National Aeronautics and Space Administration

Cooking with the Sun

Build a Solar Oven Design Challenge

5E Lesson Plan

Source Material: Build a Solar Oven (pages 115-128)
Mission Focused Area: Earth/Climate Science, Earth's Moon

Lesson Overview

In this lesson, students will engage in the engineering design process to construct a solar oven capable of melting s'mores. The only constraints on the design are the size of the box and that it must be capable of increasing the temperature by 5°C in 5 minutes. Students will practice basic data collection techniques using a thermometer. After testing their designs, students will engage in a crucial element of the engineering design process by evaluating their results and attempting to improve their design. Throughout the lesson, there are opportunities for a more scaffolded and teacher directed approach for younger learners, while older students are able to take more control of the design process if feasible.

NASA Connection

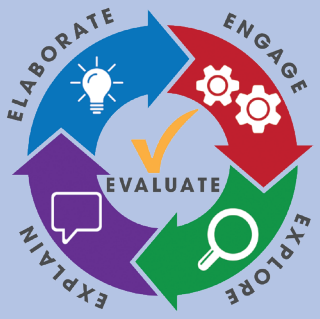
While astronauts might have to bring just about everything with them when we establish a habitat on the Moon, one thing they won't need is solar energy. There may be no atmosphere, and no climate or weather on the Moon, but that DOES make it an ideal place to collect solar energy. Much of the Moon is exposed to sunlight constantly, except briefly during a rare lunar eclipse. If that energy could be harnessed, it could power almost everything in the lunar habitat … including that most important device that helps prepare delicious food – an oven!

National STEM Standards

NGSS

- **1-PS4-3** Plan and conduct investigations to determine the effect of placing objects made with different materials in the path of a beam of light.
- **K-2-ETS1-3** Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

5E Instructional Model



NASA is sending humans back to the Moon through the Artemis program. While exploring and living on the Moon, astronauts will have to make use of the resources present there. Sunlight is an abundant resource in space and can be used for a variety of applications. Students will model this idea in this lesson by using sunlight in an attempt to melt a s'more, meant to simulate the process of cooking.

Objectives

- Students design a simple solar oven using provided materials such as foil, boxes, and plastic wrap.
- Students record temperatures in the solar oven using a thermometer.
- Students improve their solar oven design based on the results of a test.

Guiding Questions

- What data did you rely on to determine whether your oven worked?
- How can astronauts on the Moon use the Sun's energy?
- Why is it important to test a design?
- Why do engineers have to redo their designs?

Materials

- Thermometers
- Stopwatches
- Cardboard box (no smaller than 40 cm wide), one per student group
- Aluminum pie pans
- Aluminum foil
- Black construction paper
- Plexiglass or plastic wrap to cover boxes

Suggested Scaffolding

This 5E lesson is written for a second grade audience but can be adjusted to fit a kindergarten or first grade classroom. Teachers at the first and kindergarten level should consider providing additional supports such as a template for the design drawing or a partially constructed oven. For example, teachers could line boxes with foil before giving them to students and allow them to choose how they wish to use the remaining material in their design. Limiting the variables in the design and construction process will simplify the activity for younger students while still allowing students to experience the engineering design process. For smaller class sizes, there is also the option to do the oven build and data collection as a group so that students have more assistance with the technical aspects of the lesson such as reading a thermometer.

Teacher Action

Engage - NASA's BEST Students Video, white vs. black paper in the Sun

- Play video for students and follow up by asking the CFU questions included before
- Set up demonstration with two thermometers on a white and black piece of paper (can be done before video to allow paper to heat up while video plays)
- Demonstrate proper technique to read temperature from the thermometer

Scripted CFU questions

- What types of work do engineers do?
- How do engineers decide what they need to build?
- How does imagination help engineers do their work?
- Which piece of paper had the higher temperature after five minutes in the Sun?
- How can aluminum foil help your solar oven?

Explore - Plan and Build Solar Oven

- Distribute supplies to students
- Model how to place the pieces of the oven together and the order in which to do it, i.e., do not put plastic wrap on before placing foil and paper in the oven
- Demonstrate how to record temperatures in the data table using an example
- Facilitate testing of designs and collection of data

Scripted CFU questions

- Why is a plan so important in an engineering project?
- What should you do with the numbers that you read on the thermometer? (record on data sheet)

Explain - Evaluate Data and Design Effectiveness

- Lead students in evaluating their data
- Remind students of the constraints (5ºC in 5 minutes)

Scripted CFU questions

- If an initial design does not work, what should an engineer do next?
- Did the design meet constraints?

Elaborate - Improve Design

- Guide students into redrawing their designs to improve them. Even if they met the constraints, they could still improve.
- Provide suggestions: more foil, larger window, more black paper, etc.

Scripted CFU questions

- What changes did you make to your oven and why?

Evaluate - Design Evaluation

- Have students evaluate final design
- Remind students that drawings should be labeled

Scripted CFU questions

- What made your design successful?
- If your design still did not work, what would you want to change?

Student Action

Engage - NASA's BEST Students Video, white vs. black paper in the sun

- Watch engineering video and answer teacher discussion questions
- Make predictions about which piece of paper, black or white, will be hotter

Explore - Plan and Build Solar Oven

- Draw an initial design of solar oven on provided handouts
- Following teacher guidance, construct solar oven
- Place s'more on the inside and expose to sunlight or a heat lamp
- Record the temperature every minute for 5 minutes in the provided data table

Explain - Evaluate Data and Design Effectiveness

- Examine data
- Determine whether the design met the criteria

Elaborate - Improve Design

- Create a new drawing of the improved design
- Retest the new design

Evaluate - Design Evaluation

- Draw a picture of the final design in a journal or science notebook
- Label the parts of the solar oven
- State whether the design was successful
- Use data gathered in data table to support the claim

Additional Literature Connections

1. "Rosie Revere, Engineer" by Andrea Beaty
2. "Have You Thanked an Inventor Today?" by Patrice McLaurin
3. "Ada Twist, Scientist" by Andrea Beaty