Engineering Prep Activity: What Is Engineering?

Educator Preview

Activity Overview

Youth engineer a tower to support a model antenna and reflect on the engineering design process they used.

Timing		Prep Snapshot	21st Century Skills
Introduction	5 min	Prep Time 5 min	**Connection**
Identify and Investigate	5 min		• Collaboration
Imagine, Plan, and Create	20 min	Invite a family or community member to your program for the next Activity.	**Habits of Mind**
Test, Improve, and Communicate	15 min		• Envision multiple solutions.
Reflect	10 min		• Construct models and simulations.
Total	**55 min**		

Guiding Question	Youth Will *Do*	Youth Will *Know*
How can we design something to solve a problem?	• Think like engineers to design technologies that solve problems. • Design their own engineering design process to solve a problem for their community.	• Engineers use an engineering design process as a tool to solve problems. • Technology is any object, system, or process designed by people to solve a problem.

Connecting Across Activities

This activity establishes a baseline understanding of how an engineering design process creates technologies that solve problems. Next, in the Engineering Context-Setting Activity, they explore how engineers work together to design technologies to solve science problems.

Educator Resources

Access Activity resources using link or QR code.

Activity Resources

QR code leads to resources available for this Activity.

https://planets-stem.org/**betars-activity-p1**/

Materials and Preparation

Materials

For the whole group

- EiE's *Engineering Design Process* poster
- collection of *Engineering Design* posters
- example technologies, such as common classroom supplies
- 3 clips, binder, medium
- 1 index card
- 4 rolls of masking tape
- a way to record ideas, such as chart paper or a shared document

For each group of 4

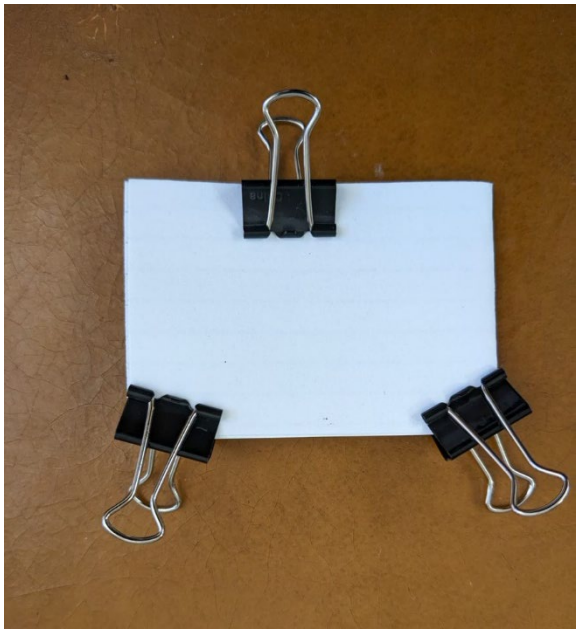
- 100 index cards
- 1 ruler
- 1 pair of scissors
- writing utensils
- items that youth can write on and rearrange, such as sticky notes, index cards, or entries on a digital whiteboard

For each youth

- Engineering Notebook

Preparation (5 min)

1. In case youth don't have stories to share, think of some locally relevant problems and technologies that solve them. Example problems include travelling around your community, getting water to homes in your community, and protecting your community against weather events.
2. Please consider planning ahead for the next Activity and invite a family or community member to your program in advance. See the *Connecting with Families* resource.
3. Prepare a model antenna. Fold one index card in half widthwise and attach three binder clips to it. The appearance of the antenna is unimportant. It just needs to be weighty enough to pose a challenge for youth to balance.



4. Arrange 100 index cards, a ruler, and a pair of scissors for each group on the Materials Table so groups can easily retrieve their materials.
5. Place 4 rolls of masking tape on the Materials Table for groups to share.

Activity Guide

Guiding Question: How can we design something to solve a problem?

Post the question somewhere accessible, such as on chart paper or a shared document, so that youth can refer to it throughout the activity.

Introduction (5 min)

1. Share the guiding question with youth:

   Q: How can we design something to solve a problem?

2. Explain to youth that a word for the objects, systems, and processes that people design to solve problems is ***technology***. The word is sometimes used to refer only to electricity-powered devices such as phones and computers, but it can also refer to simpler things such as scissors, tape, and clothing. Allow youth to examine classroom supplies such as writing utensils while explaining that those are technologies.

Notes

For many people, the word *technology* suggests electrical devices for communication or computing. In fact, technology is any object, system, or process designed by people to solve a problem.

Natural objects on their own are not technologies. People can turn those objects into technologies, however, if they use them to solve problems. For example, people can use rock to grind corn or build walls, and they can use wood to build houses or musical instruments.

3. Pass out an Engineering Notebook to each youth. Explain that the notebook is a place they can find information about their engineering challenges and record their ideas.

   Explain that today, youth will have an opportunity to design a technology to solve a problem. A town wants to improve their cell phone coverage, so they need to design a tower to support an antenna. They would like our help thinking about the best designs, so youth are going to create model towers. To support youth understanding, ask the following question:

   Q: Do we have cell towers in our community?

   A: Accept all responses. Youth may share examples of cell towers with which they are familiar. They may share that it's hard to get cell service sometimes when they are far from a cell tower.

   If youth do not discuss their knowledge of cell towers, add a follow-up question:

   Q: What do you know about cell towers?

   A: Accept all responses. Youth may know that a cell tower is a structure that uses radio waves to let people make phone calls and access the Internet. They may share examples of familiar, local cell towers, stories of new tower construction, plant-mimicking disguises for towers, and/or controversy around building a new tower.

   If youth do not know what a cell tower is, have them turn to *Cell Towers*, pages 2 – 3 in their Engineering Notebook. The images may help them recognize that they have seen cell towers.

4. If youth do not already know the word, explain that ***antenna*** refers to the structure at the top of the cell tower. Explain that antennas help cell phones communicate with each other. In the model cell towers that youth will design, a set of binder clips on an index card will serve as a model antenna. Give students time to examine the model antenna.

Identify and Investigate (5 min)

1. Organize youth or have them organize themselves into groups of four. Have youth turn to *Needs and Limits* on page 4 of their Engineering Notebooks. Have youth review the things their towers need to do:

    - **Each tower must be at least 1 foot (30 cm) tall, not including the antenna. (The higher a tower is, the larger an area it will serve.)**
    - **Each tower must hold up the antenna for at least 10 seconds.**

    Have youth review the limits on their designs:

    - **Each group will have 100 index cards and masking tape as materials to build their tower.**
    - **Each group will have a ruler and a pair of scissors to use as tools, but these tools cannot be part of the tower.**
    - **Youth have 20 minutes to create their towers.**

    You can record the needs and limits in a shared location as well, such as on chart paper or in a shared document, so that youth can refer to them throughout the activity.

Imagine, Plan, and Create (20 min)

1. Have each group retrieve 100 index cards, a ruler, and scissors from the Materials table. Have groups share the masking tape.

Supporting Learner Variability
For an additional challenge, you can limit each group's masking tape to anywhere between one and four feet.

2. Remind groups that they have 20 minutes to engineer their towers.

3. As groups work, give them further opportunities to examine the model antenna.

4. As you visit each group, encourage reflection by asking questions like the following:

   Q: How did your group come up with this design?

   A: Accept all responses. Possible responses include investigating the features of the index cards and masking tape, imagining the benefits and drawbacks of possible designs, and making a plan using the ideas they'd imagined. Youth may draw on knowledge of structures in their community.

   Q: Why do you think your design will work well?

   A: Accept all responses. Youth may share prior knowledge or test results indicating that their towers have the necessary features (such as stability and height) to accomplish the criteria of their task.

   Q: How are you changing the shape of the cards to make them stronger?

   A: Responses will vary. Possible responses include taping cards together and folding them into shapes, such as cylinders or prisms. Youth may share prior knowledge about ways in which materials can be reshaped to make them stronger.

   Q: Do you have any questions about what the tower needs to do, or the limits on its design?

   A: Accept all responses and answer questions as they arise.

5. Let groups know when they have 15, 10, and 5 minutes remaining.

Test, Improve, and Communicate (15 min)

1. Test each design by having one group member measure the height of the tower and another place the model antenna on top. Measure ten seconds with a stopwatch or by having youth count aloud.

Supporting Youth Thinking

When youth test their towers, emphasize that failure is a useful learning experience. If a tower fails to meet the criteria, instead of saying "Too bad!" or "That's okay," model questions that lead to understanding, such as "Why do you think that happened?" or "How might you prevent that effect when you redesign?"

2. Give groups ten minutes to redesign their towers using the information they gathered from their tests.

3. Once groups have redesigned their towers, have them record an answer to the following question using their preferred medium (such as video, audio, drawing, or writing):

   Q: How did you redesign your tower and why?

   A: Responses will vary. Possible responses include changing the shape or arrangement of index cards and the use of tape. Youth will use the results from their tests to justify their changes.

4. Have youth examine other groups' towers and reflect on the diversity of designs by asking the following question:

   Q: What is the same about the designs? What is different?

   A: Responses will vary. Possible responses include that all towers are made of index cards and some are constructed using similar methods. Some groups may have used different building strategies, and the towers may be different heights. Youth may compare towers to local structures with which they are familiar.

   Point out that there are multiple solutions to the same problem and none of them is the only or the best solution.

5. Have youth test their redesigned towers.

Reflect (10 min)

1. Explain that a term youth can use for things a successful design needs to do or have is ***criteria***, while a term for limits on a design is ***constraints***. Have them record these terms next to the headings on *Needs and Limits*. If time permits, allow youth to discuss examples of criteria and constraints elsewhere in their lives.

2. Have youth reflect on the Guiding Question:

   Q: How can we design something to solve a problem?
   A: Accept all responses.

   Ask:

   Q: What steps did you use in the process of designing your tower?
   A: Accept all responses. Possible responses include identifying the problem of designing a cell tower, investigating the tower's criteria and constraints, imagining possible tower designs, planning and creating one design, testing the tower's height and ability to hold the model antenna, improving the tower design, and communicating about the tower.

   Have each group record the steps they identify in a form that they can rearrange, such as sticky notes, index cards, or entries on a digital whiteboard.

Teaching Tip
Small groups can work together to generate their steps in the engineering design process first and then each group can take turns sharing. This will allow the youth to learn from one another as they then move into creating a whole group process in the next step.

Supporting Youth Thinking
At first, youth may describe specific actions, such as "We cut slots in the index cards so they would fit together." Through discussion, encourage youth to come up with terms to describe each step of the process more generally, such as "We talked about it" and "We built the tower."

3. Have the whole group rearrange the steps (index cards, sticky notes, etc.) they identified to make comparisons. Have youth group the steps that are similar and then choose a single list of five to ten steps. (For example: identify, investigate, imagine, plan, create, test, improve, and communicate.)

4. Once youth have agreed on a list of steps that describe the process they used, ask:

   Q: How can we remember this list so we can use it again the next time we have a problem we need to solve? Can we come up with a picture or something it reminds us of?

   A: Accept all responses. Youth may suggest processes or symbols that are important in their cultures, such as medicine wheels; geographic directions or routes such as roads or rivers; or technologies such as gears or electrical circuits.

   If youth do not identify cultural symbols, consider asking them to examine *Examples of Engineering Design Processes*, pages 5 – 6 in the Engineering Notebook.

   Have youth choose a process or symbol that resonates with as many of them as possible. Have them record their steps and this process in a form that can be saved and accessed, such as on a poster or in a shared document.

5. Explain that the work youth did to design their towers is called ***engineering***, which is the use of creativity and knowledge of math and science to design things that solve problems. There are many kinds of engineers, and they work to help people in different ways. The set of steps youth came up with is called an ***engineering design process***, which is a set of steps that engineers use to design things to solve a problem. Ask:

   Q: What do you already know about engineers or engineering?

   A: Accept all responses. Youth may know real or fictional engineers or have previous experience with engineering activities.

   Q: When have you used creativity and knowledge of math and science to design things that solve problems?

   A: Accept all responses. Youth may design solutions at home, in school, or in their community.

Supporting Youth Thinking

The success or failure of the technology that youth build in this activity (index-card towers) is less important than youth understanding that they can use an engineering design process to design technologies to solve problems.

6. If you have not done so already, ask youth to examine *Examples of Engineering Design Processes*, pages 5 – 6 in the Engineering Notebook. Explain to the youth that there is more than one way to think about an engineering design process and that a process can reflect community or cultural practices. Ask:

   Q: What is similar about the different engineering design processes? What is different?

   A: Accept all responses. Possible responses include that processes have the same or different kinds of steps, names of steps, numbers of steps, and images or symbols.

   Q: Were there steps that were important in your process that are not found in the samples?

   A: Accept all responses. A possible response is that our process has a Reflect step and the examples do not.

   As necessary to support understanding, describe or share photographs, videos, or written descriptions of engineers and engineering in your local community.

7. Have youth fill out *My Engineering Profile*, pages 7 – 8 in their Engineering Notebooks, to reflect on engineering skills they have and those they would like to improve. This activity reinforces youths' engineering identities and makes them feel that they are thinking like engineers.

8. While youth are completing the page, reflect on the following educator prompt:

   Q: What are your teaching strengths? Reflect by filling out *My Educator Profile*.

After the Activity

1. Plan ahead for the Engineering Context-Setting Activity. See Context-Setting Activity Materials Preparation on page 20.

2. If you have not yet done so, take time to reflect on the following educator prompt.

   Q: What are your teaching strengths? Reflect by filling out *My Educator Profile*.

Remote Sensing Unit Resources

QR code leads to resources available for this unit.

https://planets-stem.org/**betars-unit-landing-page**/

Engineering Prep Activity

My Educator Profile

Record your teaching strengths. You can write, draw, or check off boxes below.

☐ **Cultural Responsiveness**
- I give youth opportunities to work on topics that are meaningful to them.
- I value the assets that youth bring to their learning.

☐ **Experiential Activities**
- I help youth make meaning through active engagement.
- I help youth reflect on their experiences.

☐ **Local Relevance**
- I connect topics to the local community.
- I give youth chances to use their local knowledge.

☐ **Multilingual Learning**
- I use strategies to support youth of all linguistic backgrounds.
- I focus on what youth can do at all levels of language learning.

☐ **Real-World Relevance**
- I demonstrate how topics matter in the world.
- I help youth understand how different careers help people, animals, the environment, and society.

☐ **Subject Integration**
- I make connections between academic subjects.
- I give youth opportunities to use their knowledge from other subjects when learning.

☐ **Universal Design for Learning**
- I plan for learner variability among youth.
- I provide youth with multiple means to engage, represent information, and express themselves.

Record teaching areas where you want to learn or develop. You can write or draw below.