comprehension errors; c) transformation errors; d) process skills errors and; e) encoding errors. This study is a qualitative study with a case study to analyze elementary school students' understanding of mathematical concepts in solving problems about flat shapes. In deciding the subjects of this study, a purposive sampling technique was used by selecting and sorting subjects that met the predetermined criteria. The subjects of this study were all fifth-grade students at an elementary school in Bandung Regency, totaling 33 students. The instrument in this study was a test of understanding mathematical concepts about shapes. The results showed that students who experienced reading errors were 9.09%, comprehension errors were 30.03%, transformation errors were 51.51%, process skill errors were 39.39%, and encoding errors were 30.03%.

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INTRODUCTION

Learning is an active process that involves the transfer of information and knowledge between teachers and students. This process is supported by educational facilities available in a structured learning environment. In the national scope, learning is considered an interaction that involves several essential elements, including teachers, students, as well as all educational resources, as well as a learning environment that is continuously supported in good condition (Nuriyatin, 2020; Nurwijayanti, 2018). As stated in Law no. 20 of 2003 of the Republic of Indonesia concerning the National Education System. Therefore, learning is a complex system that integrates various interrelated components to produce optimal achievements according to the desired targets (Aulia et al., 2024).

Mathematics is a subject that is taught widely, starting from elementary school to high school. This scientific discipline aims to develop critical thinking skills and know the right methods for solving various problems. Mathematics has a prominent role in everyday life because mathematics can shape students' thinking patterns. Learning mathematics is an exact science that requires more understanding than memorization (Suswigi & Zanthy, 2019). The learning activities carried out by each teacher emphasize memorization and getting answers and leaving the answers completely to the teacher to figure out whether the answer is right or wrong, so that students' comprehension abilities are low (Yanti et al., 2019).

One of the branches of mathematics taught in schools is geometry (Kemdikbudristek RI, 2022[a]; Kemdikbudristek RI, 2022[b]). Many mathematical concepts can be showed or explained with geometric representations (Dini et al., 2018). Apart from being able to develop logical thinking skills, geometry is also effective in helping solve problems. problems in many branches of mathematics (Hallowell et al., 2015). In the 2023 independent curriculum, geometry has a substantial part of mathematics lessons at both levels Elementary, middle, and high school. This

shows that geometry is an important material and must be mastered by students. Geometry is an important branch of knowledge in mathematics learning that students must understand because the concept of geometry is very closely related to the context of everyday life (Panaoura, 2015; Rofii et al., 2018).

Geometry is one of the basic methods that people not only use to understand and explain the surrounding environment, where people live and the movement of people in their environment but also as a basic foundation that has an important role in supporting the mastery of the concepts of algebra, numbers, arithmetic and further mathematical concepts. The ability to understand good concepts is very necessary in geometry material because it is closely related to everyday life (Cross et al., 2009).

Conceptual understanding is a student's ability to re-express what has been communicated to him, use concepts in various different situations, and develop several outcomes from a concept (Davita et al., 2020). The aim of assessing the conceptual understanding aspect is to find out how well students understand the basic mathematical concepts being taught and how well they understand these concepts. Understanding concepts in elementary school is very important because if students understand concepts, it will be easier for them to learn mathematics. Understanding concepts is also important to continue learning at the next level. Students are considered to have understood mathematical concepts if they can explain these concepts clearly.

According to NCTM in Dini (2018) says that the ability to understand concepts can be achieved by doing the following: a) Rephrasing a concept; b) Categorize objects according to their concepts; c) Provide examples and non-examples of the concept; d) Presenting concepts in various mathematical representations; e) Create necessary or sufficient requirements for the concept; f) Use, utilize, and select appropriate procedures or operations; and g) Applying concepts or algorithms in solving mathematical problems.

Elementary School students need to use real situation problems to understand learning. The rediscovery process helps students understand mathematical concepts formally. According to Fitriani &Yuliani (2016) found several causes of the problem of students not understanding mathematical concepts, including: students don't think about the concepts they have learned, so these concepts don't last long; students are reluctant to understand practice questions before working on the questions, and students find it difficult to apply the material in everyday life. This is in line with research conducted by Yulianingsih et al. (2018) where systematic and consistent errors occur due to students' poor level of mastery of the material. It is very difficult for students to understand mathematical concepts because their understanding of concepts is very individual. Students' abilities to understand mathematical concepts vary. However, for students to be successful in learning, it is necessary to increase their understanding of mathematical concepts. The students will have difficulty solving mathematics problems because their understanding is unstable, according to Priyo in Kustiyati (2016).

Overcoming barriers to student learning requires specific skills that educators must have in order to be able to adapt their competencies according to the demands of the times, advances in science and technology (Cayani et al., 2021). One way is through learning activities that are able to develop thinking abilities that are not focused on assessing learning outcomes (Sowanto et al., 2019). Understanding students' learning difficulties in mathematics lessons is important for teachers to use as input to improve the teaching and learning process in the classroom. Because furthermore, as a source of knowledge, the teacher's role in designing learning that is interesting and easily accepted by students is one of the keys to the learning process (Sowanto et al., 2019).

This research is intended to analyze and evaluate the difficulties faced by students in understanding geometric concepts based on Newman's analysis. It is hoped that this research will provide information and explanations about the reasons why students experience difficulties in working on problems understanding mathematical concepts, so that it can be used as evaluation material for future learning. Therefore, analysis of students' difficulties in solving problems understanding mathematical concepts is needed to identify students' learning problems

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and to find alternative solutions in solving mathematics problems. Compared to reasoning, communication, creative thinking, and critical thinking, understanding concepts is an important ability. The aim of this research is to find out how big the percentage of errors made by students in solving mathematical problems on flat shapes based on Newman's Analysis, which consists of several types of errors: (1) errors in reading the questions (reading errors), (2) errors in understanding the questions (comprehension errors), (3) difficulty of transformation (transformation errors), (4) process skill difficulty (process skill errors), and (5) difficulty in writing final answers (encoding errors).

This study, which analyzes students' difficulties in understanding mathematical concepts in geometry, provides valuable insights that directly inform and improve educational practice. By systematically identifying where and why students experience difficulties in solving geometry problems, it enables teachers to design more effective teaching strategies and learning environments. For example, findings have shown that students often face challenges in connecting geometric concepts to real-world applications and in visualizing abstract shapes, underscoring the importance of incorporating hands-on activities, visual representations, and contextual problem solving into geometry lessons. In addition, this research supports the development of targeted interventions that can promote more effective learning, and help students overcome specific barriers to understanding geometry. The insights gained not only guide curriculum development and teacher training but also contribute to a deeper theoretical understanding of how students learn geometry. Ultimately, these benefits lead to increased student achievement and engagement in mathematics, equipping learners with the cognitive skills necessary for success in learning geometry and related fields.

RESEARCH METHODS

This research uses a qualitative approach, namely a method that aims to describe a phenomenon systematically. As explained by Jalaluddin Rakhmat in his book Internal Communication Research Methods (Putri & Fitriyani, 2024). The aim of this method will be described in the form of a description that is linked to the theory and findings to collect detailed factual information about emerging symptoms, identify problems, and analyze ongoing conditions and practices (Hidayat, 2019). Additionally, this method allows for comparison or evaluation, understanding how others tackled similar problems, and drawing lessons from their experiences to plan future decisions. The aim of this research is to analyze and evaluate elementary school students' difficulties in understanding mathematical concepts about geometry material.

By selecting and sorting subjects that meet certain criteria, techniques purposive sampling used to decide the subjects of this research. Students who meet these criteria show difficulty in understanding mathematical concepts in geometry material. The data collection method uses trials. This research method consists of five questions in the form of descriptions related to geometric material. These questions last 60 minutes and show a person's ability to understand mathematical concepts. This research involved all 33 grade V students in one of the state elementary schools in Bandung Regency, with samples selected from students with high, medium and low abilities. The instrument used in this study was in the form of questions about the description of flat shape material consisting of 5 questions based on indicators of mathematical concept understanding ability. Furthermore, the indicators of concept understanding ability in the questions used are explained in Table 1.

Table 1. Indicators of ability to understand mathematical concepts in geometry material

Question Number	Indicator
1.	Define concepts in writing
2.	Define and identify examples and non-examples
3.	Presenting a concept in the form of models, diagrams, and symbols
4.	Changing one form of representation to another
5.	Get to know the conditions that decide a concept.

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After obtaining the percentage of respondents' answers, an interpretation or assessment of the research results is then given. Researchers used the interpretation method according to Arikunto in Juliana & Zanthy (2020) the interpretation methods are in Table 2.

Table 2. Percentage Value Categories

Number	Limit Percentage	Assessment Category
1	0 – 20 %	Very low
2	21 – 40 %	Low
3	41 – 60 %	Medium
4	61 – 80 %	High
5	81 – 100 %	Very high

Provide several factors and indicators that cause students to make errors in solving essay questions based on the Newman procedure (Singh et al., 2010). Table 3 contains factors and indicators that cause students to make mistakes.

Table 3. Factors and indicators that cause student difficulties

Factors Causing Student Mistakes	Indicator
Reading errors	• The questions' symbols are not readable or recognizable by the students. • Every phrase, term, and symbol in the problem has an interpretation that students cannot understand.
Comprehension errors	• Students do not fully comprehend the facts contained in the inquiry. • Students do not fully comprehend the question's content.
Transformation errors	• Using the information they have learned, students are unable to construct mathematical models. • The formula that will be applied to solve the problem is unknown to the students. • The mathematical processes that will be applied to solve the problem are unknown to the students.
Process skills errors	Students are unaware of the stages or processes that will be required to properly tackle the problem.
Encoding errors	• Based on the methods or techniques that have been employed, students are unable to decide the problem's ultimate outcome. • Students are unable to show their final solution to the issue. • According to the conclusion, students are unable to write the last response.

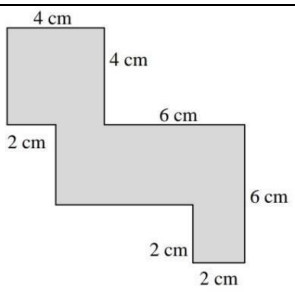
RESULTS AND DISCUSSION

According to the outcomes of the 33 students' job description test, which was administered using the Newman process, students encountered a range of challenges when answering the questions. Table 4 contains the questions tested, the questions consist of five questions.

Table 4. Concept Understanding Ability Questions

Number	Indicator	Questions
1.	Define concepts in writing	In your opinion, what is meant by square and rectangular figures? And mention the similarities and differences in the elements of the geometry!

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2.	Define and show examples and non-examples	Look at the following picture!  a. Based on the picture above, which is a square or rectangular shape? b. Give reasons for each picture that you have grouped!
3.	Presenting a concept in the form of models, diagrams, and symbols	A space agency is observing the movement of foreign objects in the earth's atmosphere. At the beginning of the observation, the object was at point (0,2), then successively the object moved to point (8,2); (8,10); (0.10) and return to the starting point of observation. Draw a sketch of the movement of the object and state what shape is formed from the movement of the object? Calculate the area of the shape!
4.	Changing one form of representation to another	Calculate the area of the following combined flat shapes! 
5.	Get to know the conditions that decide a concept	The walls of a room measuring 3 m x 4 m will be painted. On this wall there is a door measuring 1 m x 2 m and a window measuring 1 m x 1 m. Calculate the area of the wall that will be painted!

Based on Newman's error analysis, the following student error results were obtained:

1. Difficulty Reading Questions

At the stage of difficulty in reading questions, students experience the least difficulty. This is because the form of the questions uses good and easy-to-understand Indonesian and does not use many symbols. The average error made by students is 9.09%. Students' difficulties at the stage of reading questions can be seen in questions number 1 and number two as shown in Figure 1 and Figure 2. Students are said to have difficulty reading if they cannot recognize/read the symbols in the questions, understand the meaning of the symbols in the questions or interpret the keywords in the questions (Halim & Rasidah, 2019). Many 5th grade students have difficulty understanding the properties and characteristics of geometric shapes, such as squares and rectangles. This difficulty is often exacerbated by a lack of attention and motivation, with

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students considering geometry material as something difficult. This causes challenges in interpreting and answering geometry questions accurately, especially those involving two-dimentional figures (Kusuma et al., 2023).

One of the difficulties that students often experience is not being able to translate story problems into mathematical models. This is a critical obstacle in solving geometry problems because students may not understand what is being asked in the problem or may apply the wrong concept to find the solution. This problem does not only occur in geometry but is especially seen in spatial problems and problems related to shapes (Ramdjid et al., 2022).

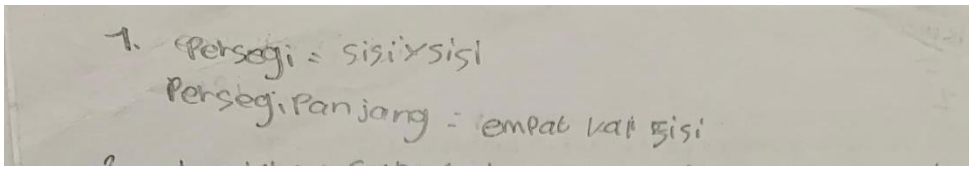


Figure 1. Examples of student's difficulties in reading questions.

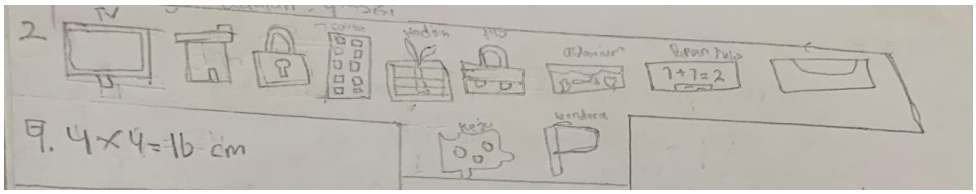


Figure 2. Examples of student's difficulties in reading questions.

Figure 1 is one of the results of student work on question number 1, namely on the indicator of defining concepts in writing. In this question, students write the answer to the formula for the area of a square and the formula for the perimeter of a square and do not write down the meaning of a square and a rectangle as well as the similarities and differences between these flat shapes. Meanwhile, in Figure 2, which is question number 2a, on the indicator of defining and identifying examples and non-examples, it can be seen from the students' answers when asked which are square and rectangular figures, the students drew all the illustrations in the question and did not choose any objects which were included as figures squares and objects that include rectangular shapes.

2. Difficulty Understanding Questions

In the indicator of difficulty in understanding questions, the percentage of students who have difficulty understanding questions is 30.03%. This happens if students are unable to distinguish between what is known and what is asked (Melisari et al., 2020). This causes students to often misunderstand the properties of flat shapes, such as area and circumference, and have difficulty connecting geometric concepts with their daily experiences (Leton et al., 2020). The difficulties experienced by students in understanding questions can be seen in Figure 3.

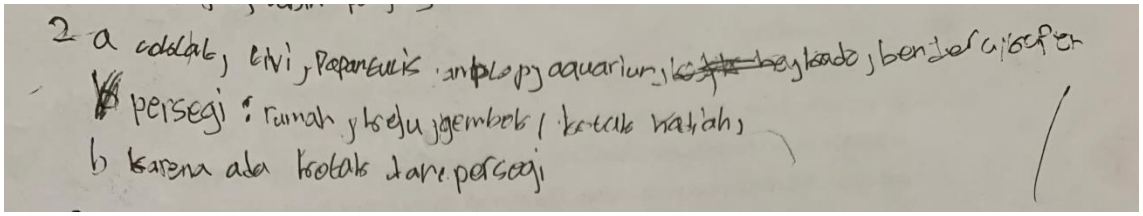


Figure 3. Examples of student's difficulties in understanding questions

Based on the results of the students' work as seen in the picture above, namely question number 2b on the indicator defining and identifying examples and non-examples. The picture shows students' answers that do not explain what was asked. This is because students answered incorrectly when asked to understand the reasons why students chose the objects in the illustrations to be called square or rectangular figures. Students are expected to be able to answer the question based on the characteristics of a square or rectangular shape, such as having 4 sides and angles of the same length, or having 2 pairs of sides of the same length so that errors occur in understanding the question. In students' answers when asked why these objects are

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called square and rectangular figures, students answered inaccurately, such as because there are squares in squares. Therefore, question number 2b is categorized as having difficulty reading the question.

3. Difficulty of Transformation

The dilation and translation subtopic accounted for the majority of student mistakes. Conceptual errors, ignorance of procedures, and hurry and inaccuracy in answering questions were the main causes of errors. Therefore, a procedural error occurs when an unsystematic approach to problem-solving is used, which affects the result (Winarso et al., 2021). Causal factors include discontinuous learning methods, lack of effort, and weak mastery of basic mathematical concepts. Regarding the various difficulties of elementary school students in learning geometry, including in the material on plane shape transformations (Nia Aprilia et al., 2024). It was emphasized that the main difficulties for students were in understanding basic concepts, visualizing, and applying transformations such as translation, reflection, and rotation. The causative factors include weak abstract thinking skills, lack of concept mastery, and limited learning media that support visualization.

In the transformation difficulty indicator, 51.51% of students experienced difficulties. If students do not explain the method to be used, write the method incorrectly or incompletely, or write the technique but do not write the mathematical formula needed to solve the problem, then the student is considered to have difficulty in performing the transformation. Figure 4 shows students' difficulties in performing the transformation.

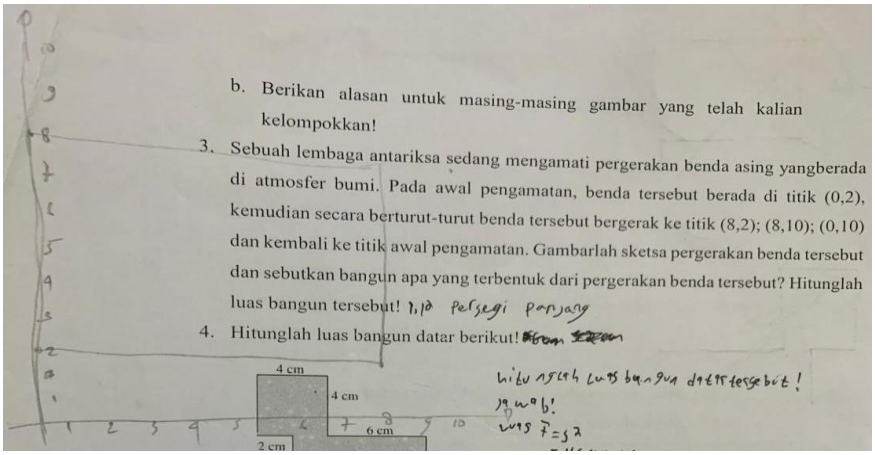


Figure 4. Examples of student's difficulties in transformations on questions

Figure 4 shows one of the students' answers to question number 3 with indicators of presenting a concept in the form of models, diagrams, and symbols. Based on the results of the students' work shown in the picture above, it can be seen that the students were less precise in answering the question when deciding the coordinate point (8,10); (0,10) when working and the answers obtained were incorrect and there were difficulties in transformation of the questions.

4. Process Skill Difficulty

Students struggle to translate real-world geometry problems into mathematical models. A 2023 study found that 60% of fifth-grade students were unable to show relevant data or apply scaling principles when completing tasks involving 3D objects or photographs. This problem stems from weak spatial reasoning and abstract thinking skills (Jablonski, 2024). Fifth grade students often make calculation errors (arithmetic operations) when solving geometry problems, both in plane and solid shapes (Hartini & Setyaningsih, 2023). Errors include the use of incorrect formulas, errors in addition, subtraction, multiplication, and division operations, and lack of care in the calculation process. The main causative factors are lack of understanding of the concept, inaccuracy, and lack of practice. I n the process skill indicator, 39.39% of students experienced difficulties. Students are said to experience process skill difficulties if they make mistakes in calculating, conceptual errors, do not continue the solution procedure, or do not write down the calculation stages. In the process skill difficulty indicator, there are still some

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students who make these mistakes. Figure 5 and Figure 6 show that students make calculation errors when working on problems.

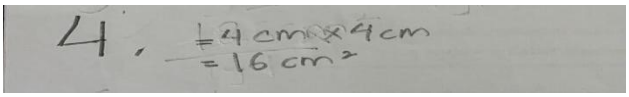


Figure 5. Examples of student's difficulties in process skills

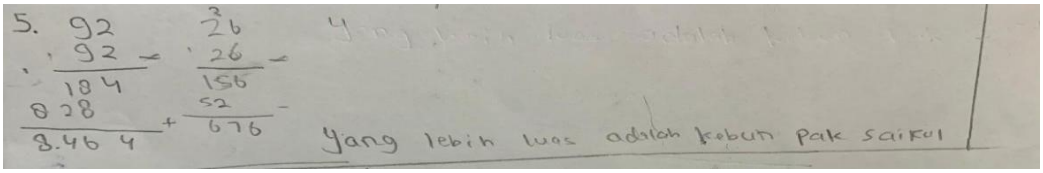


Figure 6. Examples of student's difficulties in process skills

Based on the results of the students' work shown in the picture above, it can be seen that the students had difficulty with the computational indicators, namely that the students did not complete the work process on number 4. There were students who had difficulty working on question number 5, shown by students who were not able to apply the formula for the area of combined flat shapes and carrying out incorrect calculations so that in this study students were said to have difficulty processing skills.

5. Difficulty in Writing Final Answers

Many 5th grade students have difficulty in writing the final answer. These difficulties include; 1) not writing the final answer at all, even though the calculation process is correct, 2) writing the answer without units, or not concluding the final result explicitly, 3) forgetting or not knowing that they have to write the final conclusion of the calculation results, 4) students are often in a hurry, lazy to write because the question is considered too long, or do not understand the question instructions well (Silalahi & Dewi, 2023).

Table 5. Percentage of students' ability to solve geometry material questions based on indicators of understanding mathematical concepts

Question Number	Indicator	Persentage	Category
1.	Define concepts in writing	63.6%	High
2.	Define and identify examples and non-examples	45.5%	Medium
3.	Presenting a concept in the form of models, diagrams, and symbols	36.4%	Low
4.	Changing one form of representation to another	24.2%	Low
5.	Get to know the conditions that determine a concept.	18.2%	Very low

Students are said to have difficulty writing the final answer if the student can complete the solution correctly but does not write a final answer conclusion or concludes a final answer that is not in accordance with the context of the question. In this indicator, there are no answers that show an error in writing the final answer because the questions given did not contain students who completed the solution correctly but did not write the conclusion of the answer. Apart from that, the question that requires a solution is only number 5, while all students cannot understand the solution to that question.

Students' comprehension of mathematical ideas is generally quite poor. The percentage table of student responses based on the following ideas' understanding markers shows this bellow (Table 5). Based on the results shown in Table 5, students' level of understanding is still low in their ability to understand mathematical concepts when solving geometric problems of square and rectangular shapes for each indicator. The sample consisted of 33 students from one of the schools in Bandung Regency consisting of high, medium, and low ability students. Based on the results shown in Table 5, students' ability to understand concepts in solving geometry problems for all indicators is still low. Samples were obtained from high, medium, and low ability students, where student data was taken from students' daily mathematics test scores. The following is data on students' daily test scores (Table 6).

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Tabel 6. Transcript of students' daily test scores

Number	Name Initials	Mathematics Test Scores				Number	Name Initials	Mathematics Test Scores			
1	AQA	72	70	77	75	18	KKPM	68	63	67	75
2	AFFA	56	58	55	67	19	KPG	24	57	57	55
3	AAR	40	52	57	48	20	KDK	72	70	67	85
4	AAK	28	41	55	63	21	LPS	58	78	75	83
5	AOS	52	45	47	73	22	MAJM	16	30	37	50
6	AH	66	70	70	78	23	MPW	34	32	40	42
7	ATP	60	50	60	62	24	MIS	52	73	77	90
8	ANA	52	58	70	68	25	MF	40	59	70	72
9	APNS	54	70	62	73	26	PS	52	43	70	60
10	ADF	66	72	73	88	27	RM	16	16	28	28
11	BPH	78	80	85	85	28	RRA	38	54	47	70
12	DMW	48	62	77	60	29	RS	42	56	55	72
13	DA	60	53	71	68	30	RMA	34	46	38	48
14	FF	62	46	70	47	31	RAP	74	70	85	83
15	GAP	64	48	72	77	32	RO	44	60	78	82
16	HAAG	38	50	70	77	33	RRS	59	58	73	80
17	KLT	52	39	70	68						

Students' habit of memorizing formulas without understanding the concepts and material is the main cause of making mistakes, choosing, or applying formulas (Sumargiyani & Ainurrahman, 2024). The reason why students apply formulas incorrectly occurs because of students' lack of understanding in applying the concepts of the material (Sari et al., 2022). Based on the research data contained in the table and the results of data analysis, several research findings were obtained, namely:

1. Students have difficulty understanding the concept, this fact can be seen from students' mistakes in determining the formula for the area of a square and the formula for the perimeter of a square and not writing down the meaning of square and rectangle as well as the similarities and differences between these flat shapes. Around 9.09% of students were unable to answer the question correctly because students did not understand the concept of square and rectangular shapes. Students still often make mistakes in writing the formula for the area of flat shapes, so that when working on these problems, students are less able to understand the mathematical concept.
2. Students are weak in understanding the characteristics of basic calculation operations, this can be seen from the results of error analysis where students are unable to do or correctly calculate the combined area of flat shapes. Students' understanding is still low in mathematical calculation operations, thus affecting the final results obtained. This is proven by 30.03% of students having difficulty answering questions related to identifying examples and non-examples of squares and rectangles based on the characteristics of square or rectangular figures.
3. Students find it difficult to differentiate between the properties of square and rectangular shapes. This can be seen in students' mistakes in choosing objects in illustrations called square or rectangular shapes based on the characteristics of square or rectangular shapes, such as having four sides and angles of the same length or having two pairs of sides of the same length, so errors occur in answering questions.

Furthermore, from the results of the findings above, several alternative solutions that can be implemented are as follows:

1. Study the concept in its entirety regarding square and rectangular shapes, all mathematics material always adheres to the concept, the same goes for square and rectangular shapes, where students must be able to fully understand the concept of this material, if students already understand this concept then it will be easy to answer various kinds of questions related to this material. Teachers should explain the concept of square and rectangular

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figures carefully, not only explaining the formulas used but must also be able to explain the concept of these formulas.
2. Increasing practice questions is the most effective way to understand square and rectangular shapes. The key to success in studying mathematics is to often do practice questions/cases. This will automatically form new concepts in students' thinking so that they are able to solve all types of problems.
3. Reinforcing mastery of arithmetic operations is one of the important points in studying this material. Mathematics is a lesson that requires students to get final results, this is related to the ability to calculate. Therefore, if students are weak in arithmetic, they will have difficulty getting appropriate final results.

CONCLUSIONS AND SUGGESTIONS

Newman's analysis of fifth-grade students studying geometry at one of the Bandung Regency's elementary schools revealed that: (1) the percentage of reading questions that were difficult was 9.09% in the very low category; (2) the percentage of understanding questions that were difficult was 30.03 percent in the low category; (3) the percentage of transformation difficulty was 51.51% in the medium category; and (4) the percentage of process skills difficulty was 39.39% in the medium category. So, it can be concluded that the most mistakes made by class V students in one of the schools in SDN Bandung Regency in solving mathematics problems on geometry material based on Newman's analysis lies in the difficulty of understanding transformations as much as 51.51%. This is due to the students' low ability to understand the material geometry and Cartesius coordinates material so that many students forget what they have been taught. Therefore, teachers play a big role in providing understanding to students in explaining the material, not just conveying the material.

One of the main factors that influences students' learning difficulties is students' inability to understand abstract concepts and students' lack of interest in mathematics. This problem happened becaused by various factors, including understanding complex concepts, so that students are unable to understand the mathematical concepts being taught. limitations in abstract thinking, difficulty in combining various shapes in one problem, and negative thinking patterns towards mathematics. Therefore, teachers must implement various strategies that can support students in mastering geometry material better. This problem arises as a result of students' inability to understand the mathematical concepts being taught.

Geometry is an abstract and complex material, so a solution is needed to overcome this problem. This especially needs to be done in the learning process so that students can understand difficult geometry material well. With various proper learning approaches and strategies and using learning media, it is hoped that it can help overcome students' difficulties in understanding geometry material more effectively and comprehensively.

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