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Descriptions of Students' Conceptual Understanding Levels (CUL) in Exponent Using Certainty of Response Index (CRI)

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ABSTRACT

The study intends to determine the students' understanding of concepts in terms of understanding the concept, understanding the concept but not sure, misconception, and not knowing the concept of Exponent using Certainty of Response Index (CRI). The type of this study is a qualitative study with a descriptive approach. The subjects of this study were 11 students, who represent each level of conceptual understanding from grade XI of Senior High School. The instruments of this study consist of objective tests and interview schedules. Levels of conceptual understanding, categorized using CRI category. This study shows that: (1) The students understand the concept well because of their high motivation in learning and their love with mathematics. (2) The students understand the concept. Still, they are unsure because of their lack of self-confidence, their high false fear, lack of mastering the mathematic concept, and not being careful in answering the questions. (3) The Students experience misconceptions caused by a lack of understanding and even misunderstanding the concept. Several types of misconceptions in this study are misconceptions in notation, misconceptions in the sequence of operations, misconceptions due to systematic errors, and misconceptions due to transformation errors. (4) The students do not understand/ do not know the concept caused they do not have knowledge in answer the question of Exponent, their lack of ability and insight in working on the questions, lack of mastering the concept, not understanding the questions, and the students lack ability in transform the questions. Suppose the teacher knows the level of conceptual understanding of students. In that case, the teacher will know the location of the material that must be emphasized so that students do not experience misconceptions. The teacher can also give special treatment for students who have misconceptions and do not understand the concept.

Keywords: understanding, concept, exponent, misconception, Certainty of Response Index (CRI).

1. INTRODUCTION

CUL is the level of a person's ability to be able its to understand a fundamental thing, which they obtain from the learning process so that the level of conceptual understanding of each student varies. One of the topics in mathematics lessons that require conceptual understanding is Exponent.

There are several levels of conceptual understanding, conceptual understanding, conceptual understandings but not sure, misconceptions, and do not know the concepts. So, in the learning process, every student must have one or several levels of those conceptual understanding. Therefore, we need to know the level of student conceptual understanding in Exponent.

A previous study about the Exponent has been carried out by Agustin [1]. The study was discussed students' mistakes in Exponent. The errors obtained include student misconceptions in Exponent that is $3^2 \times 3^2 = 9^4$. While the problem can be solved by using one of the properties of Exponent, that is $a^x \times a^y = a^{x+y}$, where $a \neq 0, \; x, y \in \mathbb{R}$.

One of the methods used to identify the levels of conceptual understanding is using the Certainty of Response Index (CRI). The CRI method is a method based on the students' level of confidence towards their given answers. This method was introduced by Hasan [2], who stated that the CRI method was effective in diagnosing students who did not understand the concept and students who experienced misconceptions. CRI can identify both of them based

on respondents' confidence levels based on the questions given. CRI was then modified by Hakim [3]. They changed the determination of the students' conceptual understanding categories based on the choice of answers, reasons, and CRI values. This current study used the CRI method that has been modified by Hakim et al. (2012).

This study intends to describe students' conceptual understanding by using CRI grade XI in one of the high schools. This study also revealed the causes of students that experience a certain level of conceptual understandings, especially in Exponent.

Understanding is one of the psychological elements in learning to understand the concepts as a whole [4]. According to Anas [5], what is meant by understanding is the ability to use the knowledge that has been remembered at least the same as what has been taught and in accordance with the intended use.

In accordance with the two opinions above, that is understanding. Soedjadi [6] said concepts are abstract ideas that can hold the classifications or classifications generally expressed by a term or series of words. Different case, Bell [7] stated that a concept in mathematics is an abstract idea that enables the object and events to be examples or non-examples of the abstract idea.
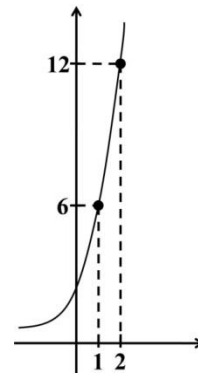
2. RESEARCH METHOD

This study is qualitative with a descriptive approach. The research was conducted in grade XI in one of the high schools at the end of the second semester of 2018/2019.

2.1 Procedure

Subjects in this study consist of 11 subjects, that is 3 subjects who conceptual understanding of well (W), 3 subjects who conceptual understanding but not sure (NS), 6 subjects who experienced misconceptions (M), and 3 subjects who do not know the concept (NK), in this case, there are same subjects who experience several levels of different understanding concepts on different questions. Here are two examples of questions used, numbers 4 and 5, in this study.

Direction: There are 10 questions that you must answerer in 90 minutes. Mark the one alternative that best answerers the question and give the reason. For each selected response, provide a degree of certainty.
4. Note the graph below!

An exponent function from the graph is …
a. 2×3^{-x} c. 2×3^{x}
b. 3×2^{-x} d. 3×2^{x}

Reason:

………………………………………………

………………………………………………

……

5. A simple form from $\left(\frac{9a^{-5}b^{-3}}{3^{5}a^{-7}b^{-5}}\right)^{-1}$ is …

a. $27(ab)^2$

b. $\frac{27}{(ab)^2}$

c. $\frac{(ab)^2}{27}$

d. $\frac{(a^3b^2)^4}{3^7}$

Reason:

………………………………………………

………………………………………………

……

2.2 Instrument

The instruments used in this research were objective tests in the form of reasoned multiple-choice tests (completion process). Data collection techniques in this study that is objective tests are used to determine the level of students conceptual understanding about the Exponent, then interviews are used to explore the level of students conceptual understanding in Exponent to clarify the objective test results data which not all can be explained through the analysis of test results student objectives, and documentation is used to complete data from interviews, as well as field notes, namely photographs and sound recordings.

The following is the CRI degree, which is used to determine students' CUL.

Table 1. CRI Degree

CRI	Criteria
5	Certain
4	Almost Certain
3	Sure
2	Not Sure
1	Almost a guess
0	Totally guessed answer

The next step is to select several students who will be the subject of research can fulfill each level of conceptual understanding on each possible question; there are 11 subjects. Next, to clarify the results data of the objective test, and then continued interviews with the subject. Data from the results of the interview are then described. The descriptions of the interview will describe the levels of students' conceptual understanding and causes. The last step is presenting the data; the results of objective tests and interviews are shown in a description.

The category of CUL, showing according to the table below.

Table 2. Category of CUL

Answer	Reason	CRI Value	Description
True	True	> 2,5	Understand The Concept of Well
True	True	< 2,5	Understand The Concept but Not Sure
True	False	> 2,5	Misconceptions
True	False	< 2,5	Do Not Know The Concept
False	True	> 2,5	Misconceptions
False	True	< 2,5	Do Not Know The Concept
False	False	> 2,5	Misconceptions
False	False	< 2,5	Do Not Know The Concept

3. RESULT FINDINGS AND DISCUSSIONS

Description of students CUL in Exponent using the CRI and the causes of the level of conceptual understanding. There are four sample questions, number 1, 2, 7, and 9, with four subjects in different CUL.

3.1. Conceptual understanding of Well

Below is the test results of subject W on question number 1. Furthermore, it is briefly described students understanding concept level in problems solving verbally and writing.

Note the form of the multiplication repeated below

$$t \times a \times t \times a \times t \times a$$

i. $t^3 + a^3$ iii. $(t \times a)^3$

ii. $(t + a)^3$ iv. $t^3 \times a^3$

Which is the right form of the power based on the multiplication above?…

a. i and ii   c. iii and iv

b. ii and iii   d. i and iv

(a)

(b)

(c)

Figure 3. 1. (a) Answer, (b) Reason, and (c) CRI Subject W Number 1

Figure 3.1. (a) showed that the subject W answered the question correctly, that is, choosing c. Figure 3.1. (b) showed that subject W gives a reason with the correct completion process, firstly subject W equates iii and iv, and then spell out iv. After that, produces the spell out iii by using commutative properties on multiplication. Figure 3.1. (c) showed that subjects W ticked correctly on the CRI scale provided. According to the level of conceptual understanding categorized using the CRI category in Table 2, the subject of W is included at the level of conceptual understanding of well.

To know whether the subject W understands the concept well, an interview is conducted on the subject of W. The interview begins by asking the subject to review the answer; after that asked subject W to

explain the answer. From the interview, we know that subjects W like mathematics. That is similar to Siregar's [8] opinion that if students' perceptions of mathematics are accessible, they like mathematics and make mathematics their favorite lesson, and vice versa.
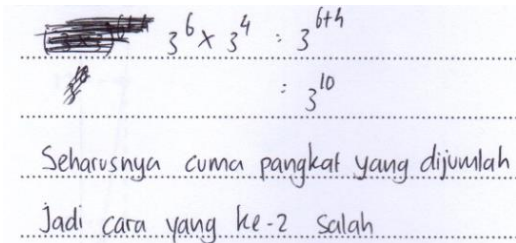
3.2. Understanding the concept but not sure

Below is the test results of subject W in question number 2. Furthermore, it is a brief description of students understanding concepts but not sure about problems solving verbally and writing.

Starting in what number the role in simplifying the result of the multiplication of

$$3^6 \times 3^4 = (3 \times 3)^{6+4} = 9^{10} = 3^{20}$$
$$\underbrace{}_{1} \quad \underbrace{\phantom{(3 \times 3)^{6+4}}}_{2} \quad \underbrace{\phantom{9^{10}}}_{3} \quad \underbrace{\phantom{3^{20}}}_{4}$$

a. 1 c. 3
b. 2 d. 4

(a)

(b)

(c)

Figure 3. 2. (a) Answer, (b) Reason, and (c) CRI value of Subject NS in Number 2

In Figure 3.2. (a), the answers of subject NS are correct, which is choosing b. Figure 3.2. (b) showed that subject NS gives a reason with the correct process. Subject NS uses the properties of Exponent. If there is a base similar to the multiplication operation, we only write one of the bases, then add the sum of each base without processing the base. Figure 3.2. (c) showed that subjects NS is ticking not sure on the CRI scale provided. According to the categorization of the level of conceptual understanding using CRI in Table 2, subjects NS is included at a level of conceptual understanding but not sure.

To know why students did not know their answers, an interview was conducted with subject NS. From the

interview results, it was known that the subject NS chose not sure because subjects NS was not confident with the answer. Subjects NS chosen not sure even though the answers and reasons that he wrote were correct because of subject NS can't ask his friend who is smarter in mathematics than him. Subject NS felt he was not good in mathematics and needed to ensure his answers to his friends.

This is reinforced by Sari's [9] opinion about the causes of students' lack of confidence in learning; one of the reasons is the student's character that generally who have a fear especially became the fear of being wrong in answering the question. Included in this case is fear the answer is wrong when answering the question.

3.3. Misconception

The test results subject M in question number 7. Furthermore, a brief description of the subject M who experienced misconceptions in verbal and written problems.

If $2^{(2x-1)} - 4 = 2^x$, then $x = \cdots$

a. -2 c. 3
b. 2 d. 4

(a)

(b)

(c)

Figure 3. 3. (a) Answer, (b) Reason, and (c) CRI value of Subject M in Number 7

In Figure 3.3. (a) it seems that subject M answers the question incorrectly, he was choosing d, but it should be b. Figure 3.3. (b) shows subject M gives a reason with a wrong completion process, that subject M experiences a misconception in the reduction

operation, subject M directly subtracts the base with the base too and subtracts the Exponent with Exponent too, and subject M thinks that $-2^2 = 2^2$. Figure 3.3. (c) shows subject M checked correctly on the CRI scale. Subject M is included at the misconception levels by referring to CRI conceptual understanding levels in Table 2.

To know why the student has a misconception, then an interview was conducted with subject M. From the interview results, it was found that subject M checked correctly because subject M did not initially know that the thing he did was wrong. Subject M thought that the final answer was the correct answer without understanding what the questions asked about, misconceptions the nature of integer operations which think $-2^2 = 2^2$, and believed that the solution is $2^3 - 4^1 = -2^2$

This misconception is caused by subject M having the wrong concept and certain with the answer. This is reinforced by Sadhu [10] that misconception in student caused because a student who had the wrong concept when answer the question tends to feel sure or confident about their answer; it is called a misconception. Other misconceptions are the same as Allen [11] shows that in the exponent, one of the misconceptions students make is students have problems in the sequence of operations; they think $-4^2 = 16$, but it should be $(-4)^2 = 16$. Keep in mind that misconceptions affect further learning negatively; if the misconceptions are not corrected, new learning can be encumbered, or it might not take place at all [12].

3.4. Don't Know the Concept

Below are the test results of subject NK in question number 9. The next, a brief description of the subject at the level of not knowing the concept in problem-solving verbally and in writing.

In a study, it is known an amoeba T breed by splitting themselves as much as 2 times every 30 minutes. How many amoeba T for one day if in an observation there are 4 tail amoeba?

a. 2^{48} c. 2^{96}

b. 2^{49} d. 2^{98}

(a)

(b)

(c)

Figure 3.4. Answers, Reasons, and CRI Values of Subject NK in number 9

In Figure 3.4. (a) it seems that the NK subject answered the question incorrectly, namely choosing a, but it should be d. Figure 3.4. (b) shows that the subject NK only writes what is known from the problem. Figure 3.4. (c) shows the subject NK checking almost a guess on the CRI scale provided. Referring to the categorization of the CRI conceptual understanding level in Table 2, subject M is included at the level of not knowing the concept.

To know why subject NK did not understand the concept, the researcher interviewed subject NK. From the interview, we know that the subject NK cannot explain the answer that he wrote, does not understand the purpose of the question, and does not know how to answer the question. That is because subject NK is known to lack the ability and insight to work on the problem; subject NK does not know to transform the problem into a mathematical form. This is confirmed by Khasanah [13], who stated that the factors of student difficulty in working on the problem-solving question, because students were not able to identify the purpose of the problem as well, could not identify/ write down what was asked and sought by the question, and the lack of students' ability to transform sentences into mathematical models.

4. CONCLUSION

Based on the results and discussion, it can be concluded several things :
1) Students who understand the concept well about exponents choose the right option with the right reasons and CRI values $> 2,5$. Students understand the concept well due to the high motivation to learn and their like mathematics.
2) Students who understand the concept of Exponent but are not sure choose the right option with the right reasons and CRI values $< 2,5$. Students are less confident in their understanding, even though their understanding is correct, due to students' lack of confidence, high fear of being wrong, lack

of mastery in mathematical concepts, especially exponents, and haste in answering questions.

3) Students who experience misconceptions in Exponent choose the right or wrong option with the wrong reasons, and CRI values > 2,5. This is because students misunderstand or even have misconceptions about the basic concept of Exponent, especially in the properties of Exponent. Several types of misconceptions in this study are misconceptions in notation, misconceptions in the sequence of operations, misconceptions due to systematic errors, and misconceptions due to transformation errors.

4) Students with a level of ignorance or lack of conceptual understanding of Exponent choose the wrong option with the wrong reasons, and CRI values < 2,5. Students do not know the concept because of the lack of ability and insight of students in solving the question, lack of mastery of the Exponent concept, not being able to correctly identify the purpose of the problem, lack of students' ability due to transform questions into mathematical models, lack in mastering the concepts applied, and the students challenging to determine the formula or strategy used.

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