

# An Analysis of Student Misconceptions in Learning Algebra Using Conventional Learning Model by Using Three Tier Test

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## ABSTRACT

This research investigates how seventh-grade students of SMP Negeri 17 Makassar have misconceptions when learning algebraic forms and operations. This study used a qualitative method to approach and explain the issue. The research subjects were recruited from seventh-grade students of SMP Negeri 17 Makassar with 6 subjects, 2 students with misconception (false negative) type, 2 students with misconception (false positive) type, and 2 students with misconception type. The instrument used in this study was the researcher himself as the main instrument assisted by algebra material diagnostic test and interview guide. Furthermore, this research collected its data through interviews, documentation, and a Three-Tier Test diagnostic test to find out students who have misconceptions. The stage of data analysis in this research was misconceptions data analysis in Learning Algebra. Data analysis of misconceptions in Learning Algebra used a qualitative description analysis with data reduction, data presentation, drawing a conclusion, and verification stages. The results of data analysis have provided this research with several significant findings. First, Three Tier-Test were given to seventh-grade students of SMP Negeri 17 Makassar. The findings suggested that 37% of total samples develop misconceptions, especially on materials related to algebraic concepts, algebraic elements, addition operations, subtraction operations, multiplication operations, and division operations. The second finding addressed the reasons causing students to have misconceptions about the algebraic materials. Factors such as students' unfamiliarity with the algebraic concepts, lack of interest, and the conventional learning model contribute to students' difficulty in understanding the algebraic concepts on the 7th-grade students of SMP Negeri 17 Makassar.

**Keywords:** *Misconceptions, Three Tier Test, Algebra, Conventional Learning Model.*

## 1. INTRODUCTION

Education has a very important role in improving the quality of human resources. Moreover, education also has a significant value in life. Therefore, education must be conducted as well as possible to obtain optimal results. Education is often interpreted as the effort of humans to develop their personality regarding the values in society and culture in its development. The term of education means guidance or assistance given intentionally by adults to make people mature. Furthermore, education is an effort conducted by a person or group of people to

be an adult or reach a higher level of life. Humans have a lot of potential in themselves [1].

Nowadays, mathematics still becomes a big problem for most students. Most students think that mathematics is a difficult subject because it contains complex numbers and a set of rules that must be understood. One of the materials considered difficult in learning mathematics is algebra, especially for junior high school students. When students learn about algebra, they still often experience conceptual errors in

understanding it. Students must master many things in understanding algebraic concepts, including algebraic forms and their elements, linear equations and inequalities, solutions, sets and operations, relations, functions, and graphs. The concept of algebra can be given and embedded effectively by teaching algebra in school. Through mathematics, algebra was introduced to students at the junior high school level. Algebra learning aims to enable students to think logically, analytically, systematically, critically, creatively, and collaboratively[2].

Misconception refers to a concept that is not appropriate to the scientific understanding accepted by experts in that field. According to Brow, a misconception is an idea that is not appropriate to the current scientific understanding. While, Fowler views misconception as an inaccurate understanding of concepts, the use of wrong concepts, the classification of wrong examples, the confusion of different concepts, and the hierarchical relationships of incorrect concepts[3]. A teacher should choose the right strategy in teaching mathematical concepts. This is carried out so that students do not mistakenly accept mathematical concepts taught because it is very difficult to change the understanding of wrong concepts.

Based on the interview results with the 7th-grade teacher of SMP Negeri 17 Makassar, students often have difficulty understanding mathematical concepts and applying them in problem-solving. These problems can occur because students prefer to memorize formulas, so there is an inaccurate understanding of the concept, the use of the wrong concept, and the meaning of different concepts. This causes students to experience misconceptions; for example, students often add up different variables. Based on the observations, it was found that the method used by the teacher was a conventional learning model so that it causes students to be less active in the learning process.

Based on theories about misconceptions and the results of interviews with mathematics teachers, to find out the misconceptions by students in solving problems on the algebra subject, the researcher scientifically examined the misconceptions of algebraic material based

on the conventional learning model in 7th-grade students of SMP Negeri 17 Makassar.

## **2. LITERATURE REVIEW**

A concept is a class or stimuli category that has common characteristics. Stimuli are objects or people[4]. Misconceptions are different from mistakes. Error is the result of a lack of understanding of algebraic forms and operations. On the other hand, misconception refers to an idea causing a series of errors resulting from a false premise that underlies a particular concept or process[5]. Students who have incomplete or imperfect initial concepts can experience misconceptions. Initial conceptions or preconceptions that are not appropriate to the scientific concept are called misconceptions. As stated by Oliver in Savitri, an error is a symptom of the conceptual structure that underlies the cause of the error. This underlies beliefs and principles in cognitive structures, which cause systematic conceptual errors called misconceptions[6].

On the other hand, misunderstanding can be described as ideas that give a wrong understanding of an idea, object, or event built on someone's experiences, including presumptions, non-scientific beliefs, naive theories, mixed conception, or conceptual misunderstanding [7]. Mary, Larrabee, and Charles used the term of misunderstanding to refer to the students' ideas that differ from those generally accepted by scientists [8]. Generally, the causes of misconceptions are summarized in five groups, students, teachers, textbooks, and teaching methods[9] The following is how to find out the students' misconceptions:

### **2.1 Certainty of Response Index (CRI)**

Certainty of Response Index (CRI) is a technique to measure a person's misconceptions by measuring a person's level of belief or certainty in answering any related questions[10].

### **2.2 Multiple Choice Test with Open Reasoning**

In this test, students work on multiple-choice questions and write down why they have such an answer. The wrong answers were then used as material for the next test. Based on incorrect answers, the researcher conducted interviews with students to

examine why students chose those answers[11].

### 2.3 Three Tier Test

Developed by Eryilmaz and Surmeli, the instrument of the three-tier diagnostic test combines the two-tier test with the Certainty Response Index (CRI). The instrument of the three-tier test has the advantage of distinguishing between misconception and lack of understanding of the concept or not knowing the concept through the level of confidence of students' answers so that it is accurate in knowing misconceptions [12]. A three-tier test is a valid test that can be used efficiently with large students and help the researchers understand the students' reasoning behind their answers without conducting interviews to distinguish misconceptions and lack of understanding[13]. A three-tier test is a diagnostic test that uses the identification of misconceptions and understanding of concepts. The three-tier test has three levels. The first is to ask students' knowledge about the concept of multiple choice. The second level is the students' reasoning from the process of answering at the first level. The third level is a question about students' beliefs regarding the first and second levels[14].

The conventional learning model places the teachers as the primary source of information that has a dominant role in the learning process. The teachers act as a knowledge transfer to their students, and the students are considered passive recipients of knowledge. The stages passed tend to be informed verify practice or oriented to the stages of opening-presenting-closing. In this learning activity, the teachers often use the lecture method, in which the teachers explain the entire content of the lesson. Understanding or definitions, theorems, derivation of formulas, examples of questions, and the solutions are all carried out by the teachers and given to the students. The steps of the teacher are followed carefully by the students. They imitate the way the teachers work and take notes in an orderly manner[15]. Thus, in the conventional learning model, the teachers only try to transfer or copy the knowledge to the students.

## 3. RESEARCH METHODS

The method used in this study was a qualitative research method using a descriptive approach. This study described the misconceptions experienced by students in algebraic materials. This study was conducted at SMP Negeri 17 Makassar. This study was qualitative research, so the research subjects used to obtain data were not chosen randomly. It was conducted selectively according to the objectives of this study, which is to find out the misconceptions of 7th-grade students of SMP Negeri 17 Makassar. The selection of the subjects was conducted by providing criteria based on the results of the Three-Tier Test. The number of subjects in this study was 6 students; 2 students experienced misconceptions (false negative).

Suppose the student's answer is wrong but can explain the problem-solving process and is sure of the solution. In that case, 2 students experience misconceptions (false positive). If the student's answer is correct but cannot explain the problem-solving process and is sure of the response and 2 students experienced misconceptions. The instrument used in this study was the researcher itself as the main instrument assisted by a diagnostic test of algebraic materials and interview guidelines. Furthermore, this study collected the data through interviews, documentation, and the Three-Tier Test diagnostic test to find out students who have misconceptions. The stages of data analysis in this study were data analysis of misconceptions in Algebra Learning. The data analysis of misconceptions in Algebra Learning used qualitative description analysis with stages of data reduction, data presentation, conclusion, and verification. This study used triangulation of data sources by testing the validity of the data through 4 steps, Credibility, Transferability, Dependability, and Comfirmability. The data analysis technique used data reduction, data presentation, conclusion, and verification.

## 4. RESULTS AND DISCUSSION

### 4.1. RESULTS

#### 4.1.1. Description of Test Data

Knowing whether there are misconceptions in the algebraic material, a test was conducted on 7th-grade of SMP Negeri 17 Makassar to obtain information

about the material which experienced misconceptions.

**Table 1 Data Results of Algebraic Material Experiencing Misconceptions**

Number	Indicators of Algebra Materials	Misconceptions	
		Yes	No
1	Explaining algebra concepts	Yes	
2	Identifying elements of algebraic forms	Yes	
3	Solving algebraic addition operations	Yes	
4	Solving algebraic subtraction operations	Yes	
5	Solving algebraic multiplication operations	Yes	
6	Solving algebraic division operations	Yes	

Table 1 shows that every algebra material had misconceptions experienced by 7th-grade students of SMP Negeri 17 Makassar.

#### **4.1.2. The Data Presentation of Interview Results**

In this study, the interview method was used as a method of collecting data. The purpose of this interview was to ensure the misconceptions experienced by students in solving algebra material questions. The data presentation of the interview from 6 subjects selected based on the results of the Three-Tier test as follows:

##### **4.1.2.1. Subject 1**

The interview with student 1 showed that the misconceptions experienced by students were caused by the lack of interest in the learning process of algebra materials. This was because the students did not like mathematics. They felt bored because the way of teaching was less interesting.

##### **4.1.2.2. Subject 2**

Interview with student 2 showed that the cause of the misconceptions experienced by students was the students felt the process of learning algebra materials was less attractive. This was because the students had difficulty in understanding addition and subtraction operations. This also showed that the students experienced pre-concepts in pre-algebra, in which the students have not understood addition and subtraction operations, and they felt bored learning algebra.

##### **4.1.2.3. Subject 3**

Interview with student 3 showed that the cause of the misconceptions experienced by students was a low initial knowledge or pre-

concepts in pre-algebra. Thus, the teachers were expected to strengthen the students' initial knowledge before continuing to the following material.

##### **4.1.2.4. Subject 4**

Interview with student 4 showed that the cause of the misconceptions experienced by students was that the learning process of algebraic materials was less attractive. This was because the students had difficulty understanding algebraic materials and lacked interest in learning.

##### **4.1.2.5. Subject 5**

Interview with student 5 showed that the cause of the misconceptions experienced by students was that the students felt learning algebraic material was not interesting. This was because the students were not interested in learning algebra, and they also felt bored. Students' interest in learning is also one of the causes of misconceptions.

##### **4.1.2.6. Subject 6**

Interview with student 6 showed that the cause of the misconception experienced by students was the students feel the learning process of algebra is not fun because the students do not like the learning method or model applied by the teacher.

## **4.2. DISCUSSION**

### **4.2.1 Explaining Algebra Concepts**

This indicator consists of 1 question item, question number 1. In question number 1, it was identified misconceptions (false

negative) of 80%. Students' understanding of misconceptions (false negative) in question number 1 was shown from their answer who chose S-B-Y. The answer revealed that the students assume that a mathematical form, which in its presentation contains letters to represent unknown numbers, is the definition of the variable. Therefore, it can be concluded that students experienced misconceptions with algebraic concepts. Students experience misconceptions (false negatives) because they have not fully understood the meaning of algebra.

#### **4.2.2 Identifying the Algebraic Elements**

This indicator consists of 2 questions, questions number 2, question number 3, and question number 9, which determines terms, variables, coefficients, and constants. In question number 2, students identified experiencing misconception were 30%, and misconception (false positive) was 7%. The understanding of students experiencing misconception in question number 2 was shown on their answer who chose S-S-Y. Moreover, students identified experience misconception (false positive) in question number two on their solution who chose B-S-Y. The reply indicates a lack of students' understanding of variables, coefficients, and constants.

In question number 3, students identified experiencing misconceptions were 33%. The understanding of students identified misconceptions was shown from their answer who chose S-S-Y. The answer revealed that the students have difficulties determining the coefficients and constants. It can be stated that the students are wrong in distinguishing between variables, constants, and coefficients.

In question number 9, students identified experiencing misconception were 27%, and misconception (false positive) was 3%. The understanding of students identified misconceptions was shown from their answer who chose S-S-Y. The understanding of students identified misconception (false positive) was shown from their solution who chose B-S-Y. The response indicates that the students have difficulties in determining terms in algebra.

Reny Silviani proposed that many misconceptions come from the students themselves. Students' misconceptions can be

collected in several ways, student interests and student abilities [14]. This is in line with the misconceptions experienced by the students in the indicators of identifying algebraic elements caused by the lack of interest in learning and their low level of understanding.

#### **4.2.3 Completing Addition and Subtraction Operations**

This indicator consists of 6 questions shown in questions number 6, 7, 8, 12 that determine the simple form of algebra, and questions 11 and 13 that determine the sum of algebraic numbers.

In question number 6, students identified misconceptions were 63%, and misconception (false positive) was 3%. The understanding of students identified misconceptions was shown from their answer who chose S-S-Y. The understanding of students identified misconception (false positive) was shown from their solution who chose B-S-Y. The response indicates that the students have difficulties combining the same or similar variables due to the students' lack of understanding of algebraic concepts.

In question number 7, students identified misconceptions were 27%, and misconception (false positive) was 17%. The understanding of students identified misconceptions was shown from their answer who chose S-S-Y. The understanding of students identified misconception (false positive) was shown from their solution who chose B-S-Y. Both answers show that in question number 7, students have difficulties combining the same or similar variables.

In question number 8, students identified misconceptions were 37%. The understanding of students identified misconceptions was shown from their answer who chose S-S-Y. The answer revealed that in question number 8, students also have difficulties combining the same or similar variables. Thus, it can be stated that students misinterpreted how to solve the addition and subtraction of algebraic numbers.

In question number 11, students identified misconceptions were 7%. The understanding of students identified misconceptions was shown from their answer who chose S-S-Y. The answer revealed the students' lack of understanding in making a substitution.

In question number 12, students identified experiencing misconceptions were 30%. The understanding of students identified misconceptions was shown from their answer who chose S-S-Y. Therefore, it can be concluded that the lack of understanding regarding algebraic operations causes students to be unable to answer addition and subtraction operations.

In question number 13, there were no students identified experiencing misconceptions based on the results of the Three Tier-Test.

From the result above, misconceptions occur in the indicator of completing addition and subtraction. The percentage of misconceptions shows that the lack of students' understanding is related to combining variables and making substitutions or substitutions. This is in line with the opinion by Ozkan in Karolin that a low understanding of a concept makes students create their own understanding of the concept [16]. This shows that students experiencing misconceptions are caused by the students' lack of ability to understand the algebraic concept.

#### **4.2.4 Solving Multiplication and Division Operations**

This indicator consists of 4 questions, question number 4, number 5, number 10, and number 15. In question number 4, students were faced with algebra problems in daily life. In questions number 5 and 10, students were asked to determine the multiplication result of algebraic numbers. In question number 15, students were asked to determine the division result of 2 algebraic numbers.

In question number 4, students identified misconceptions were 10%, and misconception (false positive) was 27%. The understanding of students identified experiencing misconceptions was shown from their answer who chose S-S-Y, while students identified experiencing misconception (false positive) were shown from their response who choose B-S-Y. These answers show the student's mistake in converting story questions into algebra form. In question number 5, students identified misconceptions were 13%. The understanding of students identified misconceptions was shown from their answer who chose S-S-Y. This answer indicates that

students were wrong in determining the multiplication results of the variables.

In question number 10, students identified experiencing misconceptions were 17%, misconception (false positive) was 27%, and misconception (false negative) was 3%. The understanding of students identified misconceptions was shown from their answer who chose S-S-Y. The understanding of students identified misconception (false positive) was shown from their solution who choose B-S-Y. The understanding of students identified as misconception (false-negative) was shown from their answer who choose S-B-Y. The three answers show that students were wrong in determining the multiplication results of algebraic numbers.

In question number 15, students identified misconceptions were 17%. The understanding of students identified misconceptions was shown from their answer who chose S-S-Y. This answer shows that students make mistakes in determining the division results of the variables.

From the results above, misconceptions occur in the indicator of completing multiplication and division. The percentage of misconceptions shows that the lack of students' understanding is related to combining variables and making substitutions or substitutions. This is in line with the opinion by Ozkan in Karolin that a low understanding of a concept makes students create their own understanding of the concept [16]. According to Sarlina, misconception refers to one of the concepts that are not in accordance with the scientific definition accepted by the experts [3].

The results of the Three Tier-Test conducted showed the misconceptions in every indicator of algebraic material. This is in line with the results of interviews conducted with students and the teacher. The results identified the cause of misconceptions from the student's perspective: the lack of understanding of algebra concepts, the lack of students' interest in learning algebra, the student's inconvenience in learning algebra due to small classrooms, and the pre-algebra concepts. Meanwhile, from the teacher's perspective, the lecture method is not suitable for the learning process of algebra materials. In teaching specific mathematics subjects, especially algebra, an exciting teaching method is required to increase students'

interest. The teacher also does not understand what misconceptions are and the cause of misconception, so that the teachers will have difficulty overcoming this problem. Both of these problems will cause students to experience misconceptions.

## 5. CONCLUSION

Based on the results of the study and discussion, it can be concluded as follows:

1. Based on the results of the Three Tier-Test given to 7th-grade students, it is identified that students experience misconceptions on algebraic materials with a percentage of 37% from all 7th-grade students. The majority of misconception occurs on all algebraic materials, algebraic concepts, algebraic elements, addition operations, subtraction operations, multiplication operations, and division operations.
2. Factors causing misconception on 7th-grade students in SMP Negeri 17 Makassar are:
  - a. The lack of students' ability in understanding algebraic concepts deeply,
  - b. The lack of students' learning interests, especially algebra,
  - c. The method frequently used by the teacher is the lecture method so that it makes students difficult to understand algebra materials,
  - d. Pra-concept pra-algebra.

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