Analysis of Studens' Understanding on Electrical Dynamics using Certain Response Index (CRI)

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Keywords: Electrical dynamic, certainty of response index (CRI)

Abstract : This study aims to identify students' conceptual understanding of electrical dynamics concept with Certainty of Response Index method. The type of this research is a quantitative descriptive study design. For data collecting, this research performs the DIRECT test—a multiple choice questions type with open reasons. Finally, the results show that 13.81% and 1.43% of the subjects are totally understand and uncertain regarding the concept, respectively. While 47.55% of students are misconception and 37.44% are uncomprehending. This result, furthermore, might provide information about students' understanding level regarding the concepts in the lesson of dynamic electricity.

1 INTRODUCTION

In recent years, physics educators are looking to determine students' understanding level regarding the physics concepts (Fisher and Frey, 2011). This condition, furthermore, point out the term ''misconception''- a word that explains the students' incorrect pattern of response. This pattern could be part of a naive theory on some physical phenomena or a more fragmented and primitive responses as a result of the posed questions (Engelhardt, 1997)

Deeper understanding in scientific concepts becomes the fundamental focus in higher education (Fisher and Frey, 2011). This unit plays a prominent role in building the scientific knowledge . However, the related studies notice that student's understanding at the initial point remain contrasts the scientific concepts (Syaharudin *et al.*, 2015; Suyatna and Anggraini, 2016). This gap, moreover, is refereed to the term of misconception. The term "misconceptions" might disrupt the comprehension of scientific concepts in cognitive structures (Suparno, 2013). Misconceptions in science apparently occur from elementary to higher education level (McDermott and Shaffer, 1992; McDermott, 1995).

The curriculum in physics education department of Universitas Sriwijaya consist of several basic courses related to physics discussion, fundamental physics, for instance. This lesson contains some concepts which is an integration of several sub-concepts. Concept definition stands for a thoughts or an ideas, including anything that is logically related to a category.

Part of sub-concepts in physics learning is electrical dynamic (Serway, Faughn and Vuille, 2008). This sub-concept is an essential material due to its features such as: plunge into the basis for higher levels of education (any lesson related to electrical circuits), occurs in daily life—society, science and technology, provides high application value (instructional application in any level of education), stands for the fundamental theory for all electronics circuits and devices).

A widespread usage of several instruments such as Force Concept Inventory (FCI) and the Test of Understanding Graphs in Kinematics (TUG-K) has brought a new way in evaluating students' conceptual understanding (Gurel, Eryilmaz and McDermott, 2015). However, more instruments need to be developed to allow instructors for better evaluation—determining the students' understanding of physics concepts and measuring the feasibility analysis regarding the teaching method (Kaltakci-gurel, Eryilmaz and Mcdermott, 2017). DIRECT, meanwhile, is an abbreviation of Determining and Interpreting Resistive Electric Circuit Concepts Test which is developed to evaluate students' comprehension regarding direct current (DC) resistive electrical circuits concepts (Kapartzianis, 2013; Breukelen, Smeets and Vries, 2015). DIRECT

Akhsan, H., Ulfa, M. and Ariska, M.
Analysis of Students' Understanding on Electrical Dynamics using Certain Response Index (CRI).
DOI: 10.5220/0009994100002499
In *Proceedings of the 3rd Sriwijaya University International Conference on Learning and Education (SULE-IC 2018)*, pages 178-182
ISBN: 978-989-758-575-3

is designed for high school and university level. Common misconceptions are incorporated into the distractor of the test items (Closset, 1983).

Student's perception concerning DC resistive electric circuits is quite diverse. They assume with two different standpoints: current is consumed and the battery is a source of constant current. In addition, students alternately use terms related to circuits, often assigning the current to voltage, resistance, energy, or power (Hestenes, Wells and Swackhamer, 1992). With reference to the related work, in this paper, we aim to determine students' comprehension on electrical dynamic concept using CRI.

The rest of this paper is systematized as follows. Section 2 elaborates the research method. Section 3 presents the result along with the discussion. Section 4 outlines the conclusion.

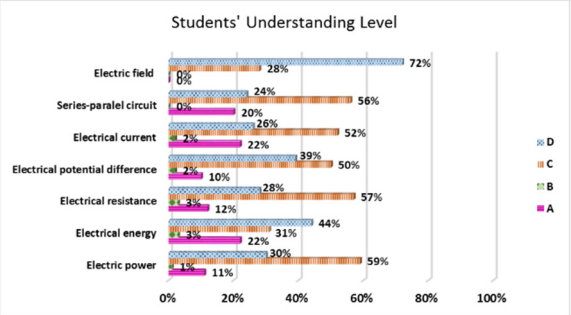
2 RESEARCH METHOD

This research adopts the quantitative descriptive study design for research method. By using this method, the authors can achieve the representation of student's perception on the sub-concept of direct current electric circuit (DC) through CRI instrument. This instrument consists of several criteria as the reference analysis. The researcher, moreover, will determine the concept understanding level on the sub chapter of direct current electric circuit—consists of electric current, electrical resistance, electric potential difference, electrical power, electrical energy, electric field, and series-parallel circuit. Each concept will be analyzed through student answers from the given conceptual questions.

This research was conducted in Department of Physics Education of Sriwijaya University from 3rd March 2018 until 15th July 2018 on academic year 2017-2018. The research subject, furthermore, were the students in the related period. The 3rd semester students represent as the sample of this study. In this research, the researchers classify the students into two groups with different abilities based on their latest achieved GPA. Moreover, the instrument provides questions about the form of conceptual understanding of sub-concepts on electrical direct current circuits in order to obtain students' level of understanding in each group.

3 RESULTS AND DISCUSSION

From the conducted research, data is obtained through students responses regarding the given form. The researchers analyze their reasons and then group the anwers into four categories which is outlined in Figure 1.



A = totally understand; **B**= uncertain;
C = misconception; **D** = uncomprehending

Figure 1**:** The students' understanding level regarding the concept on electrical dynamics.

Based on the figure 1, the graph illustrates the level of students' comprehension in terms of percentage. We group the data according to sub-concepts in the syllabus of electrical direct current which consists of seven concepts: electrical power, electrical energy, electrical resistance, potential electrical difference, electric current, series-parallel circuits, and electrical fields. Each concept, furthermore, is analyzed regarding the four categories of understanding concepts indicator. The obtained score in each indicator, moreover, provide the quantity for determining the average percentage. According to the results, misconception occurs with the highest percentage to the research subject, while uncertain comprehension stands for the lowest proportion.

3.1 Electric Power Concept

This research adapts the DIRECT (Determining Interpreting Resistive Electric Circuits Concepts Test) as the instrument. Based on the obtained results, 11% of the students are totally understand the concept. This data explains that some students have understood the equation of electrical power—means that the greater number of the resistance in a circuit, the lower number of produced power with constant potential difference.

3.2 Electric Energy Concepts

Related to the result in this study, 22% of the subjects are totally understand with this concept. This phenomenon reveals that students have comprehended with this statement, if two batteries are arranged in a chain, it increases the potential difference, while pararel circuit decreases. Energy per second (electric power) is proportional to the potential difference squared (V^2) and is inversely proportional to the resistance value (R). Therefore, the largest produced energy per second is provided through series arrangement of the two batteries.

3.3 Potential Electrical Difference Concept

Regarding the results, only 10% participant who are totally comprehend with this concept. By this, those subjects are familiar with the equation of the potential difference equation in the series form which is outlines in equation 1.

$$V=V_{12}+V_{34}+V_{45} \quad (1)$$

Then 2% of the subjects are uncertain regarding the concepts which stands for the smallest proportion among the four indicators. Furthermore, as many as 49.65% students have misconceptions—the highest proportion in this sub concept.

3.4 Electrical Resistance Concepts

In this sub-concepts, only 12% of the student are totally understand. Surprisingly, misconception also appears as the major among all indicators—stands for 57%. Apparently, several students are generally familiar with the series type circuit rather than the pararel arrangement of the resistor. They recognize easily that series circuit might increase the total value of the resistors, while face difficulty when the resistors are in pararel scheme might decrease its total value. The students who experience misconceptions are the subjects who answer the choice of answers correctly but give the incorrect reasons (with a confidence level > 2.5). While as many as 28% of the participants are uncompressed regarding the concept—they give incorrect answers and reasons by lower than 2.5 of the confidence levels.

3.5 Electric Current Concepts

In the concept of electric current, 22% of participants are totally understand the concepts. A great gap remains occurs related to misconception level which stands for 52%. While as many as 25.75% of the students are uncomprehend the concept—a similar number compared to the subjects who totally understand. This concept is related to the understanding level of student to apprehend the Ohm Law. In description, they might explain concretely that the current flowing is directly proportional to the potential difference and inversely proportional to the resistance. Students who do not understand the concept are the students who offer both of correct or incorrect answer regarding the question and reasons with a confidence level lower than 2.5.

3.6 Series and Paralel Circuit Concept

Through the data analysis, it is obtained 20 % and 24% for the students who completely comprehend and uncompressed, respectively. While 56%, as the largest part of percentage level in this concepts represent the number of the students who have misconception. Meanwhile, there is none of students who are uncertain regarding the concept.

The indicator level of understanding regarding this concept is the comprehension of reading the series-parallel circuit diagrams from several lamp resistors in schematic diagrams to be outlined in the form of ordinary circuits. Those participants who uncompressed the concept are the students who give both of correct and incorrect answers or reasons with a confidence level below 2.5.

3.7 Electric Field

On the electric field concept, as much as 28.3% of the students have misconceptions. While 71.7% are uncompressed the concept.

3.8 Related Work

The research in determining student's misconception had been conducted by (Nugraha *et al.*, 2018). The obtained outcomes shows that several students remain face the difficulty in understanding the physics concept, specifically in electrical current, voltage, and resistance. Regarding the data, it is apparent that only around a half of the participant who have the correct perception to the concepts. Another related research also have performed by (Perdana, Suma and Pujani, 2018). It is evident from the information provided that misconception had by far the highest number of students' perception percentage 44% among all categories. Figure 2 and Table 1 illustrate the comparison with some preliminary research.

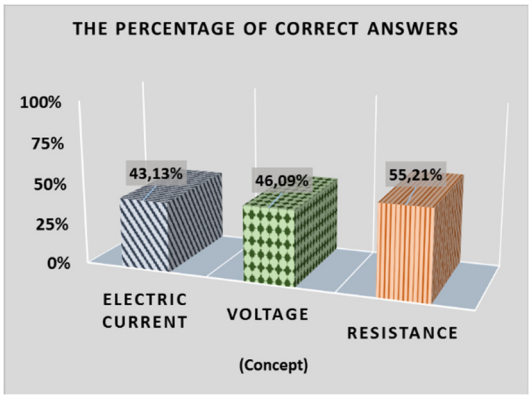


Figure 2: The percentage of student achieving the correct answer (Nugraha *et al.*, 2018)

Table 1: The comparison of students' conception regarding the Electrical Dynamic Concept

Concept	Conception (%)							
	SK		M		E		LK	
	A	B	A	B	A	B	A	B
Current	36,4	22	43,2	52	5,0	26	15,4	2
Resistance	34,2	12	43,9	57	2,0	28	19,9	3
Series-paralel circuit	22,3	20	46,6	24	5,1	24	26,0	0
Potential difference	19,1	10	35,3	39	0,0	39	45,6	2
Energy and electric power	16,7	16,5	50,0	45	0,2	37	33,1	2

A= Perdana, Suma and Pujani, 2018; B = results in this research
SK=Scientific Knowledge; M= Misconception; E=Error; LK=Lack of Knowledge

A glance at the figure 2 provided reveals a proportion of correct answers in electrical dynamics concepts. Of these concepts, resistance seems to be more simplify among others concept in terms of understanding. Accounting for around to 55% of respondents—which is the highest proportion of true answers. On the other hand, voltage and electric current are lower—less than a half correct answers of the total proportion.

Nugraha (Nugraha *et al.*, 2018) lists several reason for those problems. Firstly, many students answer the question according to their argument with the wrong concept—well-known as concept error. Secondly, the way teachers teach might affect the understanding level regarding the concepts.

Meanwhile, given the table comparing the students' conception percentage in higher education. Overall, the most students have misconception regarding the concepts. It seems that participant in Research A are mostly misconception with electrical energy and power while in this study, resistance stands for the most risky concept which might arise the misconception.

Moreover, it is surprisingly that both researches has significant difference in terms of percentage—the indicator of error and lack of understand category. Although the proportion tend to be similar, the gap remains contrast. The level of lack of understanding shows A stands for the large score while group B provide minimum value. While, for error indicator level, it is revealed that Group A is lower compared to Group B. This certain gap might be caused by several problems—such as less practical lesson in the school.

The beneficial aspect through this study is providing initial description of students' understanding in electrical dynamics concept. Although there is a significant gap with both groups, there should be several factors that affect the scores. According to Perdana, Suma and Pujani (2018), some suggestions are considerable specifically for teacher. Firstly, the teacher should aware their students' conception. It might be fatal for the students on further learning due to misconception. Secondly, some instructional should help in building students' understanding of the concepts. Last, teacher should creatively arrange the learning progress and motivate the students to read more book.

4 CONCLUSION

Based on the results obtained in this research and the discussion, we reach the conclusion that majority of students in Physics Education Department have misconception in electrical dynamics lesson. Although the analysis is limited in several ways (only provide misconception data without finding its causal factors), our study provide the framework as the reference for further research regarding the solutions to misconception, such as conceptual change, for instance.

ACKNOWLEDGEMENT

Thanks to the 2018 Science, Technology and Art research grants with the research contract number 0179.66/UN9/SB3.LP2N.PT/2018.

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