Analysis of the livewire software application on students’ learning understanding and motivation on ohm’s law concepts

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Abstract. The study aimed to analyze the conceptual understanding and motivation to learning physics in schools with the help of livewire software. An experimental method with a post-test-only nonequivalent control group design was used to examine Ohm's Law. The sample for the study consisted of a control class with 36 students and an experimental group comprising 37 learners drawn from a population of 145 through random sampling. Data collection tools used were tests and questionnaires to collect data, which was analyzed using the non-parametric statistics technique. The results showed that the livewire software made students' understanding of Ohm's Law concepts better compared to learning without the help of the software. Livewire software can motivate students to study Ohm’s Law.

1. Introduction
Physics is an interesting Natural Science, which is further supported by the rapid technological advancement across the globe. Physics is also taught in schools to help students expand frontiers of knowledge about nature and help them in everyday life. However, in reality, many students think that this subject is difficult. Among the challenges students face while studying physics include connecting the concepts from the practicum with story problems and calculations [1].

The observations made in a senior high school in West Kalimantan Province found that students have difficulties understanding Ohm's Law material concepts. According to the study, many students could not determine the relationship between the quantities contained in Ohm's Law and the value of substitute resistance in an electrical circuit. Generally, abstract material has been pointed out as the cause why students have problems with the Ohm's Law concept. The daily tests given to students confirm that only a few students are able to score above the Minimum Completeness Criteria while the rest fall below the Minimum Completeness Criteria [2]. Therefore, there is a need to find lasting solutions to help students understand the concept. Being an abstract matter, Ohm's Law requires teachers to use visual tools to enable students to see the concepts taught [3]. For instance, the use of simulation media in learning has a positive impact on students' knowledge levels besides influencing the attitudes of tutors towards teaching the subject [4].

The efforts to improve students’ understanding of electrical concepts on electrical materials including Ohm's Law have been conducted by a number of previous researchers. For instance, the use of augmented reality (AR) - based media [5][14], android - based media [7] and python script media [8]. The advantages of this technology is that it is able to display scientific phenomena and simulations in real life. Simulation - based multimedia that introduces electrical circuits suitable for elementary and middle school students [9]. This can be done by students together so as to increase collaborative
activities in learning. Collaboration is very important to improve the understanding of the concept of electricity compared to cooperative and lecture methods [10].

Namun penggunaan media ini membutuhkan keterampilan teknologi, membutuhkan perangkat yang kompatibel dan akses internet sehingga kurang cocok untuk siswa yang tidak memiliki hal tersebut. However, the use of such media requires technological skills, compatible devices and internet access. Nonetheless, the media is less suitable for students who do not in possession of those things. Therefore, the media needed in this context is a media that can simulate the concept of electronics, but does not require the internet and high-tech skills in its operation. Livewire software can be installed on low-specification computer devices, can be used offline and is easy to operate.

Livewire software has many components such as switches, transistors, and diodes that can be connected to investigate the behavior of a circuit [11]. The simulation displayed in the livewire-professional edition makes it easier for students to do inquiry activities such as investigating, making hypotheses, formulating problems, experiments, and conclusions. Other livewire simulation software suitable for teaching electronics concepts include Phet simulation [12] and Physlab [13].

2. Method
The experimental method with a post-test-only nonequivalent control group design was used in the study. This method involved the experimental and the control classes whereby the experimental class was taught Ohm's Law using the livewire software as the visual aid, while the control class was only given a theoretical approach regarding the concept. After learning, both classes were subject to a post-test concerning what had been taught.

The sample population for the study involved 73 students who were randomly selected from a total population of 145 learners. The sampled population was put into two groups, including the experimental class with 37 students, while the remaining 36 were put into the control group.

The data collection techniques used included measurement and communication methods. Measurements were used to determine students' understanding of Ohm's Law material, while indirect communication determined students' learning motivation after applying livewire software in learning. The tool for data collection involved the concept of understanding test and a learning motivation questionnaire. The students' understanding of Ohm's Law concepts was obtained from the post-test results and analyzed by non-parametric statistics. The hypothesis for this study was that there were differences in students' understanding of Ohm's Law concepts after applying learning with livewire software. The results of the calculation of the percentage score are matched with categories according to [14], as presented in Table 1.

| Interval     | Category |
|--------------|----------|
| 0%-20%       | Very low |
| 21%-40%      | Very low |
| 41%-60%      | Medium   |
| 61%-80%      | High     |
| 81%-100%     | Very high|

3. Result and Discussion
Data on the acquisition of post-test scores in the experimental and control classes are presented in Table 2.

| Description     | Experiment class | Control class |
|-----------------|------------------|---------------|
| Total Students  | 37               | 36            |
| The highest score| 100.00           | 100.00        |
| Lowest value    | 0.00             | 0.00          |
| Average score   | 74.86            | 64.03         |
| Standard deviation| 20.09            | 23.42         |
Based on Table 2, the students in the experimental class performed better with an average of 74.86 compared to the control class, whose score was 64.03. Additionally, the standard deviation of the experimental class was 20.09, while that of the control group was 23.42. This indicated that the average student in the experimental class scored marks almost similar to the average class score. In the control group, the average student had a greater diversity of data than the average in the experimental class. The analysis prerequisite test includes the normality test and homogeneity test of the data presented in Table 3.

| Class     | \( \chi^2_{\text{count}} \) | \( \chi^2_{\text{table}} \) | Conclusion   |
|-----------|-------------------------------|-------------------------------|--------------|
| Experiment| 94.12                         | 7.81                          | Not Normal   |
| Control   | 311.49                        | 7.81                          | Not Normal   |

The results above show that the calculated chi-square value of the experimental and control classes is greater than the chi-squared table. This confirms that the student learning outcomes data from the experimental and control classes are not normally distributed hence, a homogeneity test is not carried out. The hypothesis testing results using the Mann-Whitney U test are presented in Table 4.

| Class   | Total samples | Total ranks  | Value \( Z_{\text{count}} \) | Value \( Z_{\text{table}} \) |
|---------|---------------|--------------|-------------------------------|------------------------------|
| Experiment | 37        | 1563.50      | -2.15                        | -1.54                       |
| Control   | 36        | 1137.50      |                              |                              |

Based on the hypothesis test data results using the Mann Whitney U test, the value of \( Z_{\text{count}} < Z_{\text{table}} \) means Ho is rejected and Ha accepted. Thus, it can be concluded that students who learned using livewire software understood the Ohm's Law concept better. This is because livewire software attracts attention, and that is why students who usually make circuits with electronic components are challenged to use an application. Through simulations on the livewire software, students are able to analyze quantities in Ohm's Law and how they affect each other. Furthermore, livewire software helps students see the effects of the resistance given to the intensity of the lamp and a given voltage source on the resulting lamp. Additionally, students make connections between sources of voltage, current, and resistance in a circuit, which allows them to formulate Ohm's Law. Conclusively, developing interest in learning positively impacts the outcomes since students become attentive in class, which results in grasping the concept being taught [15,16].

The study also analyzed students' motivation after learning using livewire software, and the recapitulation of the results is presented in Table 5.

| Motivational aspect | Percentage | Category |
|---------------------|------------|----------|
| Pleasure            | 76.69%     | High     |
| Attention           | 75.34%     | High     |
| Interested          | 77.70%     | High     |
| Curiosity           | 58.45%     | medium   |
| Enthusiasm          | 62.61%     | medium   |
| Average             | 70.16%     | medium   |

The above results indicate that students' learning motivation is in the medium category but ranks high in pleasure, attention, and interest. When students are engaged during learning, they become active and are able to ask areas questions regarding difficult concepts. Therefore, the use of livewire software is enough to motivate students to learn Ohm's Law concepts. The simulations displayed on livewire and freedom to express their ideas increase concentration during the process of learning. Furthermore, the use of livewire software educates students to have constructivist thinking patterns and visualize physics...
concepts. This is in line with several studies conducted, which affirm that the use of simulations and virtual labs in learning increases students’ learning motivation [17–19].

4. Conclusion
In conclusion, livewire software simulation enhances a better understanding of Ohm’s Law concept compared to ordinary learning. Furthermore, the software motivates students to learn and achieve more in education, especially in physics.

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