Designing Animations and Simulations for Ohm's Law

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Abstract: Rapid developments in technology, diversification of tools provided that can be used in the education stage. These new technologies facilitate learning improving the quality of learning and affects students’ performance. In accordance with physics laws, it is desired to describe events or experiments. It is possible to create animations and simulations with the help of various programs in the computer. It is thought that via animation and simulation, student can learn the concepts which can be learned in laboratories used for physics lessons with lower cost and in shorter time. In this study, general physics course and laboratory test commissioned by the resistance ammeter-voltmeter method of determination of the issue are utilized in better animation lectures and simulations in order to comprehend by the students. Descriptions relating to experiments and issues were formed as animations. With animations, it has been shown how ammeters, voltmeter and rheostat will be connected, to the circuit. With the sample in the animations, it has been shown that the extraction of the formula how to calculate the current and voltage values from ammeter and voltmeter. In the simulation which is given at the end of the experiment, let the student to enter to the blank space in the table which the values students want to enter, it is aimed for students to understood and test how good they can understand the fact that how potential difference, flow violence or resistance values are calculated. It has also been worked to defeat misconceptions on this issue. In this way, more comfortable experiment understanding of the students’ has been targeted.

Keywords: Physics Education, Ohm's Law, Animation, Simulation.

1. Introduction

When the research on physics teaching in universities is considered, some important studies have been done on the students’ efforts to understand the physical world, and unfortunately they have shown that students could not understand the concepts as required. Many research done on subject have shown that students misunderstood the concepts of the subject when the class was over. These scientific truths are considered just as another class subjects and it has been observed that these facts were forgotten quickly by students [1, 2].

Developments in computer technology also affects the physics education. For this reason, it is important and required to make that physics education is computer aided. Mathematics, which is one of the tools, is used in physics science. Usage of mathematical expressions to explain the complex physics problems results the vague understanding of circumstance to be grasped. It is obvious that computers are useful tools in physics education when they are used effectively in learning [3].

When the research done on the physics education is examined, the most commonly studied and stressed research field are related to the use of animations, simulations and analogical models. It is possible to use simulations and animations in computer environment about the physical situation or experiments which are designed due to the explained concepts of the physical laws [4].

In the study was carried out by Marshall and Shipman, in contrary to the written texts, scientific events are explained interactive multidimensional by using animations. Animations with attractive visual shows have bring a new vision for physics education to help students to draw new horizons-dreams for the scientific development.

In physics education, the observable changes like color changes, smell and boiling can be given in two ways. One of them is in laboratory level, the other one is in microscopic level. Lecturing in microscopic level can be done either qualitatively by using symbols and signs or quantitatively by means of mathematics and computers [5].

It is observed that animations has resulted for students to gain positive viewpoint about the classes, to think in three dimension and to get the ability of competing in modern educational institutions.

The effective use of the animations provides direct access of key concepts by the students and remove unnecessary information load given to the students. It also provides meaningful links to previously given subjects and ease the job of educator in the process. This increases the discernment ability, objectify the abstract circumstances and creates appropriate schemes in the mind. Additively, animations not only increase the cognitive intelligence but also assist the learning visually and auditory. It was mentioned that a learner remembers 10% of what it reads, 20% of what it hears, 30% of what it sees, 50% of what it either hears or sees simultaneously [6]. Simulations help to remove the disconnection between the learning style of the students and teaching style of the teachers [7].

It is recommended that the teaching of the abstract concepts in
physical sciences should be attractive and the requirement of the use of animations are advised. Additionally, it is also pointed out that the teaching by using animations are more positively affect the students compared to the other teaching methods [8].

2. The Object And The Importance Of The Research

In this research, the resistance determination by using ammeter - voltmeter method (Ohm's Law) is explained. The animations and simulations are especially designed to be attractive for students. The information and action are mainly presented and placed in a single screen in a comprehensive manner. In the study, animation presentations are prepared to be crisp and vivid. One of the object in the designing process is to minimize the misapprehension of the concepts about the experiment. Different animations are prepared for easy learning of the subjects.

3. Application

In this study, the animations and simulations are utilized to teach the subject of resistance determination by using ammeter - voltmeter method to increase the understanding of the students. The definition of ammeter and voltmeter given in the animations. The properties of the ammeter and voltmeter to make sensitive measurements are given. The connection methods of the ammeter and voltmeter to the circuit are also presented by using animations. The definition and formalism of Ohm's Law are given by animations. The calculation of current and voltage by using formulas are shown in animations for the students to comprehend the formulas. When the button is clicked, related calculations and formulas can be seen. The students are asked to measure the current flows and potential differences, the measured values in the experiment are asked to be plotted, and the relation between the values are expected to be commented. Moreover, it is aimed for better comprehension of the Ohm's Law by putting any desired values in the empty spaces of the tables to see how to calculate the current, voltage and resistance values accordingly [9].

When the animations are set up, they are prepared by considering the relation between the animations and the lecture subjects. Moreover, taking of students’ attention to the subject are greatly taken into account. Hence, enjoyment on the subjects of the students are realized. The colors and action pieces used in the animations are mainly presented and placed in a single screen in a comprehensive manner. They are aimed to make the strain and are prepared to be crisp and vivid. Natural sounds are used. Animations are used according to the student’s ages. Animations and simulations are prepared as visual auditory and operative. Font style, color and size are chosen according to their readability and easiness of the action perception. Each animation and simulation have buttons to move backward and forward for previous and next steps, and a calculate button is placed for students to carry out numerical calculations. Not very long texts were preferred, hence the information presented becomes more capturing [9].

In Figure 1, introduction screen of the second experiment of the course, which is "resistance determinations by using ammeter - voltmeter method", can be seen.

![Figure 1. Screen image of Experiment 2 resistance determinations by using ammeter - voltmeter method.](image1)

This method, as can be seen from the name suggested, is used to determine the unknown resistance R by connecting an ammeter and a voltmeter to the circuit by using Ohm's Law. The current flowing through the resistor is read in Amperes by using an ammeter and potential difference between the terminals of the resistor is read in Volts by using a voltmeter. By using the two R resistance values measured is obtained in units of Ohm. In Figure 2, animation shows a definition of an ammeter and gives some detailed information about which properties does an ideal ammeter must have for a sensitive current measurement. An ammeter is serial connected in serial to the circuit. The organised experiments are designed considering an understanding in a comprehensive manner.

![Figure 2. Definition of an ammeter](image2)

In Figure 3, a serial connection of an ammeter to the circuit is shown with animation. Consequently, increase in permanency of the information about the connection of ammeter in the mind is achieved.

In Figure 4 how to connect an ammeter serial and a voltmeter parallel to the circuit are shown. Hence it is aimed to minimize the misconceptions about the experiments.
In Figure 5, a $V_{AB}$ potential difference is applied to the circuit in the experiment of determination of resistance by using ammeter - voltmeter method. Later different values of voltages applied to the circuit. The changes of current values are noted. As the rule suggested simulation shows a constant rate of current flowing to potential difference existing between the two terminals of the conductor.

In Figure 6 (a, b and c), after performing the steps of the experiments, it is shown by using animations that "The rate of potential difference between two terminals of a conductor to the current flowing through the conductor is constant". This constant value is the resistance of the conductor and symbolized by $R$. Ohm's law is one of the foundation rules of the electricity. A current flowing through a conductor is directly proportional to the
potential difference and inversely proportional to the resistance.

In Figure 7, animation shows how an ammeter and voltmeter are to be connected to the circuit. Different animations are included to ease the learning of the subject.

In Figure 8, the animation shows how students calculate current and potential difference by using formulas for better grasp of the concepts. When “Calculate” button of the animation is clicked, related calculations and formulas are shown.

In Figure 9, in order to minimize misconceptions, a rheostat was added to the circuit. This application helps us to calculate changes in the current and potential differences for different resistance values of the rheostat. In this way, we can understand the working situations of the circuit by entering different inputs and by reading different output values.

In Figure 10, five different resistance values are entered by means of rheostat, and current and voltage difference for every resistance value are calculated. This aims for students to get better grasp of the experiment.

In Figure 11, a graphics of current against voltage is asked to be drawn by using current and potential difference values of the experimental results and interpretation of the graph and relationship between the current and voltage values are requested.

In Figure 12, the current and voltage values calculated by applying different resistance values and by using the rheostat in
the experiment are tabulated. By using the table, unknown resistance value is calculated as 2 ohms.

In Figure 13, different values found in the rheostat experiment are tabulated and related graph is drawn.

In Figure 14, blank spaces left in the table, so the students can enter any values of current, resistance and voltage difference in the cells and observe the calculated results. By using the table, students will be aimed to learn how the values are calculated and grasp the meaning of the Ohm's Law.

4. Results And Suggestions

The usage of animations and simulations during lecturing time in the class ease the comprehension of abstract concepts and hard to grasp subjects, furthermore, it also helps the class to be more visual and enjoyable.

At the end of the study, teaching using animations has shorten the learning time and eases the grasp of the subjects compared to the classical methods.

Animation and simulation experiments can be used instead of laboratories which may not exist in the institutes because of insufficient funding.

During a class lecturing, animations and simulations are frequently used as teaching aid materials for subject hard to grasp.

Changes in the behavior of the students who are taken animation and simulation assisted courses can be researched compared to other research on teaching techniques.

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