Internet of Things (IoT) at UCF

UNIVERSITY OF CENTRAL FLORIDA

UCF RET Site: Collaborative Multidisciplinary Engineering Design Experiences for Teachers

#2001340: Environmental Science

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#2001340: ENVIRONMENTAL SCIENCE

6/10/2019

READ THIS FIRST

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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: IoT and E-Waste Lesson/Unit Plan

Subject Area(s): Science

Course(s): #2001340: Environmental Science

Grade Level: 9-12

Suggested Length of Lesson: 5-10 days

Lesson Summary: Today, we live in an IoT world. Students will explore the **Internet of Things** (IoT). As our need for technology grows, so does the **accumulation of waste products** and discarded high tech equipment. Where does it go? Landfills are already overflowing and are not equipped to dispose of discarded technologies that are embedded with toxic chemicals, hazardous energy sources, and additional plastics and leaching metals. As we crave for a need for smaller, faster, and more efficient electronic devices, we need to also account for the additional environmental and health impacts they will also bring into our world. In this lesson, students will explore the **life cycle of a cellular phone**. Students will explore what a cellular phone is made of, where those materials come from, how those materials are combined to produce the product, the hardware and software used to drive the product, the use of the product and then the final disposal of the product. Along the way, students will research and understand the environmental impacts that each stage of a cellular phone's life cycle brings with its development.

Prerequisite Knowledge: Students must have a basic understanding of the Internet, integrated technologies, and computer skills.

Materials/Technology Needed

- Collection of Typical E-Waste: cell phones, SMART watches, tablets, etc…
- Worksheet #1 – IoT Background Information
- Worksheet #2 – E-Waste Home Survey
- Worksheet #3 – Class Results Table
- Article #1 – "The Story of Stuff" at https://storyofstuff.org/movies/story-of-electronics/
- Article #2 – "Where does it come from?" –a material search of cell phone components. https://www.compoundchem.com/2014/02/19/the-chemical-elements-of-a-smartphone/
- Article #3 – "IoT and E-Waste". https://www.nwf.org/~/media/PDFs/Eco-schools/KQED-ewaste.ashx
- Article #4 – https://bebusinessed.com/history/history-cell-phones/
- Article #5 – "What do we do next?" https://eekwi.org/teacher/ecycle.htm
- Research Paper Rubric
- Pre-Test
- Post-Test

Where this Fits/Lesson Dependency

- Units where this lesson can be incorporated include, but is not limited to:
    - Unit 1: Ecology and Ecosystems
        - The Environment and Sustainability
    - Unit 4: Environmental Quality
        - Geology and Nonrenewable Mineral Resources
    - Unit 5 Environmental Concerns
        - Human Population and Urbanization
        - Environmental Hazards and Human Health
        - Solid and Hazardous Waste

Lesson Objective(s)/Learning Goal(s) (2-4)	

Lesson Objective(s)/Learning Goal(s) (2-4)
- Students will be able to describe the concept of sustainability and its significance to environmental science.
- Students will be able to describe how mineral resources can become economically depleted.
- Students will be able to discuss the harmful effects of mineral mining.
- Students will be able to explain how mineral resources can be used more sustainably.
- Students will be able to identify new materials that are replacing some metals for common use.
- Students will be able to explain how mineral resources can be used more sustainably.
- Students will be able to understand how chemicals in the environment can harm the human body.
- Students will be able to define and give examples of solid waste.
- Students will be able to explain what happened to solid waste after it's disposed.
- Students will be able to define and give examples of hazardous waste and understand why hazardous waste requires special handling.
- Students how waste management, waste reduction, and integrated waste management differ in their approaches to dealing with solid waste.
- Define the 4Rs approach to dealing with solid waste and identify ways individuals, industries, and communities can use this approach to limit waste and pollution.
	- HE.912.C.1.3
	  - Evaluate how environment and personal health are interrelated.
	- SC.912.L.17.14
	  - Assess the need for adequate waste management strategies.
	- SC.912.L.17.16
	  - Discuss the large-scale environmental impacts resulting from human activity, including waste spills, oil spills, runoff, greenhouse gases, ozone depletion, and surface and groundwater pollution.
	- SC.912.L.17.18
	  - Describe how human population size and resource use relate to environmental quality.
	- SC.912.L.17.15
	  - Discuss the effects of technology on environmental quality.
	- HS-ESS3-4
	  - Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.*

Standards for Mathematical Practice	Instructional Strategies
▪ MAFS.K12.MP.2.1 ○ Reason abstractly and quantitatively. ▪ MAFS.K12.MP.5.1 ○ Use appropriate tools strategically. ▪ MAFS.K12.MP.6.1 ○ Attend to precision. ▪ MAFS.K12.MP.7.1 ○ Look for and make use of structure. ▪ MP.2 ○ Reason abstractly and quantitatively. ▪ MAFS.K12.MP.1.1 ○ Make sense of problems and persevere in solving them. **Evidence of Learning (Assessment Plan)** ▪ Pre-Test ▪ Laboratory Report ▪ Research Paper ▪ Post-Test	▪ General Instructional Strategies ○ Group Collaboration ○ Cooperative Learning ○ Technology ○ Problem Solving ○ Small Group Instruction ○ Whole Class Instruction ○ Modeling/Scaffold Instruction ○ Checking for Understanding ○ Providing Verbal Immediate Feedback ○ Review of Material ▪ ELL Strategies ○ Paired Reading ○ Group Activity ○ Preferred Seating ○ "Hands-on" Activity ○ Dictionary for Reference ▪ ESE Strategies ○ Guided Inquiry ○ Preferred Seating ○ Repeat of Instruction ○ Clarification for Understanding ▪ Other strategies listed in individual student's IEP/504

Description of Lesson Activity/Experiences

1. Take the Pre-test.
2. Complete the Dissection of a SMART phone Laboratory Activity.
3. Discuss what it all means.
4. Watch video "The Story of Stuff" at https://storyofstuff.org/movies/story-of-electronics/
5. Begin Lesson – Intro Activity
6. Research Activity – "Where does it come from?" –a material search of cell phone components. View: https://www.compoundchem.com/2014/02/19/the-chemical-elements-of-a-smartphone/
7. Discuss research results.
8. Read Article on "IoT and E-Waste". Read and review: https://www.nwf.org/~/media/PDFs/Eco-schools/KQED-ewaste.ashx
9. Research Activity – "How is it produced?" –a manufacturing virtual tour. Watch and review: https://www.youtube.com/watch?v=V8ZVHpgYAzs
10. Discuss research results. Read and Review: https://bebusinessed.com/history/history-cell-phones/
11. Hand out IoT E-Waste Home Survey (students will complete as homework and return it next day).

12. Research Activity – "What do we do next?" –a mission on reducing E-waste, recycle it, reuse it or landfill bound? Read and review: https://eekwi.org/teacher/ecycle.htm
13. Discuss research results.
14. Write a research paper summarizing the research completed during the week: the dissection of the SMART phone, the life cycle of a SMART phone, and future research questions.
15. Extension: Create an E-Waste Recycled Art Project. Read and review: https://www.todaysoftmag.com/article/2582/reduce-reuse-recycle-an-environmental-approach-to-your-iot-projects
16. Extension: Create an Awareness Poster or Brochure on the Life Cycle of a SMART phone or any topic covered during this research lesson.
17. Take the Post-test.

Recommended Assessment(s) and Steps

- Pre-test
- Formative Evaluation (answering verbal questions by teacher)
- Written follow-up questions
- Research Report
- Post-test

List of Materials/Resources Used

- Environmental Science Textbook
- Article: IoT and E-Waste
- Article: Recycled Material into Art

Engineering Connection (60-100 words/3 sentences)

Students will research and identify any problems in the life cycle of a cellular phone. Students will research every aspect of the process of creating to disposing of a cellular phone. Students will brainstorm and explore better engineering practices in the mining, developing, manufacturing, and disposing of cellular phones. Students will have a better understanding of the impact the electronic devices have on human health and the environment.

Engineering Category (choose one)

XXX	relating science and/or math concepts to engineering (primarily science & math with some engineering)
	engineering analysis or partial design (primarily engineering with some science/math)
	engineering design process (full engineering design)

Key Words

IoT, E-Waste, sustainability, renewable resource, nonrenewable resource, mineral, reserve, depletion time, nanotechnology, materials revolution, toxic chemical, carcinogen, mutagen, teratogen, solid waste, industrial waste, municipal solid waste (MSW), hazardous waste, waste management, integrated waste management, sanitary landfill, primary recycling, secondary recycling.

Introduction/Motivation (written as if talking to students)

Teacher prepared before students enter room: variety of cellular devices at each station.
Teacher: How many of you own a cellular phone? How many have more than one cellular phone?
Student responses.
Teacher: Almost all of you own cellular phone and many of you have multiple phones. Now think about your household, how many of the people that you live with have a cellular phone and better yet, how many of those

people have more than one cellular phone? Interesting. Do you know that statistics show that individuals today have at least 7 electronic devices and by 2020 that number will be up to 13 electronic devices?
Student responses.
Teacher: This lesson we are going to look at some key concepts in environmental science, including sustainability, mining, renewable and nonrenewable resources, nanotechnology, waste management and the 4Rs: reduce, reuse, replenish, and recycle. Welcome to the life cycle of a cell phone!

Lesson Closure (written as if talking to students)
Teacher: Well, we've neared the end of our life cycle of a cell phone, we've covered many key concepts along the way that we will explore further and more in-depth as those topics re-surface. For now, you have just experienced the life cycle of the cell phone. What were the key topics that we discussed?
Student will respond, writing in their interactive notebooks.
Teacher: Pair and share your list with your table and be prepared to share your results with the rest of the class.
Student will combine their lists and be prepared to share what they have learned with the rest of the class.
Teacher: What concepts did you have in common with the rest of your table? Please share. (Go around the room, table by table comparing the results with the rest of the class).
Teacher: What was the most interesting fact that you learned from our lesson? What would you like to research more about? Do you still have any unanswered questions?
Students will respond, teacher continuing to prompt answers to be written in interactive notebooks.
Teacher: Great job everyone, together we've learned what it takes to have that amazing device at your fingertips! This year we will continue to learn about the common everyday items and how they impact both human health and the environment. It's going to be a great year!

Lesson Background & Concepts for Teachers
This lesson is research based. The ability of having information at our fingertips has had an environmental impact that has not been addressed. Students do not fully understand how such a small device may have such a huge impact on our environment. Teachers, please read all articles and handouts with care. Please note all instructions. The lesson is focused on bringing an understanding of what impact electronics and their components have on our environment. From start to finish electronics are impacting our world.

Important Vocabulary

Term	Definition
Internet of Things (IoT)	The interconnection by the Internet of computing devices embedded in everyday objects, enabling them to send and receive messages
Electronic Water (E-Waste)	Discarded electronics or electronic devices.
Sustainability	Capacity of Earth's natural systems that support life (including human social systems) to maintain stability or to adapt to changing environmental conditions indefinitely.
Renewable resource	Resource that can be replenished rapidly (in hours to centuries) through natural processes as long as it is not used up faster than it is replaced.
Nonrenewable resource	Resources that exists in a fixed amount and takes millions to billions of years to form, so it will be used up more quickly than it can be replaced.
Mineral	Chemical element or inorganic compound that exists as a solid with a regularly repeating internal structure.
Reserve (mineral)	Portion of a mineral resource that is economically and technically feasible for mining.
Depletion time	Amount if time it takes to use a certain proportion (usually 80%) of the reserves of a mineral at a given rate of use.
Nanotechnology	Use of science and engineering to manipulate and create materials out of atoms and molecules at the ultra-small scale of less than 100 nanometers.
Materials revolution	Replacement of minerals with other materials for the use in industry and technology.

Toxic chemical	Element or compound that can cause temporary or permanent harm or death.
Carcinogen	Chemical, type of radiation, or virus that can cause or promote cancer.
Mutagen	Toxic agent such as a chemical or form of radiation that causes or increases the frequency of mutations in the DNA molecules found in cells.
Teratogen	Chemical that harms a fetus or embryo or causes birth defects.
Solid waste	Any unwanted or discarded material people produce that is not a liquid or a gas.
Industrial waste	Solid waste produced by mines, farms, and industries that supply people with goods and services.
Municipal solid waste (MSW)	Combined solid wastes produced by households and workplaces other than factories.
Hazardous waste	Any discarded material or substance that threatens human health or the environment.
Waste management	Managing wastes to limit their environmental harm without trying to reduce the amount of waste produced.
Integrated waste management	Variety of coordinated strategies for both waste reduction and waste management designed to deal with solid wastes humans produce.
Sanitary landfill	Waste disposal site on which waste is spread in thin layers, compacted and covered with a fresh layer of clay or plastic foam each day.
Primary recycling	Using materials again for the same purpose.
Secondary recycling	Process in which waste materials are converted into different products.

Troubleshooting Tips

If audio failure: provide transcripts of audio clips.
If computer failure: provide handouts of all articles.
If overhead project failure: provide handout of presentation, worksheets, and lab activity.
If you believe students will be unable to open discarded electronic devices: pre-open the devices and place pieces of the device in a sealed bag of the appropriate size.

Other Helpful Information

To prepare for the “Dissection of a Cell Phone” laboratory activity, it may be helpful to go to a thrift store to ask for a donation of the mobile phones to dissect. Also, if unable to get discarded mobile phones, may consider using any discarded electronic device and manipulate the activity to suit that type of device.

Attachments

- Cell Phone Dissection Lab
- Daily Report Template High School Version
- IoT and E-Waste Pre-Test
- IoT and E-Waste Post-Test
- Pre-Test/Post-Test Answer Key
- IoT and E-Waste – Vocabulary Activity Key
- IoT and E-Waste – Vocabulary Activity
- IoT and E-Waste – Intro Activity
- IoT and E-Waste – Home Survey
- Research Paper Rubric
- Research Paper Template High School Version
- Reviewing Literature High School Version
- Transcripts:
    - KQED-ewaste
    - SoElectronics_Annotated_Script
    - The-Chemical-Elements-of-a-Smartphone

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