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Study on Latent Misunderstanding on Electrical Current Concept and Its Impact

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Abstract. Misunderstanding of the electrical current concept has been identified and is known since many years ago, but a similar error occurs still in the students today. This research will try to uncover why the misconception that ever happened was still going on today. What important factors that contribute to the occurrence of such misconceptions and its impact on understanding and mastery on the subject of electricity.

1. Introduction

The concept of electric current is one of the important and fundamental concept in understanding the problems of electricity, the misunderstanding of this concept will have an impact on difficulty and even failure in the next understanding of the concepts associated with electric current, in terms of learning about the electricity always related to the concept of electric current.

An electric current is defined as a flow of electric charge. A current may be a flow of positively charged particles, negatively charged particles, or both positive and negative charges simultaneously. By international agreement, the direction of *conventional electric current* is taken as the direction of positive charge flow; if negative charge particles, i.e. electrons move one way in a material, the conventional current is in the opposite direction [1]. The voltage of a battery causes a movement of charge, or electric current, around a conducting circuit. In most cases, the charges are carried by electrons. The greater the voltage produced by the battery, the greater will be the electric current in the circuit.

Usually, teachers use an analogy to get down the concept of electric current and potential to the student in their class. A battery is analogized as a water-pump that gives energy to the water to flow in the pipe. This analogy should be used carefully, because the situation is not quite the same. The water can flow in the open end pipe, but the electric current only flows in the complete circuit. The analogy should be chosen properly, otherwise will be contra productive [2,3]

Conventional electric current, I_c

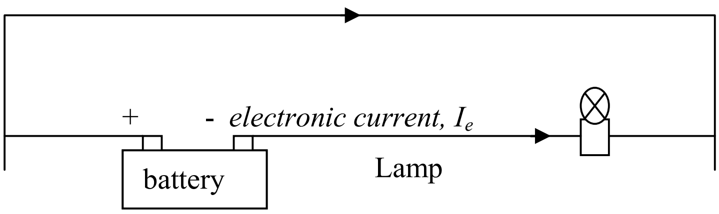


Fig. 1. A simple closed circuit current.

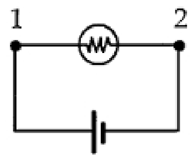
Misunderstanding of electric current has been recognized by physics teachers since decades of years ago [4]. When SEQIP (Science Education Quality Improvement Project) program has been implemented through an upgrading and development a subject matter tutor in Primary School Science in some provinces in Indonesia during the 2000's this problem were widely considered and discussed [5], however problem of misunderstanding is still happening, even with some prospective Post-graduate students of Science S2 Unnes and is also found in some of the final semester students.

Latent misunderstandings that continue to emerge are encouraging an attempt to question why this fault persists. It becomes a challenging study for those who engaged in physics education - science.

2. Methods

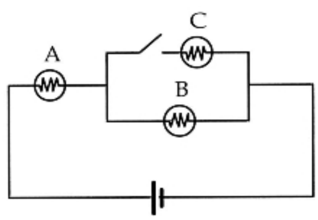
Problems revealed by a test, given to 25 students who choose study in science, Post-graduate program at Unnes 2016, and also to 3rd-semester students of Science program mayor in biology. Item tests related to electric current were based upon some test items developed by DIRECT program [6] as follows:

1. The electric charges flowing in a closed circuit are consumed by the lamp to produce light.
   a. Yes, the charge is consumed by the lamp filament to produce light
   b. Yes, charges are emitted
   c. No, thechargeis conserved. It is simply converted to another form such as heat and light
   d. No, thecharge is conserved. A charge moving through the filament produce "friction" which heats up the filament and produces light.
2. Compare the electrical current strength at point 1 and point 2. Which point has the larger electric current is….
   a. Point 1
   b. Point 2
   c. Neither, they are the same
   d. Both points have a volatile, strong electric current



3. What happens to the brightness of lamps A and B when the switch is closed?
   a. A stays the same, B dims
   b. A and B increase
   c. A and B decrease
   d. A brighter, B dims

   (Note: A, B, C are identical lamps)



The answer to these questions is obtained as follows

No. item test	options				Group respondents
	a	b	c	d	
1	1	9	3	12*	Candidates Science Postgraduate students (25 students) (Group I)
2	3	6	15*	1	
3	12	2	6	5*	
1	7	0	1	1*	Third semester Science Postgraduate students, mayor in Biology. (9 students) (Group II)
2	2	0	5*	2	
3	5	2	0	2*	

* Choice of correct answers.

3. Results and Discussion

Presumably understanding of the concept of electric current in a closed circuit is still an issue in the discussion on electricity. More than half (13 out of 25) of respondents group I did not answer correctly. Nine students from this group consider electric charge is consumed by thelamp and converted into light then emitted by the lamp. They may assume that the light has energy, and this energy is produced from electric current. The Even more astonishing answer was given by the respondent of group II. Seven out of nine respondents answered theelectric charge that flows consumed by the lamp and then converted into light. This choice is interesting to study further, whether the answer choices are influenced by the biology subject studied? A creature must consume something before producing anything. It could be misunderstanding caused by intuition [4] which is affected by the disciplines studied, that create a background knowledge [7]

In general, it can be said that students had misconceptions in understanding the energy carried by electrical currents. This is clear from the answers that flow is reduced when passing through the light because some current turned into energy. In explaining this case, a teacher can use an analogy [2] of water flowing from an elevation. Water was pumped into a water tower, and then the water flowing down turning a waterwheel and collected in a tank to be pumped back. Moving of circulated water can be analogous to the electric current. The water pump which pumps water up to the tower it can be considered as a battery, it will give energy (namely mechanical energy) to the water. When the water is flowing down from the water tower, it has a kinetic energy and therefore able to rotate the waterwheel. The waterthen ends up in the tank; the mechanical energy was reduced because it has been used to slide down and drive the waterwheel, however, the amount of water remains unchanged. The same thing happens when the current flows through the lamp resistant. The energy carried by electric charges obtained from the battery as a voltage source encounter a friction with resistivity on the lamp, causing heat and light, but the charge in itself is not reduced.

Referring to the answers given by the respondents, both in group I and II, it can be concluded that in general the students have understood that a strong electric current in a closed chain is equally same. Respondents who answered point 1, currents larger than 2 points, we need to track closer their understanding of current and potential. Moreover, who answered point 2 is larger, need to be tracked if they are not able to distinguish between electric current and flow of electrons. Both those who chose point 1 or point 2 had larger current; it seems that students to solve the problem by way of sequential reasoning. Students reasoning by way of sequential assume that the current flowing in the circuit is affected whenever encountered element in the circuit [6,8]

Observing the respondents' answers to question no 3, it was only a small part of the group that can answer correctly, 5 among the 25 in group I and 2 out of 9 in Group II. Most of the respondents chose answer lamp A stays the same and lamp B dims. They think that after the current go through the lamp A, there is no longer effect against the lamp A, but because the current meet a branching, the flow will be divided. Consequently the current through the lamp B is smaller, and the lamp dims. In solving this problem, the students are likely to think using the pattern of sequential reasoning and then the local reasoning [6]. These patterns of reasoning may cause misunderstandings in resolving the question no 3. They are supposed to analyze in a comprehensive manner by looking at the circuit as a whole.

When the switch is closed, then there is a parallel relationship between B and C lamps, replacement value (B *) will be smaller than the lamp B, so that the total value of resistivity in closed circuit A + B > A + B *. Thus, in the condition of the switch is closed, the current in the circuit through the lamp A larger and brighter.

4. Conclusion

Misunderstanding the concept of electric current turned out to be a problem that always occurs on the topic of electricity in physics instructions. Various factors may play a role in the cause of this misunderstanding. This misunderstanding needs to be considered and addressed in order not to be a misconception that more difficult to overcome and lead to learning difficulties and might also in the development of scientific literacy [9]. There are some efforts to overcome this misunderstanding such as: using an analogy that is well structured in carrying out the teaching learning activity [2], problem-solving strategy based on conceptual and procedural knowledge [10], inquiry-based learning through inquiry lab instruction [11], but it is important to recognize that there is no singular method of science [12], This study is an initial study to detect and find solutions to the various misconceptions that repeatedly occur in a variety of discussion topics of physics

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