Professor Kirchhoff Ohm's

Fantastic Lab of Electrical Discovery

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Introduction

ABSTRACT

Professor Kirchoff Ohm's Fantastic Lab of Electrical Discovery is an interactive learning experience where Fifth Grade students utilize elementary math skills to solve complex electrical problems. The program uses a multi-platform approach to teach basic electrical principles and laws then encourages students to practice what they've learned in a safe, virtual lab environment.

This courseware provides an open format for learning, that is to say that the students are free to explore wherever and whenever they would like. By allowing learner exploration, the courseware encourages the student to move on. For example, if the student chooses to explore the lab before taking the lessons, they will, in all probability, be inspired to learn the laws so that they may guess the values which will appear when they manipulate the circuit. The courseware is designed to inspire curiosity and exploration rather than a step by step approach to learning.

TARGET LEARNERS

The courseware is designed for Fifth Grade learners, and while at first glance, this topic may seem beyond their ability, Fifth Graders possess the required math skills and reasoning skills with which to complete it successfully. At its core, the application of Kirchhoff's and Ohm's laws is simply a matter of rudimentary addition, subtraction, multiplication and division. The topic is presented in such a way that circuit analysis is condensed down into simple math problems. Thus this simulation will prove useful for both math and science skills.

PURPOSE AND OBJECTIVES

The courseware serves a dual purpose. At first glance it seems to be a tool to teach electrical principals and laws. As such, it is an ideal tool for use in the science classroom. However, the program offers much more than an introductory physics lesson. By applying the methods required to complete the electrical lessons, students will be introduced to algebraic fundamentals. By approaching the math portion of the program as part of a lab rather than simply a straight math lesson, the courseware reinforces the math skills of the learner. It serves as an entertaining lesson to the student who questions the practical application of mathematical skills. The objectives of the lesson are supplied below.

Upon completion of this lesson, the learner will be able to:

- Define the terms voltage, current and resistance as they apply to an electrical circuit.
- Calculate the equivalent resistances of both series and parallel resistive circuits
- Apply Kirchhoff's Current Law to determine the amount of current flowing through each leg of a resistive circuit.
- Apply Kirchhoff's Voltage Law and Ohm's Law to determine the voltage drop across various components of a resistive circuit.

Equipment

The minimum system requirements are:

- A Computer with Microsoft Windows XP SP2 or later or Macintosh equivalent.
- A High Speed Internet Connection (if online version is to be run.)
- The latest version of Adobe Flash Player. Latest version can be found at https://get3.adobe.com/flashplayer/update/plugin/
- Onboard audio or discrete audio card and speakers.
- Web Browser: Mozilla Firefox 4.0 and above, Google Chrome; Safari 5.0 and above; Internet Explorer 7.0 and above; Opera 11 and above.

Getting Started

NETWORK OR CD ACCESS

The course can be run via the internet or directly from a folder loaded on the computer. If the program is to be run directly from the computer, it is imperative that the .swf file remain where it is. The courseware utilizes relative addressing, meaning that if the .swf file is relocated, the program will not work.

Running from the internet

Copy and paste, or type, the following url into the browser address bar.
http://www.jimdoran.me/edtech511/final/home.htm

Running directly from computer

Refer to Figure 1 below. Double click on projectfinal.swf. This will bring up the courseware in its own window. There is no need for the internet if none is available as all files are contained in this folder.

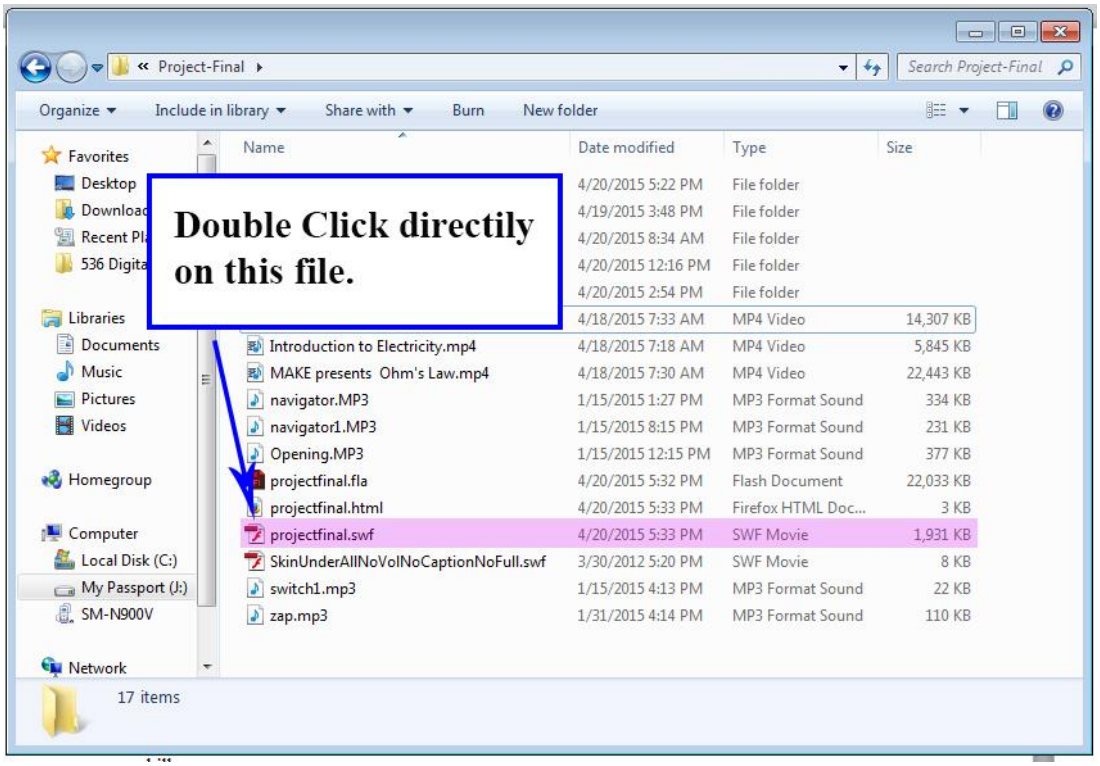

Figure 1
Running Directly from Computer

Normal Running of Courseware

TIME TO COMPLETE COURSEWARE

The courseware should take about 4 hours to complete. This timeframe allows sufficient time for the student to complete and understand each of the four lessons and watch all 3 videos. The video portion of the courseware contains 3 videos which, in total, last approximately 22 minutes. The time spent on the lab is left to the discretion of the instructor, but sufficient time should be allowed to allow the students to explore and predict results based on their new found knowledge. There should be 15 minutes allotted for the quiz activity.

USER INTERFACE COMPONENTS

Navigation Station

Figure 2
The Navigation Station

After clicking the "Enter" Button on the Start Screen, the user is shown the Navigation Panel. The Panel is initially darkened out and will stay that way until the user clicks on the light switch. Once this action is performed, the student is free to explore any of the areas by the tabs in the upper portion of the navigation panel. The Return button returns the user to the Start Screen.

Lessons

Figure 3
Lesson Navigation

This is the written lesson portion of the courseware. The activity consists of four separate lessons based on the following topics

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- Basic Electricity
- Ohm's Law
- Kirchhoff's Voltage Law
- Kirchhoff's Current Law

The lessons explain each of the electrical principles as well as presenting examples which can be used during the lab activity. They are designed to offer an introduction to electrical laws and calculations. The return button in each individual lesson will return the user to the main lesson screen. The return button on the main lesson screen will return the user to the navigation panel. It is not necessary for a student to complete a lesson before starting another. As previously stated, the courseware is designed to allow exploration.

The Lab

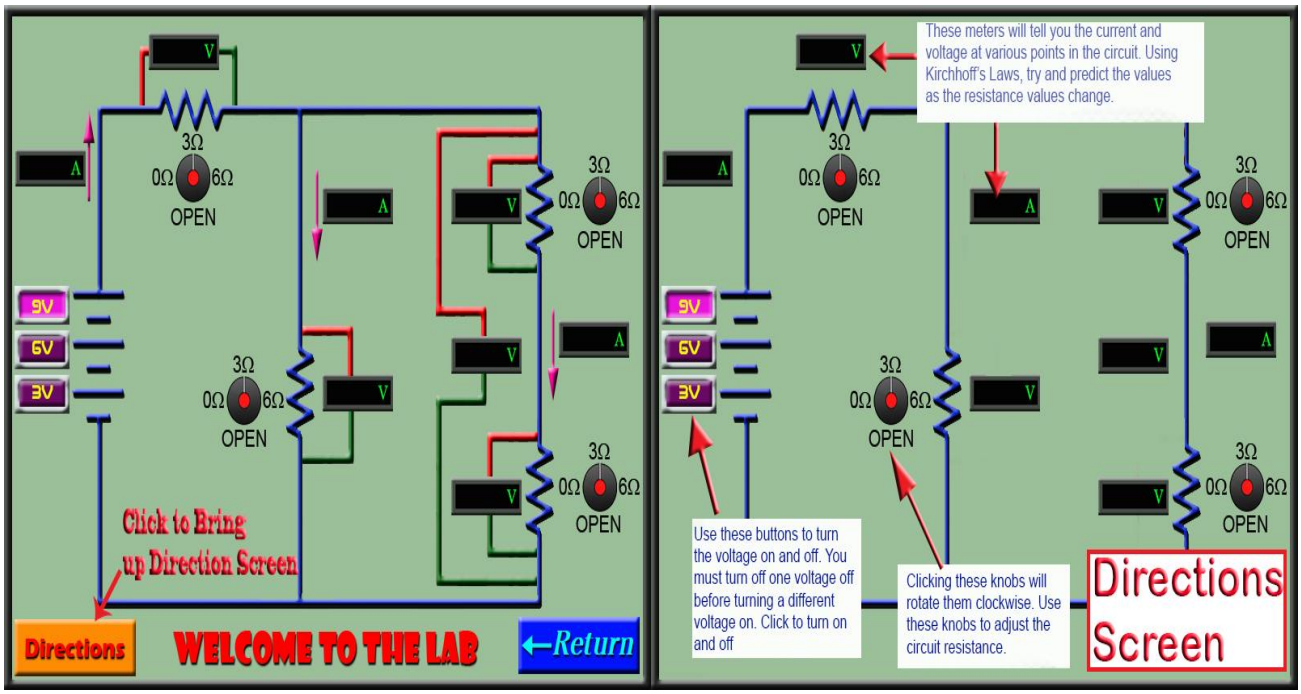

Figure 4
The Lab

The Lab is a self-directed, self-paced exercise which allows the student to practice what they have learned about Ohm's and Kirchhoff's laws. The Lab consists of a series of adjustable resistors which allow the student to create a number of different circuits. There are also three different voltage settings which allow further flexibility. Lastly, voltages and currents throughout the circuit are measured by a series of meters, allowing the students to view the real time results of their action. The "Directions" button in the lower left corner of the screen shows a help screen that explains the functions of the buttons and indicators. This help screen pops up over the lab and collapses with the click of a "Back To the Lab" button.

Lastly the lab has a feature which the students may, or may not discover. A short circuit, that is a circuit which has zero resistance, is dangerous. Any voltage divided by a resistance of zero results in near infinite current. The lab reflects this in that if a student tests a short circuit condition, a special screen is brought up informing them of what they have done. A return button is provided to bring the student back to the lab.

Videos

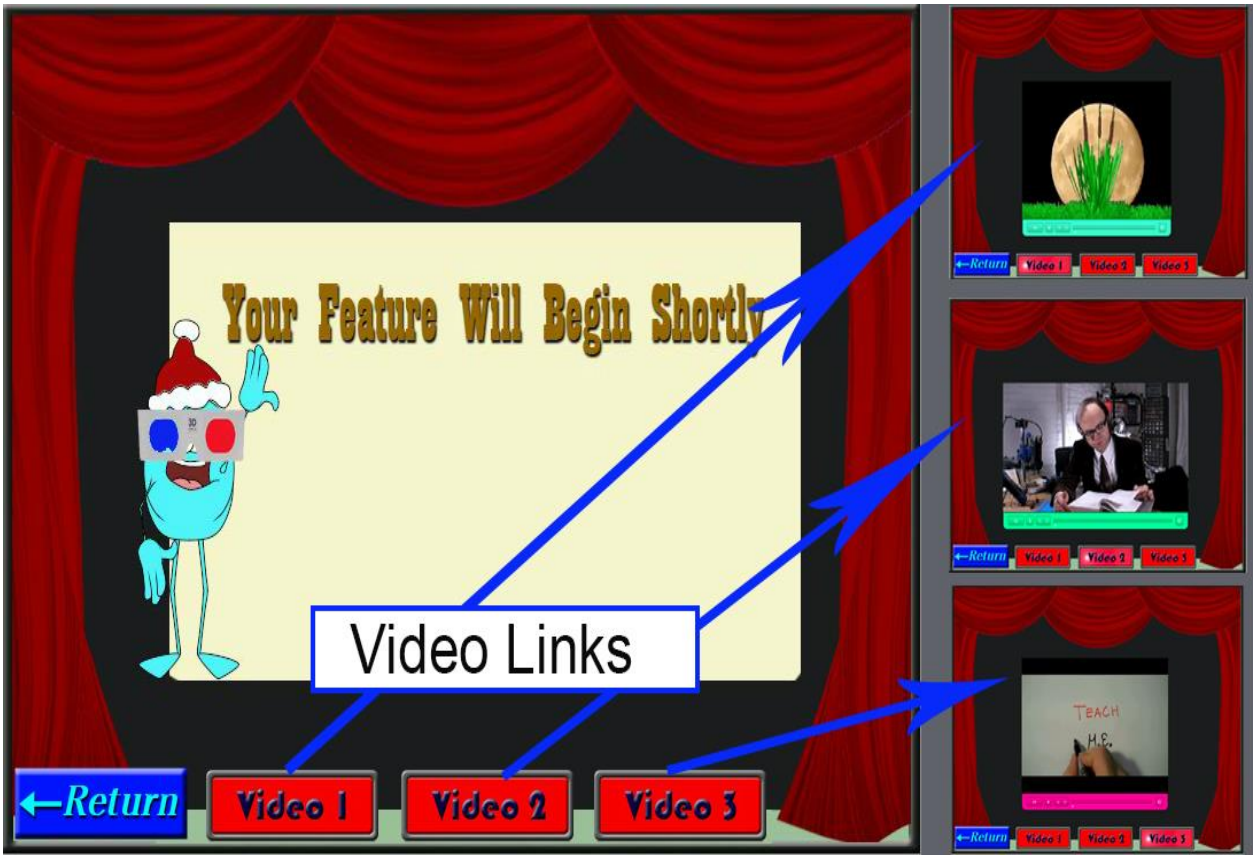

Figure 5
Videos

The videos support the concepts introduced in the lesson portion of the courseware. Video 1 is an introduction to electricity covering the concepts of voltage, current and resistance. Video 2 explains Ohm's Law in an entertaining manner and covers much of the math involved with manipulating the equation. The last video is a worked example using Kirchhoff's laws. This provides the student with a means of solving their own equations once they get into the lab portion of the courseware. Videos can be selected using the links on the screen and a user is not required to view the entire video before selecting another. The return buttons on the individual videos take the user back to the main video screen while the return button on the main video screen returns the user to the navigation panel.

Quiz

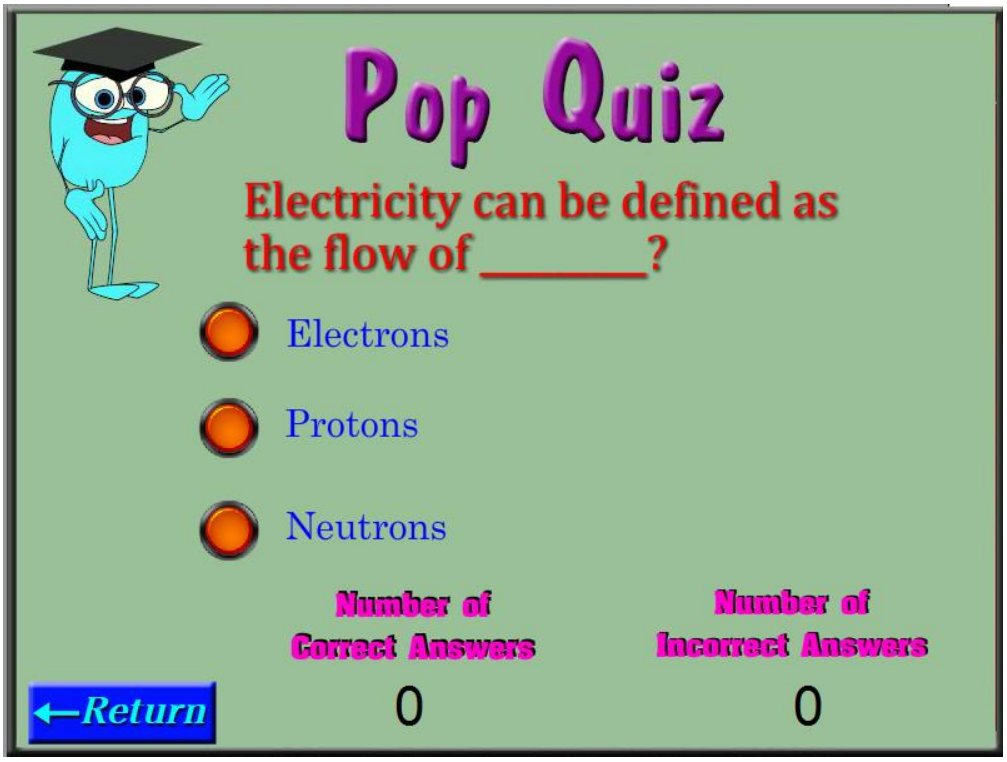

Figure 6
Quiz

The quiz is designed to be a reward for completing the lesson. It should not be used as evaluation. It is important to remember that the purpose of this courseware is to teach the students basic electrical principles and provide an understanding of the usefulness of mathematics. Should an evaluation of this unit be required, it is recommended that additional classical instruction take place and the principles taught in the lessons and the videos be reinforced. It is also important to remember, that once these concepts are taken on board, they offer the instructor another avenue for testing mathematical skills. The return button on the quiz will return the user to the Navigation Panel.

Ending the Program

The program can be ended at any time. If the courseware is being run from the internet, the user may simply close their browser. If the courseware is being run directly from the computer, the user simply clicks on the "X" in the upper right hand corner to close the window.

Troubleshooting

Technical problems or browser error messages may be due to an out of date Flash Player. See the link above to download the latest version. This courseware has not been designed for tablet computers. The program should be run on a desktop or laptop using the Windows or Mac OS operating systems. Users my experience delays due to the loading of videos or graphics based on the processing speed of the computer. It is recommended that, if the student will be using an online connection for the program, the program be run previously to allow the images and the video to cached within the computer's memory.

Credits

GRAPHICS AND IMAGES

Site graphics and images were created by Jim Doran using Anime Studio Pro and Adobe Photoshop.

MUSIC AND SOUNDS

Music and sounds for the courseware were created by Jim Doran using the MusicMaker and Audacity software.