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Revealing Student's Multiple-Misconception on Electric Circuits

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Abstract. Quick identification of misconception on classroom setting is an important step to gain deep understanding on physics. The study aims at developing simple tools to determine students' misconceptions and to reveal students' misconception about electric circuits. This research was conducted in the form of a survey study. Initially, Multiple Misconception Revealing Test (MMRT) with some characteristics, i.e. arousing curiosity on students to solve using of several concepts, potent to reveal one or more student's misconception(s), allow the students to explain their answers, as well as allow to be followed up, was developed. The test was administered to 60 of higher education students (prospective science teachers) and data were analyzed both quantitatively and qualitatively. The results shows that only 17% students have right conception about electrical circuit, the others have one of three type of multiple misconception. About 7% students hold Type 1 multiple misconception (cannot distinguish between serial and parallel principles); 43% students have the Type 2 (misunderstand circuit principles as well as cannot distinguish between serial and parallel principles); and 33% students have the Type 3 (misunderstand circuit principles, misunderstand circuit components, and cannot distinguish between serial and parallel principles). The conclusion is that there is no single student misconception on classroom, particularly on electrical circuits; and the MMR test can reveal three kinds of multiple misconception on it.

1. Introduction

It is known that students often have ideas and knowledge about nature that are substantially different from the views of scientists [1], called misconceptions. Misconceptions are encountered at various levels of educational units and cultural backgrounds [2][3]. Magnusson, Bole and Templin [1] state that experts may still have a misconception encoded in the neural networks of their brains that must be inhibited in order to answer scientifically. Misconceptions may deeply penetrate into students' minds and be resisted to change [4][5]. Misconception is one of the major obstacles in studying physics [6], and thus leads students to the failure when studying physics [1].

Misconceptions occur on a variety of physics topics, including electricity. The misconceptions include consumption model, current collision model, equalize or exchange current with voltage, closed circuit model without including voltage source [7]. In addition, there are students who misunderstand the series and parallel circuits, including the current and voltage properties of the circuit [4][8]. Misconceptions, including in electrical circuits, are not single in one concept, but tend to be interconnectedness between concepts [2]. Also, students tend to have misconceptions including more than a concept or multiple misconceptions.



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Remedial of misconceptions can be done, but not easy. It is not only the students' misconception tend to be multiple, but also they tend to hold on to the explanations they have formulated in their minds. This remediation requires conceptual change in students. These are cognitive conflicts and analogies [9], including using educational-technology [10].

In the context of prospective science teachers, misconceptions about the electricity they may have must be remediated. To teach physics effectively, misconceptions must be spotted and overcome [11]. This remedy is conducted in a relevant lecture. However, this remedy requires a quick way to uncover any misconceptions that may occur to them.

Various methods of uncovering misconceptions have been developed, among others: concept inventory, test with Certainly Response Index (CRI) or two tier test [12], which later developed into 3 tiers [13][6], and 4 tiers [9]. They require a sufficiently long time to administer test, analyze, and determine misconceptions for students. In addition, the test is in the form of multiple choice, generally each item is only related to a single misconception. Therefore, these methods are not suitable for classroom diagnostic test purposes, such as a simple way to reveal students' misconceptions fastly as well to be handled easily by teacher.

In order to classroom diagnostic tests for misconceptions, the idea is: do not need many test items, test items that engaging curiosity on student (to solve), on "inclusive concept" so that requiring students to use of several concepts, as well as allow to be followed up. However, whether this idea can reveal one or more student's misconception(s), this needs to be examined.

2. Method

This research was conducted in the form of a survey using Multiple Misconception Revealing Test (MMRT) completed with selected interview. MMRT was administered to 30 of prospective science teachers at one of the state universities in Indonesia who take Electricity and Magnetism course, and interviews are conducted on 9 selected students in response to MMRT. The data were analyzed descriptively by categorizing data, crosscheck with students' notes and results of interview. The MMRT as a data collection tool is developed according to the ideas above, with the following details:

1. the test is about open ended question;
2. problems developed in parallel circuits, allowing students to use a variety of relevant concepts;
3. problem is on the level of creating, ie in the form of constructing [14] with certain rules. Problem solving by drawing, so easily recognizable right or wrong quickly (in the context of diagnostic test) and expected arousing curiosity on student to solve; and
4. problems are equipped with a level of confidence and an explanation of why they answer like that (the idea of three tiers test). See Figure 1.

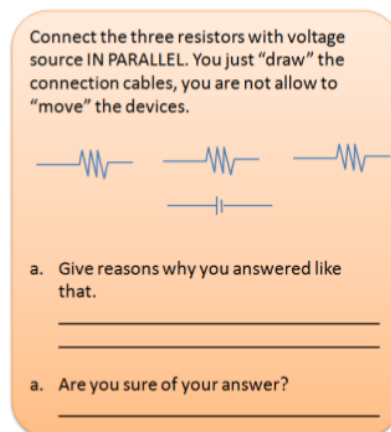
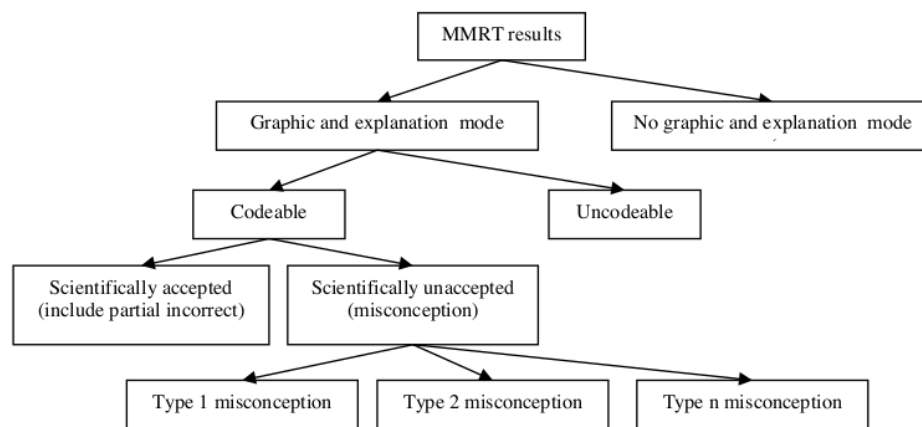


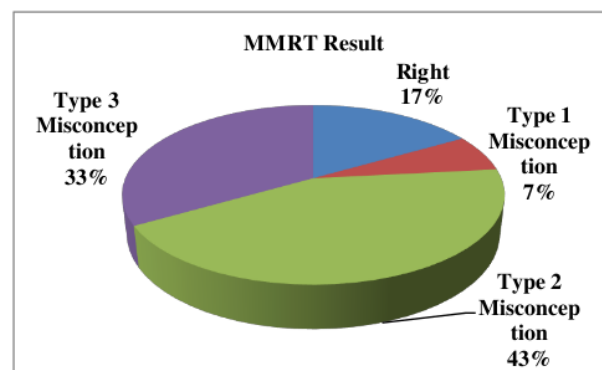
Figure 1 The MMRT of Electric Circuit**2**

Data obtained from MMRT were analyzed using the approaches which require the definition of scientifically complete response (nomothetic) and the classification of explanations in certain categories (ideographic) [4]. See Figure 2.

**Figure 2** Analysis of MMRT Result**2**

3. Results and Discussion

As the analysis of the data was completed, the findings obtained show that only 7% answers were in the scientifically accepted category. Because all participants answered with confidence (pictures and explanations), the rest (93%) experienced misconceptions. The results of further analysis show, misconceptions that occur can be categorized into 3 types of misconception. See Figure 3

**Figure 3** MMRT Results Analysis

Almost all textbooks and explanations in the class use a picture of a parallel circuit like Figure 4 (a). It seems that students hold this strong in their cognitive structure. This is evident from the student's writing, "... this matter is not the same as in the book, it makes me ...".

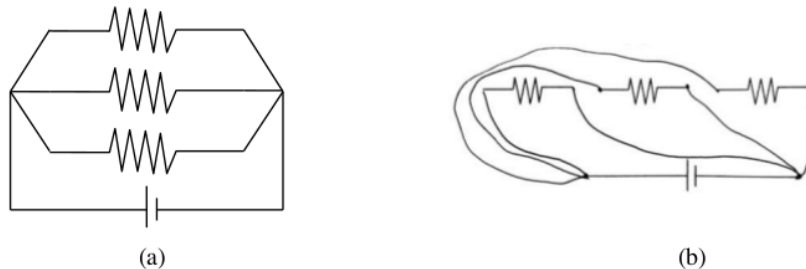


Figure 4 (a) Parallel circuits commonly described in books, and (b) correct answers

The mental picture in his/her mind of parallel circuits makes it memorized, so that students are unable to recognize the essence of parallel circuits. Generally, misconception tests on electrical circuits do not extend up to this point, so these results cannot be confirmed with other studies. However, it is known that one will have a mental picture of something, in this case a parallel circuit. The mental picture is useful because it is the simplest and most imaginable one, but it apparently makes the person misunderstood of the essence, in this case is parallel circuit.

The misconceptions that occur to them are not only in one concept but in some other aspects, including: the inappropriateness of distinguishing the essence of series and parallel circuits, the inaccuracy in understanding closed circuits, and the inaccuracy in understanding of the components in a closed circuit. So, it turns out this misconception is layered on each student, so it tends to be multiple misconception. Multiple misconceptions that occur can be classified into 3 categories, as follows.

1.Type 1 Misconception

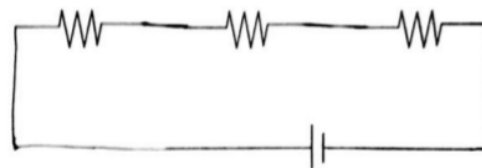


Figure 5 Example of Type 1 Misconception

On Type 1 Misconception, they can't distinguish between series and parallel circuits, but they have a correct understanding of closed circuits. According to them, "... according to the book, if there are three resistor lined horizontally, the circuit is like that ...". Apparently, the process of thinking: "**The type of circuit depends on how the resistors are placed with each other**" becomes misconception on electric circuits. Such misconceptions have never appeared in previous research.

2.Type 2 Misconception

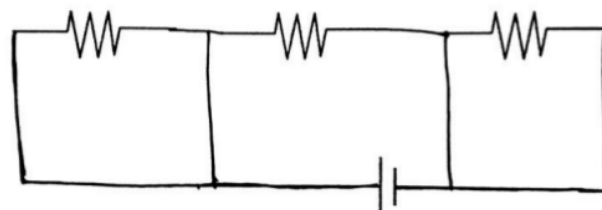


Figure 6 Example of Type 2 Misconception

On Type 2 Misconception, they cannot distinguish between serial and parallel principles. They also misunderstand about circuit principles. According to student's notes, "...I try to imitate the drawing in the book..". The misconception closes to "unipolar model" [15]

3.Type 3 Misconception

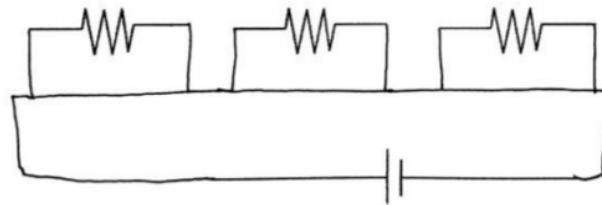


Figure 7 Example of Type 3 Misconception

On Type 3 Misconception, they cannot distinguish between serial and parallel principles. They also misunderstand about circuit principles as well as circuit components. Again, mental images "in accordance with the book" seem to have been held in their minds and defeated the essence of electrical circuits. The misconception closes to "Scientifically Unacceptable" category [4].

4. Conclusion

To conclude, there are two main findings of the study, that are:

1. MMRT can reveal students misconception relatively quickly, so it can be a diagnostic tool in the learning process.
2. On the subject of research, only 17% have right concept about parallel circuit, the rest tend to have multiple misconceptions. There is the misconception not encountered in the previous studies: the type of circuit depends on how the resistors are placed with each other.
3. There are 3 kinds of multiple misconception on electric circuits. The standard drawing of parallel circuits in the book seems to make students not recognize the essence of parallel circuits. It is needed to be further develop of MMRT on another subject.

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