PowerUp Lesson Plan Overview

This lesson is one of six lessons developed as a classroom companion to PowerUp, a free, online, educational video game that allows students to experience the excitement and the diversity of modern engineering.

The lessons are designed to be flexible and scalable to meet your students' needs. Facilitation tips, extension activities and resources for learning more can be found in the Teachers' Guide, which is available for download along with each of the lessons. For these resources, as well as to download and play PowerUp for free, go to http://powerupthegame.org.

PowerUp was created by IBM and TryScience/The New York Hall of Science with scientific content and expertise provided by the Tech Museum of Innovation, the Bakken Museum, Idaho National Laboratory and the National Renewable Energy Laboratory.

Student Objectives

In this lesson students will discuss their ideas about who Engineers are and what they do, including any negative preconceptions they may have about Engineering. Students will compare their conceptions of Engineering against brief descriptions of “a day in the life” of three real Engineers.

Students will consider Energy Innovation as one real world problem that many Engineers are currently working to solve, and the context for the Engineering activities in PowerUp and classroom activities.

Students will review law of conservation of energy. Using a series of pictures students will describe all of the ways that energy is being transformed in a given scenario by both natural and man-made processes. Students will understand that all energy on Earth – energy from renewable sources and fossil fuels – originates from the Sun.

Students will draw annotated diagrams of an instance of their own energy usage that explain where energy is being harnessed, in what ways it is transformed, and in what ways during transformations energy is transferred to the environment as heat. Diagrams will demonstrate what positive and negative impacts these transformations have on students' community and the local ecology.

Class Time

- One Period
- Introduction and Discussion: What's Engineering all about? (10 minutes)
- Energy Transformation Review (10 minutes)
- Drawing/Diagramming #1 Everyday Energy Use (15 minutes)
- Wrap up Discussion (5 minutes)

Home Work

- Drawing/Diagramming #2 Greener Energy Solution
  Students will draw a second diagram in which they take on the role of Engineer and design a green energy solution to alleviate the negative impacts of one or more energy choices in their original diagram.
- Describe solution and its impacts on community, local ecosystem and other, remote communities and ecosystems.
- Play PowerUp!!

Materials

- Energy Transformation Review – pictures included in this document
- Drawing/Diagramming – paper/pencils/markers

Correlation to National Standards 9-12

NS.9-12.2 Physical Science
As a result of activities in grades 9-12, all students should develop understanding of:

- Motions and forces
- Conservation of energy and increase in disorder
- Interactions of energy and matter

NS.9-12.4 Earth and Space Science
As a result of activities in grades 9-12, all students should develop understanding of:

- Energy in the earth system
- Geochemical cycles

NS.9-12.6 Personal and Social Perspectives
As a result of activities in grades 9-12, all students should develop understanding of:

- Natural resources
- Environmental quality
- Natural and human-induces hazards
- Science and technology in local, national and global challenges

NS.9-12.7 History and Nature of Science
As a result of activities in grades 9-12, all students should develop understanding of:

- Science as a human endeavor

Classroom–Game Connections

When your students log in to PowerUp and enter the **Orientation Center** they will have many opportunities to apply and investigate concepts addressed in this lesson. You may chose to have your students play PowerUp before the lesson, to prime their prior knowledge of the field of Engineering and to review energy concepts or you may assign gameplay for homework after this lesson to reinforce lesson concepts in a highly motivating context.

Here are some examples of the classroom – game learning connections:

- **Energy choices can impact the environment locally and globally**: Playing PowerUp your students will take on the roles of Engineers who must work together to solve a planetary energy crisis. They will experience the detrimental effects of burning carbon-based fuels and learn about renewable energy alternatives in a highly motivational, immersive context.
- **I can make choices to conserve energy**: Your students will be given the task to explore the Orientation Center and make improvements in energy conservation. They will learn about energy conservation strategies and be rewarded for the number of positive changes they can make.

- **Engineering is a diverse field. Engineering is for people like me:** Your students will meet interact with the characters based on over a dozen real Engineers (Including those three Engineers your students will have been introduced to briefly in this lesson). Through conversations with these characters your students will learn about the energy crisis that grips Planet Helios and will be given hints about how they will work in teams to solve Engineering challenges in order to save the day. The Engineer characters are further programmed to converse with your students on topics ranging from what inspired them to choose engineering as a career, the educational path they took to achieve their goals and what they enjoy most about their work to details of their own backgrounds and advice to students who may be interested in Engineering.
- **Renewable energy is transformed to create electricity and do other work.** In the outdoor areas that surround the Orientation Center structure your students will meet three renewable energy expert engineers. Each will be working on a large or small scale application of their respective renewable energy source: wind, solar and water power. Through investigating their devices and interacting with the characters students will see the steps by which renewable energy is harnessed and transformed to create electricity and do other necessary work.

  Students will further apply these concepts in the next phase of gameplay: the renewable energy missions.

Lesson Facilitation

Intro: What's engineering all about? (10 minutes)

Explain to students that throughout the next weeks students will be taking on the role of Engineers both in classroom activities and while playing PowerUp online. Probe students' knowledge of Engineering: What do Engineers do? How have they come to know about Engineers and Engineering? Is engineering a career path that the students would like to pursue? Why, Why not?

Through discussion, different student perceptions and attitudes about Engineering will emerge. Encourage students to think about Engineering as the creative application of scientific principles to design and develop a solution to a problem.

If many misconceptions or negative impressions of Engineering emerge, ask students why it is that Engineers have such a bad reputation!

Students read short profiles and decide which describes an engineer (all of them)

A – George grew up on a Reservation in Alaska. As a kid he remembers constantly asking his mom questions. He says, “But *why?* Was my favorite sentence.” He is happy to have found a career that allows him to keep asking questions and exploring, “Half of the time I'm drawing and planning in my office, the other half I'm up on a mountain, next to the ocean, or even in a mine shaft.”

B – Amanda says she picked her career because she wanted to “be where the action is.” also that it “suits my passion for working with a team to create buildings and developments that are environmentally, socially and economically friendly.”

C – Tim has always loved listening to and playing music. In high school he was in bands and in his schools' plays. This love of music inspired him to pursue his current career which involves building synthesizers and designing and working with digital oscillators, filters and amplifiers to manipulate sounds. When he's not at work, he still loves to unwind by playing music.

Explain to students that each of these profiles is based on a real Engineer, and each one has a character based on him or her in PowerUp. As your students play they will have the opportunity to meet these Engineers and interact with them. They can ask them questions about their backgrounds, their engineering specializations, what they like best about their jobs and how they came to choose Engineering as a career.

Ask students for examples of problems that are facing our world right now and in our immediate future that Engineers are working to solve. It is likely that, among other things, students will mention climate charge, and/or fossil fuel dependence – or one example of a solution, such as Hydrogen Cells or Electric Cars.

Explain that these are areas of great interest to engineers and that Energy Innovation is the context within which the class will be engaging in engineering activities.

Energy Transformation Review (10 minutes)

Review law of conservation of energy (Energy can not be created or destroyed; it can only be changed from one form to another. Whenever energy is transformed from one form to another, the process is not 100% efficient - that is, energy is also transferred to the environment as heat.)

- Students look at pictures. They describe the many energy transformations occurring in each scenario and identify energy loss mechanisms.

Photo: Dustin White - http://flickr.com/photos/tastybite/

Photo: Shaji Sarasan - http://flickr.com/photos/shajis

Photo: Michael Erhardsson - http://flickr.com/photos/michaelerhardsson

Photo: Dnzsea - http://flickr.com/photos/dnzsea

Photo: Philipp Bunge

- Students reflect on ways they use energy throughout the day. Where does that energy come from?

Students may trace energy use back to fossil fuels, continue probing: Where do fossil fuels come from? How can we create more? Even fossil fuels can be traced back to the Sun, but once used, they cannot be quickly replaced. Fossil fuels come from the fossilized remains of plants and tiny animals that lived millions of years ago. As carbon-rich organisms died they sank to the bottom of swamps and oceans where they formed layers of spongy material called peat. After hundreds of years layers of sand and clay and other minerals were deposited on top of these peat layers and became sedimentary rock. Over millions of years of exposure to heat and pressure in the Earth's crust the remains have become coal, petroleum and natural gas. We call fossil fuels a "non renewable resource" because the process by which they are "replaced" takes hundreds of millions of years.

- How are fossil fuels transformed? What are the pros and cons of using them for energy?
- Ask students for examples of renewable energy sources. Where do they come from? How are they transformed? What are pros and cons of using them for energy? Why do we call them "renewable"?

Help your students to understand that all energy on Earth can be traced back to the Sun. Heat from the sun is absorbed by the gases and water vapor in the Earth's atmosphere. This drives the water cycle. As the sun's energy is absorbed by the atmosphere and the oceans it creates areas of higher and lower temperatures. These differences in temperature create temperature-driven wind and ocean currents. When we harness the energy of the wind – as in the picture of the sailboat – we are actually harnessing solar energy. The sun provides heat to the surface of the Earth and primary producers turn solar energy into chemical energy through photosynthesis. The food we eat, the wood we use to build with and the fossil fuels we burn can be traced back to photosynthesis.

Drawing/Diagramming #1: Everyday Energy Use (15 minutes)

Using one instance of their own daily energy use, Students draw a diagram that shows how the energy is harnessed, transformed, transported and applied to do a job. Students should note where and how energy is transferred as heat to the environment. Diagram should include notes on the positive and negative impacts these energy transformations have on their community and the local ecology.

Wrap up Discussion (5 minutes)

- Ask the students to reflect on their work: What are some of the negative impacts of your own energy usage that you noted on your diagram? Do these negative impacts have a cumulative negative effect?
- Invite the students to take on the role of an engineer and design a green energy solution to alleviate the negative impacts of one or more energy choices in the first diagram.
- (If time permits begin this in class, if not assign for homework)
  Students draw a second diagram, switching the original source of energy to that of a renewable resource.
- How does this change your diagram? Are there costs/benefits for the end user (you)? For the local ecology? For your community? Do these local decisions impact people in other parts of the world? If so, whom might they impact, and how?

Homework:

- Drawing/Diagramming #2: Greener Energy Solution
  Students complete second diagram and write answers to questions posed in wrap up discussion.