



Analysis of Student Misconceptions Using Evaluation Tools Based *Three Tier Multiple Choice*

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ABSTRACT

The purpose of this study was to identify and analyze the types of students' misconceptions on the geometry material of the quadrilateral sub-material. This type of research is descriptive quantitative. The research subjects were students of class VII SMPN 5 Lamongan as many as 120 students. The research instrument used was a three-tier multiple choice diagnostic test sheet. The result of the research is that 56.2% of students have misconceptions about the quadrilateral material, including the category of moderate misconceptions. From these misconceptions, the types of misconceptions are grouped into classificational misconceptions by 15%, correlational misconceptions by 19.1%, and theoretical misconceptions by 22.1%.

Keywords : Evaluation tool, three tier multiple choice, and, misconception.

INTRODUCTION

Understanding mathematical concepts is the ability to understand concepts, operations, and relationships in mathematics (Kilpatrick, 2010). Mathematics is a science that studies abstract concepts (Wahyudi et al., 2021) the material is arranged in a spiral, so that if you do not understand the initial concept, it will be difficult to understand higher concepts (Abrar, 2018). The discrepancy or error in understanding the concept is called a misconception. Misconception is a concept that is not in accordance with the concept recognized by experts (Ainiyah, 2016).

According to Permendikbud Number 104 of 2014 assessment of learning outcomes (evaluation) is the process of collecting information/evidence about student learning outcomes in the competence of spiritual attitudes and social attitudes, knowledge competencies, and skills competencies that are carried out in a planned and systematic manner, during and after the learning process (Purnamasari & Rochmawati, 2015). The results of the evaluation aim to

measure the extent to which the success of educators in providing material and the extent to which students understand the material that has been given.

Geometry is a material in mathematics that studies the relationship between points, lines, angles, planes and planes and shapes. The objectives in learning geometry are to develop logical thinking skills, develop spatial intuition, impart knowledge to support other materials, and be able to read and interpret mathematical arguments (Budiarto & Artiono, 2019). However, in reality there are still many students who think that geometry material in mathematics is difficult. This is also supported by the results of research conducted (Basuki, 2012), namely the difficulty experienced by most students in solving a question about a flat plane is not understanding the concept. Therefore, understanding the concept is important in learning geometry.

The initial concepts brought by students can be in accordance with scientific concepts called conceptions. However, it can also be inconsistent with scientific concepts or referred to as misconceptions. The failure of students to work on math problems, especially geometry (Özerem, 2012) and (Sunardi, 2002), is due to difficulties in understanding concepts and not using good reasoning. One of the factors of low learning achievement of students can be caused by a preconception that is different from scientific concepts.

Understanding concepts is an ability that must be mastered by students in learning mathematics because concepts in mathematics are interrelated; (Suryanti et al., 2017); (Djam'an et al., 2019) (Aydeniz et al., 2017). Students are always classified into three criteria, have met the criteria for understanding the concept, do not understand the concept, and have misunderstandings. Why should misconceptions be considered because if misconceptions are left unchecked, it will affect the next concept (Muryani et al., 2022).

Misconceptions are student conceptions that do not match up with scientists. Misconceptions occur consistently in the minds of students (Djam'an et al., 2019) (Muryani et al., 2022) (Wiyono et al., 2016). Students' misconceptions that are not identified and verified will cause these misunderstandings to be well maintained. In fact, misconceptions are one of the factors that cause students' low understanding of concepts. Misconceptions can cause new knowledge to not be properly integrated into students' cognitive structures (Fitriah, 2017) (Abbas, 2018). This misconception can be caused by several sources, namely from students, teachers, textbooks used, context, facilities and infrastructure in schools, and teacher teaching methods (Vellayati et al., 2020) (Wahyudi et al., 2021) (Haryono & Aini, 2021).

One way to find out the occurrence of misconceptions in students is with the Three-Tier Test diagnostic test (Kustiarini et al., 2019) (Taufiq et al., 2020) (Riswandi et al., 2022); (Asiana et al., 2022). This diagnostic test is to find out the weakness of understanding about a concept. Generally, this test is designed in the form of a branched tree (Prodjosantoso et al., 2019) (Jauhariyah et al., 2018). This type of three-tier multiple choice assessment is advantageous because it easily ensures the level of reliability and efficiency of multiple-choice assessments, as well as the ability to diagnose students' understanding and reasoning at a deeper level. However, because the two-level test did not distinguish students' lack of knowledge from the misconceptions they held, the three-level test included an additional level of confidence that was better.

If students experience misconceptions or have not even mastered a concept, then students will have difficulty understanding the next concept. In this case, educators must be sensitive to misconceptions that occur in students so that educators can design effective learning processes to overcome these misconceptions. Teachers must provide careful explanations followed by opportunities that create opportunities for students to understand and absorb the ideas presented clearly, so that students become proficient in mathematics (Kusmaryono et al., 2020).

Therefore, misconceptions need to be identified so that they can take action to help students replace them with more scientific concepts.

The way to identify misconceptions is by means of a diagnostic test. Diagnostic tests that are widely used are one-tier, two-tier, and three-tier. Three-tier multiple choice is a development of two-tier multiple choice using a simple and easy way to identify misconceptions and distinguish them from lack of knowledge (lack of knowledge), namely by adding the level of confidence that students choose (Hakim et al., 2012). Thus, the proposed solution that can be used in this problem is to carry out an evaluation based on three-tier multiple choice. Three-tier multiple choice is a form of test with three levels of questions. The first level is a choice of answers to multiple choice questions, the second level is the reason for students to answer questions at the first level, and the third level is the level of confidence of students in choosing answers and reasons at the first and second levels.

Several studies, both developing and implementing a three-tier multiple-choice diagnostic test, include (Nabilah et al., 2020) on a three-tier diagnostic instrument that functions to detect the misconceptions of class VII students of SMPN 24 Makassar on fractional material. As a result, students experienced misconceptions on indicators explaining the definition of fractions, comparing and sorting fractional numbers, calculating addition, subtraction, multiplication, and division operations of fractions. And the three-tier test that was developed met the criteria of being valid, reliable, and with a difficulty level of 6.7% easy, 26.7% moderate, and 66.6% difficult. Development research (Rovita, 2020) evaluation tool for mathematics learning based on two tier multiple choice using the ispring suite 9 application on line and angle material. Another study on the application of the Three-Tier Test instrument to identify the misconceptions of high school students in the Material of Balance of Rigid Objects concluded that there were misconceptions among students (Fitrianingrum, Sarwi, & Astuti, 2017).

Meanwhile only a few of these studies used two- or three-level assessments in their attempts to measure the conceptual understanding of geometry. We focus on conceptual understanding of geometry, because geometrical topics are rarely the center of attention of teachers at the junior high school level. Therefore, the investigation of junior high school students' conceptual understanding and related problems deserves further exploration. In this study, we used a three-level diagnostic test to assess understanding of geometry.

In conducting multiple choice evaluation tests, students do not include reasons for choosing the answer. The level of confidence of students in choosing answers is also unknown, so that it can allow students during the evaluation of the origin of choosing answers. Especially in the current Covid-19 pandemic situation, students who study online do not want to learn before online learning begins and do not want to study the material that has been given, so that students are less able to understand the concepts in mathematics. It is easier for students to misunderstand concepts so that they form misconceptions.

Therefore, there needs to be an evaluation that can be used to find out the reasons and the level of confidence of students in choosing answers such as three-tier multiple choice which can identify students' misconceptions.

METHOD

The type of research used in this research is descriptive quantitative research. The subjects of this study were students of class VII SMP Negeri 5 Lamongan as many as 120 students consisting of 73 boys and 47 girls spread into 4 classes. The data collection method used in this study is a three-tier multiple choice-based evaluation test method to find out students' misconceptions. The evaluation test is carried out online using a smartphone. The instrument of this research is a test sheet based on three tier multiple choice on quadrilaterals consisting of 8 questions. Students take a three-tier multiple choice test by choosing one answer and the right reason from 4 answer options at the first level and 4 reason options at the second level. While at the third level, students are also required to choose the level of confidence in answering the question. The score obtained is seen from the number of questions answered correctly by students at both the first and second level, and the percentage of the number of correct answers is obtained from the number of correct answers divided by the number of questions multiplied by one hundred percent.

The students' misconceptions were analyzed after conducting a three-tier multiple choice-based evaluation test on the rectangular shape material. The test results are first grouped into understanding the concept, not understanding the concept and misconceptions. Students' misconceptions are divided into three types, namely classificational misconceptions, correlational misconceptions, and theoretical misconceptions (Ainiyah, 2016). The students' misconceptions in this study were tested using questions in the form of a three-tier multiple choice test. The three-tier test consists of four answer choices, closed form reasons for test answers consisting of 4 answer choices, and the Certainty of Response Index (CRI) (Namulawa et al., 2013) at the third level with a scale of 1 to 4 with certain categories, if the interpretation scales 1 and 2 then the CRI is low and if the interpretation is scales 3 and 4, the CRI is high.

RESULTS AND DISCUSSION

Overview of Research Objects

The results of this study first obtained right and wrong answers from students in grades VII-B, VII-C, VII-D, and VII-E totaling 120 students. From 120 students who worked on 8 questions, 960 possible answers were obtained. Of the 960 possible answers, the correct answer is 329 or 34.27% and the wrong answer is 631 or 65.73%.

Understanding of Students' Concepts

After knowing the number and percentage of correct and incorrect answers, students who answered the highest correctness could not be said to understand the concept. Likewise, students who answered the lowest correctly could not be said to not understand the concept. Therefore, it is necessary to see whether the reasons they choose for each answer are right or wrong and how confident the students are in answering the questions. So, it will be seen whether the student understands the concept, misconception, or does not understand the concept.

The percentage of students who understand the concept is taken from the correct answers and reasons with a high level of confidence. Students who experience misconceptions are taken

from correct answers - wrong reasons or wrong answers - right reasons or wrong answers - wrong reasons with a high level of confidence. Students who do not understand the concept are taken from correct answers - right reasons or correct answers - wrong reasons or wrong answers - right reasons or wrong answers - wrong reasons with a low level of confidence. The number and percentage of students who understand concepts, misconceptions and do not understand concepts can be seen in Table 5.

Table 5. Criteria for Understanding Concepts, Misconceptions and Not Understanding Concepts Based on Items

Butir Soal Nomor	Kriteria						Jumlah
	Paham Konsep		Miskonsepsi		Tidak Paham Konsep		
	Frekuensi	%	Frekuensi	%	Frekuensi	%	
1	52	16,56	66	12,30	2	1,83	
2	55	17,52	58	10,80	7	6,42	
3	24	07,64	87	16,20	9	8,25	
4	25	07,96	62	11,54	33	30,28	
5	38	12,10	73	13,59	8	7,34	
6	32	10,19	72	13,41	16	14,68	
7	46	14,65	54	10,06	20	18,35	
8	41	13,08	65	12,10	14	12,84	
Jumlah	314		537		109		960
%	32,5		56,2		11,3		100
Total Siswa	39		67		14		120

Based on Table 5 shows that from 120 students, there are 39 students or 32.5% of students understand the concept of meaning in answering questions, students choose the correct answer and reason with a high level of confidence, 67 students or 56.2% have misconceptions about the meaning in answer questions students choose correct answers - wrong reasons or wrong answers - correct reasons or wrong answers - wrong reasons with a high level of confidence, 14 students or 11.3% of students do not understand the concept of meaning in answering questions students choose correct answers - correct reasons or right answer - wrong reason or wrong answer - right reason or wrong answer - wrong reason with low confidence level. Students who understand concepts, misconceptions, and do not understand concepts are illustrated in Figure 1.

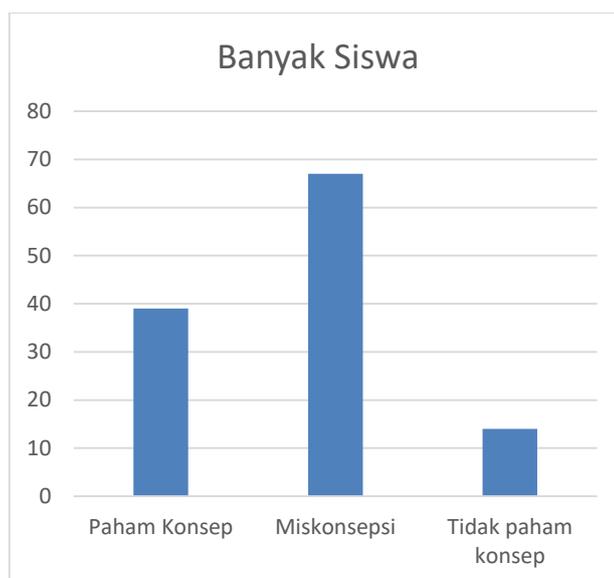


Figure 1. Criteria for understanding students' concepts

Types of Students' Misconceptions

After knowing the percentage of understanding the concept, misconception, and not understanding the concept. So, the data obtained from the misconceptions are used to identify the types of misconceptions in students. The types of misconceptions are divided into three: classificational misconceptions, namely the form of misconceptions based on misclassification of facts into organized charts, correlational misconceptions, namely the form of misconceptions based on errors regarding related special events, or observations that are related to each other. consists of assumptions, especially in the form of formulations of general principles, and theoretical misconceptions, namely misconceptions based on errors in studying facts or events in an organized system. Previous data showed that there were 67 of the 120 students who experienced misconceptions with a percentage of 56.2% so they were included in the category of moderate misconceptions. From this data, it will be grouped into three types of misconceptions based on the items that can be seen in table 9 below:

Table 6. Total and Percentage of Types of Students' Misconceptions Based on Items

Butir Soal Nomor	Jenis Miskonsepsi					
	Klasifikasional		Korelasional		Teoritikal	
	Banyak siswa tiap butir	%	Banyak siswa tiap butir	%	Banyak siswa tiap butir	%
1					8	6,9
2					7	6,1
3					11	9,1
4			8	6,6		
5	9	7,5				
6	9	7,5				
7			7	5,7		

8			8	6,8		
Total & Persentase	18	15	23	19,1	26	22,1

Table 6 shows that of the 67 students who experienced misconceptions there were 18 students or (15%) including the type of classificational misconception. Classificational misconception is a form of misconception based on misclassification of facts into organized charts. Many students in classifying rectangular and non-rectangular shapes are not quite right. Of the 67 students, 23 students or (19.1%) experienced correlational misconceptions. Correlational misconceptions are forms of misconceptions based on errors regarding specific, interconnected events, or observations that consist of conjectures mainly in the form of the formulation of general principles. Students in representing each question in the form of a picture according to the order of the question incorrectly. And from 67 students there are 26 students or (22.1%) experiencing theoretical misconceptions. Theoretical misconceptions are forms of misconceptions based on errors in studying facts or events in an organized system. Students define a parallelogram that is not in accordance with its meaning (Ainiyah, 2016).

This study confirms that false positives are also the cause of misconceptions. This shows that the correct answer does not always mean that students understand a concept and all wrong answers do not necessarily experience misconceptions (Muryani et al., 2022). This study also confirmed misconceptions in algebraic material with the categories of misconceptions and misconceptions (false positive). Most of the misconceptions occur in all algebraic materials, namely: algebraic concepts, element algebra, addition operations, subtraction operations, multiplication operations, and division operations. In addition, it was also found that the factors causing the misconceptions of class VII B SMPN 54 Makassar, namely the lack of students' ability to understand algebraic concepts in depth, lack of interest in learning specifically for algebra students, the method often used by teachers, namely the lecture method, this makes it difficult for students to understand algebra material and pre-algebra concepts (Riswandi et al., 2022). Students experience misunderstandings in algebra, namely: lack of understanding of the definition of degrees of variables, variables, coefficients, and constants; misunderstanding in solving equations; lack of understanding about turning problems into mathematical models (Djam'an et al., 2019)(Abidin et al., 2019).

This study certainly also complements the previous findings where high school students experienced the lowest misconceptions on the subconcepts of solving the problem of the proposition of triangles and segments, and the highest misconceptions on the subconcepts explaining symmetry and angles. The order of the three categories of misconceptions from the highest to the lowest in the Field Geometry concept that occurs is as follows: pure misconceptions, false positives, and false negatives (Istiyani et al., 2018). Meanwhile, geometric misunderstandings that occur in students can be divided into three categories, namely: pure misconceptions, false positives (lack of understanding), and false negatives (uninformed or careless) so that efforts are needed to improve the conceptual understanding of prospective mathematics teachers in geometry. (Prayitno et al., 2020).

The three-tier multiple choice diagnostic test is able to evaluate students' misconceptions by looking at the answers, reasons and level of confidence in answering questions. Thus, the three-tier multiple choice diagnostic test used in this study is able to identify the level of understanding of the concepts students have (Vellayati et al., 2020). Three-Tier Test is very suitable and accurate to measure misconceptions that occur in students, and to monitor learning progress. This test is valid and reliable to measure the percentage of students' level of

understanding. This test can distinguish lack of knowledge, false positive and false negative (Istiyani et al., 2018).

One of the challenges of assessing students' conceptual understanding is the scarcity of reliable assessment tools and methods (Aydeniz et al., 2017); (Suryanti et al., 2019). Although this assessment has been widely used, there have been some recent criticisms. This assessment has been criticized for certain limitations in helping educators to access and understand students' reasons behind their answer choices. So that an alternative open questionnaire emerged to assess students' conceptual understanding. However, this open questionnaire model has several weaknesses including; it takes a lot of time, especially in large classes, it is difficult to get a comprehensive understanding of the evaluation of students' cognitive structures quickly and comprehensively.

CONCLUSION

Understanding the concepts of students identified through a three-tier multiple choice-based evaluation tool using the wondershare quiz creator is known from 120 students, 39 students or (32.5) are classified as understanding concepts, 67 or (56.2%) have misconceptions, and 14 or (11.3%) do not understand the concept. Of the 67 students who experienced misconceptions, there were 18 students or 15% belonging to the type of classificational misconception, 23 students or (19.1%) experienced correlational misconceptions, and 26 students or (22.1%) experienced theoretical misconceptions.

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