The certainty of Response Index (CRI) and scale of honesty to identify student misconceptions

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Abstract. Research related to the identification of misconceptions has been carried out by some researchers, notably using the CRI scale (Certainty of Response Index). But there were no results that underline misconceptions by using a scale of honesty. This study aimed to identify misconceptions on relations and functions at Basic Math Capita Selecta subject using CRI and Honesty Scale. The study used survey methods, the instrument used was a questionnaire scale CRI, honesty scale questionnaire and interview guidelines. The results showed that: 51,32% student understand the concept; 12,63% high guess element of the correct answer; 16,32% are misconceptions; and 19,47% did not know the concept. Based on the results of the honesty scale which was strengthened by interviews, it is shown that students were wrong in understanding the concept of the relation of functions for a one-to-one correspondence between two sets, and wrong in determining the function of the graph. With the results of this identification, enables teachers to provide reinforcement for students who were still weak at a concept to provide a review of the material.

1. Introduction

Students mistake in understanding the concept in the learning process is the most frequently encountered. Such mistakes primarily occurred when studied mathematics. If students do not understand the math concepts are meaningful, then it will naturally make mistakes in performing various mathematical operations [1]. As Makonye & Fakude to say that there are several types of errors in mathematics, namely misconceptions (conceptual understanding that bad), procedural errors, strategic errors, logical errors (adaptive reasoning bad), and lazy to learn the numbers are interrelated (disposition productive poor) [2]. Misconceptions that students do in fact, have a positive side, which is evidence of their ability to use their minds. Exploration and discussion can help students uncover the limits of application related to the misconceptions that they do lead to a stronger and broader conception that will help the students’ subsequent mathematical development [3].

Misconceptions can be a problem for two reasons, namely, when students experience new learning and emotional and intellectual attachment to the misconceptions that students experience due to the reinforcement of the concepts they set [4]. Misconceptions can be determined by examining each student's diagnostic test answers, then find the pattern and to analyze the possible causes of these misconceptions [5]. One thing that should be known by a teacher, that misconceptions that occur in students should acquire direct intervention, but can be done by peers to correct the error [6]. Teachers should immediately detect misconceptions that occur in students, so that did not last long, because it will have a negative impact on the learning of mathematics in the future [7]. This is also because the mathematical material is interrelated so it needs understanding in the previous concepts.
At a freshman student of Mathematics Education Department, mathematics materials commonly found in Basic Math Capita Selecta subject. This course can broaden the knowledge of knowledge about mathematical material, especially the novelty of the development of mathematical material [8]. The material studied mathematics at the course is algebra, geometry, analysis, and trigonometry. Errors can occur from the results of the previous study [9], or when they learn mathematics matter because just based on the formula, the same model of solving problems, and weakly basic concepts. The conclusion of these errors based on the results of answers and brief interviews with a number of students who have contracted the Basic Math Capita Selecta subject.

Misconceptions can be seen by the teacher, other than through the analysis of the test results, as well as through scale *certainly of Response Index* (CRI). CRI is used to identify the level of misconception in students [10]. Through the CRI, the teacher can know that students know the concept, one concept, or do not know the concept, so that could be the right measurement tools for mastery of concepts [11]. Concept errors can be asked by teachers, in addition to through analysis of test results, also through the Certainty of Response Index (CRI) scale. CRI is used to install the level of misconception in students [10]. Through CRI, teachers can understand that students know the concept, wrong concept, or do not know the concept, so that it can be an appropriate measurement tool for mastering the concept [11]. Several studies have been conducted in using CRI to find out students errors in understanding concepts. [12, 13]. CRI is a simple measurement tool, but it is very important in the honesty of students as research subjects [14]. Honesty is a key that strongly supports the success of the use of CRI, for that we need another addition to learning honesty of students. Another measuring tool is called the honesty scale. What distinguishes it from previous studies is the use of CRI to identify concept errors in students by strengthening the results using the honesty scale. The honesty scale is a new finding in summarizing the results of the CRI scale. Before students fill out the CRI scale and the honesty scale, the researcher asks them to fill in according to their conscience and abilities. Researchers also supervise as they work on all questions and fill out questionnaires, to ensure their honesty is explicit.

Honesty scale developed to measure students' honesty characters that statement there were no decreases, increases, and conceal information [15]. Honesty scale is used to reinforce each answer student who has provided the answer to every point test and charging CRI of each point of the test. Based on previous research, identification of misconceptions is only based on the CRI scale and the results of the interview without being strengthened through the honesty scale first after filling in the CRI. As a form of renewal for research on the identification of misconceptions of students in Basic Math Capita Selecta subject, the researchers filled in the CRI scale and the honesty scale for the tests they had done, then confirmed through interviews with each student. The completeness of the instrument is proof that honesty is an important character for students in carrying out examinations as a form of understanding their concepts from the material they have learned. These results can be used by teachers to provide reinforcement in accordance with the misconceptions made by students. Because if a misconception is not immediately known and analyzed by the lecuturer, it will carry over when the student learns the next material that uses the material relations and functions as a prerequisite.

2. Methods
The study used survey methods, the instrument used are questionnaire CRI scale and the scale of honesty. Instrument in accordance with the questionnaire used for the purpose of research to reveal the respondents' opinions about the various things that they feel [16, 17]. To clarify the results of the questionnaire, it is necessary to approach the match in order to be valid the results of data collection, one of them through interviews [17]. The sample was 20 students taking the Basic Math Capita Selecta subject of all students at level 1 on the Mathematics Education Department. Students acquire a set of function and function graphs material test, with attachment questionnaire CRI scale and the scale of honesty. Students do the questions multiple-choice tests consist of 20 questions, by first obtaining guidance on how to fill out questionnaires CRI scale and the scale of honesty. After students
complete the test and filling the questionnaire, then the initial analysis was done to know there are misconceptions on both materials. To strengthen the results of the questionnaire scale and scale honesty CRI students, the researchers conducted interviews on the entire sample by interviewing them one by one. In this study, researchers used the CRI scale 6 (0-5), with the criteria as shown in Table 1 below.

| CRI Scale | Criteria                | Confidence Level | Explanation                      |
|-----------|-------------------------|------------------|----------------------------------|
| 0         | Totally Guessed Answer  | Low              | Correct, totally guessing        |
| 1         | Almost Guess            |                  | Wrong, not knowing the concept   |
| 2         | Not Sure                |                  |                                  |
| 3         | Sure                    | High             | Correct, Knowing the concept     |
| 4         | Almost Certain          |                  | Wrong, Misconceptions            |
| 5         | Certain                 |                  |                                  |

The criteria are shown in Table 1, to show the confidence level of students in answering all the exercises on function and graphics functions material. To distinguish between individual students who know the concept, there are misconceptions, or do not know the concept, then the following classified student answers shown in table 2.

| Answer test | CRI value | Description                                      |
|-------------|-----------|--------------------------------------------------|
| Correct     | > 2.5     | Know the concept of relation functions and graphics functions properly. |
| Correct     | < 2.5     | Do not know the concept of relation functions and graphics functions, contain elements of high guesses. |
| False       | > 2.5     | Misconceptions occurred on relation functions and graphics functions material. |
| False       | < 2.5     | Do not know the concept of relation functions and graph functions. |

A value of 2.5 as a standard emerged as a Likert scale used in the CRI is 0-5, then the criteria of confidence in answering test questions matter relations functions and graphs of functions that are two low and high. The median value being decisive is 2.5. To make it easier to identify the CRI scale and the scale of honesty, then the total amount of data that has been calculated, the percentage is calculated in the following way.

\[ x = \frac{p}{n} \times 100\% \]  

Information:
\[ x \] = average every criterion of scale CRI
\[ p \] = the total amount of each criterion CRI scale of 20 questions test
\[ n \] = many numbers matter.

To scale honesty, researchers used a scale of 4 (1-4). Indicators of honesty presented in the questionnaire shown in Table 3.
Table 3. Indicators of Scale Honesty

| Honesty Scale | Indicators of Honesty |
|---------------|-----------------------|
| 1 = Always Doing | • Not cheat when working on material test item relation graph functions and function |
| 2 = Often Make | • Write down the answers about what the appropriate concept that I understand |
| 3 = Sometimes doing | • Admitting the mistake I did, as a result of applying the concept or cheating |
| 4 = Never Did | • I never guess the answer to the test material and function relationships graph function |
|               | • I do all the test questions themselves |

To simplify the classification of misconceptions, the researchers adjust the numbering of tests with the aim of lectures arranged in several indicators. Here in Table 4 show the indicators in question.

Table 4. Indicators Tests of Relation Function Material

| Material       | Indicator                                                                 | Number |
|----------------|---------------------------------------------------------------------------|--------|
| Function Relation | - Able to implement the understanding of function relations in various cases. | 3,10   |
|                 | - Able to determine the functional components, namely domain, codomain, and range. | 2,7,8,12 |
|                 | - Able to determine the types of functions in various cases.               | 4,5    |
|                 | - Able to implement various examples of functions in the Venn diagram.     | 11     |
|                 | - Able to determine the number of possible relations of two sets.         | 20     |
|                 | - Able to determine the shadow of a variable on the function.             | 13,17  |
|                 | - Able to complete algebraic operations on functions.                     | 9      |
|                 | - Able to determine other elements of the function if the formula for the function is known. | 14,15,16 |
| Function Graphs | - Able to determine the function graph in accordance with the understanding of relations. | 1,18,19 |
|                 | - Able to determine the intersection of quadratic functions with respect to the x and y axes | 6      |

3. Result
The study produced data in the form of a questionnaire assessment. Results if the data from the questionnaire that has been distributed to students are grouped into four criteria, namely the idea of the concept (a), does not know the concept of the high guesses element (b), the misconceptions (c), and does not know the concept of (d). If the results of the questionnaire shown in Table 5 below.
### Table 5. Percentage of Questionnaire using CRI
Based on students' answers on the Relationship Function and Function Graph tests

| Number | Problem | (A)  | (B)  | (C)  | (D)  |
|--------|---------|------|------|------|------|
| 1.     | 21.05   | 5.26 | 21.05| 52.63|      |
| 2.     | 68.42   | 21.05| 5.26 | 5.26 |      |
| 3.     | 78.95   | 5.26 | 10.53| 5.26 |      |
| 4.     | 52.63   | 31.58| 10.53| 5.26 |      |
| 5.     | 10.53   | 5.26 | 42.11| 42.11|      |
| 6.     | 10.53   | 0.00 | 36.84| 52.63|      |
| 7.     | 68.42   | 26.32| 0.00 | 5.26 |      |
| 8.     | 68.42   | 10.53| 5.26 | 10.53|      |
| 9.     | 26.32   | 10.53| 15.79| 47.37|      |
| 10.    | 73.68   | 5.26 | 5.26 | 15.79|      |
| 11.    | 73.68   | 5.26 | 5.26 | 15.79|      |
| 12.    | 68.42   | 5.26 | 0.00 | 26.32|      |
| 13.    | 57.89   | 10.53| 10.53| 21.05|      |
| 14.    | 47.37   | 15.79| 26.32| 10.53|      |
| 15.    | 52.63   | 21.05| 10.53| 15.79|      |
| 16.    | 47.37   | 10.53| 21.05| 21.05|      |
| 17.    | 42.11   | 10.53| 31.58| 15.79|      |
| 18.    | 63.16   | 26.32| 5.26 | 5.26 |      |
| 19.    | 31.58   | 10.53| 42.11| 15.79|      |
| 20.    | 63.16   | 15.79| 21.05| 0.00 |      |
| Average| 51.32   | 12.63| 16.32| 19.47|      |

Shown in Table 5, the average percentage of students who knew the concept as much as 49.21%, answered correctly but there is an element of guesswork with a high of 12.63% category, experiencing misconceptions as much as 18.42%, and that does not know the concept of as much as 19.47%. Students experienced the biggest misconceptions about the percentage that number 5 and 19 is equal to 42.11%. Problem number 5 represents the material relations functions, while the matter of the number 19 represents the material graph of the function. So that errors occurred in the second concept of the material. Students wrong in applying the concept relations function for a one-to-one correspondence between the two sets. They only see the number of members in the two sets that are the same as 3 numbers, so most student directly answers the number of correspondence as much as 3 pieces. Misconceptions also occur in determine the graphs of function. most students are wrong in representing the shape of the function of the graph in the form of a parabola. They misunderstand related domain layout and codomain which eventually resulted in a parabolic shape that includes an inverse function with that instead. In line with this result, students experienced difficulties in demonstrating surjection of a function when finding the inverse of a given function and had misconceptions on inverse function and inverse relation [21, 22]. With appropriate pedagogy, it is possible for students to learn substantial and non-trivial mathematics at the high school level, and that the Algebra Project approach is one example of such a pedagogy [23].

Meanwhile, the percentage of students who knew the concept of 51.32%; just guess the correct answer of 12.63%; occurred one concept as much as 16.32%, and did not know the concept as much as 19.47%. On average, the students already understand the concept at the moment working on the problems of material relations exercise functionality and graphics functions, while misconceptions do not show a large percentage. This could be a sight for Capita Selecta lecturer of Mathematics to provide a second reinforcement material by focusing on students who experience any concept, just guess the correct answer, and did not know the concept. Thus the concept of the two materials can be accepted student correctly. To strengthen the results of each grouping above the CRI scale, researchers...
also group the results of an assessment of the scale of the completed student honesty. Based on the results of the honesty scale grouping that are tailored to the indicator, the result as shown in Table 6.

Table 6. Summary of Questionnaire Results Scale Honesty

| Indicators of Honesty | Honesty scale (Number of Students) | 1 | 2 | 3 | 4 |
|-----------------------|-----------------------------------|---|---|---|---|
| 1. Not cheat when working on material test item relation graph functions and function | 17 | 2 | 1 | 0 |
| 2. Write down the answers about what the appropriate concept that I understand | 15 | 3 | 2 | 0 |
| 3. If cheating at the time working on this matter, I'll admit it. | 17 | 2 | 1 | 0 |
| 4. I never guess the answer to the test material and function relationships graph function | 15 | 5 | 0 | 0 |
| 5. I do all the test questions themselves | 18 | 1 | 1 | 0 |

Table 6 can provide the information that the students in working on relations functions and graphics function material test, as many as 17 people or 85% of the students did not cheat. They are honest in filing an answer because when interviewed after the test and questionnaire filling CRI completed, they convey if they want to know each other's abilities. They hope if many mistakes then the teacher can give the review material so they increased understanding of the concept. This conclusion is reinforced from point 3, that 85% of students admit guilt if they cheated, but the honesty shown they did not cheat. Likewise for point 2 scale honesty. A total of 15 people or 75% of the students to write answers to the corresponding concepts that they can understand. This resulted in the calculation results on the identification of misconceptions students do not need to doubt its truth. They hope to measure the truth of a concept already understood. As many as 75% of students admit they never guessed the correct answer, so the elements can be measured the ability to understand the concept in relation function and quadratic functions graphs. For work that should be done about the individual, it turns out it is supported by the percentage of 90%. So the workmanship tests conducted are becoming an increasingly strong element of truthfulness.

Some research related to misconception has been done by several people. Hasyim, Suwon, and Susilo [19] argue that concept errors experienced by students need to be immediately analyzed to obtain information in an effort to reduce or prevent the emergence of concept errors in subsequent learning. One instrument that can be used to measure concept errors in students can use CRI [10,20]. Identifying student misconceptions plus interviews need to be carried out to find out why students experience misconceptions [14].

4. Conclusion

Misconception scale with CRI, which is equipped with the honesty scale is the right tool to find out the misconceptions of students. So, that lecturers can reinforce students who are still experiencing misconceptions or a low understanding of concepts. The results showed that more than half of the students who took the Capita Selecta for Basic Math course understood the concept, and the rest of it was students who answered correctly by guessing, not understanding the concept and experiencing misconceptions. What we need attention is 16.32% misconceptions occur, and 19.47% did not know the concept. Further research needs to be done in designing instructional materials that focused on Strengthening the concepts to overcome the misconceptions that occur.
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