Co-funded by the Erasmus+ Programme of the European Union

This lesson plan was created within Erasmus+ project 2018-2020
Explore the World – Inspire Yourself

Lesson plan: Physics

"THE TEACHING OF THE CONNECTION IN A SERIES OF TWO RESISTANCES WITH THE SOFTWARE PHET COLORADO"

TECHNOLOGY IN THE TEACHING OF NATURAL SCIENCES

CONTENTS

1 INTRODUCTION

In recent decades, there has been a rapid development of modern technology in today's society. Understandably, information and communication technologies (ICT) show an ever-increasing development in both the global and the Greek school reality. According to research, an average student performs more than 12% when taught with the help of modern technology compared to traditional teaching.

In the present work a teaching plan is proposed in the attempt to investigate whether the teaching of Physics, and in particular the concept of connection to a series of two resistors using the simulation software 'PhET (Physics Education Technology) project' (https: //phet.colorado. edu), prevails over teaching in the traditional way.

2. THEORETICAL FRAMEWORK

Modern science teaching literature shows that the use of modern technological tools, such as simulations and virtual labs, can support both teachers to improve their teaching and students to equip themselves with such skills. so that they can evolve into future thinking and active citizens (Petropoulou, Kasimati, Retalis, 2015).

The main learning advantage of introducing simulations into the teaching process is that the world to be simulated is not prefabricated, but enables the student in an environment of interaction and inquiry to create his or her own virtual, laboratory experiment. More specifically, simulations and virtual workshops are based on the theory of exploratory-apocalyptic learning, the idea of constructive but also collaborative learning as they allow students to explore, experiment, predict, verify and generalize their findings.

For the purposes of this sample teaching, the teacher chose to use the application "Construction of circuits AC + DC" (http://phet.colorado.edu/el/simulation/circuit-construction-kit-ac) from the software 'PhET (Physics Education Technology) project '(https://phet.colorado.edu). The choice of the application "Construction of AC + DC circuits" was based on three reasons, that: a) it is an easy-to-use and multi-feature virtual laboratory, which supports the construction of direct current electrical circuits, with the support of students' self-action to make connections between theoretical scientific knowledge of the phenomenon of electricity and real life, b) runs with any browser, and most importantly c) is open, albeit source, code, ie belongs to free software and is therefore provided free of charge. More specifically, this software provides all the instruments (voltmeter, ammeter, battery - source 1.5V and 9V, resistors, etc.) and materials (switch, cables, etc.) so that students can build simple electrical circuits. It is addressed mainly to Lyceum students but can also be used to students of the 3rd grade of Gymnasium.

3. METHODOLOGY

The purpose of this study is to teach, using the software "Construction of AC + DC circuits", the connection of a series of two resistors.

It is suggested that this sample teaching take place in the school's computer lab and that students work with a computer per group of 2-3 students with the parallel use of a projection screen by the teacher, whose role is supportive and not guiding. The groups of students (one after the other) will perform an activity on the computer and the other groups will watch on the video projector. In addition, distribute to each student a worksheet (see appendix) which includes 7 activities that students are asked to complete by working sometimes individually and sometimes collaboratively (according to the peer instruction method). In addition, it is estimated that the time required to complete the lesson plan is one teaching hour, with a possible extension to teach the parallel connection of resistors.

The teaching objectives are set, so that students can:

• Design and assemble simple electrical circuits.

• To be able to properly connect the measuring instruments ammeter and voltmeter and to practice in measurements with them.

• To determine the usefulness of the switch (open-closed electrical circuit).

• Experimentally confirm Ohm's law.

• Understand the concept of equivalent resistance and experimentally confirm the relationship for finding the equivalent resistance (Rol) of two or more resistors in series.

• Students should understand that in the connection of resistors in series the total resistance increases and, if we remove one resistor the others do not leak current (Antoniou, et al., 2011).

Initially, with appropriate questions the teacher will seek to retrieve students' prior knowledge regarding the concepts of: a) electricity, b) current, c) voltage at the ends of a source or an electric dipole and d) of electrical resistance, as well as their units of measurement. In addition, students should be familiar with Ohm's law and the use of ammeter and voltmeter gauges, as well as what closed and open circuit means and what the switch is for.

It is then advisable for the teacher to introduce the students to the simulation environment "Circuit Construction (AC + DC)" by making a demonstration of its capabilities, as well as to ask students to open the application stored on the computer desktop. and work on 'Activity 1' following the instructions in the worksheet.

Activity 1st

Here students, taking into account the image they see in the worksheet, are asked to construct the circuit, following the instructions given to them. It is expected that it will take some experimentation time for them to succeed, during which the teacher, with appropriate targeted questions, will help the students to clarify basic concepts such as voltage, current and direction of the current. In addition, at this point it is tempting to emphasize the term ‘series connection’, as students often mistakenly believe that the two resistors should be in a straight line. It is worth noting that the importance of the error in the construction of the circuit is recognized, meaning that during its correction the student learns.

Activity 2nd

Students are asked to use the tools provided by the "Construction of circuits (AC + DC)" simulation to determine the values of the resistors of the two lamps, which will be used in Activity 5 so that they can experimentally verify Ohm's law. .

Activity 3rd

In this activity the students have to take measurements with the virtual voltmeter of the voltage at the ends of each lamp as well as at the ends of the source, to record their measurements in the relevant table and to confirm experimentally that the total voltage of the source is distributed at the ends of the two lamps -resistants.

Activity 4th

Similar to Activity 3, students are asked to measure with a virtual ammeter the intensity of electricity at various points in the circuit and record their measurements in the relevant table, leading to the experimental finding that in series connection the intensity of current is the same at all points in the circuit.

Activity 5th

Using Ohm's law () students should calculate the resistance of each bulb (or alternatively, use the values in the table in activity 2) as well as the total resistance, in order to conclude on their own that when connecting in a series of two resistors the total resistance has a value equal to the sum of the values of the two resistors.

Activity 6th

With the first two questions of this activity students are asked to predict what will happen if three light bulbs are connected in series. In the third question students are asked to verify or disprove their claims, through cognitive conflict, constructing the corresponding circuit, with the help of simulation capabilities. In addition, this activity can serve as an evaluation of exemplary teaching as it shows on the one hand if the students (and to what extent) understood the lesson and on the other hand, if they can expand the new knowledge they have acquired.

Activity 7

Closing the worksheet, students are asked to symbolically design the electrical circuit, correlating all the elements of the circuit with the corresponding symbols in order to emphasize the connection of the theoretical thinking of Physics with its experimental-practical dimension.

If there is time left at the end of the lesson, the teacher can use it by discussing the conclusions of the worksheet with the whole class.

4. CONCLUSIONS

In summary, we would say that, for a better understanding of the conceptual-theoretical approach of Physics, it is proposed to include virtual simulated experiments in combination with real laboratories in order to conduct an effective teaching (Zacharia et.al., 2008; Jaakkola , Nurmi & Lehtinen, 2011). In closing, it should be emphasized that the teacher is the protagonist of the whole educational process, therefore, he is called to listen to the needs of the students in his class, and based on these to determine his curriculum, as our students ask:

Teacher, I am not a container to be filled, I am a match to light me!

5. BIBLIOGRAPHY

Greek-speaking

Avraamidou, L. (2012). Current Trends in Science Teaching and Teacher Training. In Evagorou & Avraamidou, Theoretical and Didactic Approaches to the Natural Sciences. Athens: Interaction.

Antoniou, N., Dimitriadis, P., Kampouris, K., Papamichalis, K., Papatsimba, L. (2011): Physics of the 3rd Gymnasium. Athens: Textbook Publishing Organization

Antoniou, N., Dimitriadis, P., Kampouris, K., Papamichalis, K., Papatsimba, L. (2011): Physics C 'Gymnasium Teacher's Book. Athens: Textbook Publishing Organization

Interactive School books (h.s.). Physics (3rd Gymnasium) - Student Book. Retrieved from: http://ebooks.edu.gr/modules/ebook/show.php/DSGYM-C201/531/3516,14426/ Accessed on 15-11-2017.

Training material for the training of teachers in the Training Support Centers, Issue 1: General Part (Third Edition). (March 2013). Patras.

Training material for the training of teachers in the Training Support Centers, Issue 5: Branch PE04. (Second Edition). (December 2010). Patras.

Pantazou, D. (2016). Real, virtual experiment or a combination of both? A case study in the teaching of the electrical circuit in the 5th grade. Bachelor's thesis. ΕΑΠ.

Papakanakis, G. (2016). Critical analysis of PHET COLORADO simulations. Possibilities and their uses in the classroom. Bachelor's thesis. ΕΑΠ.

Petropoulou, O., Kasimati, A., Retalis, S. (2015). Modern forms of educational evaluation with the use of educational technologies. Athens: Association of Greek Academic Libraries. Retrieved from: https://repository.kallipos.gr/handle/11419/232. Accessed on 20-11-2017.

Sariannakis, I., (2015). Development and study of thermodynamic cycles of thermal machines with simulations through a virtual thermodynamics laboratory. Thesis. Kavala.

Stavrou, Ch., (2017). Study of the effect of simulation experiments on the teaching of continuous electrical circuits: Application to students of the University of Ioannina. Diploma thesis. Ioannina.

English

Bandoy J., Pulido M., Sauquillo D. (2015). The Effectiveness of using PHET Simulations for Physics Classes: A Survey. Retrieved from: https://www.researchgate.net/publication/282219928_The_Effectiveness_of_using_PHET_Simulations_for_Physics_Classes_A_Survey Accessed 25-11-2017.

European Commission (2007). Science Education Now: A Renewed Pedagogy for the Future of Europe. Brussels. Retrieved from: http://ec.europa.eu/research/science-society/document_library/pdf_06/report-rocard-on-science-education_en.pdf. Accessed on 25-11-2017.

Jaakkola, T., Nurmi, S. &, Lehtinen, E. (2011). A comparison of students 'conceptual understanding of electrical circuits in simulation only and simulation-laboratory contexts, Journal of Research in Science Teaching, 48, 1, pp.71-93.

Marks, D., Laxton, T., McPhee, I., Cremin, L., Sneider, A. & Marks, L. (2013). Does the use of touch screen computer technology improve classroom engagement in children? The Online Educational Research Journal. Retrieved from: http://www.oerj.org/View?action=viewPDF&paper=76. Accessed on 26-11-2017.

Perkins, K. Adams, W. Dudson M. Finkelstein, N. Reid, S. Wieman, C. (2006) Phet: Interactive Simulations for Teaching and Learning Physics. Colorado, the Physics Teacher. Retrieved from: https://phet.colorado.edu/publications/physics%20teacher_finalwithpicts.pdf Accessed 26-11-2017.

PhET (Physics Education Technology) project '. Retrieved from: https://phet.colorado.edu). Accessed on 15-11-2017.

Tamim, R., Bernard, R., Borokhovski, E., Abrami, P. & Schmid, R. (2011) .What Forty Years of Research Says About the Impact of Technology on Learning: A Second-Order Meta-Analysis and Validation Study, Review of Educational Research, 81 (1), p. 4-28

Zacaria, Z. C., Olympiou, G., & Papaevripidou, M. (2008). Effects of Experimentation with Physical and Virtual Manipulatives on Students 'Conceptual Understanding in Heat and Temperature, Journal of Research in Science Teaching, 45, 9, pp.1021-1035.

6. ANNEX

Worksheet "Connecting resistors in series" worksheet

WORKSHEET 1

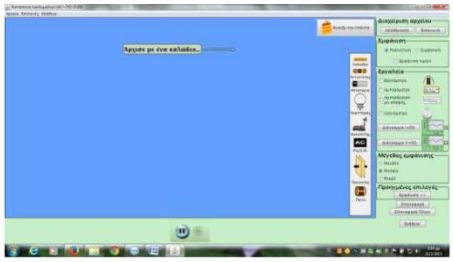
Connecting resistors in series

CLASS: GYMNASIUM DATE:… ../ …… / ……

TEACHER: TSAPAKI ELENI TIME: 45 min

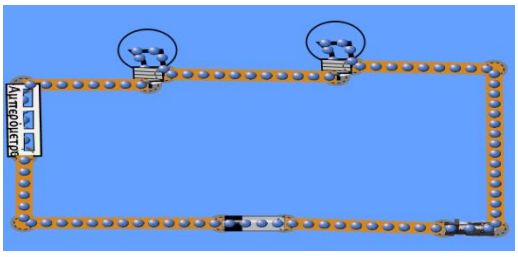
FULL NAME:……

Open the application  on your desktop by double-left-clicking the icon. The above image will appear on your screen.



ACTIVITY 1st: (10 min)

Build the electrical circuit shown in the image below according to the following instructions:



STEPS:

1. From the vertical shelf of the instruments, select and drag the following instruments on the work table:

a) one battery, 

b) 2 lamps, 

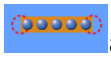
c) a switch, 

d) many (!!!) cables 

and

e) a voltmeter  and an ammeter 

(after first selecting them from the tools)

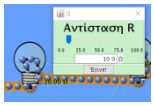
2. To connect the cables to the instruments, first select the cable and it displays two loops at its ends  and then drag it close to the point where you want to connect the end of the cable  . The loop should be 'blackened' to make sure the cable is 'buttoned'  .

3. Turn off the switch and if the light bulbs turn on then you will have made a closed electrical circuit (Well done!).

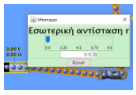
If not, do not be discouraged (you are not the only one!), You would do something wrong. Repeat the process, paying attention to how you connect the cables.

ACTIVITY 2nd (2 min)

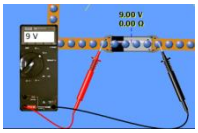
By right-clicking on each tool (electric dipole) you can define its properties.

a) Set the resistance of the lamp1 equal to R1 = 10Ω (ohm) 

b) Similarly defined the resistance of the lamp2 equal to R2 = 20Ω (ohm)

c) Make sure the battery has zero internal resistance. 

ACTIVITY 3rd (4 min)

Use the voltmeter  and take the following measurements and note them in the table below:

a) Voltage (potential difference) between the ends of the battery (source),

b) The voltage V1 (potential difference) between the ends of the 1st lamp,

c) The voltage V2 (potential difference) between the ends of the 2nd lamp,

Voltage(V)	V_1=	V_2=	$V_{o\lambda}$=

Write the relation that connects the quantities Vol, V1, V2	

ACTIVITY 4th (4 min)

Use the ammeter (or for convenience, the non-contact ammeter) and take the following measurements and note them in the table below:

a) The current Iol that flows through the battery,

b) The current of I1 flowing through the 10 lamp,

c) The current I2 flowing through the 2nd lamp,

Intensity(A)	I_1=	I_2=	$I_{o\lambda}$ =
Write the relation that connects the quantities Iol, I1, I2			

ACTIVITY 5th (3 min)

With the help of activity 2, complete the following table:

Resistance(Ω)	R_1=	R_2=	$R_{o\lambda}$=
Write the relation that connects the quantities Rol, R1, R2			

ACTIVITY 6th (10 min)

A) If you connect a series and a third lamp, what do you predict will happen:

a) the intensity of the current flowing through the source?

……

b) the total resistance of the circuit?

……

B) Confirmed his claims experimentally.

ACTIVITY 7th (7 min)

Can you symbolize the circuit you made?

Fotos