Energy in Action: Create an Energy Converting Device

Energy Transfer using the Engineering Design Process

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Grade Level	4th – 6th Grade	**Time Frame**	50 min. sessions
Subject	Science	**Duration**	2-3 class periods
Course	Oklahoma Young Scholars/Javits, Physical Science		

Essential Question

What does an engineer do? What is the Engineering Design Process? How is the Engineering Process used to design a device that converts energy?

Summary

Students will delve into the engineering design process by developing devices that convert energy from one form to another. First, they will assess their understanding of energy transfers using the "Always, Sometimes, or Never" strategy. Then, they generate a word cloud to explore their knowledge about what engineers do. After learning about the engineering process, students will deepen their comprehension by creating a user manual for their device and conclude with an exploration of the Engineering Design Process.

Snapshot

Engage

Students assess their understanding of energy transfers using the "Always, Sometimes, or Never" strategy. Then, using Mentimeter the class generates a word cloud to explore their knowledge about engineers.

Explore

Students create a device that converts energy from one form to another using simple materials and clear parameters.

Explain

Students are introduced to the Engineering Design Process and watch a video. Next, they compare designing and building their device to the engineering process and create individual anchor charts.

Extend

Students create an instruction manual for their energy devices. They will provide step-by-step instructions for their devices and explain how energy is transferred when operating them.

Evaluate

The class creates a second word cloud about engineers and compares it to their original word cloud. Students identify changes in their ideas based on what they have learned.

Standards

Oklahoma Academic Standards (4th Grade)

4.PS3.4 : Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.*
4.PS3.4.3: Possible solutions to a problem are limited by available materials and resources (constraints). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.
4.PS3.4.4: The success of a designed solution is determined by considering the desired features of a solution (criteria).
4.PS3.4.5: Engineers improve existing technologies or develop new ones.

Oklahoma Academic Standards (4th Grade)

6.PS3.3.4: The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful.
6.PS3.3.6: A solution needs to be tested, and then modified on the basis of the test results in order to improve it.

Attachments

- Airplane Landing Cards—Energy in Action.docx
- Airplane Landing Cards—Energy in Action.pdf
- Always, Sometimes, Never Cards—Energy in Action.docx
- Always, Sometimes, Never Cards—Energy in Action.pdf
- Always, Sometimes, or Never True Answer Key—Energy in Action.docx
- Always, Sometimes, or Never True Answer Key—Energy in Action.pdf
- Engineering Design Process Anchor Chart—Energy in Action.docx
- Engineering Design Process Anchor Chart—Energy in Action.pdf
- Engineering Design Process Diagram—Energy in Action.docx
- Engineering Design Process Diagram—Energy in Action.pdf
- Lesson Slides—Energy in Action.pptx
- Scenarios 1 and 2—Energy in Action.docx
- Scenarios 1 and 2—Energy in Action.pdf
- Scenarios 3 and 4—Energy in Action .docx
- Scenarios 3 and 4—Energy in Action .pdf

Materials

- Lesson Slides (attached)
- Airplane Landing Cards (attached)
- Always, Sometimes or Never True? Cards (attached)
- Always, Sometimes, or Never True? Answer Key (attached)
- Engineering Design Process Diagram (attached)
- Engineering Design Process Anchor Chart (attached)
- Scenarios 1 and 2 (attached; optional)
- Scenarios 3 and 4 (attached; optional)
- Supplies for the devices
    - Tissue boxes
    - Paper towel tube
    - Pencils
    - Rubber bands
    - Tape and scissors

35 minutes

Engage

Teacher's Note

Before starting this lesson, students should have some understanding of converting energy from one form to another.

Teacher Preparation: You will use two strategies blended together, "Always, Sometimes, or Never True" and a modified "4 Corners" to review energy transfers. Print out the Always, Sometimes, or Never True Cards and post them in three different areas of the room.

Mentimeter **prep: Step-by-Step**

1. Go to Mentimeter.com and select "Sign up" or "Log in" in the top right corner.
2. Select "New Menti."
3. Create a title for your presentation by clicking "Untitled presentation" at the top of the page.
4. Select "Start from scratch."
5. Under "Slide type," select Word Cloud
6. Type the prompt **What does an engineer do?** in the "Question" field.
7. Select "Share" in the upper-right corner of your screen to share with students.
   Depending on your screen size, this may be hidden in the "..." menu next to the "Present" button
8. To share with students via a link, select "Copy Link." To share with a QR code, select "Download QR".
9. Students can also go to menti.com and enter the code displayed on the Share screen. *If using the code option, make sure to adjust the option under "Access code expiration" to ensure the code will still be valid when you present the Mentimeter.*
10. To display participants' responses, select "Present" in the upper-right corner of the screen.
    To share results with participants at a later time, select "Link to the live results" and then select "Copy link."

Start the lesson by sharing the essential questions with your students using **slide 3** of the attached Lesson Slides.

Next, explain the strategy *Always, Sometimes, or Never True* using **slide 4.** Then have students read the energy statement on **slide 5**, and determine if they think the statement is always, sometimes, or never true. Students then move to the designated area that agrees with their thinking and form small discussion groups. Have the class share a little from each group's thinking. Then, as a class, decide on the best answer and reasoning. Continue this process with the statements on the next four slides.

- **Slide 5** The total amount of energy in the world changes.
- **Slide 6** An energy transformation is the change of energy from one form to another.
- **Slide 7** Heat is a byproduct of energy changing from one form to another.
- **Slide 8** If you place a spoon in a pot of boiling water, the end of the spoon not touching the water gets very hot.

If you prefer, pass out a copy of the attached **Always, Sometimes, or Never True? Cards** to each student. Have students read through each of the four statements on the handout, and label them as "always true," "sometimes true," or "never true." Next to each statement, ask students to explain their reasoning for why they chose each label. After students have had time to work, go through each statement and invite students to share out which label they chose and why. Then, as a class decide on the best answer and reasoning.

After the discussion, tell the class that they will be creating devices that use energy transfer to work.

Display **slide 9.** Have students think about the question, *What does an engineer do?* Instead of using a whiteboard, use the word cloud feature of Mentimeter to create a word cloud. Input words for students as they share, or have students use their devices and go to menti.com, put in the custom code or scan the QR code you created, and type in their own responses. Use the "presentation" mode on Mentimeter to display the word cloud generated by their answers.

30 minutes

Explore

Teacher's Note

Display the materials students will use on a table at the front of the room so they are visible to all students. Also, write a list of the materials on the board or show **slide 10**.

Materials: Tissue boxes, paper towel tubes, pencils, rubber bands, tape, scissors.

The product created probably will resemble a guitar or a ukulele. This device will convert potential energy to kinetic energy to produce sound waves and sound energy (with heat energy as a byproduct) when the strings are strummed or plucked.

Display **slides 11-13** as students are introduced to the procedures for their experiment. As the class progresses through the slides, follow the procedure in class.

Procedure:

1. Ask students, "How can you convert energy from one form to another using simple materials?" on slide 11.
2. Make sure students know they can only use the materials provided and they must convert energy from one form to another.
3. Before the materials are passed out, provide students with 10-15 minutes to brainstorm and draw a picture of their device. *Students can use* AutoDraw *to design their device and then upload it to their digital notebook or desktop.* They should list the materials and the quantity needed and describe how their device will convert energy. (You may want to provide a timer for this activity. See slide 12.)
4. When students are ready, or when the timer finishes, provide students with the materials they need.
5. Allow students around 20-30 minutes to create and test their devices using the timer on slide 13. Any changes they make to their original design should be recorded on their design paper with a different colored pencil. This will help them track their changes.
6. Have students test their devices with you to check for functionality and energy conversions. This can be done at table groups or 1-1.
7. Students then make final revisions and using another color of pencil, record their changes on their design sheet and re-test for functionality and energy conversions.

In preparation for the class Gallery Walk, show **slide 14** and have students display their design sheet and device. During the Gallery Walk students will view and discuss the design of their device and be able to explain how it converts energy to fellow classmates.

45 minutes

Explain

Start this session by asking students to think about what they did during the designing and building of their device and show **slide 15.** Have students share their ideas with an Elbow Partner and then ask for a few volunteers to share with the class. To help facilitate the share-out, you may want to use the Airplane Landing Strategy and hand out the attached **Airplane Landing Cards** 1,2,3, to the first three hands that go up.

Next, show the class the chart depicting the engineering design process on **slide 16.** Ask the students to think about how engineers design things using this process and also how this process relates to how they worked on their devices.

During the class share-out, periodically stop to define and clarify the following vocabulary terms with the class on **slide 17**

- **Engineering Design Process** - A series of steps that engineers use to find a solution to a problem.
- **Constraint** - A limitation or restriction.
- **Criteria** - Explicit goals that a project must achieve to be successful.

Show the students the video The Engineering Process: Crash Course on **slide 18.** Have students write a "Two-minute Paper" comparing what they did during their activity to the engineering process. Show the class the prompts on **slide 19:** What did they do that was the same or different? Did they do things in a different order, or skip a part? What about the researching, testing, or improving of components?

Display **slide 20.** Students will now connect the steps they used in building their devices to the components of the Engineering Design Process. To demonstrate this, students will create their own Anchor Charts that outline each step of the Engineering Design Process. On the chart, they should include examples from their device-building experience to explain each step. Students can choose to do this activity either in their Science Notebook or on a piece of paper.

35 minutes

Extend

Display **slide 21.** Tell students that the next step is to create an instruction manual for their energy device that includes step-by-step instructions for how to use their device and an explanation of how energy is transferred when operating the device.

If needed, have your class review and create a list of transitional words, starting with the list on **slide 22,** that could help with their writing.

Possible Transitional Words:

- First, second, third...
- After, before, during....
- Finally, later, next, soon, then....
- Under, over, near, besides, above...
- Furthermore, in addition, besides, in fact...

After the instruction manuals are complete, have students read them to a classmate and see if that student can operate their device using the instructions. Do the instructions include what energy is being transferred? How is it transferred when operating their device?

30 minutes

Evaluate

Display **slide 23.** Using mentimeter, have students create a second word cloud by typing in words to respond to the question, *What does an engineer do?* Then, display the word clouds from the beginning of the lesson and this recent one. Have students compare the content. Students should notice a larger variety of tasks and skills performed by engineers.

2nd or Optional Assessment: Show **slide 24** and give students the handout with the two scenarios. Have students choose the scenario that they think will work the best and then explain the reasons why the one they chose will work better than the other. (There are two different handouts attached: **Scenarios 1 and 2** and **Scenarios 3 and 4**). You may give students both or vary among the students.

Differentiation Activities

Exploring Renewable Sources of Energy: Have students explore different types of renewable energy and the benefits and detriments these types of energy may offer. Students may also want to explore regions of the world to explore and identify the kinds of renewable energy that would be beneficial for that region and why they would work.

Teacher's Note

There is potential here to have students examine areas without energy and find ways to provide them energy through alternative and renewable resources. Students would need to find ways to store energy gathered for later use.

Resources

- Crash Course Kids. (n.d.). The Engineering Process: Crash Course [Video]. YouTube. https://www.youtube.com/watch?v=fxJWin195kU
- K20 Center. (n.d.). Airplane landing. https://learn.k20center.ou.edu/strategy/78
- K20 Center. (n.d.). Always, sometimes, or never true. https://learn.k20center.ou.edu/strategy/145
- K20 Center. (n.d.). Anchor charts. https://learn.k20center.ou.edu/strategy/58
- K20 Center. (n.d.). Autodraw. https://learn.k20center.ou.edu/tech-tool/3472
- K20 Center. (n.d.). Elbow partners. https://learn.k20center.ou.edu/strategy/116
- K20 Center. (n.d.). Four corners. https://learn.k20center.ou.edu/strategy/138
- K20 Center. (n.d.). Gallery walk https://learn.k20center.ou.edu/strategy/118
- K20 Center. (n.d.). Mentimeter. https://learn.k20center.ou.edu/tech-tool/645
- K20 Center. (n.d.). Two-minute paper. https://learn.k20center.ou.edu/strategy/152