# IDENTIFICATION OF STUDENTS' MISCONCEPTIONS ON INTEGRAL TOPIC USING A FOUR-TIER DIAGNOSTIC TEST

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**Abstract:**
Every student has a different ability to understand mathematical concepts, thus affecting the students' misconceptions. The research aims to identify the misconceptions using a four-tier diagnostics test method in integral topic. This research uses the qualitative method with study case strategy. The data are obtained from the four-tier diagnostic test on the integral topic. The subjects in this research are XII grade students at MAN Kota Magelang. The research results show that students' misconceptions divided into several categories of misconceptions, namely misconceptions, did not understand concepts, understood some concepts, understood concepts, and were undefined. The cause of students experiencing misconceptions on integral topics is that there are too many formulas to be memorized by students, and teacher learning methods are less attractive to students' learning interests on integral topics.

**Keywords:** Four-Tier Diagnostic Test, Misconceptions, Integral

## IDENTIFIKASI KESALAHPAHAMAN SISWA PADA MATERI INTEGRAL DENGAN TES DIAGNOSTIK EMPAT-TINGKAT

**Abstrak:**
Setiap siswa memiliki kemampuan berbeda untuk memahami konsep matematika, sehingga memengaruhi kesalahpahaman pada siswa. Penelitian ini bertujuan untuk mengidentifikasi kesalahpahaman dengan metode uji diagnostik empat-tingkat dalam materi integral. Penelitian ini menggunakan metode kualitatif dengan strategi studi kasus. Data diperoleh dari uji diagnostik empat-tingkat pada materi integral. Subjek penelitian ini adalah siswa kelas XII di MAN Kota Magelang. Hasil penelitian menunjukkan bahwa beberapa kategori kesalahpahaman, yaitu kesalahpahaman, tidak memahami konsep, memahami beberapa konsep, memahami konsep, dan tidak terdefinisi. Penyebab siswa mengalami kesalahpahaman tentang materi integral adalah bahwa ada banyak rumus yang harus dihafal oleh siswa dan metode pembelajaran guru kurang menarik bagi minat belajar siswa pada materi integral.

**Kata kunci**: Tes Diagnostik Empat Tingkat, Kesalahpahaman, Integral

## INTRODUCTION

Mathematics is one of the mandatory subjects in the 2013 curriculum. Therefore, mathematics is learned from elementary school education to middle school level because of mathematics cannot be separated from various aspects of life (Siagian, 2017). By learning mathematics, someone will get used to thinking scientifically, systematically, critically, logic, and can increase creativity (Krajewski & Schneider, 2009; Peng, Namkung, Barnes, & Sun, 2016; Raghubar, Barnes, & Hecht, 2010). So, mathematics has a vital role in life because it exists in every level of education. According to Ramadhani & Jazwinarti (2019), one of the objectives of mathematics learning is to understand the concept and explain the link between concepts or algorithms in a flexible, efficient, accurate, and precise way in solving mathematical problems.

Understanding ability is a process, method or action to understand or to know in detail the concepts being studied. This reflected in students' learning outcomes (Setyowati, Widiyatmoko, & Sarwi, 2015; Suryani, Rusilowati, & Wardono, 2016). According to Eriana, Kartono, & Sugianto (2019), in general, conceptual understanding can be interpreted as the ability of students to understand concepts, redeclare concepts in their language, and associate concepts with each other in daily life.

Sefik & Dost (2019) state that the application of concept understanding will be increasingly absorbed by students if each individual can understand the concept. Therefore, understanding the concept becomes the basis for understanding simple to complex learning.

Dahar (2011) mentions that "if it is ideal, concepts are the stones of development in thinking". It will be difficult for students to go to higher learning if they have not yet understood the concept. Hence the understanding of mathematical concepts is one of the purposes of learning mathematics.

Hasratuddin (2015) suggests that based on its characteristics, mathematics is the regularity of organized structures, the mathematical concepts arranged hierarchically and systematically, ranging from simple to complex concepts. APOS theory is a theory of learning in mathematics education, analyzing the mental construction formed by a person about

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mathematical concepts (Arnon, Cottrill, Dubinsky, Oktac, Roa Fuentes, Trigueros, & Weller, 2014). This theory suggests that learning must have a scheme. The scheme here is a structure that includes definitions, organizations, and examples of mental constructs in building mathematical concepts (Arnon, Cottrill, Dubinsky, Oktac, Roa Fuentes, Trigueros, & Weller, 2014). So understanding the concept of mathematics is to create the regularity of a person formed by analyzing the mental construction that includes the definition, the organization to build the concept of mathematics.

One of the subjects in mathematics is integral (Yudianto, 2015). Integral material is felt difficult for students because integral material is a complex material. Integral plays an essential role in various fields of science and industry (Monariska, 2019). Integrals are also widely used in solving problems in areas such as volume, curve length, population estimate, and others.

In Indonesia, Integral began to be taught to high school students and continued in college. The definite integral concept is one of the main concepts introduced in calculus and essential to students to master it (Serhan, 2015). Many research studies show that students experience difficulties with certain integral concepts and concepts of function, boundaries, and derivatives (Serhan, 2015).

There are several ways to know the understanding of student concepts, one of them using diagnostic tests. A diagnostic test is a test used to know precisely and ensure the weakness and strength of the students in particular learning (Zaleha, Samsudin, & Nugraha, 2017). Because understanding the concept is very important, one way to identify it by using the Four-Tier Diagnostic Test. This diagnostic test is the development of a triple-choice diagnostic test and has four levels to determine the understanding of the concept of the student or student is subjected to misconceptions.

The first level is a multiple choice question with four mountebanks and one key answer that students must choose. The second level is the student confidence level in choosing answers. The third level is the reason students answer the question, which is the four reasons options that have been provided, and one reason is open. The fourth level is the student confidence level in selecting a reason (Fariyani, Rusilowati, & Sugianto, 2017). Based on the explanation above, researchers are interested in identifying students' misconceptions on integral topics with a four-tier diagnostic test.

**RESEARCH METHOD**

The subject in this study was grade XII students of MAN Kota Magelang. The reason for this school was chosen as the research site because of the following considerations:

1. MAN Kota Magelang including a school ranked 6th in the national exam in Magelang, so it is hoped that the results in the research will have different results.

2. Research about a method of the four-tier diagnostic test has never been done in MAN Magelang city.

This research is descriptive qualitative research with a case study approach. The case study is an empirical inquiry that purposed to investigates a contemporary phenomenon within its real-life context (Zainal, 2007). The test instrument consisted of 5 questions divided into subtopics of partial integrals, substitution integrals, definite integrals, indefinite integrals, and unnatural integrals. Each question consists of four stages. This research uses a four-tier diagnostic test method. The purpose of the method can measure how much understanding the student's concept is.

This research approach uses quantitative and qualitative descriptive where the approach is to calculate the correct number, false, confident, and unsure of the student's answer to each question. The sub-topic used in this study consisted of an integral concept. Data were analyzed with Miles and Huberman steps of analyzing involve data reduction, data display, and verification (Sugiyono, 2013).

Data collection techniques are carried out with test instruments where researchers have given test questions with the four-tier diagnostic test method. The four-tier diagnostic test is the result of the development of a three-tier multiple-choice diagnostic test. The development is found on the added level of students' confidence in choosing answers and reasons. The first level is a multiple choice question with four mountebanks and one key answer that students must choose. The second level is the student confidence level in choosing answers. The third level is the reason students answer the question, which is the four reasons options that have been provided, and one reason is open. Level four is the student's confidence level in choosing a reason. A combination of four-tier diagnostic test answers is outlined in table 1.

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Table 1. Student Conception Category Based on Answers to the Four-Tier Diagnostic Test

| Number | Category | Option | Confidence Level | Reason | Confidence Level |
|---|---|---|---|---|---|
| 1 | Misconception | False | Sure | False | Sure |
| 2 | Do not | False | Sure | False | Not sure |
| 3 | Understand | False | Not sure | False | Sure |
| 4 | the Concept | False | Not sure | False | Not sure |
| 5 | Understand | True | Sure | True | Sure |
| 6 | the Concept | True | Sure | True | Not sure |
| 7 | | True | Not sure | True | Sure |
| 8 | | True | Not sure | True | Not sure |
| 9 | | True | Sure | False | Sure |
| 10 | | True | Sure | False | Not sure |
| 11 | Understand | True | Not sure | False | Sure |
| 12 | Some | True | Not sure | False | Not sure |
| 13 | | False | Sure | True | Sure |
| 14 | | False | Sure | True | Not sure |
| 15 | | False | Not sure | True | Sure |
| 16 | | False | Not sure | True | Not sure |
| 17 | Cannot be Encoded | If one, two, three or all of them are not filled | | | |

The test is used to identify students' misconceptions in an integral topic. The students' misconception is identified based on the student confidence level in answering four-tier diagnostic test instruments at the second and fourth-tier while the concept of understanding can be identified through instruments in the third step.

**RESULTS AND DISCUSSION**

There are four steps taken to analyze the data, (a) answers at the first-tier (multiple choice questions on an integral topic), (b) answers at the second tier, (c) answers the reason (at the first tier), and (d) answers to the fourth tier. Based on the answers at each level, the level of student understanding can be categorized (Pesman & Eryilmaz, 2010). Based on the categorization of student answers, it can be analyzed into several different levels: students can answer correctly, give the right reasons at the second level, the level of confidence given by students is confident with the answers given for the first and second levels,

if students answer incorrectly for the first and second level, then it can be a determinant of whether students have misconceptions on the integral topic.

The picture below is an example of a four-tier diagnostic test instrument used to see misconceptions experienced by students on integral material. In the third tier, some questions can be answered by students following their beliefs in the previous tier, namely the second tier.

Hasil dari $\int \frac{x+2}{\sqrt{x^2+4x-5}} \, dx$ adalah....

  A. $\sqrt{x^2+4x-5}+C$
  B. $2\sqrt{x^2+4x-5}+C$
  C. $4\sqrt{x^2+4x-5}+C$
  D. $6\sqrt{x^2+4x-5}+C$

Apakah anda yakin dengan jawaban tersebut . . .
A. Ya
B. Tidak
Alasan anda memilih jawaban tersebut adalah ...
A. 2 du = (x+2) dx
B. $\frac{du}{x+2} = \frac{1}{2} \, dx$
C. $\frac{1}{2} du = (x+2)dx$
D. du = 2 dx

Apakah anda yakin ?

A. Ya
B. Tidak

Figure 1. Four-tier Diagnostic Test

Based on the results of data processing carried out, obtained information about misconceptions that occur in the material. Students' misconceptions supported by testing the level of confidence students in answering test instruments. The test instrument used in this study was a four-level diagnostic test on integral material. Confidence in answering students on a four-tier diagnostic test instrument can be seen from the questions at the second and fourth-tier. Besides, based on the instrument of a fourth-tier diagnostic test can be obtained information about the causes of misconceptions that are submitted through students' answers in answering questions at the third-tier.

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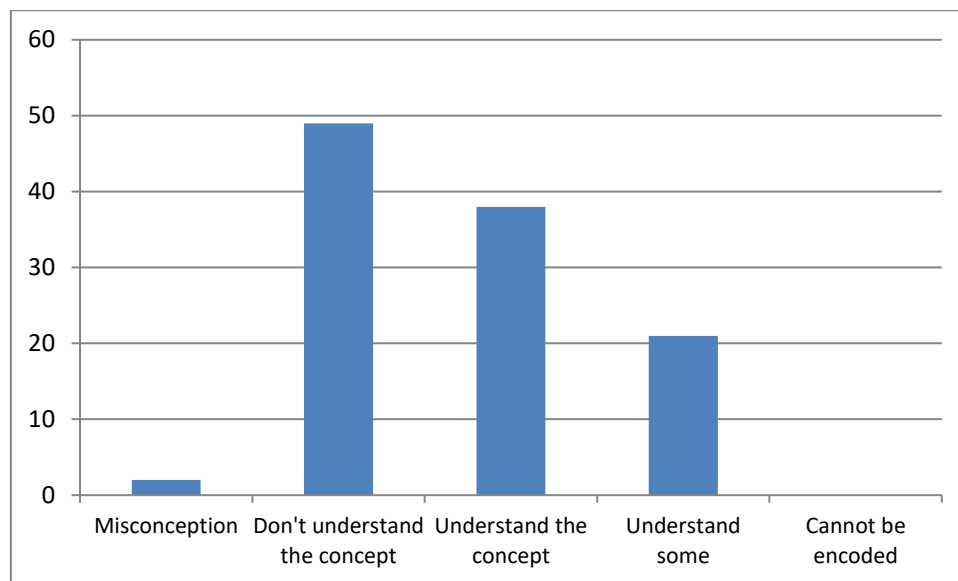
Figure 2. Chart Percentage of Students' Misconception

Based on the pictures, it is found that the percentage of students who increased several categories of misconceptions, namely misconceptions, did not understand concepts, understood some concepts, understood concepts, and were undefined (cannot be coded). There are 2% of students included in the category of misconception, 44% of students included in the category do not understand the concept, 34% of students included in the category of understanding some concepts, 20% of students included in the category of understanding concepts, and 0% of students fall into the category that cannot be coded.

The use of a four-tier diagnostic test instrument designed from fundamental questions is an effective way to find conceptual errors (Tarmizi, 2010). Based on the results of the study, students who experience misconceptions on integral material have difficulty in determining the formula of partial integrals, substitution integrals, indefinite integrals, and unnatural integrals in problem-solving. Students have difficulty in distinguishing the concepts of partial integrals, substitution integrals, indefinite integrals, and unnatural integrals. There are 40 out of 45 respondents who did not use the concept of integral substitution to solve the problem in figure 1. Students solve these problems vary, using the concepts of partial integrals, unnatural integrals, and indefinite integrals. Besides, the respondent who experiences misconceptions about integral material is also unsure of the answers they give. This is seen in the answers in the second tier. There were 37 of the 45

respondents who answered incorrectly at the third tier, namely the reason for choosing the answers at the first tier. In the last tier, there were 42 of 45 subjects who answered unsure of the reasons given in the third tier.

Based on the research results obtained by the data that causes students to get misconceptions, students feel that there are too many sub-topics that must be studied, namely substitution integrals, definite integrals, indefinite integrals, partial integrals so that too many formulas must be memorized. Besides, the learning model used by the teacher does not attract students to learn more.

The respondent in this research has several misconceptions in integral material, such as failure to understand the concept of substitution integrals and the difference between substitution integrals with the concepts of partial integrals, indefinite integrals, and unnatural integrals. Integral is one topic that is considered difficult by students, and students often experience misconceptions about this topic (Tarmizi, 2010). Even if students experience misconceptions on a topic, students may have difficulty in understanding the concept as a whole (Ozkan & Ozkan, 2012). By finding the misconceptions that occur in an integral topic will make it easier for teachers to find difficulties experienced by students, so they can immediately provide appropriate assistance. The use of multi-tier instrument tests is effective for identifying students' concept understanding abilities and misconceptions (Mutlu & Sesen, 2014).

**CONCLUSION**

Students' misconceptions divided into several categories of misconceptions, namely misconceptions, did not understand concepts, understood some concepts, understood concepts, and were undefined (cannot be coded). The cause of students experiencing misconceptions on integral topics is that there are too many formulas to be memorized by students, and teacher learning methods are less attractive to students' learning interests on integral topics.

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