What Is It Like to Live Without Electricity?

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Overview

Electricity is a given for most urban high school students. Flip a switch or plug it in and the magic electricity does its job. The purpose of this unit is to increase students' awareness of electricity. The unit will teach students how electricity is measured and allow students an opportunity to investigate electrical usage. Students will use statistics in the collection of data, reading the data and analyzing the data and hopefully in making inferences for the future.

The unit was designed for a high school statistics course, but could be used in any other course where real life issues are emphasized. The statistics class in conjunction with the physics teacher(s), will experiment with electricity and its measurement. Many of the research topics will require students to collect data on various sources of electricity and how much electricity is produced and used. They will need to be familiar with the basics of both of these.

A **choice board** will be used to present the research portion of the project. Because the students will be doing research on only one or two possible topics about electricity and its usage, they will be primed and interested in their classmate's presentations; primed because they'll know something about electricity and interested because they have done their own research on another aspect of electricity usage.

Rationale

The more details students learn about electricity, its sources, its production, its availability and the impact on the environment, the more involved they are likely to become in some aspect of it. In the TIP seminar "Penn Laboratory on Energy,

Sustainability and Environment" we used a Fermi questions to explore multiple topics in energy, sustainability and the environment. There were assignments that allowed the fellows to explore the intricacies of a problem and personalize it, realizing that there is more than one solution and more than one way to approach an outcome. One of the ways this curriculum unit hopes to arouse interest is by giving students a choice for their research. The only requirements are that they display and analyze the data they collected or researched. It is the hope that through the preparation of their presentation or from the presentations of their peers that topic of electricity becomes real to them.

The Next Generation Science Standards makes the following statement about making connections to the Common Core State Standards for Mathematics. "During the middle school and high school years, students develop a number of powerful quantitative tools, from rates and proportional relationships, to basic algebra and functions, to basic statistics and probability. Such tools are applicable far beyond the mathematics classroom. Such tools can also be better understood, and more securely mastered, by applying them in a variety of contexts. Fortunately, the NRC Framework makes clear in its Science and Engineering Practices (Analyzing and Interpreting Data, Using Mathematics and Computational Thinking) that statistics and mathematics have a prominent role in science. NGSS aims to give middle school and high school science educators a clear road map for how they can prepare their students for the quantitative demands of college and careers, where students need to apply quantitative tools in an applied or scientific context. For all these reasons, NGSS requires key tools from Grades 6−8 and High School Common Core to be integrated into middle school and high school science instructional materials and assessments."

This curriculum unit could be done solely in a physics or statistics class, without the collaboration. It may be more difficult for the statistics teacher, but it is possible to de-emphasize some of science of electricity depending on the research topic they choose. A minimum review of "how electricity is measured" will be necessary.

Objectives

This unit is designed for a high school statistics class. In my school, the seniors take statistics as a 5th year math elective. All seniors must also take physics, so this unit is designed for collaboration between the math teacher and the physics teacher. The unit could be adapted for use in any math or science class where real life issues are explored or emphasized.

The overall objectives of the lesson is to apply statistics to data collected or researched in order to display, analyze and make inferences for the future. The specific objectives for the unit will include:

1. Measure wattage use in various light bulbs using a watt meter or energy monitor

2. Compute the cost/day of various light bulbs using its watts.
3. Read and discuss an article about a village in India without electricity.
4. Research a topic about electricity.
5. Collected and/or research data.
6. Display data
7. Analyze data
8. Make inferences from data
9. Present researched topic to class
10. Comment on peer projects
11. Reflect on learning

Strategies

The suggested strategies for this unit are meant to give the students freedom and independence. Academic choice helps engage and motivate students. It allows for creativity and exploration into areas of interest. The more students have choice in assignments, the more responsibility and ownership they have.

The research topics suggested all contain the directions to investigate and analyze. This also allows freedom. The teacher or student will have to answer the question "how deep?" One of the most rewarding things for me when investigating is to extend the thread further and further and wind up with at least 10 tabs open on my driver. In the olden days I would do the same with encyclopedias! The analysis will depend on the level of the students' knowledge in statistics. A simple analysis such as the mean kilowatt hours of electricity used for 12 months could be sufficient, or perhaps a more complex analysis such as the standard deviation of electricity usage from school to school.

Classroom Activities

Lesson 1 How is electricity measured?

Learning Objective: At the end of this lesson students will be able to use an energy monitor to measure the amount of electricity used by various types of light bulbs

Materials:

- Various types and strengths of light bulbs. Try to include compact fluorescent, LED and incandescent bulbs.
- An energy monitor that measures the power in watts.
- A lamp or fixture to hold the light bulb.

Procedure:

1. After a demonstration of its use, instruct and supervise as students use the energy monitor to find the wattage of at least 3 different light bulbs.
2. Explain the kilowatt hour, the typical billing unit for electricity.
3. Give the students the typical cost of electricity in your area. (cost/kilowatt hour).
4. Ask students to compute the cost per day (four hours of use) of each bulb tested.
5. Extend the lesson to include light bulbs you didn't test and/or various electronic appliances including a refrigerator or TV that are always plugged in.

Lesson 2 What is it like to live without electricity? Ask an Indian Villager.

Learning Objective: At the end of this lesson students will be able to discuss the five essential elements of the article/interview by Julie McCarthy (the characters, the setting, the plot, the conflict and the resolution).

Materials:

- NPR story "What's It Like To Live Without Electricity? Ask an Indian Villager." (transcript and link provided in appendix)
- Audio of Morning Edition story "What's It Like To Live Without Electricity? Ask an Indian Villager" (link provided in appendix)

Procedure:

1. Listen and/or read "What's It Like To Live Without Electricity? Ask an Indian Villager." You could assign the reading the night before you listen as a class. You could have students popcorn read the article.
2. Dissect and discuss the article as a class or in teams.

Lesson 3 Research topics based on the NPR story ""What's It Like To Live Without Electricity? Ask an Indian Villager." or other topics about electricity production and usage

Learning Objective: At the end of this lesson students will be able to display and analyze energy data they collected or researched for a presentation to the class.

Materials:

- Project Choice Board (appendix)
- Project Presentation Choice Board (appendix)
- Internet access
- Project Rubric (appendix)
- Presentation Rubric (appendix)
- Peer rating sheets (appendix)
- Reflection questions (link provided in appendix)

Procedures:

1. Provide students with the project and project presentation choice boards.
2. Explain the parameters, expectations and scoring rubric to students.
    a. Bibliography - this depends on the number and types of sources you will require/allow and the citation method.
    b. data display - this will depend on data displays covered in class, but it could include a circle graph, histogram, box and whiskers plot, frequency distribution, line graph and scatter plot.
    c. Data analysis - this will also depend on what type of analysis your class covered, but it could include measures of central tendency, or variance.
    d. Presentation - you can use the second choice board or a uniform method of presentation.
    e. Reflection of learning - you can use the included reflection worksheet or perhaps something uniform that you and/or your school have adopted.
3. Allow the students class time on the first day to investigate topics and choose partners (optional).
4. Allow the students to work on their projects in class. (optional) Be sure to schedule or assign check-ins with the students to ensure they are working and meeting deadlines.
5. Collect projects.
6. Schedule teams or individuals for presentations. Allow each team/individual 5 minutes for their presentations and 5 minutes to answer questions.
7. To ensure that the class is paying attention, assign peer rating sheets and do not allow students to have their presentation materials at their seats.
8. Assign the reflection portion of the project after all teams/individuals have presented so students can incorporate their peers' projects.
9. Don't forget to debrief and reflect upon the unit yourself and with other members of your team. Note suggestions for the next time you use the unit.

Endnotes

This unit is intended for an interdisciplinary physics and statistics class, which assumes the students know something about electricity. If this is not the case and some more lessons in electricity are desired, I have provided the following outline of how it could be done.

1. What is electricity? Students will research and be able to define and describe the following:
    a. Electrons as parts of the atom
    b. Positive and negative charges
    c. The flow of electrons
2. How is electricity produced?

    a. traditional fossil fuel power plants
    b. hydroelectric plants
    c. geothermal
    d. wind power
    e. photovoltaic panels (solar)
3. What is a circuit?
4. What are insulators and conductors?
    a. Test for conductivity
    b. Determine what types of materials are conductors and insulators
5. What is resistance? How is it measured? What types of devices produce resistance?
6. How do generators and motors relate to each other? How do they work?
7. How is electricity measured? Units of Measure:
        i. joule
        ii. kilowatt
        iii. kilowatt hour

Annotated Bibliography/Works Cited/Resources

NGSS Lead States. "Next Generation Science Standards: For States By States" Appendix-L_CCSS Math Connections 2013 Achieve, Inc. http://www.nextgenscience.org/

"What's It Like To Live Without Electricity? Ask An Indian Villager." Goats and Soda/Morning Edition. NPR. February 17, 2015. Radio. http://www.npr.org/sections/goatsandsoda/2015/02/17/386876116/whats-it-like-to-live-without-electricity-ask-an-indian-villager
http://www.npr.org/templates/transcript/transcript.php?storyId=386876116

Used with permission from NPR, 1111 North Capitol St., NE, Washington, DC 20002

Annotated Bibliography for Teachers

Reflection Questions - maybe ask students to answer 1 or 2 from each category http://www.edutopia.org/resource/40-student-reflection-questions-download

http://www.iclimate.org/ccc "Your Families Carbon Footprint" Copyright©2008 Purdue University - this may provide a topic for students

http://www.yale.edu/ynhti/curriculum/units/1989/7/89.07.01.x.html#top Teaching some basic concepts of electricity

http://www.energylens.com/articles/ BizEE Energy Lens - they are actually selling energy management systems, which is not why their link is there. Much of their background information is straight forward.

http://www.nmsea.org/Curriculum/Listing.htm
New Mexico Solar Energy Association; Summary of Solar Energy Curriculum; Energy Physics Primer

http://www.ucsusa.org/clean_energy/our-energy-choices/how-is-electricity-measured.html#.VQStcGaay24
Union of Concerned Scientists; How is Electricity Measured

http://www.yale.edu/ynhti/curriculum/units/1989/7/89.07.01.x.html#top Teaching some basic concepts of electricity

http://www.need.org/ The National Energy Education Development Project; The NEED Project P.O. Box 10101, Manassas, VA 20108 1.800.875.5029

http://www.parks.ca.gov/pages/501/files/unit.pdf California Department of Parks and Recreation; A Teaching unit on Electricity featuring the Folsom Power House© 2002 by Steve Gregorich

Appendix/Content Standards

From the Common Core State Standards for Mathematics

Statistics and Probability – S-IC 2. Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

Statistics and Probability – S-IC 3. Recognize the purposes of and differences of experiments, and observational studies; explain how randomization relates to each.

From the Next Generation Science Standards

2. Influence of Engineering, Technology, and Science on Society and the Natural World
9-12 Connection Statements
Modern civilization depends on major technological systems, such as agriculture, health, water, energy, transportation, manufacturing, construction, and communications.

Practices for Context
Science and Engineering Practice – 9-12 Condensed Practices

Apply concepts of statistics and probability from the High School Common Core State Standards (found in S) to scientific and engineering questions and problems, using digital tools when feasible.

HS.PS3 Energy

As part of this work, teachers should give students opportunities to reason quantitatively and use units to solve problems, and apply key takeaways from grades 6–8 mathematics:
Quantities (N-Q) / Reason quantitatively and use units to solve problems:
N-Q.1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and origin in graphs and data displays.
N-Q.2. Define appropriate quantities for the purpose of descriptive modeling.
N-Q.3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

HS.LS2 Ecosystems: Interactions, Energy, and Dynamics

As part of this work, teachers should give students opportunities to reason quantitatively and use units to solve problems, represent quantitative data, and apply key takeaways from grades 6–8 mathematics:
Quantities (N-Q) / Reason quantitatively and use units to solve problems:
N-Q.1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and origin in graphs and data displays.
N-Q.2. Define appropriate quantities for the purpose of descriptive modeling.
N-Q.3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
Science examples: (1) Recognize the difference between intensive and extensive quantities (e.g., a quantity with units of tons/acre is insensitive to the overall size of the area in question, unlike a quantity with units of tons). (2) Carefully format data displays and graphs, attending to origin, scale, units, and other essential items.

Interpreting Categorical and Quantitative Data (S-ID) and Making Inferences and Justifying Conclusions (S-IC).

From the PA Reading, Writing, Listening and Speaking Standards

1.2. Reading Critically in All Content Areas
1.2.11 B. Use and understand a variety of media and evaluate the quality of material produced.
· Select appropriate electronic media for research and evaluate the quality of the information received.

1.4 Types of Writing
1.4.11 B. Write complex informational pieces
(e.g., research papers, analyses, evaluations, essays).
· Include a variety of methods to develop the main idea.
· Use precise language and specific detail.
· Include cause and effect.
· Use relevant graphics (e.g., maps, charts, graphs, tables, illustrations, photographs).
· Use primary and secondary sources

1.5 Quality of Writing
1.5.11 B. Write using well-developed content appropriate for the topic.
· Gather, determine validity and reliability of, analyze and organize information.

1.6 Speaking and Listening
1.6.11 A. Listen to others.
· Ask clarifying questions.
· Synthesize information, ideas and opinions to determine relevancy.
· Take notes.
C. Speak using skills appropriate to formal speech situations.
· Use a variety of sentence structures to add interest to a presentation.
· Pace the presentation according to audience and purpose.
D. Contribute to discussions.
· Ask relevant, clarifying questions.
· Respond with relevant information or opinions to questions asked.

Electricity Project Choice Board

Investigate and analyze how energy/electricity is wasted in your home, your school or your area.	*Investigate and analyze the introduction of electricity in your area. How did people and their things have to adapt?*	*Investigate and analyze the electricity used in your house over the last year.*
In 2008, then Vice President, Al Gore, challenged our nation to repower America with 100 % carbon-free electricity within 10 years. Investigate and analyze the country's progress.	Every project must include: • A bibliography • a data display • a data analysis • a presentation (see other side) • a reflection on your learning (completed by each individual)	Choose a city, village or town that does not have reliable electricity. What are the long-term effects? What suggestions would you have to supply electricity?
Investigate and analyze and compare the electricity usage and sources in a green school vs. a regular school. (You may substitute a home or business for a school)	Investigate, analyze and explain energy efficient appliances. Compare them to older appliances.	Investigate and analyze the electricity usage of a school or business in your area.

Electricity Presentation Choice Board

Create a PowerPoint or prezi	*Create a comic book*	*Create a commercial*
Create and perform or record a drama	**Project Presentation Choices: Don't forget to include a data display!**	Create a pamphlet or brochure
Create an interactive game	Create a science fair poster	Create and perform or record a talk show scenario

What Is It Like to Live Without Electricity – Presentation Choice Board

What Is It Like to live Without Electricity Project
Grading Rubric

Task	Points Possible	Points Earned
Project completed on time (- 5 points per late day)	20	
Bibliography accurate and complete with at least --___ sources	20	
Data display present and accurate	20	
Data analysis present and accurate	20	
Personal Learning Reflection present and thorough.	20	
Presentation*		

*** The presentation can be graded separately and counted as an additional assessment. Please see Presentation Rubric.**

PRESENTATION SCORING RUBRIC FOR TEAM/PARTNERS		
Date: **Topic:**		
Members Present:		
Members who prepared materials but are not present:		
	POSSIBLE POINTS	**POINTS EARNED**
a. Summarize topic	**20**	
b. Detailed explanation of topic	**20**	
c. Correct details	**20**	
d. Data displayed and correct	**10**	
e. Materials neat and easy to read & follow	**10**	
f. All team members understand	**10**	
g. Team members interact well with class	**10**	
h. Above and beyond bonus points		
Total points		

PRESENTATION SCORING RUBRIC FOR INDIVIDUAL		
Date: **Topic:**		
Individual Presenter:		
	POSSIBLE POINTS	**POINTS EARNED**
a. Summarize topic	**20**	
b. Detailed explanation of topic	**20**	
c. Correct details	**20**	
d. Data displayed and correct	**20**	
e. Materials neat and easy to read & follow	**10**	
f. Presenter interacts well with class	**10**	
g. Above and beyond bonus points		
Total points		

Name:_____ Date:_____

Please complete one box for each team or individual who presents. Grade them honestly and sincerely. Turn this sheet in at the end of the period.

Date:_____ Team/Ind. _____

Topic:_____

Presentation Rating: (0-10)_____

Project Rating: (0-10)_____

Positive Comments:_____

_____

Constructive Comments:_____

_____

Date:_____ Team /Ind. _____

Topic:_____

Presentation Rating: (0-10)_____

Project Rating: (0-10)_____

Positive Comments:_____

_____

Constructive Comments:_____

_____

Date:_____ Team/Ind. _____

Topic:_____

Presentation Rating: (0-10)_____

Project Rating: (0-10)_____

Positive Comments:_____

_____

Constructive Comments:_____

_____

Date:_____ Team/Ind._____

Topic:_____

Presentation Rating: (0-10)_____

Project Rating: (0-10)_____

Positive Comments:_____

_____

Constructive Comments:_____

_____

Date:_____ Team/Ind. _____

Topic:_____

Presentation Rating: (0-10)_____

Project Rating: (0-10)_____

Positive Comments:_____

_____

Constructive Comments:_____

_____

Date:_____ Team/Ind. _____

Topic:_____

Presentation Rating: (0-10)_____

Project Rating: (0-10)_____

Positive Comments:_____

_____

Constructive Comments:_____

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What's It Like To Live Without Electricity? Ask An Indian Villager

February 17, 2015 5:04 AM ET

RENEE MONTAGNE, HOST:

When the sun goes down in India, fully a quarter of India lives with little or no light. To fix that, Prime Minister Narendra Modi told global investors this week that his country needs $100 billion in green, renewable energy. NPR's Julie McCarthy has this report on coping with darkness in India and ventures that are bringing light.

JULIE MCCARTHY, BYLINE: In many of India's poor villages, you make your own energy. Sagarwati, who goes by one name, digs her hands deep into manure and slaps cow dung into patties to burn as fuel to cook her family's food - drudgery that takes hours of her day. We are on the outskirts of Sadikpur, a village in India's most populous state of Uttar Pradesh in the north of the country. The road is lined with cow dung pies drying in the sun - their version of coal.

(SOUNDBITE OF BLADE CUTTING SUGAR CANE)

MCCARTHY: In this village of bucolic fields, mother and daughter-in-law Sheela and Sunita Devi are the horsepower that churns a blade that shreds sugarcane into feed. Sitting cross-legged in a courtyard hand-weaving a basket, 70-year-old Baburam says nothing is mechanized here. The residents of Sadikpur have never been connected to the national power grid. They are among the estimated 300 million Indians - roughly the population of the United States - who have no regulated source of electricity. Baburam, a grandfather, is angry that six decades after India's independence, kerosene still illuminates the houses with a light so dim he says it discourages anyone from learning to read.

BABURAM: (Foreign language spoken).

MCCARTHY: Baburam also says the fumes from kerosene and wood-burning indoors "burn our eyes, and we cannot breathe." Exposure to indoor air pollution as a result of smoke from burning biomass is estimated to cause more than a half a million premature deaths a year in India. Rahul Tongia is an adjunct professor at Carnegie Mellon University specializing in sustainable development and energy policy in India.

RAHUL TONGIA: The indoor air pollution is so bad that per one major study, it was the single largest cause of disability-adjusted life years, or impact on health - more than tobacco, more than blood pressure, heart attacks, all of these things. And it disproportionately impacts those who are indoors a lot, which is women and children.

MCCARTHY: Doing anything productive at night requires real grit. Resident Ajay Kumar Singh, 26, has ambitions of joining the state's civil service. That requires a lot of study. And if you are studying at night, how are you reading?

AJAY KUMAR SINGH: (Foreign language spoken).

MCCARTHY: "A lamp," he says, "rigged to the one generator shared by 150 families here." And even at times, he says he relies on candlelight. Village petitions for power have gotten tangled in the complex web of government edicts, power companies and suppliers. The villagers of Sadikpur are dismayed to learn they lack the 3,000 residents required to qualify for electricity. At the local electric company, we put the question to the superintendent engineer, Punkaj Kumar.

How is it that you could go for 67 years and not have electricity in a rather sizable village?

PUNKAJ KUMAR: It's a very big country. In 67 years, we have completed almost 95 percent of the country electrified.

MCCARTHY: India's electric grid may reach 95 percent of villages, but that doesn't mean it covers all of the houses. The 2011 census says that just 55 percent of rural homes use electricity as the primary source of lighting. This shortage in one of the world's largest electricity markets is stirring a modern-day gold rush.

Global investors from U.S.-based Sun Edison to India's energy giant Reliance came together this week in Delhi and pledged to install green power that would double India's energy capacity. India's Minister for Power, Coal and Renewable Energy Piyush Goyal says it will cut India's dependence on fossil fuels that make it the world's third-biggest polluter.

PIYUSH GOYAL: And for the people of India, it's more power to the villages. It's more power to the common man. It's more power to the last man on the street who's been deprived of it for 67 years.

MCCARTHY: For a look at how small entrepreneurs are helping some of those 300 million still not connected to India's power grid, we had South - a three-hour flight to Bangalore, then a seven-hour drive to the lush hills of the state of Karnataka. The last leg - a spine-jolting ride in a Jeep - is a metaphor for the challenge people who live here face.

ANANTH ARAVAMUDAN: This is a place where you don't have any electricity at all.

MCCARTHY: That's Ananth Aravamudan with the Indian energy company SELCO. It works with local banks to make loans to poor villagers to buy SELCO's $200 solar home lighting system on installments for as little as a hundred rupees or $1.60 a week. Arriving at the village of Tulasikere, women fetch water as they have for centuries. This 36-year-old farmer named Dummada says there's been no development here for the last three generations and says the government wants to reclaim the land as forest.

DUMMADA: (Foreign language spoken).

MCCARTHY: Feeling let down by the government, Dummada electrified his own home - the first in the village to install the small solar lighting system. Seventy-five percent of the villagers now have solar panels attached to their roofs. The young farmer says the panels charge the portable torches villagers use at night to protect their fields against pillaging animals. Their

children study at night with solar-charged lanterns. The headmaster reports school attendance is up. SELCO founder Harish Hande sees clean energy as an agent of social change.

HARISH HANDE: We look at sustainable energies as absolute catalyst between development, increased income and better quality of life leading to social sustainability, where people feel - yeah, everybody has a chance. And that's at stake.

MCCARTHY: Hande says India's rural poor are not looking for sympathy. They are looking for a partner. Julie McCarthy, NPR News, New Delhi.

http://www.npr.org/templates/transcript/transcript.php?storyId=386876116