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Analysis of Students' Misconceptions On The Characteristics of Flat Shapes Using Two-Tier Multiple-Choice Diagnostic Test in Grade V Elementary School

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Abstract

This study aimed to identify students' misconceptions regarding the characteristics of flat shapes in mathematics learning, using a two-tier multiple-choice diagnostic test instrument. This research employs a descriptive qualitative approach. The subjects of this study were fifth-grade elementary school students, totaling 25 students. The data used in this study are observation results, two-tier diagnostic test results, diagnostic interviews with students, and documentation. The data analysis method used includes data reduction, data presentation, and conclusion drawing. The validation results indicate that the two-tier diagnostic test instrument meets the criteria for validity and feasibility, achieving an average total score of 43 out of a possible 44, which reflects a positive response; thus, the instrument is highly suitable for use in the field. The results indicated that among grade V elementary school students learning about the characteristics of flat shapes, 29.40% demonstrated complete understanding of the concept, while various types of misconceptions were identified: 10.00% had positive misconceptions (false positives), 7.40% had negative misconceptions (false negatives), 7.80% had pure misconceptions, 12.10% guessed answers, and 15.20% and 17.80% did not understand the concept at all.

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INTRODUCTION

Mathematics serves as a fundamental foundation for the advancement of science and technology. Therefore, gaining a clear understanding, studying, and mastering it is essential for its application in daily life. This lesson highlights the importance of conceptual understanding in learning mathematics. Such understanding plays a vital role in the teaching and learning process, particularly when grasping mathematical content. One important branch of mathematics is geometry, which also requires strong conceptual comprehension to be effectively learned.

Regulation of the Minister of National Education Number 23 of 2006 states that students are expected to have excellent skills and abilities in learning mathematics, including understanding concepts, procedures, reasoning, communication, problem solving, and appreciation of the benefits of mathematics. This shows that concept understanding is the main basis that students need to master in order to more easily continue to a higher level of understanding of mathematics. Abraham (Ainiyah, 2016) states that a student is considered to have an understanding of the concept if it meets certain criteria. These criteria include the categories of understanding, misconception (wrong concept), and not understanding. Strong concept understanding in a subject, especially mathematics, will not interfere with students' understanding of other concepts. Thus, misconceptions about a mathematical concept do not occur. Conversely, a less strong understanding of concepts can actually lead to misconceptions.

Tracht (Natalia, Karolin, et al., 2016) argues that mathematics is a subject filled with various concepts. Uncertainty about one concept can impact the comprehension of other concepts due to their interconnectedness. Therefore, it is necessary to understand basic concepts so that students can more easily understand subsequent concepts. This lesson shows the importance of concept mastery in learning mathematics.

One of the materials that often causes misconceptions in elementary school students is geometry. Geometry discusses various dimensional objects, both one, two, and three dimensions, which aim to develop students' visual abilities towards the shapes of objects. Geometry is a part of mathematics that is difficult for students to understand (Wahyudi et al., 2022). Geometry, particularly the topic of flat shapes, is often viewed as challenging because it requires strong visualization and analytical skills to comprehend abstract concepts. Meanwhile, elementary school students are still at the concrete operational stage, where they need real objects to help them understand things. This situation contributes significantly to geometry's potential for creating math misconceptions among elementary school students.

Misconceptions are concepts that are wrong but considered correct and used as a habit. Misconceptions can cause understanding of a concept to be inconsistent. As according to Nurkamilah & Afriansyah (2021), who define misconceptions as an inaccurate understanding of concepts, the use of concepts that do not align with those This agreement among experts in specific fields highlights the inability to correctly connect the initial concept with subsequent concepts, which can lead to resistance or

difficulty in implementing change. Students must understand the concept as the primary foundation, and any misconceptions require serious attention. Ignoring misconceptions is not a simple problem. The emergence of misconceptions is one of the obstacles that students face in receiving and linking knowledge.

According to Soedjadi (Mufidah & Budiarto, 2018), misconceptions can arise due to preconceptions. Preconceptions are a person's first understanding of an object, which may differ from what they learned in class. In such conditions, preconceptions can turn into misconceptions. Misconceptions in mathematics learning can arise in quadrilateral flat material, which is part of the study of geometry in the school mathematics curriculum. Some research results show that students experience misconceptions in understanding this material. Based on research conducted by Ningrum and Budiarto (2016), students showed misconceptions about the definition of quadrilateral flat shapes, where most students only understand quadrilaterals as shapes that are always regular. In addition, misconceptions also occur in understanding the properties of quadrilateral flat shapes. When students experience misconceptions in geometry material, this can be an obstacle in understanding other related mathematical concepts, such as the relationship between points, lines, angles, planes, and spaces. Given that flat building and geometry materials require a high level of concept understanding, it is important to make efforts to identify student misconceptions. One way is to develop a diagnostic tool that can be used after the learning process is complete.

The methods used to identify student misconceptions include the use of concept maps, interviews, and diagnostic tests. The two-tier diagnostic test is a form of test that consists of two levels. In the first level, students are given questions with five answer choices. Meanwhile, in the second tier, students are asked to choose a reason from five options that match the answer they chose in the first tier (Chandrasegaran, 2007). The main principle in diagnostic tests is that teachers need to take into account students' prior intuitive knowledge to understand how they think about the science concepts that have been taught (Mubarak, Susilaningsih, & Cahyono, 2016). Misconception detection diagnostic tests are designed in such a way that they can be used to analyze concept understanding.

Diagnostic tests have the basic principle that teachers must pay attention to the basic visual abilities that students have when trying to understand their thinking related to understanding other concepts that have been delivered. Diagnostic tools used to identify student misconceptions should also be able to provide feedback that can generate comprehensive information from student responses (Depdiknas, 2007). Two-level multiple-choice tests have an advantage over regular multiple-choice tests, as they can reveal the reasons behind the answers chosen by students. This advantage helps reduce the possibility of students choosing answers incorrectly. In addition, this The test also indirectly suppresses the habit of students answering randomly, because Students are only considered to have answered correctly if they provide the right answers at both levels of questions: the first level and the second level (Tuysuz, 2009).

Based on the above explanation, the researcher wants to examine more deeply the misconceptions experienced by students with the material to design more effective learning strategies, as well as develop teaching methods that can help students understand the concept of flat shapes better.

METHOD

This research is a type of qualitative descriptive study aimed at describing student misconceptions regarding the characteristics of flat shapes. The research subjects consisted of one class, specifically 25 fifth-grade students from elementary schools in Cirebon City. The research design begins with observing the characteristics of educators, students, the learning process, and evaluation of ongoing learning.

The research procedure includes the preparation stage, the implementation stage, and the final stage of the research. The preparation stage consists of several main activities, namely needs analysis, literature review, preparation of question grids, preparation of diagnostic test questions, preparation of interview guidelines, instrument validation, and analysis of question validity. The implementation stage was carried out by administering two-tier diagnostic test instruments and student diagnosis interviews. The final stage of this research was carried out by analyzing students' misconceptions on the material of the characteristics of flat shapes based on the interpretation of a combination of student answers and drawing conclusions on students' understanding through test instruments, interview results, and documentation.

The data analysis process in this study refers to the Miles and Huberman model, which consists of three main stages: data reduction, data presentation, and conclusion drawing (Sugiyono, 2016). Data reduction is done by sorting, grouping, and organizing data according to the research focus. Data presentation aims to display information that has been collected in a visual form, such as tables, graphs, or diagrams. The conclusion drawing is a process of interpreting and verifying data continuously until the final conclusion is obtained.

Data from the two-tier multiple-choice test results were analyzed based on the answers chosen by students at the first level and the second level. The combination of answers to the first-level and second-level questions and the results of interviews in answering are then converted into a percentage and will be analyzed for student misconceptions on the material of the characteristics of flat buildings.

Following their completion of the two-tier multiple-choice questions and the classical student interviews, the researchers grouped the students' answers according to potential patterns. Students' understanding and misconceptions on each Possible answers were analyzed based on the answer combination pattern proposed by Arslan, Harika Ozge, Cigdemoglu, Ceyhan, and Moseley (2012), as shown in Table 1.

Table 1. Classification of Student Answers

Answer Combination			Student Answer Classification
Tier 1	**Tier 2**	**Interview**	
Correct	Correct	Able to Explain	Complete Understanding / (CU)
Correct	Incorrect	Able to Explain	Misconception (+) / (Mp)
Incorrect	Correct	Able to Explain	Misconception (–) / (Mn)
Incorrect	Incorrect	Able to Explain	Misconception / (Ms)
Correct	Correct	Unable to Explain	Guessing / (G)
Correct	Incorrect	Unable to Explain	Partial Understanding / (PU)
Incorrect	Correct	Unable to Explain	Partial Understanding / (PU)
Incorrect	Incorrect	Unable to Explain	No Understanding / (NU)

The research data analysis also uses question validity as one of the requirements that a good instrument must have: that the instrument must be valid. Validity is a measure that shows the level of validity or validity of an instrument (Arikunto, 2015). The instrument validation sheet is used to measure the validity of the instrument developed. This research was conducted with instrument validation by experts (expert judgment). The validator is asked to provide an assessment by giving an opinion on each indicator assessed and providing suggestions if needed.

RESULT AND DISCUSSION

The two-tier model diagnostic test instrument on the characteristics of flat shapes, before being used, is first subjected to expert validation. The extent to which a test has evidence of validation is determined according to a rational analysis of the test content, whose assessment is based on individual subjective considerations, although subjective, but those involved are several experts in the field being measured so that the results can be accounted for. Validation is carried out by test instrument experts. The results of the recapitulation of test instrument expert validation are presented in Table 2.

Table 2. Recapitulation of Expert Validation of the Test Instrument

No	Validator Code	Assessment Items											Total Score
		1	2	3	4	5	6	7	8	9	10	11	
1	Validator-1	4	4	4	4	4	4	4	4	4	4	3	43
2	Validator-2	4	4	4	4	4	4	4	4	3	4	4	43
Total Score		8	8	8	8	8	8	8	8	7	8	7	86
Average Score													43

The two-tier test questions totaling 20 items meet the eligibility criteria on each assessment item with an average score of at least 3.9 out of a maximum score of 4 on each item assessment with a total of 11 assessment items. A recapitulation of the results collected by researchers is that the test instrument has been validated by 2 validators

consisting of 2 elementary school class teachers. The validation results indicate an average total score of 43 out of a possible 44, which demonstrates a positive response and confirms that the instrument is very feasible for use in the field. Thus, this instrument can support the analysis of student misconceptions more accurately.

Based on the test results and data analysis using the two-tier test instrument administered to 25 student participants, the types of conceptual understanding among the students were categorized as follows: 29.40% demonstrated a complete understanding, 10.00% showed positive misconceptions, 7.40% had negative misconceptions, 7.80% exhibited general misconceptions, 12.10% were guessing, 15.20% showed limited understanding, and 17.80% had no understanding. A detailed breakdown of students' conceptual understanding profiles is presented in Table 3.

Table 3. Recapitulation of Conceptual Understanding Profile Analysis

Total	**Conceptual Understanding Profile Classification**						
	Cu	**Mp**	**Mn**	**Ms**	**G**	**Pu**	**Nu**
Overall	147	50	37	39	62	76	89
Average	7.35	2.5	1.85	1.95	3.1	3.8	4.45
Percentage	29.40 %	10.00 %	7.40%	7.80%	12.10 %	15.20 %	17.80 %

Students' Misconception Profile

Students' comprehension profiles were categorized based on the combination proposed by Arslan et al. (2012), with modifications completed through the development of interviews. Researchers used the combination of students' answers and the results of the conducted interviews to obtain data on the students' complete understanding profile in the diagnostic test, allowing for a deeper and more accurate misconception analysis. Based on the research, misconceptions were classified into three categories: false positive, false negative, and pure misconceptions. A false positive misconception occurs if the answer is correct at the first level but incorrect at the second level, with the interview results being able to explain both answers. Meanwhile, false negative misconceptions occur when the answer is wrong at the first level and correct at the second level, but students are able to explain and are confident during the interview. Meanwhile, pure misconceptions occur when students' answers are wrong at the first and second levels, but they are able to explain during the interview why students are confident in choosing these answers.

The following table shows the percentage of positive, negative, and pure misconception profiles on each item. This table provides an overview of the misconception patterns experienced by students so that they can be further analyzed to determine the right learning strategy in overcoming them. The recapitulation of the misconception profile calculation analysis is presented in Table 4:

Table 4. Recapitulation of Misconception Profile Calculation Analysis

Item No.	Conceptual Understanding Profile (%)		
	Positive Misconception ***(False Positive)***	**Negative Misconception** ***(False Negative)***	**Misconception (Pure)**
1	12%	0%	0%
2	8%	0%	4%
3	8%	4%	0%
4	8%	0%	4%
5	8%	12%	16%
6	0%	0%	0%
7	8%	8%	4%
8	32%	12%	12%
9	8%	16%	0%
10	0%	8%	4%
11	4%	8%	16%
12	0%	12%	28%
13	12%	0%	16%
14	24%	4%	4%
15	4%	24%	8%
16	0%	4%	8%
17	12%	4%	8%
18	16%	16%	12%
19	24%	12%	12%
20	12%	4%	0%

Based on the table above, it can be concluded that each item shows the presence of students who experience positive misconceptions (false positive), negative misconceptions (false negative), and pure misconceptions. The highest positive misconception occurred in item number 8, with 32% of students identified in this category. Meanwhile, the most negative misconceptions were found in item number 15, where 24% of students experienced undetected conceptual errors. The highest pure misconception was recorded in item number 12, with 28% of students who actually experienced a false understanding of the concept being tested. The following is a table that presents an analysis of students who experience misconceptions on each item on the characteristics of flat shapes, along with the concepts that should be understood correctly. Student misconceptions on the items are presented in Table 5:

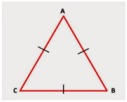
Table 5. Students' Misconceptions on the Topic of Flat Shapes

Item Number(s)	Related Concept	Students' Misconception	Correct Concept
1, 2	Equilateral and isosceles triangles	An equilateral triangle has two equal sides. An equilateral triangle has three equal sides.	An equilateral triangle features three sides of the same length, whereas an isosceles triangle contains two sides of equal length and two angles that are also equal.
3, 11	Interior angles in triangles	A right triangle has more than one 90° angle. An equilateral triangle has different angles or one 90° angle.	A right triangle contains a single right angle measuring 90 degrees, while an equilateral triangle consists of three equal angles, each measuring 60 degrees.
4, 15	Properties of parallelograms	All sides of a parallelogram are equal. A parallelogram has right angles or equal-length diagonals.	A parallelogram has two pairs of opposite sides that are equal. Its angles are not 90°, and its diagonals are not of equal length.
5, 7	Shapes with four equal sides	All shapes with four equal sides are squares. A rectangle has four equal sides.	Shapes with four equal sides can be squares or rhombuses. A rectangle has two pairs of equal-length sides.
6, 16	Characteristics of scalene triangles and trapezoids	A scalene triangle has two equal sides. All trapezoids have two pairs of parallel sides or right angles.	A scalene triangle has no equal sides. A trapezoid has only one pair of parallel sides and may have varying angles.
8, 12	Symmetry in flat shapes	All triangles have rotational symmetry. All shapes have the same number of lines and rotational symmetries.	Not all triangles have rotational symmetry. Only certain shapes like squares and equilateral triangles, have the same number of lines and rotational symmetries.

Item Number(s)	Related Concept	Students' Misconception	Correct Concept
9, 19	Similarities and differences between rectangles and parallelograms	Rectangles and parallelograms have all right angles. A rectangle has three equal angles.	A rectangle has four right angles, while a parallelogram doesn't necessarily have right angles. A rectangle has four equal angles, not three.
10, 20	Axes of symmetry in flat shapes	All flat shapes have axes of symmetry. All trapezoids have two axes of symmetry.	Not all flat shapes have axes of symmetry. Trapezoids usually have one or no axis of symmetry.
13, 18	Properties of rhombuses and squares	A rhombus has three angles. A square has two lines of symmetry or unequal diagonals.	A rhombus has four angles, and its diagonals are perpendicular. A square has four lines of symmetry and equal-length diagonals.
14, 17	Shapes in everyday life	A notebook is square. A right trapezoid has one acute angle or all right angles.	A notebook is rectangular. A right trapezoid has two right angles and two acute angles.

Students' Misconception Profile with False Positive Misconception Classification

Based on the combination of answers given by students as well as supporting data from the results of diagnostic interviews that have been conducted, the students' misconception profile on the diagnostic test was obtained. The pattern of answer combinations with positive misconception categories indicates that at level 1, the answer is correct; at level 2, the answer, which provides the reason, is incorrect; and during the interview, students are able to explain their reasoning. The highest positive misconception profile was shown in item number 8, where 8 out of 25 students experienced positive misconceptions, or about 32%. Item number 8 has an indicator that students can determine the number of rotary symmetries in a triangle. Students assume all triangles have rotary symmetry. All figures have the same number of folding and rotary symmetries. However, students do I do not understand that not all triangles have rotary symmetry. The following is an excerpt from question item number 8, presented in Figure 1:



8. The number of rotary symmetries in the triangle above is...

a. 0
b. 1
c. 2
d. 3

The reason that supports your answer above is...

a. An isosceles triangle can be rotated three times until it reaches the starting position.
b. An equilateral triangle can be rotated three times until it reaches the starting position
c. An isosceles triangle can be rotated twice until it reaches the starting position
d. An equilateral triangle can be rotated twice until it reaches the starting position

Figure 1. Excerpt of Problem Item Number 8

The results of interviews with students on question number 8 are:

Teacher: Do you think all triangles have rotary symmetry?
Student: Yes, all triangles must have rotary symmetry because when rotated, they remain triangular.
Teacher: What about isosceles, equilateral and arbitrary triangles? What is its rotary symmetry?
Student: Since the triangles have 3 sides, they all have 3rd degree rotary symmetry
Teacher: Actually, only the equilateral triangle has 3rd degree rotary symmetry, while the other triangles do not.
Student: Oh, I think all triangles can be rotated and have 3rd degree rotary symmetry because the number of sides is 3.

Figure 2. Interview Excerpt for Question Number 8

The interview results show that students have misconceptions about rotary symmetry in triangles. Students assume that all triangles have rotary symmetry because if rotated, they remain triangular. The correct theory, as presented by geometry experts, states that not all triangles have rotary symmetry. Equilateral triangles have 3rd degree rotary symmetry because they can be rotated by 120°, 240°, and 360° and still look the same. Meanwhile, isosceles triangles and arbitrary triangles have no rotary symmetry, which means they only return to their original shape after one full rotation (360°). Thus, the assumption that all triangles have third-degree rotary symmetry according to their side lengths is incorrect. Suparto et al. (2022) found correlational misconceptions on the concept of triangle symmetry, where students have difficulty connecting the concept of symmetry with the properties of triangles. In addition, it is also in line with research by Hidayah & Fitriani (2021), which revealed that students have difficulty applying the properties of the sum of triangle angles when solving problems and do not understand well the concept of triangle angles.

The lowest positive misconception profile is shown in question items number 6 and 16, both of which have no students who experience positive misconceptions. Item number 6 has an indicator that students can identify the characteristics of an arbitrary triangle, and item number 16 has an indicator that students can determine flat shapes based on their special properties. The lowest understanding profile in item number 22 is possible because the questions in question numbers 6 and 16 are possible because

the questions in these numbers test concepts that are more concrete and often encountered in learning. Students are familiar with the characteristics of arbitrary triangles and the properties of flat buildings, so they understand and answer correctly more easily. This result shows that the concepts in both items have been well understood by students. The recapitulation of students' misconception profiles with the classification of false positive misconceptions on each item can be seen in Figure 3.

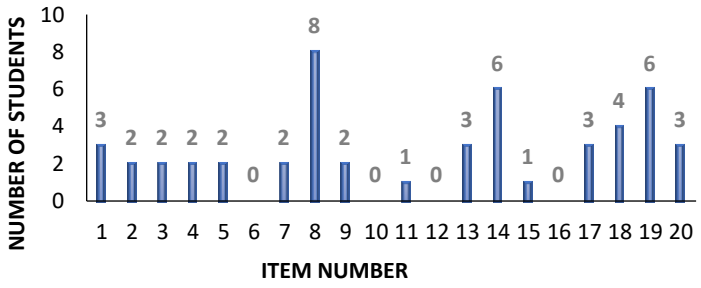


Figure 3. Recapitulation of Students' Misconception Profile with False Positive Misconception Classification on Each Question Item

Students' Misconception Profile with False Negative Misconception Classification

Students experience negative misconceptions if they answer the question incorrectly at the first level and then answer correctly at the second level, and learners are able to explain the reasons for choosing both answers. The highest negative misconception profile is shown in item number 15 on the material properties of the parallelogram; namely, as many as 6 out of 25 students experienced negative misconceptions, or around 24%. Item number 15 is designed to assess students' ability to recognize the properties of a parallelogram based on its defining features. Students exhibiting negative misconceptions believe that all sides of a parallelogram are equal in length and that it has right angles or perpendicular diagonals. However, the accurate concept is that a parallelogram has two pairs of equal sides, its angles are not right angles, and its diagonals bisect each other. Item number 15 is illustrated in Figure 4.

15. Consider the following properties of flat shapes:
    1)Has two pairs of parallel sides
    2) The opposite angle is equal
    3) Both diagonals intersect perpendicularly
    4) The sum of the size of adjacent angles 180 degrees
    The properties of the parallelogram is . . . .
    a. 1), 2), and 3)
    b. 1), 2), and 4)
    c. 1), 3), and 4)
    d. 2), 3), and 4)
    The reason that supports your answer above is...
    a. A parallelogram has 4 equal sides and right angles.
    b. The two diagonals of a parallelogram are parallel rather than perpendicular
    c. A parallelogram has 4 sides and there are 2 pairs of parallel and equal length sides
    d. The sum of the measures of adjacent angles in a parallelogram is 90°.

Figure 4. Excerpt of Question Item Number 15

The outcomes of student interviews regarding question number 15 are as follows:

Teacher: Are all sides of a parallelogram equal in length?
Student: Yes, all sides are the same length like a square.
Teacher: What about the corners? Are there right angles like a square?
Student: Yes, a parallelogram definitely has right angles.
Teacher: Actually, a parallelogram only has two pairs of sides that are equal in length, and the angles are not 90° or do not have right angles.
Student: Oh, I thought a parallelogram has all sides of equal length and right angles.

Figure 5. Interview Excerpt for Question Item Number 15

The interview results show that students have misconceptions about the properties of parallelograms. Students initially think that all sides of a parallelogram are equal in length and have right angles, like a square. This evidence suggests that students may equate parallelograms with other more familiar flat shapes, such as squares or rectangles. Agustyarini et al. (2023) show that students have misconceptions about the concept of a parallelogram, specifically that they consider a parallelogram to be a tilted rectangle. Additionally, students are confused about the difference between sides and ribs, and they have a limited understanding of the characteristics of regular flat shapes. This finding is also in line with the results of Elisahaya & Imami's (2019) study, which shows that students' connection skills are still in the low category. After being given an explanation, students began to understand that a parallelogram only has two pairs of facing sides that are equal in length, the angles are not 90°, and the diagonals are bisected.

Question items number 1, 2, 4, 6, and 13 exhibit the lowest negative misconception profile, accounting for 0 out of 25 students, or 0.00%. This shows that in these five items there are no students who experience negative misconceptions. The indicator in question item number 1 is that students are able to identify equilateral triangles based on the length of their sides, the indicator in question item number 2 is that students are able to identify the characteristics of isosceles triangles, the indicator in question item number 4 is that students are able to determine the same side length in a parallelogram, the indicator in question item number 6 is that students are able to identify the characteristics of an arbitrary triangle, and the indicator in question item number 13 is that students are able to identify the incorrect properties of a rhombus. In these five indicators, students did not experience negative misconceptions. This lack of negative misconceptions is due to the fact that students had a strong understanding of the concepts tested in these items. The material about equilateral triangles, isosceles triangles, arbitrary triangles, parallelograms, and rhombuses has clear and easily recognizable characteristics. In In addition, the properties of these flat shapes are more familiar to students, so they can identify them more easily without experiencing

negative misconceptions. Figure 6 presents a recapitulation of students' misconception profiles, classifying false negative misconceptions for each item.

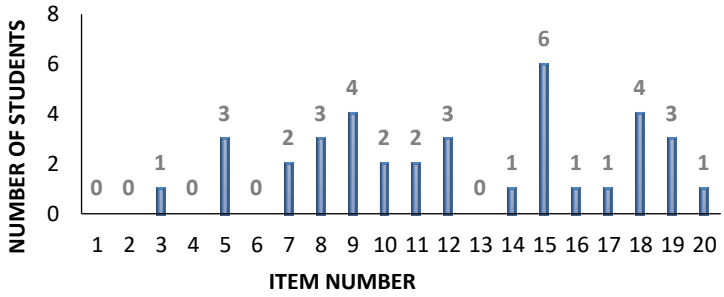


Figure 6. Recapitulation of Students' Misconception Profile with False Negative Misconception Classification on Each Question Item

Students' Misconception Profile with Misconception Classification (Pure Misconception)

The answer combination pattern in the pure misconception classification is if the student answers incorrectly on the first-level question and answers incorrectly on the second-level question, but the student is able to explain both answers during the interview. The classification of pure misconceptions was highest for item number 12, where 7 out of 25 students, or 28%, experienced pure misconceptions. The lowest percentage in question items number 1, 3, 6, 9, and 20 was 0 out of 25 students, with a percentage of 0.00%; this shows that in the five items there were no students who experienced pure misconceptions. The highest percentage in item number 12 indicates that students are able to determine which shapes have the same number of folding symmetries and rotary symmetries. Item number 12 can be seen in Figure 7:

12. A flat shape that has an equal number of folding symmetries and rotary symmetries is ....
    a. Triangle and square
    b. Kite and rhombus
    c. Square and equilateral triangle
    d. Rectangle and parallelogram

The reason that supports your answer above is...

a. Triangles and squares each have 3 folding symmetries and 3 rotary symmetries
b. The kite and rhombus have 1 folding symmetry and 1 rotary symmetry respectively
c. The square has 4 folding symmetries and 4 rotary symmetries, while the equilateral triangle has 3 folding symmetries and 3 rotary symmetries
d. Rectangles have 2 folding symmetries and 2 rotary symmetries, while parallelograms have 1 folding symmetry and 1 rotary symmetry

Figure 7. Excerpt of Question Item Number 12

Results of interviews with students on question 12:

Teacher: Which flat shapes have the same number of folding symmetries and rotary symmetries?
Student: Square and parallelogram, ma'am. Because their folding symmetry and rotary symmetry must be the same.
Teacher: Are you sure? Try to think about it again.
Student: Yes, ma'am. Because when folded or rotated, it still has the same shape.
Teacher: Actually, only the square has the same number of rotary symmetries and folding symmetries, which is 4. While the parallelogram does not, because the parallelogram only has rotary symmetry, but no folding symmetry.
Student: Oh, I thought the square and the parallelogram have the same number of folding and turning symmetries.

Figure 8. Interview Excerpt for Question Item Number 12

The interview results show that students have pure misconceptions about the concepts of folding symmetry and rotary symmetry. Students assume that a square and a parallelogram have the same number of folding symmetries and rotary symmetries. Students assume that a parallelogram and a square have similar characteristics, so they think that the two figures have the same number of folding symmetries and rotary symmetries. This behavior shows that students do not fully understand the difference between the two types of symmetry. The correct concept is that not all flat shapes have the same number of folding symmetries and rotary symmetries. A square is an example of a shape that has the same number of folding symmetries and rotary symmetries, which is four. Meanwhile, a parallelogram has no folding symmetry but has 2 rotary symmetries. According to geometry theory, fold symmetry is the number of ways a shape can be folded until its two sides overlap perfectly, while rotary symmetry is the number of ways a shape can be rotated less than one full turn and still have the same shape. Therefore, the parallelogram does not meet the requirements of having the same number of folding symmetries and rotary symmetries as the square. This view is supported by the opinion of Mufidah et al. (2018), who found misconceptions on the concept of parallelogram, where students stated that the hypotenuse is the only pair of lines that are equal in length and parallel and assumed that the parallelogram has one axis of symmetry in the form of a sloping line in the middle. One alternative solution is for teachers to enhance students' understanding of folding symmetry and rotary symmetry in flat shapes by using props or presenting images in various positions, which will help students understand more clearly and overcome misconceptions. This conclusion is supported by the opinion of Gita et al. (2018), which suggests that misconceptions can arise due to teaching methods and how to present images in learning.

Question items number 1, 3, 6, 9, and 20 display the lowest pure misconception profile, with 0 out of 25 students, or 0.00%, experiencing it. This shows that in the five items there are no students who experience negative misconceptions. The indicator in

In question item number 1, students are expected to identify equilateral triangles based on their side lengths, while in question item number 3, they are expected to identify right triangles based on their angles. The indicator in question, item number 6, is that students are able to identify the characteristics of an arbitrary triangle; the indicator in question, item number 9, is that pupils are able to analyze the equation between a rectangle and a parallelogram; and the indicator in question, item number 20 is that pupils are able to determine the properties of a trapezoid based on its characteristics. In these five indicators, students do not experience pure misconceptions; this is because pupils already have a complete understanding of the concepts tested in these items. The material about equilateral triangles, right triangles, arbitrary triangles, rectangles, parallelograms, and trapezoids has clear characteristics and is easier to recognize. In addition, the properties of these flat shapes may have often been explained and used in previous practice problems, so students can identify them correctly without experiencing pure misconceptions. The recapitulation of students' misconception profiles with pure misconception classification on each item is shown in Figure 9.

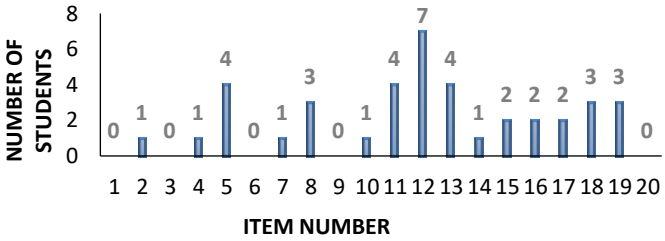


Figure 9. Recapitulation of Students' Misconception Profile with Pure Misconception Classification on Each Question Item

CONCLUSION

This study concludes with an analysis of students' misconceptions regarding the characteristics of flat shapes, which was conducted using diagnostic test instruments. two-tier multiple-choice models and diagnostic interviews showed 29.40% of students were declared to have mastered the concept well in the criteria of complete understanding; students who experienced misconceptions in the classification of positive misconceptions (false positive) 10.00%, negative misconceptions (false negative) 7.40%, pure misconceptions 7.80%, other criteria guessed 12.10%, did not understand the concept 15.20%, and did not understand the concept 17.80%. The causes of these misconceptions include erroneous preconceptions, difficulty understanding abstract concepts such as symmetry and properties of flat shapes, and the tendency of students to generalize based on more familiar shapes without understanding the specific characteristics of each shape.

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