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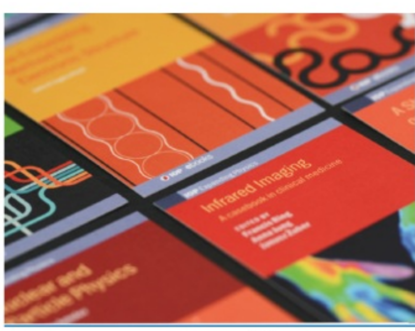

# Student conception of Ohm's law

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**Abstract**. The purpose of this study is to reveal students' conceptions of Ohm law. This study uses a qualitative method. The sample used consisted of students who took courses related to current and electrical resistance. That is the second semester (11 students), four semesters (13 students) and four semesters (17 students) in the electrical engineering education program at the Universitas PGRI Madiun. Data is collected by giving essay and interview questions. From the results of the study, it can be concluded that students who have majored in electricity have not yet 100% understood the concept of Ohm's law. The results of the analysis show that the wrong conception will arise because students do not understand the language of physics in relation to electro properly.

## 1. Introduction

Research that discusses student misconception has been carried out both in the field of science and in other fields. Dede Kurniawan and Tri Mayanti conducted a study to analyze student understanding of the concept of dynamic electricity and the results obtained stated that the majority of students still experience misconceptions regarding electric current [1]. Besides that Bilal and Erol also conduct research where students have some common misconceptions in electrical concept [2] for example in the concept of direct current electric circuits [3], open circuits [4] and understanding of the concepts of voltage and potential difference [5].

The existence of misconceptions in certain chapters cannot be separated from the role of educators and students. For example in mathematical learning, a mathematical way or process that is fast and focused on results turns out to hinder the progress of students' understanding of the real object whose future relationship is related to financial intelligence [6]. A misconception can be reduced if the way of educating and learning is appropriate [7]. In this case, several studies conclude that the acquisition of a basic concept that can reach the given field of knowledge must take into account students and scientific representation [8].

Physics-related research has been widely published [9,10,11]. One of them is related to the concept of physics. Research related to the concept of physics is very necessary to do, and in the future, it is expected to reduce misconceptions. This is because at this time in a learning process there are several concepts that are only based on intuition, which are different from scientific views which will lead to misconceptions [12].

The physics learning process has many fields, one of which is electricity. Most physics teachers who explain about electricity will begin the explanation by an understanding of electric current, electric circuits, Ohm's law, Kirchoff's law, which is continued by giving examples of problem-solving and ultimately evaluation. Based on the research that has been done, from several fields of electricity found that students will find abstract concepts that are difficult to understand when learning about Ohm's law.

There are many models and methods that can be used to learn about Ohm's law, but none of them are able to explain the concept of Ohm's law in detail and complete.

Several studies have been carried out relating to the conception of Ohm's law. In 1992 the study of the concept of electricity got the result that most students experience continuous concept difficulties in terms of simple electrical circuit analysis such as the student's inability to apply the concept of the relationship between current, voltage and resistance [13]. Other researchers found that some students had difficulty in demonstrating an electrical circuit system, furthermore if the electrical circuit was changed. This shows that the cognitive level possessed by students still reaches a low level. Where in the future will have quite serious effects related to the sustainability of learning in the classroom. Not only limited to the law, but also to science learning in general [14]. In 2016 research on how students learn about Ohm's law through traditional approaches and problem based learning approaches [11]. Research on students conception and perception of simple electrical circuits was also conducted to determine the extent of students' misconceptions about electrical circuits. From this study, it was stated that the conceptual test and presentation in various forms (multi-representation) can also be done to improve understanding of concepts [15]. The 2018 study of Ohm's law discusses that fan computers are well used for qualitative exploration of Ohm's law and simple electrical circuits using the effective resistance of each fan [16].

Some of these studies show that understanding of a concept is needed in the sustainability of the learning process. The concept possessed by the student will later have an influence in terms of understanding what he sees [17]. Five things that led to the concept of science are very difficult to learn first is the concept of science is an abstract concept, has a complex system, experience/student's previously had limited knowledge, lack of understanding of the finite symbol, and the occurrence of misconceptions in the study [18].

## 2. Method

The method used in this research is the descriptive qualitative method by taking a random sample from second-semester students, semester IV and semester VI at the University of PGRI Madiun who are dealing with subjects related to physics and electrical circuits. Data was collected using several tests on a conceptual theory about Ohm's law combined with an explanation of the answer. After the data regarding student conception was obtained, followed by the treatment which aimed to reduce student misconceptions about Ohm's law concept.

## 3. Result and Discussion

Ohm's Law was born from the results of a laboratory experiment conducted by George Simon Ohm where he discovered the relationship between current and voltage. The relationship between current and voltage can be derived from the charge conduction equation. This equation is analogous to the thermal conduction equation, as shown in equations 1 and 2,

$$\frac{dq}{dt} = \sigma A \left| \frac{dV}{dx} \right| \quad (1)$$

$$\frac{dq}{dt} = kA \left| \frac{dT}{dx} \right| \quad (2)$$

Equation 1 is the equation of thermal conduction equation, the rate of energy flow $dQ/dt$ (in SI units of joules per second) is due to a temperature gradient of $dT/dx$ in a material of thermal conductivity $k$. State analogous rules with regard to the direction of the current change in temperature [19].Equation 1 is an initial equation that can be used to reduce Ohm's Law equation. From equation 1, $dx$ is a long element that represents the conductor path traversed by the charge. By using the relation $\sigma = \frac{1}{\rho}$ so, equation 1 can be written with:

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$$\frac{dq}{dt} = \frac{1}{\rho} A \left| \frac{dV}{dx} \right| \tag{3}$$

If the two sides are integrated, then we can find equation (4)

$$\frac{q}{t} = \frac{1}{\rho} A \frac{V}{x} \tag{4}$$

Because $x$ in the equation (4) indicates the length of the conductor path traversed by the charge, it can be denoted by $l$. By change $x$ into $l$, so the equation 4 becomes:

$$\frac{q}{t} = \frac{1}{\rho} A \frac{V}{l} \tag{5}$$

Remember that $I = \frac{q}{t}$ and $R = \rho \frac{l}{A}$ so, equation 4 can be denoted:

$$I = \frac{V}{R} \tag{6}$$

Ohm's Law is very simple but only applies to the homogeneous material or linear elements. This relationship to Ohm law only applies to metal conductors, but it does not apply to other materials such as diodes, vacuum tubes, transistors, etc.

The focus of this study refers to equation 6. The tests on the concept of Ohm's law are applied to students who take courses related to electricity. This test model is conducted to find out where the students' understanding of the concept of Ohm's law before being given further learning and analysis of Ohm's law application with strong current electro devices. Conceptual tests carried out include the definition of currents, the relationship between currents, barriers, and stresses in Ohm's law, as well as several factors that influence Ohm's law series. The results obtained about this study regarding student conception of Ohm's law are shown in Table 1.

Table 1 shows a comparison of the correct concepts and wrong concepts and conceptions of students. From the table, it can be seen that students still experience misconceptions related to the concepts of currents, resistance, and differences between voltages and potential differences. Misconceptions about the basics of electricity will greatly influence the subsequent learning process. This is because the future learning process will increasingly discuss the concepts of electricity. With the existence of several correct learning processes, it is hoped that it can reduce misconceptions in students, especially in relation to the concepts of electricity.

**Table 1.** Profile of students conception of Ohm's Law

| Correct Concept | Incorrect Concept | Student Conception |
|---|---|---|
| Current is the rate at which charge flows past a point on a circuit. Currents in a circuit can be interpreted as the amount of charge Q that passes through the wire trajectory over time t. $I = \frac{Q}{\Delta t}$ | Electric current appears due to the potential difference found in the voltage source, and the size of the current depends on the resistance and voltage. | Electric current is an electron that flows because of a potential difference. Electrons will flow to a high potential difference towards a lower potential difference. |
| The value of resistance in an electrical circuit is not affected by current and voltage but by the length of the conductor, the cross-sectional area and the type of conductor $R = \rho \frac{l}{A}$ | The size of the electrical resistance is affected by the size of the voltage and electric current in the circuit. $R = \frac{V}{I}$ | Based on the equation of the ohm law $R = \frac{V}{I}$, so in an open circuit no current will appear, because the voltage is equal to zero, then the resistance is automatically zero. |
| a. The value of electric current in a circuit depends on the magnitude of the potential difference.<br>b. There is a difference between voltage and potential difference, namely in terms of placement. The potential difference is a change in the potential energy of the system divided by $\Delta V = \frac{\Delta u}{q}$ the test charge. While the voltage is a unit of potential difference. A Voltage which is a measure of electric potential difference is the cause of electrical current to flow in a closed circuit [20]. | a. The value of electric current that flows is proportional to the magnitude of the voltage.<br>b. In learning electricity the potential and voltage differences are considered the same. | The value of electric current that flows is proportional to the magnitude of the potential difference or voltage. With the assumption that the potential or voltage difference is considered the same. |

Data in Table 2 shows the percentage of understanding student concepts related to Ohm's Law. On the third concept of voltage and potential difference, there are 0.0% of students do not have the correct concept, meaning that all students have the wrong concept of voltage and potential difference. This shows that previously the explanation of the concept of stress and a potential difference is considered the same. Voltage is a unit of potential difference, while the potential difference is a change in potential energy from a system that works on a particular charge.

**Table 2**. Percentage of student conception

| Conception | Semester | | |
|---|---|---|---|
| | II | IV | VI |
| Currents in a circuit can be interpreted as the amount of charge Q that passes through the wire cross over time t. | | | |
| no conception | 54.5 | 53.8 | 47.1 |
| incorrect conception | 36.5 | 30.8 | 35.3 |
| correct conception | 9.1 | 15.4 | 17.6 |
| Factors that influence the amount of electrical resistance | | | |
| no conception | 45.5 | 46.2 | 41.2 |
| incorrect conception | 36.4 | 38.5 | 35.3 |
| correct conception | 18.2 | 15.4 | 23.5 |
| There is a difference between potential and voltage differences | | | |
| no conception | 63.6 | 61.5 | 58.8 |
| incorrect conception | 27.3 | 30.8 | 29.4 |
| correct conception | 0.0 | 7.7 | 11.8 |

Based on the results of research on student conception of Ohm's law, it is necessary to carry out further research to reduce the misconceptions that exist in the student. Thus in the future, the learning process will be able to proceed better, where students will truly understand the concepts of electric circuits. Student conception of Ohm's law was tried to be improved through the process of learning project-based learning models assisted by various electronic KITs. The results obtained are related to the three concepts that have been stated in Table 1, shown in Table 3

**Table 3.** Percentage of reduction of student conception before and after treatment

| Correct Concept | Semester | | | | | |
|---|---|---|---|---|---|---|
| | II | | IV | | VI | |
| | Before | After | Before | After | Before | After |
| $I = \dfrac{Q}{\Delta t}$ | 90.9 | 27.3 | 84.6 | 23.1 | 82.4 | 23.5 |
| $R = \rho \dfrac{l}{A}$ | 81.8 | 36.4 | 84.6 | 30.8 | 76.5 | 23.5 |
| The differences of potential difference and voltage. | 100.0 | 45.5 | 92.3 | 38.5 | 88.2 | 35.5 |

The percentage in Table 3 shows that after treatment the student misconceptions decreased. From the original majority of students experiencing misconceptions or not understanding the concept at all has decreased in number. Treatment is carried out using a project-based learning model. The students must analyze Ohm's law equation, which of the currents, voltages, and obstacles is a fixed and moving variable. The final results obtained by student understanding of Ohm's law conception have increased.

## 4. Conclusion

The student must really understand the concept of electrical physics before going further in learning. The learning project-based learning model is absolutely necessary to reduce incorrect conception. By applying this model assisted by KIT Electronics, the understanding of student concepts regarding Ohm's law has increased. This is certainly very helpful in the continuation of the next learning process.

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**References**
[1] Dede T and Sri M 2018 *Sci. Educ.* **7** 1.
[2] Bilal E and Erol M 2009 *Am. J. Phys. Educ.* **3** 2
[3] Ugur G, Dilber R, Senpolar Y and Duzgun B. 2012 *Eur. J. Educ. Res.* **1** 2
[4] Hussain N, Latiff L, and Yahaya N 2012 *Procedia – Soc. Behav. Sci.*
[5] Timmermann D and Kautz C 2014 *Front. Educ. Conf. (FIE) Proc.*
[6] Makonye J P 2018 *J. Assoc. Math. Educ. S. Afr.* **38** (1), a307.
[7] Tove C, Nina B, and Tore B 2018 *Cogent Educ* **5** 1480909.
[8] Abdeljalil M and Louis T 2012 *J. Syst. Cybern. Inform* ***10*** *2*
[9] Carmichael P, Watts M, Driver R, Holding B, Philips I and Twigger D 1990 Leeds, England: Children's Learning in Science Research Group. (University of Leeds)
[10] Pfundt H and Duit R 1991 Kiel, Gen. University of Kiel Institute for Science Education.
[11] Sarwanto, Sunarno W, and Yuliana E 2016 *Prosiding ICTTE FKIP UNS* **1** 1.
[12] Helm, H. 1980 *Physics Education*, **15** 2.
[13] McDermott L and Shaffer P 1992 *Am. J. phys, 60*, 994-1003.
[14] Estelle G and Jeanne K 2007 *Res. Gate Conf. Pap.* January 2007.
[15] Setyani N D, *et al*. 2017 *IOP Conf, Ser.: J. Phys.: Conf, Ser.* **909** 012051
[16] Mitchell B *et al*. 2018 *Am. Assoc. Phys. Teach* **56** 75
[17] Sternberg J R and Sternberg K 2011 pp. 107-108.
[18] Koba S and Mitchell T C 2011 Grades 3–5. NSTA PRESS, pp. 5-6.
[19] Halliday D, Resnick R and Walker J 2004 New York. John Wiley & Sons Inc.
[20] Serway and Jewett 2004 Thomson Brooks/Cole 6th Edition

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