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The analysis of Students' Misconceptions Using Certainty of Response Index (CRI) on Derivative Materials

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ABSTRACT

This study aimed to identify the extent of misconceptions and factors experienced by students at SMA Negeri 7 Lhokseumawe in derived materials. Students' misconception was identified by using a test noting students' ability to understand mathematical concepts. The test was equipped with a Certainty of Response Index (CRI) showing the level of student confidence, the results of which were analyzed to investigate students' misconceptions. This study was designed using a qualitative research method. The subjects were a number of 6 students, selected purposively. The data were collected through tests, interviews, and documentation. The emerging results of students' misconceptions and factors influencing their learning were analyzed through data reduction, presentation, and drawing conclusions. The results indicated that the number of misconceptions that occurred in students was 32.34%, while the number of those who did not understand the concept was 67.08%. The number of students who did not understand the concept was higher than those who were capable of. The students' misconceptions per se were triggered by their associative thinking, incomplete reasoning, learning interest, and teacher teaching methods.

Keywords: Certainty of Response Index (CRI), Misconceptions, Derivatives.

1. Introduction

Understanding concepts is a mastery of a number of learning materials. Students do not just learn to know but are able to re-express the concepts in a form that is easier to understand and applicable for them. Learning mathematical concepts and their principles is an initial requirement for the success of mathematics learning leading to a higher stage, because in mathematics, simple concepts are connected to more complex ones. When students are unable to restate what they have learned and fail to classify objects based on particular criteria, it causes misconceptions (Kilpatrick et al., 2002; Rosmawati, 2008; Ceran & Ates, 2010).

Misconceptions are descriptions of concepts in a statement that are not in accordance with general understanding, so they cannot be accepted. Misconceptions are formed as a result of someone's preconceptions that do not comply with natural concepts and go against an understanding that has been agreed upon by experts in a field of knowledge. They can occur due to an inaccurate understanding of a concept received by students, along with the use of the wrong concept and confusion of different concepts (Omrod, 2009; Dahar, 2011; Suparno, 2013; Sarlina, 2016).

Studies have shown that there is a possibility that occurs from the answers given by students, which is known as the incomplete understanding of the derivative concept or misconceptions.

Thus, identifying students' misconceptions using the Certainty of Response Index (CRI) technique is truly necessary. According to Ulfah (2017), the technique is used to distinguish students who have misconceptions by measuring their level of confidence or certainty. The level of certainty of answers is reflected in the Certainty of Response Index (CRI) scale along with responses. A mathematical misconception can be corrected.

Simply by comparing whether the answer to a question is correct or not, adjusted in line with the level of certainty index on the Certainty of Response Index (CRI) scale (Tayubi, 2005). Fadillah (2016) affirms that the inquiry process provides an overview of students' misconceptions in solving problems on comparative material using the Certainty of Response Index (CRI).

The purpose of this study was to investigate mathematical misconceptions as well as factors influencing students' learning, which was conducted on class XI students using the Certainty of Response Index (CRI) on derived materials. A study conducted by Hasan (2015) showed that when students lagged behind in accepting the described materials, teachers often teachers forward their teaching to the next material. This happened because they assumed that their students had understood the taught concepts. This condition caused students to be incorrect in using the concept incorrectly and develop mathematical misconceptions. Therefore, this study identified the misconceptions of seventh-grade junior high school students' on the whole number material using the Certainty of Response Index (CRI).

2. Review of Related Literature

Educational activities are one aspect of national development in educating the nation's life, exerted by professional teaching staff. According to Asbar (2017), education refers to a process of changing the attitudes and behavior of a person or group of people in an effort to mature humans through teaching and training. It is also known as a conscious and planned attempt to create a learning atmosphere and process so that students can actively develop their potential to have religious spiritual strength, self-control, personality, intelligence, noble character, and skills needed by themselves, society, nation, and state (Ministry for Education Affairs, 2006).

Education is a teaching process that everyone is obliged to undergo. In a narrow sense, teaching is an activity to formally deliver subject matter so that students master the teaching material. One of the teaching materials in schools is mathematics. Mathematics is one of the fields that has an important role in education. This can be seen by the stipulation of mathematics as one of the compulsory subjects in every National Examination (NE) (Ministry for Education Affairs, 2006). Mathematics is taught starting from the concrete stage, semi-concrete, to the abstract. It is also instructed from simple to complex concepts. Ernest (2004) states that mathematics is a hierarchical subject, where one topic is related to another. The aspects require students to have a good understanding of a concept in order to learn the others. If one concept is not understood, it will affect the understanding of the other concepts as they are interrelated. This means that mathematics is essential in figuring out the basic concepts so that later it will be easier to comprehend the subsequent concepts.

Umar (2004) states that "the concept is a number of theories related to an object, which are constructed by classifying and grouping the certain equal characteristics objects." According to Estavina (2019), the concept is a basis for thinking, describing a regularity or relationship with a group of factors which are indicated by some symbols or signs. The concepts play an important role in mathematics due to the fact that they are concerned with the abstract ideas that are hierarchically arranged and deductively reasoned. Therefore, it is important for teachers to pay attention to students' understanding of concepts so that misconceptions can be narrowed. Fadllan (2011) and Suparno (2013) argue that a misconception or a wrong concept refers to a theoretical basis that is not in accordance with the scientific understanding accepted by experts in the field of knowledge, such as initial concepts, errors, and incorrect relationships between one concept and another. Meanwhile, Fowler (as cited in Sarlina, 2016) views misconceptions as an inaccurate or incorrect understanding and use of concepts, wrong classification of examples, confusion of different concepts, and incorrect hierarchical relationships of concepts.

From some of the definitions above, mathematical misconceptions can be defined as an inaccurate interpretation of certain concepts that are not in line with the generally accepted understanding. If misconceptions are not immediately addressed, they will become integrated (unified) in the cognitive process. structure related to) students. The existence of misconceptions will hinder students' mastery of a concept, which then causes their low learning achievement.

Based on the results of interviews conducted on January 24th, 2022, it was discovered that a number of students was identified to have low grades and needed to take further remedial classes, especially in learning the derived materials. Similarly, students were unable to apply derived concepts dealing with derived material. According to the mathematics teacher at SMA Negeri 7 Lhokseumawe, the inconvenient performances were caused by the fact that the students' initial concepts were not investigated. When working on the problem, students were confused in determining the derivative concept. A large number of students were also found to be incapable of answering the given questions. In short, it was found that only 37 or 12.83 % of students understood the mathematical concept, while a percentage of 77.70% of students were unable to comprehend the concept. Additionally, 9.46% of students were found to have experienced misconceptions in learning the comparative material. This means that there were fewer students who understood the concept than those who did not.

3. Research Methods

The qualitative approach was used in this study. Creswell (2012) notes that a qualitative approach is useful for revealing and unearthing a problem in detail. The type of research used in this study was a descriptive research design. Similarly, it was conducted to determine the value of independent variables, either one or more variables without connecting with other variables (Sugiyono, 2019).

The research subjects were selected by purposive sampling, a technique carried out under certain considerations and goals (Sugiyono, 2019). Students who took the test were those in the selected class. They were given questions along with a Certainty of Response Index (CRI) scale in which they would choose

based on their level of confidence. There were a number of 6 students selected to be the subject of the interview based on different criteria of students' answers.

Table 1. Certainty of Response Index (CRI) Criteria and its Provision

Certainty of Response Index (CRI)	Criteria	Low Certainty of Response Index (<2,5)	High Certainty of Response Index (>2,5)	Answer Criteria
0	Totally Guessed Answer	Correct answer but low CRI means not knowing the concept (Lucky guess).	Correct and high CRI means mastering the concept well.	Correct answer
1	Almost Guess			
2	Not Sure			
3	Sure	Wrong answer and low CRI means not knowing the draft.	Wrong answer but high CRI means misconception happened.	Wrong answer
4	Almost Certain			
5	Certain			

Source: Hasan, et al (1999)

The Certainty of Response Index (CRI) technique identified not only students' misconceptions, but also it can distinguish students who know the concept, while those who do not. It can be seen from the answers and the confidence scale given by the students as shown in the table below. The following shows four possible combinations of answers (true or false) and a high or low Certainty of Response Index (CRI) for each individual respondent in answering questions (questions). The criteria for assessing the ability to understand mathematical concepts were outweighed by several thematic performances such as the indication of restating a concept, the classification of objects, the presentation of concepts, and the application of concepts (Mawaddah, 2014).

There were three stages of procedures used to investigate students' misconceptions in learning the mathematical concept of derivative material, three the preparation, planning, implementation, and data analysis. The determination and thorough analysis of research setting was mainly done in the research setting. The planning stage in this research was to carry out several activities including reviewing theories about misconceptions, making indicators that would be used in research according to the material, and compiling research instruments, including written tests as well as the interview guidelines.

The implementation was the core stage of the research. A test was performed on derived materials with several questions, and an interview was conducted. The results of written test were then analyzed based on the indicators, and the level of student confidence was measured by the Certainty of Response Index (CRI) scale. The last stage, the data conclusion, was conducted to describe or explain the research results regarding the misconceptions, followed by drawing conclusions in the form of a written report. In this study, the information or data was obtained through a test projecting the indicators of the ability to understand mathematical concepts, equipped with a Certainty of Response Index (CRI) scale.

4. Result and Discussion

Based on the results of grouping the level of understanding of students' mathematical concepts, it was discovered that there were students who did not understand the concept. It was also found that the level of understanding of students' mathematical concepts, especially on derived material, was relatively low.

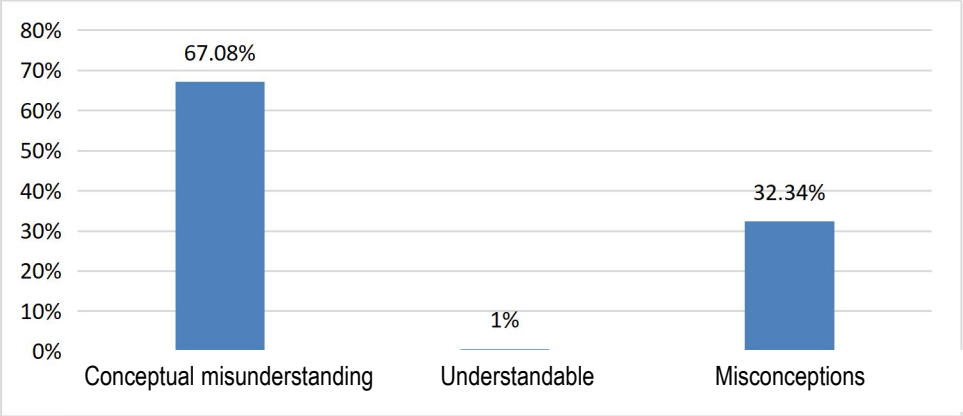

Figure 1. Level of students' mathematical concepts

Figure 1 notes that the total number of students who experienced misconceptions was 32.34%. This result was much lower than those who misunderstood the concept, assessed as much as 67.08%. This shows that the level of understanding of students' mathematical concepts, especially on derived material, was still very low. This statement can be seen from the percentage, which shows that only 1% of students understand the concept.

Table 2. Percentage of students' level of understanding on Each Item

Question Number	Total Don't Understand Concept	Percentage	Total Understanding of Concepts	Percentage	Total of Misconceptions	Percentage
1	5	14,7%	0	0%	29	85,3%
2	14	41,2%	1	2,9%	19	55,9%
3	29	85,3%	0	0%	5	14,7%
4	33	97,1%	0	0%	1	2,9%
5	33	97,1%	0	0%	1	2,9%

From the results of the students' ability to understand mathematical concepts, the results of the grouping of students' understanding levels on each item was obtained. The following is a graph of the level of student understanding on each item.

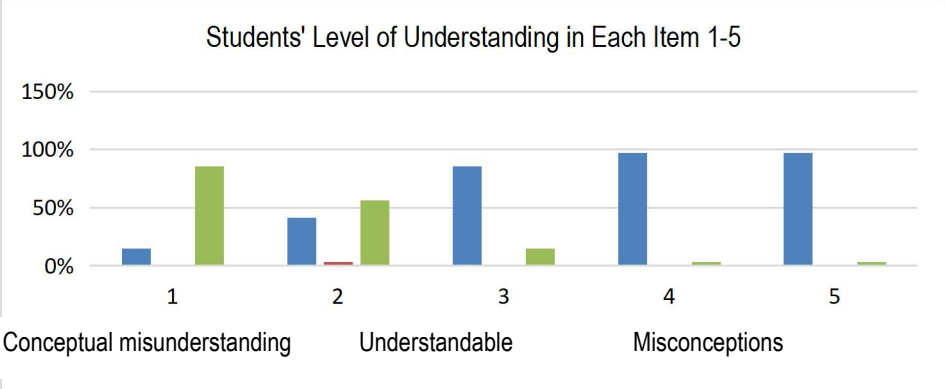

Figure 2. Students' Level of Understanding of Each Item

Based on Figure 2, in Question Number 1 with indicators of restating a concept, the percentage of answers in the category of not understanding the concept was 14.7%, the percentage in the category of understanding concepts was 0%, and the percentage of student answers in the misconception category was very high,i.e., 85.3%. In Question Number 2, with indicators classifying objects according to certain properties and concepts, the percentage of students' answers who did not understand the concept was 41.2%, the percentage of answers who understood the concept was 2.9%, while those who experienced misconceptions were 55.9%.

In Question Number 3, with indicators giving examples and not examples of a concept, the percentage of answers found to be 85.3% in the category of not understanding the concept, 0% in the category of understanding the concept, and 14.7% misconceptions. In this number, the highest percentage was in the category of not understanding the concept. In Number 4, presenting concepts in various forms of mathematical representation, there were 97.1% of students' answers in the category of not understanding the concept, 0% of understanding concepts, and 2.9% of misconceptions. While in Question Number 5, using and utilizing and choosing certain procedures or operations, the percentage of answers in the category of not understanding the concept was 97.1%, the category of understanding the concept was 0%, and the category of answers experiencing misconceptions was 2.9%.

Table 3. Data on Student Test Results for Class XI-IPA 1

No.	Initials	Question 1	CRI	Question 2	CRI	Question 3	CRI	Question 4	CRI	Question 5	CRI
1	S1	3	4	3	5	0	-	0	-	0	-
2	S2	3	3	2	3	0	-	0	-	0	-
3	S3	2	5	3	3	0	-	0	-	0	-
4	S4	0	-	3	4	0	-	0	-	0	-
5	S5	3	3	2	4	0	-	0	-	0	-
6	S6	2	3	2	4	0	-	0	-	0	-
7	S7	0	-	3	5	0	-	0	-	0	-

8	S8	2	2	2	5	0	-	0	-	0	-
9	S9	2	5	2	5	0	-	0	-	0	-
10	S10	3	5	3	5	0	-	0	-	0	-
11	S11	2	4	2	3	0	-	0	-	0	-
12	S12	2	3	3	3	0	-	0	-	0	-
13	S13	3	5	3	5	0	-	0	-	0	-
14	S14	2	5	2	5	0	-	0	-	0	-
15	S15	3	4	2	3	0	-	0	-	0	-
16	S16	3	4	2	4	0	-	0	-	0	-
17	S17	3	3	2	3	2	3	3	3	0	-

Table 4. Data on Student Test Results for Class XI-IPA 2

No.	Initials	Question 1	CRI	Question 2	CRI	Question 3	CRI	Question 4	CRI	Question 5	CRI
1	S18	2	3	4	2	2	2	0	-	0	-
2	S19	3	5	0	0	2	5	0	0	0	0
3	S20	3	5	0	0	1	5	0	0	0	0
4	S21	0	-	0	-	3	2	0	-	0	-
5	S22	2	4	1	3	0	-	0	-	0	-
6	S23	2	4	0	0	2	-	0	-	0	-
7	S24	3	5	0	0	0	0	0	0	0	0
8	S25	2	5	0	0	3	0	0	0	0	0
9	S26	2	4	0	0	2	1	0	0	0	-
10	S27	2	4	3	4	1	2	0	-	0	-
11	S28	3	3	0	0	3	-	0	-	0	-
12	S29	3	5	0	0	0	0	0	0	0	0
13	S30	1	1	2	2	2	1	0	0	0	0
14	S31	3	5	1	-	0	-	0	-	2	4
15	S32	2	5	4	5	2	5	0	-	0	-
16	S33	3	5	0	0	0	0	0	0	0	0
17	S34	3	5	0	0	2	5	0	0	0	0

In question number 1, the value of Certainty of Response Index (CRI) between the range of 3 to 5 was owned by 29 students while the range 0-2 was only owned by 5 students. This means that the level of confidence that students have in answering the questions on this number had a fairly high confidence, even though the answers given were not correct. This indicated that there was a misconception among students in answering the questions.

Question number 2, the number of students indicated to have misconceptions was 26. This can be seen from the high level of Certainty of Response Index (CRI), but the answers given were still wrong.

The high level of confidence ranges from 3 to 5, while students who had a confidence level between 0 and 2 numbered 7. However, there was 1 student who had a high level of confidence, namely 5 with the correct answer. This means that there were students who understood the concepts in the problem. The number of misconceptions in this number was much higher than the number of students who did not understand the concept.

Question number 3, the value of the Certainty of Response Index (CRI) with a range of 0-2, while owned by 27 students, in the range of 3-5, there were 7 students. This difference could be seen very far, where students who did not understand the concept were more than those with misconceptions. In number 3, many students left their answers blank or did not fill in the answers to the questions. The students also did not fill in the confidence level that had been provided. This indicates that students who did not answer were students who did not understand the concept.

In question number 4, there was only 1 student with a confidence level of 3, which means 'sure', with the answer. However, in reality, the answers given by these students were still incorrect. In this question, 29 of them who chose the Certainty of Response Index (CRI) in the range of 0-2, and 4 students selected the range of 3-5 with empty answers. This indicates that students did not understand the concept, and therefore, were unable to answer the questions given.

In question number 5, the same as the previous question, there was only 1 student who answered the question with a confidence level of 4 (almost correct). Students who did not answer the questions were in a number of 30 with a Certainty of Response Index (CRI) range between 0-2, and 3 of them had confidence levels ranging from 3-5. Based on this data, it can be said that there were more students who did not understand the concept than students who experienced misconceptions. This was shown in their answer appeared left empty as they did not choose the level of confidence in answering the questions.

From the interview excerpts of the interview, students already understood the concept of the problem being worked on. It's just that there were some operations that students underwent misconceptions. This can be seen from the multiplication of x times Δx equals Δx^2. During the interview, students confirmed that $2\Delta x$ was correct, this also showed that students had misconceptions. Additionally, in Question 2, they still experienced errors in algebraic operations. In this section students wrote $2x\,(2x) = 2x^2$. This result was incorrect. Their confidence level of students' confidence in this answer was high, indicating that it could be concluded that they had misconceptions.

In question 3, students wrote the derivative of the function given in the question with a value of 6x, which was incorrect. The student stated that he had to guess in answering this question, because he was confused. However, in the Certainty of Response Index (CRI) table, the confidence level of the selected answer was 3, which meant that they were 'sure' with the answer. Furthermore, the student also experienced an error in number 4, they gave wrong result. The error lied in the operation $\left(\frac{1}{2}\right)(3) = 3$. The level of confidence in this answer was the same as before worth 3. Therefore, it can be concluded that the students

had misconceptions. It can be seen from their answers which were wrong although they had a fairly high level of confidence.

The ability test students' mathematical concept understanding was equipped with the Certainty of Response Index (CRI) method was useful for measuring the level of student confidence in answering questions. In analyzing misconceptions, the themes had been classified into several categories, namely understanding concepts, not understanding concepts and misconceptions. The causes of misconceptions were not only from students, it could be from teachers, teaching methods, books and also the context (Liliawati, 2008). The test results of the test showed that a large number of students had been dealt with misconceptions and did not understand the mathematical concept, while only a few students did understand it. It was also discovered that more students did not understand the concept than those who were capable of understanding it.

Based on the level of student understanding, as many as 67.08% of them were included in the category of not understanding the concept, 1% of students understood the category of understanding the concept, and as many as 32.34% of students in the category of misconceptions. This was a significant difference between students who understood the concept and those who did not. Their misunderstanding of the concept could lead to misconceptions. This statement is in line with Ozkan's (Kusaeri, 2012), which suggests that students can provide or conclude their own concepts due to a lack of understanding, leading to misconceptions.

Fadllan (2011) defines misconceptions as conceptual errors that do not align with the general or expert understanding accepted by professionals in the field. In a study by Mujib (2017), it was found that many students experienced misconceptions, particularly in calculus II courses. The results of his research revealed that as many as 53.4% did not understand concepts, and 46% had misconceptions. The number of misconceptions was higher than those who understood the concept. These findings were consistent with previous studies on students' ability to understand mathematical concepts, particularly derived material, and the prevalence of misconception students.

There were several factors that caused misconceptions in students, such as teaching mechanisms, the presentation of textbooks that were difficult-to understand. It can also come from the students themselves. This is in line with the statement of Suparno's (2005) that misconceptions can be influenced by students themselves, teaching methods, learning contexts, textbooks, and teaching. Similarly, Lusiana (2015) and Ornay (2017) suggest that misconceptions can be caused by the students themselves.

Students' associative thinking was another root of misconceptions. According to Marshall (Suparno, 2013) associative thinking was an understanding or words that were interpreted differently between teachers and students. The study found that misinterpretations made by students during interview activities. This was supported by the answers of students who were still making mistakes in writing algebraic operations and mentioning what was known in the problem. This was in line with research conducted by Hidayat, et al (2020), which that misconceptions could be caused by students' own thinking. The high level of misconceptions was caused by students building their own knowledge. In the previous study, 76.92% of students experienced misconceptions due to their associative thinking. Students often did students interpret differently from what was explained by their teacher.

Furthermore, in this study, the knowledge possessed by students was still relatively low which was supported by the understanding of their concepts that were still lacking as they were unable to answer the given questions. In addition, students were unable to describe the answers they had worked on before, and their inability to give reasons for their answers indicated that they were experiencing incomplete reasoning. This compelling factor was one of the factors that caused misconceptions. This statement was in line with research conducted by Fakhrudin et al. (2012) regarding incomplete reasoning. Incomplete reasoning can also be said to be a partial misconception, which means that students give incomplete reasons or generalize a concept incompletely, causing misconceptions. In a previous study, 12% of students had misconceptions about this factor.

Learning interests can also affect students' understanding of mathematical concepts. Student misconceptions were caused by low interest in learning mathematics; they needed attention to the teacher's explanation. Fakhrudin et al. (2012) found that high interest in learning must be more robust to keep students from misconceptions. In addition, some students choose to ask their friends instead of asking the teacher when they do not understand the concept being studied. This can trigger misconceptions. The partially true knowledge of one student was shared with others, which caused misconceptions.

The other factor contributing to the misconceptions was the students' intuition. Wrong intuition could lead to misconceptions. Intuition is a feeling in a person who expresses his attitude or idea about something before being examined objectively (Suparno, 2013). Their statements indicated the wrong intuition of students during interview activities. It was revealed that the answers obtained by students were seen by their friends without knowing the truth and the concepts used in answering the questions. This showed that students only examined the answers after writing them down. The answers. Feelings of students who believed in other students' answers could lead to misconceptions. Factors causing this misconception also occurred in a study by Fakhrudin et al. (2012). He stated that 86% of students had experienced misconceptions due to wrong intuition.

In addition, the teaching and learning process has been taking place conventionally using the lecturing method. Using inappropriate and non-interactive strategies causes students to feel bored and unable to capture the material properly and correctly. According to Suparno (2013), teaching methods are also one of the factors causing misconceptions in students. This finding is akin to that of Latifah et al. (2020), who state that the factors that cause misconceptions could arise from the teachers' teaching methods. Teaching methods that are not varied and the lack of use of learning media cause misconceptions in students.

5. CONCLUSION

Model for investigating students' problems in learning derivative material using the Certainty of Response Index (CRI) revealed an ongoing mathematical misconception among students in the classroom. Our findings indicate that the occurred misconceptions were found 32.34%, while the number of students who did not understand the concept was 67.08%.

The number of students who did not understand the concept was higher than those who did. The misconceptions were attributable to a number of factors which emerged from students' associative thinking, incomplete reasoning, wrong intuition, and learning interest to teachers' teaching methods that were used in classroom.

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