Activity 1: Introduction to the Engineering Design Process

Objectives

- Students will compare the process they use during an in-class challenge to the steps of the engineering design process.

Next Generation Science Standards (NGSS) Performance Expectation

MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

Time 90 minutes

Materials

- For each student team (4-5 students)
  - 20 sticks of uncooked spaghetti
  - 3 ft. of thin string
  - One marshmallow (not “mini” or “jumbo”)
  - 3 ft. of masking tape
  - Scissors
  - Paper and pencils
- Rules for The Marshmallow Challenge slide
- Measuring tape
- Whiteboard or chart paper
- KQED’s engineering design process graphic
- The Engineering Design Process: A Taco Party video
- Engineering Is Cleaning Poop From Drinking Water video
- Engineering for Good student notebook - either a separate Google Doc file or a printed copy of the PDF for each student

Essential Question

What are the steps of the engineering design process?

Introduction

1. Tell students that over the next couple of weeks, they will be engineering a solution for a problem faced by communities all over the world. They will be working in small groups to develop their solution, create a prototype of their solution and produce a video to share their solution with others.
2. Give students a few minutes to make a list, on page 1 of their Engineering for Good notebooks, of several engineered items that they use every day. To spur thinking, they could begin by listing items in the classroom or in their backpacks (e.g. mechanical

pencil, ballpoint pen, water bottle, etc.). Then, have students choose one of the items they listed and answer the following questions:

- What is the item? How do you use it?
- Why was it made? (What problem does it solve?)
- What are other items that solve the same, or a similar, problem? What makes this item better or worse than the others?
- Is this the original design of the item or has it changed over time? How do you think it's changed from the original version?
- What is this item made out of? Why do you think it was made out of those materials?

3. As a class, discuss a few of the items the students chose. As you listen to the students sharing, highlight and reinforce how each of the items solves a specific problem or set of problems confronted by humans.
4. Tell students that they are going to participate in a short activity--The Marshmallow Challenge--that will simulate how engineers solve problems. *(Adapted from Tom Wujec's Marshmallow Challenge.)*
    a. Place students in teams of 4-5.
    b. Tell students that the goal for the challenge is to build the tallest **freestanding** structure, when measured from the bottom of the structure to the top of the marshmallow.
    c. Give students instructions for the challenge.
        i. Teams will have 15 minutes to build their structures.
        ii. The entire marshmallow must be on top of the structure.
        iii. Teams can use as many or as few of the supplies as they want, but no additional items can be used.
        iv. At the end of the challenge, no one may be touching the structure, and it can't be leaning on anything.
    d. Begin the challenge. Remind teams of how much time is left every few minutes.
    e. On the chalkboard/whiteboard, create a table (team name/number and height) to record the heights of the teams' structures.
    f. Once 15 minutes is up, gather as a class. Go around to each team and measure their structure. Have a student record each structure's height on the board.
    g. As a class, take a look at the winning structure. Ask that team to share a little about their design.
5. Have students reflect on the process of their steps for building the tower on page 2 of their Engineering for Good notebooks. They can use the following questions to guide their written response:
    a. **Process:** What were the steps in your process? For example, how did you plan what to build? Did you make a sketch before starting? Did you test your materials before building?
    b. **Teamwork:** How well did your team work together? For example, did everyone share ideas? Did you make decisions by consensus or was there a leader?

    c. **Design:** Did you test your design and then adjust it as you started to build? Did you change your design completely along the way?
    d. **Challenges:** What were the challenges you encountered?
6. As a class, discuss the teams' processes. How did each team begin? Who changed their design along the way? Why?

(If you are splitting this activity into two days, this is a good place to stop.)

Guided Practice

7. Show KQED's engineering design process graphic (also on page 3 of the student notebook). Using the Marshmallow Challenge as an example, discuss the different steps and define key vocabulary words (i.e. constraints, criteria, prototype, iterate).
8. Watch the video The Engineering Design Process: A Taco Party. Ask students to follow along using KQED's engineering design process graphic and to pay attention to each of the steps of the process as it relates to the taco party. Periodically, pause the video to have them predict what will happen next.
9. Watch the video Engineering Is Cleaning Poop From Drinking Water.
10. Watch the video again. This time, have students deconstruct the engineering design process shown in the video using a jigsaw activity: assign each student, or group of students, two steps of the engineering design process to focus on. They should look for evidence in the video of the engineering team working through these steps. Students can record the findings on page 4 in their notebooks.
11. As a class, have students share what they found to create a chart (answer guide here) with evidence from the video of all of the steps of the engineering design process.

Classroom notes: You may choose to also use the worksheet on page 4 of the student notebook with The Engineering Design Process: A Taco Party.

Assessment/Reflection

Were the students able to complete the "Engineering Design Process in Action" chart in the final activity? Does it demonstrate an understanding of the steps of the engineering design process?