Tinkering with Simple Electric Circuits

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Overview

This unit will use the scaffolding approach to allow students to explore how simple electric circuits can be created and are used in everyday items. Students will use their knowledge of simple circuits to create crafts and games.

The intention of this unit is to simulate how engineers, electricians, designers, inventors and others who enjoy tinkering, work and create in the real world. Students will gain experience with how to construct series and parallel circuits and explain their characteristics as well as how each type of circuit works.

Rationale

More and more everyday items (greeting cards, toys, clothing, etc.) now operate using a simple circuit. Gaining an understanding of they work can inspire creativity and curiosity for students to become innovative and creative.

A simple circuit consists of three elements: a source of electricity (battery), a path or conductor on which electricity flows (wire) and an electrical resistor (lamp), which is any device, that requires electricity to operate. The flow of electricity is caused by excess electrons on the negative end of the battery flowing toward the positive end, or terminal, of the battery. When the circuit is complete, electrons flow from the negative terminal through the wire conductor, then through the bulb (lighting it up), and finally back to the positive terminal - in a continual flow.

Objectives

- Students will be able to describe the qualities that define good and poor conductors of electricity and will list at least three of each type of conductor
- After gaining foundational understanding, students create their own circuit crafts and games. Students will work in groups to build circuit board from simple materials in order to answer the following questions:
- To arrange batteries, bulbs and wires into functioning series and parallel circuits.
- To represent simple circuits using schematic diagrams.
- To explain and compare the effects of series and parallel circuits on bulb brightness, relating the phenomena to the potential differences, current, and resistances throughout the respective circuits.

Strategies

There are two eighth grade STEM sections that I teach. When I introduce a new activity, challenge or concept, I will use a combination of short lectures, videos and textual reference information so that all of my student have an opportunity to gain a clear understanding of what they need to know in order to move forward successfully to complete their task at each level.

To understand electric current, many vocabulary words must be introduced. This unit will also include hands-on, problem-solving activity that helps students define the vocabulary terms and demonstrate the terms' relationships.

Both sections of eighth grade have 32 students. Both classes consist of students from diverse ethnic backgrounds and students that have an IEP. For these students I will differentiate the instruction by breaking down the steps of the task and spend more time with them to ensure that they understand the task at hand and the content material. For the students in these sections that are mentally gifted, I will have them serve as a guide for others in the classroom. When they finish the task at hand, they go around the class to assist others with any questions they may have. I will also have these students answer more in depth questions related to the content material in order to differentiate the instruction.

Classroom Activities

Lesson One: Review of Tech-Lab Safety Practice

Big Ideas/ Concept

Compare and Contrast Lab Safety Practices (school vs. real world). It is important to provide time and guidance for students to practice the safety precautions you expect them to follow in your Tech Lab. Teaching students how to be responsible and giving them the opportunity to be responsible is an important step in successfully completing any tech lab project.

Students will work in pairs to create a concept map to compare and contrast safety rules in our schools vs. safety rules practiced by real engineering and computer programmers. Pass out a Venn diagram worksheet with three interconnecting circles. Have students label the circles School Tech Lab, College Level Tech Lab and Job Site Tech Lab. Have the student list all of the existing school safety tech lab rules in the proper circle and than do research to complete the other two circles. Share finding from each pair of students as a whole class activity.

Lesson Objectives

Students will work in pairs in order to research and create a concept map to compare and contrast tech lab safety rules in our schools vs. safety rules practiced by real tech labs either at the college level or a job site.

Materials and Technology

- Internet access
- Venn Diagram Worksheet
- Selected YouTube videos

Lesson Procedure

The students will be working in pairs for this lesson. They will be responsible for researching and comparing our school safety rules and procedures to real laboratory worksites.

The lesson will start off by showing one short 5 minute video clip related to *safety at the workplace*. Students will be able to watch this video again and two additional video on their own at the following link:

https://www.youtube.com/watch?v=RKdb2SDU-Zk [1](school)
https://www.youtube.com/watch?v=GQLkSiegHKI [2](college)
https://www.youtube.com/watch?v=6zU0ETIri_s [3](job site)

Video Discussions Questions:

After watching just the first video I will ask a set of questions such as:

1. What are some of the Tech Lab Safety Rules we use in our school lab?
2. Compare to the ones we saw in the video?
3. How might our safety rules be the same or different with a college Tech lab?
4. How might our safety rules be the same or different with a real job Site tech lab?

Pass out a Venn diagram worksheet with three interconnecting circles. Have students label the circles School Lab, College Lab and Job Site Lab. Have the student list all of our existing tech lab safety rules in the proper circle and then research online to complete the other two circles.

Lesson Two: Construction of *"The Simple Circuit Board"* [4]

Big Ideas/Concept

Student will work in pairs to create a working circuit board that can be used answer the following questions:

- What is circuit?
- What are amperes?
- What is a switch?
- What is a battery?

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2 "Safety in school shops - YouTube." 2011. 9 May. 2014 <http://www.youtube.com/watch?v=GQLkSiegHKI>

4 "Tech-ed safety rules video - YouTube." 2012. 9 May. 2014 <http://www.youtube.com/watch?v=RKdb2SDU-Zk>

3 "Michigan Tech Chemical Engineering Lab Safety ... - YouTube." 2013. 9 May. 2014 <http://www.youtube.com/watch?v=6zU0ETIri_s>

4 "Physical Science Activities - ScienceScene." 21 Jun. 2015 <http://www.sciencescene.com/Workshop%20Materials/Physical%20Science%20Activities/Physical%20Science%20Activities.htm>

- What are conductors?
- What is a fuse?
- What are volts?
- What is a resistor?
- What are the characteristics of a parallel circuit?
- What are the characteristics of a series circuit?

Lesson Objective

SWBAT demonstrate that an electric circuit requires a minimum of three components. (pathway, source of electrons and object for the electrons to act on)

Materials and Technology (per group of students)

- Download directions and make copies of *"The Simple Circuit Board"* (http://www.sciencescene.com/Workshop%20Materials/Physical%20Science%20Activities/Physical%20Science%20Activities.htm)

- graph paper
- cardboard
- ruler
- Medium Tip Sharpie Markers
- 7 Small magnets
- 7 Small paperclips
- 2 Wires
- Glue
- 4 AA battery pack and batteries

Lesson Procedure

In small groups of four students will read and review all instructions for circuit board construction and discuss/research any questions that may need more clarity before creating a blueprint can begin.

Students will individually create their own blue for *Simple Circuit Board* by following the design measurements and criteria provided (even though only one circuit board will actually be constructed for each group of four in class, every student will have their own

blueprint which will be graded and instructions to take home). The entire group of 4 will receive a grade for the construction of a working circuit board.

Lesson Three: Tinkering with Series Circuits

Big Idea/Concept

In a series circuit, electricity has only one path on which to travel. In the example to the right, two bulbs are powered by a battery in a series circuit design. Electricity flows from the battery to each bulb, one at a time, in the order they are wired to the circuit. In this case, because the electricity can only flow in one path, if one of the bulbs blew out, the other bulb would not be able to light up because the flow of electric current would have been interrupted. In the same way, if one bulb were unscrewed, the current flow to both bulbs would be interrupted.

Lesson Objective

Understanding voltage and current in a series circuit

Materials and Technology

- *The Simple Circuit Board* (use the boards that each group made)
- Multi-meter

Lesson Procedure

Students will work in groups of four, working with the simple circuit board build by their group. Groups will set-up light bulbs in a series circuit format to test and make observations on the following characteristics of a series circuits:

1. Because this circuit has two bulbs, what factors do you think would be different from the single bulb circuit? In what way would these factors be different?
2. Describe the brightness of the bulbs as compared to that in the single-bulb circuit.
3. Describe the brightness of the bulbs as compared to that in the single-bulb circuit.
4. Measure the voltage across each bulb: Bulb 1: ____V: Bulb 2: ____V.
5. How are the brightness and the bulb voltage related to each other in the one-bulb circuit and in the two-bulb series circuit?
6. How are the battery voltage and the bulb voltage related to each other in the one-bulb circuit and in the two-bulb series circuit?

7. What do you think will happen if you removed one-bulb from this circuit?
8. What conclusion can you make about the Voltage in a series circuit?

Lesson Four: Tinkering with Parallel Circuits

Big Idea/ Concept

In a parallel circuit, electricity has more than one path on which to travel. In the example to the right, two bulbs are powered by a battery in a parallel circuit design. In this case, because the electricity can flow in more than one path, if one of the bulbs blew out, the other bulb would still be able to light up because the flow of electricity to the broken bulb would not stop the flow of electricity to the good bulb. In the same way, if one bulb were unscrewed, it would not prevent the other bulb from lighting up.

Lesson Objective

Understanding voltage and current in a parallel circuit

Materials and Technology

- *The Simple Circuit Board* (use the boards that each group made)
- Multi-meter

Procedure

1. Review the definitions of series and parallel circuits with the class.
2. Because this circuit has two bulbs, what factors do you think would be different from the single bulb circuit? In what way would these factors be different?
3. Describe the brightness of the bulbs as compared to that in the single-bulb circuit.
4. Describe the brightness of the bulbs as compared to that in the single-bulb circuit.
5. Measure the voltage across each bulb: Bulb 1: ____V: Bulb 2: ____V.
6. How are the brightness and the bulb voltage related to each other in the one-bulb circuit and in the two-bulb series circuit?
7. How are the battery voltage and the bulb voltage related to each other in the one-bulb circuit and in the two-bulb series circuit?
8. What do you think will happen if you removed one-bulb from this circuit?
9. What conclusion can you make about the Voltage in a parallel circuit?

10. Once the circuits are complete, ask student groups to make predictions as to how the circuits will function if a light bulb is removed. Also discuss whether the bulbs might burn brighter in one set up than another. Students should record their predictions in their notebooks.
11. Have each student group test their predictions using their circuit board, and compare their results to their predictions.
12. Bring the student groups together to discuss their findings.

Annotated Bibliographies/Works Cited/Resources

"The Tinkering Studio." 2010. 22 Mar. 2015 <http://tinkering.exploratorium.edu/>
The Tinkering Studio is a book that offers ways to blend science with art.

"ScienceScene." 22 Mar. 2015 <http://www.sciencescene.com/>
The website offers a series of lessons for Physical Science.

“Tech-ed safety rules video - YouTube.” 2012. 9 May. 2014 <http://www.youtube.com/watch?v=RKdb2SDU-Zk>. This is a short video explaining the rules of Tech-ed safety.

“Safety in school shops-YouTube”2011.9.May.2014 < http://www.youtube.com/watch?v=GOLkSiegHKI>. This is a short video that reviews the rules of a school level Tech-ed class.

“Michigan Tech Chemical Engineering Lab Safety…-YouTube.”2013.9May.2014 <http://www.youtube.com/watch?v=6zU0ETIri s>. This video explains the rules of a real world Engineering Lab.

"PhET: Free online physics, chemistry, biology, earth science ..." 2010. 21 Jun. 2015 <https://phet.colorado.edu/>
This website offers engaging simulations for students studying physical science concepts.

The Physics Classroom." 2002. 21 Jun. 2015 <http://www.physicsclassroom.com/>
Tutorial website that offers additional resources for both teachers and students.

"Physics - Potential Difference and Resistance ... - YouTube." 2010. 21 Jun. 2015 <http://www.youtube.com/watch?v=V3jRxnoStAU>

Appendix / Content Standards

National Science Education Standards Grades 5-8 (ages 10 - 14)

CONTENT STANDARD A: Science as Inquiry As a result of activities, all students should develop Abilities necessary to do scientific inquiry

Understandings about scientific inquiry

CONTENT STANDARD B: Physical Science As a result of their activities, all students should develop an understanding of Transfer of energy

CONTENT STANDARD E: Science and Technology As a result of activities, all students should develop understandings about science and technology

Next Generation Science Standards Grades 3-5 (Ages 8-11) Energy Students who demonstrate understanding can:

NGSS 4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

NGSS: ETS1.B: Developing Possible Solutions

Common Core (CCSS)
CCSS.ELA.Literacy.CCRA.R.7
Read and comprehend complex literary and informational texts independently and proficiently.