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Analysis of Students Misconceptions by Using a Three-Tier Diagnostic Test on.pdf

WORD COUNT

3716 Words

CHARACTER COUNT

20972 Characters

PAGE COUNT

7 Pages

FILE SIZE

577.5KB

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REPORT DATE

Jun 26, 2023 4:42 PM GMT+8

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ICSAT INTERNATIONAL PROCEEDING
ISBN: 978-623-7496-62-5
Vol, 11 Issue 6

Analysis of Students' Misconceptions by Using a Three-Tier Diagnostic Test on the Equations of a Line at 8th Grade

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Abstract
This study aims to analyze the students' misconceptions by using a three-tier diagnostic test on the equations of a line in 8th grade. The research method used in this study is qualitative research, which refers to the analysis description of students' misconceptions. The subjects in this study were the students of Grade VIII in SMP Negeri 24 Makassar, which consisted of 34 students. Based on the considerations of the mathematics teacher, students' test results, and coordination with the students related to their willingness to participate in interviews, four students who experienced the misconception were selected. The instruments consist of two components, namely the main instrument and supporting instrument, the researcher herself is the main instrument, while the three-tier test and interview guide are the supporting instruments. The results of the data analysis were obtained, two students experienced classificational misconceptions, two students experienced correlational misconceptions, and four students experienced theoretical misconceptions. The study results show that the students who experienced classificational misconceptions could not utilize the information contained in the questions and experienced misunderstandings related to the concept of straight-line equation material. Furthermore, students who experienced correlational misconceptions have not been able to describe how to obtain the data presented on the answer sheet and to understand the relationship of other concepts with the concepts that will be used to solve the problems contained in the matter of the equations of straight lines. Meanwhile, students who experienced theoretical misconceptions could not re-interpret the material for straight-line equations and found the material for the equations of a line hard to understand.

Keywords: *Equations of straight lines; Misconceptions; Analysis; Three-tier test.*

INTRODUCTION

The mathematics learning process consists of various concepts that are arranged hierarchically, logically, and systematically which means that concepts are arranged sequentially so that the previous concepts that are simple in nature will be used to learn the next concept that is more complex (Ramadhan, 2017). To understand the material of straight-line equations, students must first master the material of fractions, linear equations of two variables, and coordinate systems. In this regard, Berg (Sari and Masriyah, 2017) also elaborated that in concept learning, students are expected to be able to define concepts related to other concepts, explain the relationship of concepts with everyday life, and apply them to solving problems contained in everyday life. Therefore, every student is expected to have a deeper understanding of mathematical concepts, be able to solve problems, and find solutions to problems carefully, logically, and precisely.

ISBN: 978-623-7496-62-5
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If students find it difficult to understand the basis of the topic, they will have different understandings of it. These different understandings are sometimes different from the actual basic concepts of mathematics. It is also often called a misconception. These different understandings can be in the form of an inaccurate understanding of concepts, incorrect use of concepts, and relationships between incorrect concepts.

Misconception is the difference between the concepts owned by someone and those owned by experts (Kustiarini, Susanti, & Nugroho, 2019). This misconception can come from mathematical material that does not emphasize basic concepts, learning processes, teacher factors, or student books used.

Based on the results of interviews with related mathematics teachers at SMP Negeri 24 Makassar related to understanding the concepts in the straight-line equation material, it was found that there were still students who experienced errors in applying mathematical concepts when solving straight-line equation material problems. For example, students have difficulty utilizing and processing the information in the straight line equation problem, for example, if the teacher asks to determine the shape of the equation of a line known to be the slope value and perpendicular to other lines. Students will still use the same equation formula by determining the equation of the line known points and gradients without paying attention to the perpendicular sentences contained in the problem. Of the 34 students, there were only 8 students who achieved a score of more than 75 with an average score of 54.8, meaning that the student's learning completion score has not been achieved, which is at least 75%; this means that there are still students who have experienced errors in applying concepts when doing straight-line equation problems.

Mathematical objects are very hierarchical, meaning that one concept is closely related to another, requiring everyone who studies it to understand each concept well because it is interrelated. Because each concept of the material is an extension or deepening of the material that has been studied. Thus, it is a big consideration for teachers if their students understand mathematical concepts incorrectly or even incorrectly. This error is called misconception (Purwaningrum & Bintoro, 2018). Moreover, Nurwati (2019) states that misconceptions are particularly important for teachers to know about, as the students may be reluctant or resistant to learning as the impact of misconception.

One way to find out the existence of misconceptions experienced by students is to conduct diagnostic tests. The most widely used diagnostic tests are the one, two, and *three*. *A two-tier multiple choice* is a test tool that is successful enough to diagnose misconceptions that students have and is easy to assess. S*till, the two-tier test* cannot distinguish between misconceptions and lack of knowledge (l*ack of knowledge*) (Hasan, Bagayoko, & Kelley, 1999). The *three-tier test* uses a simple and easy way to identify the occurrence of misconceptions and distinguish them from students' lack of *knowledge* by adding a level of confidence in the answers chosen by students (Hakim, Liliasari, & Kadarohman 2012).

The three-tier test diagnostic is predicted to be able to identify misconceptions owned by students more accurately than the one-tier test and two-tier test diagnostic tests (Arslan, Cigdemoglu, & Mosley, 2012), where the *three-tier test* will allow teachers to identify misconceptions easily and accurately, to improve students' mastery of the material that has been delivered, while for students will help them in turning the wrong concept into a more correct one or correcting the misconceptions they are experiencing with a scientific concept.

This is in line with research conducted by Kustiarini, Susanti, and Nugroho (2019) on the use of *three-tier diagnostic tests* open reasons to identify misconceptions of buffer solutions that indicate that misconceptions occur in all sub-materials that have been taught to students. Furthermore, research

ISBN: 978-623-7496-62-5
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conducted by Maulini, Kurniawan, and Muliyani (2016) on the use of *three-tier tests* to reveal the quantity of students who misconceptions the concept of spring force shows that there are still misconceptions possessed by students because the knowledge gained by students in everyday life cannot be scientifically proven. In addition, what causes misconceptions is that students compile the knowledge they get based on information they have gained from real experience, where students experience misconceptions in connecting one concept with another.

This study aims to analyze student misconceptions of straight-line equation material using *a three-tier test* seen from classificational, correlational, and theoretical misconceptions.

METHOD

The type of research used is a qualitative descriptive analysis which refers to the description of the student's misconception analysis. This research was carried out at SMP Negeri 24 Makassar on class VIII of the 2021 /2022 Academic Year, who had followed the material of straight-line equations. The subjects in this study were selected using *purposive sampling* techniques, which were chosen with certain considerations, namely based on the considerations of related mathematics teachers, the results of the analysis, a combination of students' test answers, and coordination of students ' willingness to be interviewed. The subjects in this study were 34 students, which was then obtained 7 students who were suspected of having misconceptions. Of the 7 students, 4 were selected based on misconceptions experienced by each student. Data collection techniques are carried out by administering tests and non-tests. Two instruments are used in this study: the researcher is the main instrument for the *three-tier diagnostic test* with line equation material. Straight and interview guidelines as supporting instruments. All instruments used have been validated. Furthermore, students are given ten *three-tier test* questions; then, interviews are conducted with selected students based on existing considerations. The last step is to process the data and analyze or decipher descriptively using a qualitative approach or strategy to the data carried out by condensing data, presenting data, and drawing conclusions. Data condensation is carried out by examining the results of a *three-tier diagnostic test* of straight-line equation material containing three levels of questions. Each level is assessed using a binary system, outlined in Table 1.

Table 1. Answer Combination Analysis

Category	Answer Type	Score	Total Score
Understanding the Concept	True + True + Sure	1 + 1 + 1	1
Lack of Understanding of Concepts	True + True + Not Sure	1 + 1 + 0	0
	Wrong + True + Not Sure	0 + 1 + 0	0
	Right + Wrong + Not Sure	1 + 0 + 0	0
	Wrong + Wrong + Not Sure	0 + 0 + 0	0
Miskonsepsi *false positive*	Right + Wrong + Confident	1 + 0 + 1	0
Miskonsepsi *false negative*	Wrong + True + Confident	0 + 1 + 1	0
	Wrong + Wrong + Confident	0 + 0 + 1	0

The next stage is the presentation of data carried out by presenting data that has been grouped at the data condensation stage by grouping the misconceptions experienced by students into groups of correlational, classificational misconceptions, and theoretical misconceptions on each question item or number. The last stage is to conclude the misconceptions experienced by the students as a whole.

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RESULT AND DISCUSSION

Result

Kutluay (2005) revealed that the three-tier test is a diagnostic test with three levels. Treagust (1995) recommended using two-tier multiple-choice instruments as an appropriate alternative to individual open-response questions or interviews to obtain information about the reasoning. The first tier of a two-tier item consists of a multiple-choice question with four choices. The second tier requires students to choose from four reasons to justify or explain their answer to the first-tier question. This test is the development of two-tier tests combined with a certain response index (CRI) or student confidence level. The first level is related to questions about a topic. The second level asks the reason for the answer at the first level, while the third level is about the level of student confidence in answering questions at the first and second levels.

This three-tier diagnostic test question consists of 10 questions of three levels. The first level contains questions of conceptual understanding of the material of students ' *straight-line* equations. The second level includes questions related to the reason for the answer chosen by the student at the first level, and the third level contains the student's level of confidence in the answer selected and spelled out. The details of each student who experienced misconceptions are presented in Table 2.

Table 2. Student Answer Combination Analysis Results

No	Student Initials	Student Answer Combination Analysis Results										Student Code
		1	2	3	4	5	6	7	8	9	10	
1	HT	M	TPK	M	TPK	M	M	M	M	M	M	MS-1
2	THREE	M	M	M	TPK	M	M	M	M	TPK	M	MS-2
3	WOULD	M	M	M	M	M	M	M	TPK	M	TPK	MS-3
4	IS	M	TPK	M	M	M	M	TPK	M	TPK	M	MS-4

Data Analysis Results

a. Subjects with a Correlational Type of Misconception

Table 3. Comparison of test question number 8

MS-2 (Question Number 8)	MS-4 (Question Number 4)
1) Not yet able to understand the relationship of other concepts with concepts that will be used to solve a given problem. 2) Unable to describe how to obtain the data presented on the answer sheet	1) Has not been able to digest the information contained in the problem, so the subject interprets himself based on the understanding that the subject has, then uses the wrong concept to solve the given problem
MS-2 (Question Number 8)	MS-4 (Question Number 4)
1) Do not understand the explanation that has been given by the teacher concerned regarding the material of straight-line equations.	1) Unable to describe how to obtain the data presented on the answer sheet 2) Unable to re-explain the material provided by the teacher

Table 1 compares the results of the analysis of student's answers to the questions and interviews related to correlational misconceptions experienced by students in question number 8.

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b. Subjects with a Type of Classificational Misconception

Table 4. Comparison of questions number 3 and 2

MS-1 (Question Number 3)	MS-3 (Question Number 2)
1) Not yet able to take advantage of the information contained in the question.	1) Not yet able to take advantage of the information contained in the question
2) Using incorrect values to solve problems results in incorrect results	2) Experiencing a wrong understanding of the concept of straight-line equations
3) Unable to re-explain the material of straight-line equations	

Table 2 shows a comparison of the results of the analysis of students' answers to questions and interviews related to Classificational misconceptions experienced by students in questions number 3 and 2.

c. Subjects with Types of Theoretical Misconceptions

Table 5. Comparison of questions number 1 and 3

MS-1 (Question Number 1)	MS-2 (Question Number 1)	MS-3 (Question Number 1)	MS-4 (Question Number 3)
1) Unable to explain the solution to the given problem	1) Unable to elaborate on the solution to the given question	1) Not confident to answer your own questions	1) Unable to explain the solution to the given problem
2) Unable to answer questions related to the material of straight-line equations without prior explanation	2) Not confident to answer your own questions	2) Not understanding the explanation of the material of the straight-line equation.	2) Don't understand the material of straight-line equations
3) Not believing in the answer given	3) Not understanding the material if it is not re-explained	3) Finding the material of a straight-line equation difficult to understand	3) Not confident to answer your own questions
4) Just guessing the answer	4) It takes time to be able to do a problem		
5) Not understanding the explanation of the material of the straight-line equation.	5) Not understanding the explanation of the material of the straight-line equation.		

Table 3 shows a comparison of the results of the analysis of students' answers to questions and interviews related to classificational misconceptions experienced by students in questions number 1 and 3.

Discussion

Correlational misconceptions, according to Moh. Amien (Das Salirawati, 2011) is a misconception that misclassifies facts into organized charts. In this study, students were categorized as experiencing correlational misconceptions if students had a wrong understanding of applying concepts and relationships between concepts. Two subjects on the same question experience correlational misconceptions. Both subjects have a wrong understanding of applying and using concepts present in

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the material of straight-line equations. Based on the data from the study, the two subjects who experienced correlational misconceptions, in which the subject MS-2 answered the question at level one with the correct answer, but when giving reasons related to solving the material, found a line equation that through two points did not apply the concept using the equation formula but equated the two pairs of known points using the equation, then MS-2 wrote down the gradient values of the two pairs of points without knowing where the gradient value comes from. Meanwhile, MS-4 answered the question at level one with the wrong answer, then gave a reason for solving the problem; MS-4 only wrote the word "Sure" and argued that the problem could not be solved.$y - y_1 = m(x - x_1)$

Classificational misconceptions, according to Moh. Amien in (Das Salirawati, 2011) is a misconception based on students' mistakes in classifying facts into organized charts. In this study, students were said to experience classificational misconceptions if students had difficulty when utilizing the information provided in a problem. Classificational misconceptions are experienced by two subjects on different questions, where both subjects have difficulty using the information contained in the material problem of straight-line equations. Based on the data from the study, MS-1 experienced a classificational misconception in question number 3, where MS-1 chose the correct answer at level one but outlined the reasons why choosing the answer by writing, "Because I believe my answer is correct," without knowing how to find the answer he gave, then MS-1 explained that he did not understand the material of straight-line equations at all. MS-3 suffers from a classificational misconception in question number 2, where MS-3 chooses the wrong answer at level one and outlines the reasons why it selects the answer for the wrong reason, where MS-3 tries an x value and substitutes it into the given equation and produces a y value, but MS-3 chooses an answer that is not the same as the given solution.

Theoretical misconceptions, according to Moh. Amien in (Das Salirawati, 2011) is a misconception based on studying facts or events in an organized system. In this study, students are said to experience theoretical misconceptions if students are unable to explain the basic concepts of the material provided. Based on the data from the study, it was found that all subjects experienced theoretical misconceptions, where MS-1, MS-2, and MS-3 experienced theoretical misconceptions at number one, and MS-4 experienced theoretical misconceptions at number three. MS-1 suffered a misconception based on the answer chosen at the wrong level one and wrote down why it chose the answer for the wrong reason; then, MS-1 said that MS-1 could not re-explain the material of the straight-line equation.

Furthermore, for MS-2, choosing the wrong answer at level one and outlining the wrong reasons why choosing that answer, then saying that MS-2 does not understand the material of straight-line equations when receiving an explanation from the teacher in question. As for MS-3, who chose the wrong answer at level one, then outlined the reason for choosing the answer in the correct step but got the incorrect gradient value. After being confirmed, MS-3 said that MS-3 could not re-explain the problem's solution because MS-3 did not understand the material of straight-line equations. Furthermore, for MS-4, where MS-4 chooses the wrong answer and outlines the wrong reason, MS-4 says that it has forgotten the material of the straight-line equation.

CONCLUSION

Based on the analysis and description of misconception data for grade VIII students of SMP Negeri 24 Makassar. Students experienced theoretical, correlational, and classificational misconceptions in each question. This is because students have received a learning that discusses the concepts of straight-line equation material. Still, students have difficulty in abstracting these concepts appropriately, so

students have not been able to explain the basic concepts of straight-line equation material, students have not been able to process the information contained in the given problem, and students have not been able to find relationships between concepts and the use of other concepts in the material of straight-line equations.

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