Internet of Things (IoT) at UCF

UNIVERSITY OF CENTRAL FLORIDA

UCF RET Site: Collaborative Multidisciplinary Engineering Design Experiences for Teachers

2003390 and Physics 1 Honors

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7/5/2017

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- Remember to do your 3R reflection include an updated copy of your lesson plan, developed assessment tools, presentation materials, to the evaluator. See implementation plan instructions developed by the evaluator. Send within a week after completing the lesson to bonnie.swan@ucf.edu

RET Site: CoMET Lesson/Unit Plan

Course(s): Physics 1 Honors
Grade Level: 10-12
Suggested Length of Lesson: 100 minutes

Materials/Technology Needed

- "Conductive Rubber Cord Stretch Sensor + extras!"—(From Adafruit; $9.95 for a meter)
- Weight sets
- Multimeter
- Alligator clips and connectors
- Batteries and Lightbulbs (optional)
- meter stick or ruler

Where this Fits

- Electric Current and Resistance Unit, when teaching students about resistance.

Lesson Objective(s)/Learning Goal(s)

- Students know how resistance of a substance varies with length, resistivity, and cross-sectional area of the substance.

Standard(s)/Benchmark(s) Addressed

- *Standards:*
  - *SC.912.P.10.15 - Current, Voltage, Resistance, and Power*
  - *SC.912.P.10.14 - Conductors, Semiconductors, and Insulators*

Evidence of Learning (Assessment Plan)

- There will be a short pre-lab assessment in the form of a "bell work" question. The students will create and turn in a lab report as a group as part of the lab. The day after the lab there will be a few post lab questions designed to focus them on the main points of the lab and to assess their comprehension of the main points of the lab.

Instructional Strategies

- Modeling
- Cooperative Learning
- Inquiry Based Learning
- Formative Assessment

Description of Lesson Activity/Experiences

1. *At the beginning of the lesson the class will be shown pictures of flexible strain sensors and they're many uses such as on a human's lung or hand or any flexible location that strain measurement is desirable.*
2. At the start of class the students are given a short bell work question to respond to while the teacher is taking attendance and preparing for the lesson. This question essentially asks them to describe in words what factors affect electrical resistance and in what ways they affect electrical resistance. This is intended as a pre-assessment of the content knowledge.
3. The lab is introduced by the teacher by discussing with the class what they've learned so far about Electric Current, Conductors, Insulators, and Semiconductors. The teacher asks two guiding questions for the lab: Why do some conductors conduct better than others? What factors affect conductivity and in what way? The teacher waits for students to hypothesize their answers to the question based on their background knowledge. (The student's lab report has a format in my class of "Question, Background Knowledge, Hypothesis, Procedure, Data, Analysis, and Conclusion"). The teacher demonstrates the materials and how they may be used; modeling the behavior he/she wishes to see replicated by the students. The teacher explains how much the cord can be stretched without breaking and the basic operation of a multi-meter to measure resistance. The main focus of the demonstration should be lab safety, not how to complete the lab. It is up to the students to design the lab procedure and answer the guiding question. This is more similar to real research.
4. The way I would do the experiment and expected results is explained briefly here. I walk around the room

helping groups that are struggling by giving hints usually in the form of questions. I would attach alligator clips to both ends of the conductive rubber cord and attach them to the multi-meter which I would use to measure the resistance it has when it is at its equilibrium state. Then I would attach the cord to a ring stand, stretching it a bit at a time by adding weights to the bottom causing it to stretch more and more. I would measure resistance after each weight is added. This would all go into the student's data. I would then graph this data in excel or by hand. The student's should see that as the cord is stretched more the resistance increases. They should also notice that the cord becomes thinner as it is stretched. Both of these factors increase resistance. They should graph enough data points so they can see the relationship between length and resistance. They should see the relationship is nonlinear in this case, because both the length and the cross sectional area are changing simultaneously.

5. The Post Lab questions after the lab would be given to each group and then they would be asked to prepare a small presentation with some chart paper. The presentation is done in front of the whole class as a lab group. I grade the presentations on participation. The students explain their lab procedure, data in the form of a graph, and conclusion to the class. Since each group is creating their own procedure it's perfectly fine if some groups do things differently, but usually the class will agree on the same conclusions regarding what factors affect resistance and in what way. Make sure to question when a group proposes a conclusion that isn't properly supported by data. Scientist must always be skeptical of conclusions not supported by scientific evidence. I sometimes find that certain groups of students may need more time than others to design and conduct their experiment. If this occurs than the Post Lab questions and the presentation should be done the following day allowing the students to complete the lab in one class period, and prepare the presentation and answer the questions on the next day.

Recommended Assessment(s) and Steps

- Pre and post assessments are below. Steps are described in the lesson activity/experiences section.

List of Materials/Resources Used

- Other than the materials/technology listed above. You may require chart paper and markers for the presentation paper for the pre and post lab questions etc…

You can create multiple lesson plans if you are developing a unit.

Important Vocabulary

Define unusual or probably unknown words. Write definitions in sentence format.

Term	Definition
Resistance	A quantity describing the voltage dissipated across a segment of material per ampere of current flowing through the material
Length	A quantity describing the extent of something from one end to the other.
cross sectional area	the area of the section that is shown when cutting straight through an object
Resistivity	A measurement of the inherent resisting power of a material based upon its material properties
Ohms	The standard measurement for resistance in the metric system
Meters	The standard measurement for length in the metric system
variable resistor	A resistor that can change its resistance without being permanently altered.

Troubleshooting Tips

The idea behind an inquiry based lab is that the students are given a guiding question and expected to create their own procedure and method to answer the question using the materials available to them. For this to work you really need to hammer into the students the importance of multiple trials, accuracy of measurement, repeatability of an experiment, proper analysis of data, and how to support a conclusion with data as evidence. If you have established these routines in your classroom you can expect them to accomplish this lab and make their procedure on their own. This gives students more ownership over their work and enhances the learning experience provided by the lab. If you have not established classroom routines for inquiry based labs it might be better to create a more structured lab for your students while still following the same basic procedure described here.

Other Helpful Information

Many students struggle with making graphs in labs merely because they are not used to making scientific graphs. They need to label their axes when making the lab and include the units and also make sure they incrementally increase the numbers on the axes and do not skip any numbers. This basic graphing knowledge would hopefully be covered ahead of time to facilitate a smoother lab for your students.

Attachments

List here any lesson or activity attachments not included within this document, such as the following:

- Pre Lab Question – Write on board for students to write on their bell work sheet: What factors affect electrical resistance and how do they affect electrical resistance?
- Post Lab Questions – Write on board for students to write on the back of their lab report:

    1. How does the changing length of the cord affect the resistance?

    2. How does the changing length affect the cross sectional area of the cord?

    3. Create a general equation describing the resistance of an object based upon its length, cross sectional area, and resistivity. Explain your equation by using the data from your experiment.

    4. What is one possible application for a variable resistor such as this cord? Explain how it would work.

Remember to send these as separate files along with your unit/lesson plan.

References

Wang, X., Sparkman, J., & Gou, J. (2017). Strain sensing of printed carbon nanotube sensors on polyurethane substrate with spray deposition modeling. Composites Communications, 3, 1-6. doi:10.1016/j.coco.2016.10.003

Acknowledgements

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Supporting Program

RET Site: COMET Program, College of Engineering and Computer Science, University of Central Florida. This content was developed under National Science Foundation grant #EEC-1611019.

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