engineering DREAMS

CREATE YOUR BEST WORLD

ACTIVITY

Solar Power Up!

OBJECTIVES

Students will:

- **Perform** research to deconstruct and better understand the problem presented.
- **Build** a prototype of an open-source design.
- **Use** the ideation process and engineering design process to innovate on an initial design.

GRADE RANGE

5–9

DURATION

One class session (approximately 45–60 minutes)

OVERVIEW[1, 2]

In places around the world like the Indian Himalayas, the devastating effects of things like deforestation and climate change affect even simple aspects of human life. Some of those aspects include cooking and staying warm. Wood cut from trees has become a valuable commodity. Reducing the fuel demand in areas like this means requiring less wood.

Products like the Himalayan Rocket Stove offer a familiar means of cooking food without wood and produce heat that requires 50% less fuel and reduces the amount of work. A unique aspect of the Himalayan Rocket Stove is that it is not a new product. It is an innovation of an existing open-source product, which demonstrates the value of iteration process and the engineering design process. It is also *not* a tech solution, but instead provides a mechanical solution with a social impact.

SOCIAL IMPACT:

The social effects that infrastructure, development, or innovations have on a population.

1 ps://himalayanrocketstove.com/
2 https://youtu.be/YUy5bkJnk5A

To better understand the problem and empathize with those whom the problem affects, students will first research the global climate crisis and the UN's Sustainable Development Goal of taking urgent action to combat climate change and its impacts by 2030. They will then analyze the problem and the design thinking used in creating the Himalayan Rocket Stove. Students will create an open-source pizza box solar oven before using the engineering design process to ideate innovative solutions that can be made mimicking the process taken by the designers featured.

EDUCATOR PREP

Before session, procure enough pizza boxes to have a few extra to use as models or for second attempts. Pizza boxes can often be obtained by contacting local pizza restaurants and asking for donations. (**Tip:** *Large size boxes usually work best!*)

MATERIALS

- Internet device with ability to project video, one per educator
- Device with internet access, one per group
- **What's the Problem? WebQuest** student handout, one per group
- **Engineering Design Process** handout, one for electronic display
- **Build a Pizza Box Solar Oven** student handout, one per group
- Pizza Box Solar Oven materials, one set per group
  - 1 large size pizza box
  - Several feet of aluminum foil
  - 1 sheet black construction paper
  - 2 ½ feet of clear plastic wrap
  - 4 feet of masking tape
  - 2 feet of string
  - Thermometer
  - Scissors or utility knife
  - Ruler
  - Black marker
  - Stick (optional)
- **Innovating a Design** student handout, one per group

Note: *If you are unable to procure pizza boxes, you can attempt to use shoe boxes or cereal boxes. Frame the activity as an "innovation" on the open-sourced concept of pizza box ovens by using materials that might be more readily available. As a group, determine if the alternate materials are as successful and effective as a pizza box.*

PROCEDURE

Engage

1. Begin the session by explaining to students that they will be learning about deforestation and climate change. Students will learn about their effects on areas of the world like the Indian Himalayans. Explain that they will learn about the featured innovator's solution and mimic his process by building pizza box solar ovens.
2. Split students into groups of 3–4 and distribute one **What's the Problem? WebQuest** handout to each group. Instruct them to use the website provided and a search engine to investigate the problem they will be working on.
3. After approximately 10 minutes, provide students with the opportunity to ask questions, provide insights, or share their causes and effects. If deforestation or pollution are not offered by students, explain the effects they have on the overall health of the planet and quality of life for humankind.
4. Use these contributions as a springboard to learn about solution initiatives such as the Himalayan Rock Stove, which is featured in the video you will show next.

Learn

5. Play the *Problem Solvers for Good: Making the World a Better Place Through Engineering* video featuring the Himalayan Rock Stove. (https://engineeringdreamsinschool.com/educators/video-topic-series/)
6. Explain that there are two unique features to this solution. One is that it is *not* a tech solution. The second is that it utilized an open-source design as a basis for innovation. Explain to students that open-source designs are ones that are freely available to everyone to use with the option to modify.
7. Display the **Engineering Design Process** handout to the entire class. Explain that the design team of the Himalayan Rock Stove used the engineering design process, including the iteration process, to take something that someone else had already designed and modify it for a better solution to use in Himalayan communities. The team innovated its design for a new purpose and was able to solve a growing problem. Remind students that this is a *process,* often represented in a circle, because it often takes more than one try to achieve success.

Apply

8. Inform students that they will now mimic the same process by building a working model using an open-source design. Distribute a **Build a Pizza Box Solar Oven** student handout and a set of materials to each group. Read and review each step out loud before having students begin.
    - **Note:** *Extra supervision may be needed during step 4 because students often cut along the fourth line as well by mistake.*
9. Provide students 20–30 minutes to build their pizza ovens, providing assistance when required.

Challenge

10. After students have finished building the open-source design, challenge them to analyze the original for any place they can innovate on the design to make it better. Can they make it cook better or at a higher temperature? Can they make it retain heat? Can they make it produce heat for warming areas?
11. Distribute the **Innovating a Design** student handout to each group to record their brainstorming.

Reflect

12. Facilitate students' reflections on their learning during this session by inviting them to summarize the global problems that led to the solution of the Himalayan Rock Oven.
13. If time allows, provide students with the opportunity to test their solar ovens. They can place food on some foil (or a paper plate) inside the oven and use string and masking tape to tie back and adjust the reflector so that sunlight is reflected into the oven. If their design works, students can enjoy their solar treats!

LEARNING EXTENSIONS

- Provide students time to build a prototype of their innovation or add it on to their initial design. Working through the ideation process, have them record successes and failures and make improvements to their designs as they go.
- Have students conduct small research projects on insulation and the role it can play in solar cooking/heating. Have students analyze their designs and the use of insulation making updates as needed. Then, students can use the thermometers to test whether insulation affects the efficiency of their designs.

NATIONAL CONTENT STANDARDS

Next Generation Science Standards

Engineering Design:

- MS-ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- MS-ESS3-1: Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.
- MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Standards for Technological Literacy (ITEAA Standards)

Standard 8: Students will develop an understanding of the attributes of design. In order to comprehend the attributes of design, students should learn that:

- E. Design is a creative planning process that leads to useful products and systems.
- G. Requirements for a design are made up of criteria and constraints.

COMMON CORE ENGLISH LANGUAGE ARTS STANDARDS

Reading:

- R.7: Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.

Writing:

- W.4: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- W.7: Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

Speaking & Listening:

- SL.1: Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.

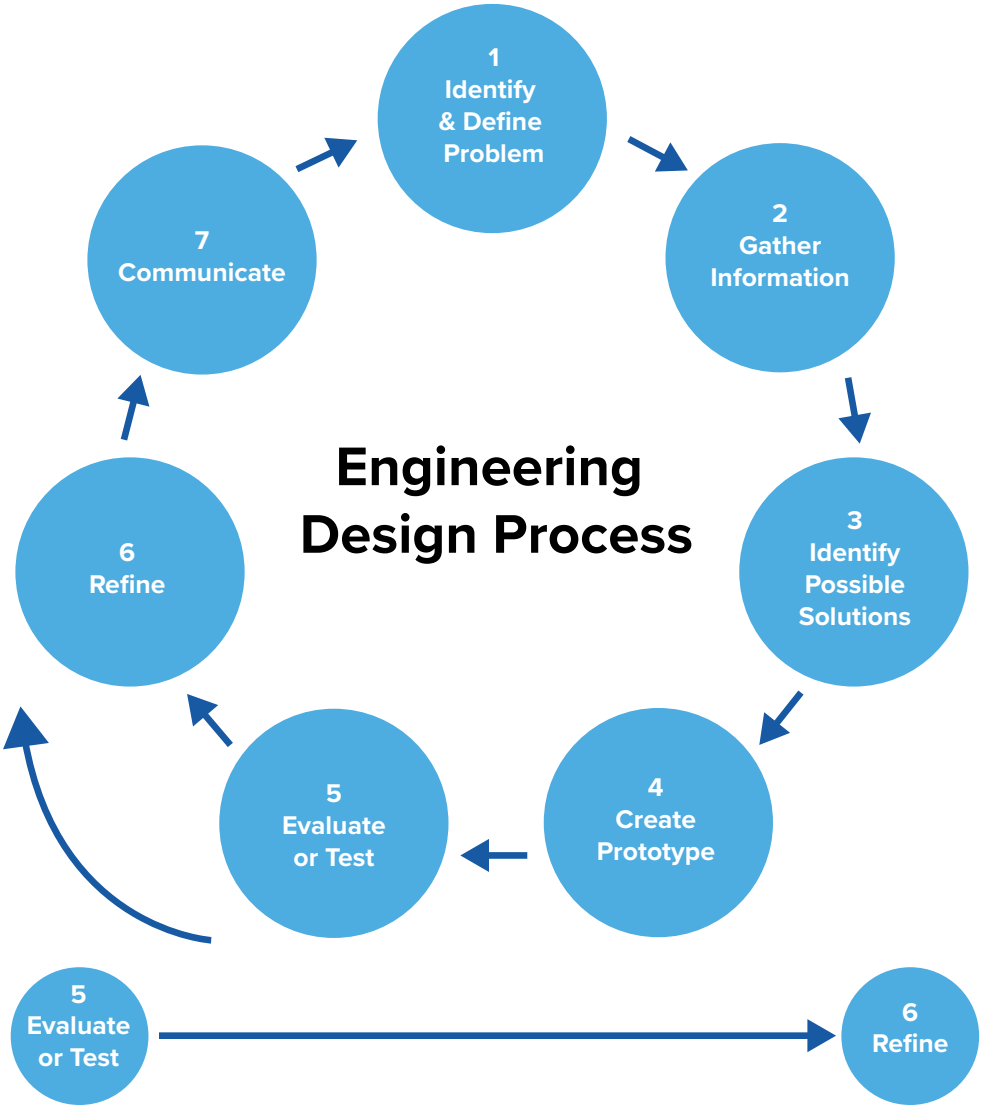
WHAT'S THE PROBLEM? WEBQUEST

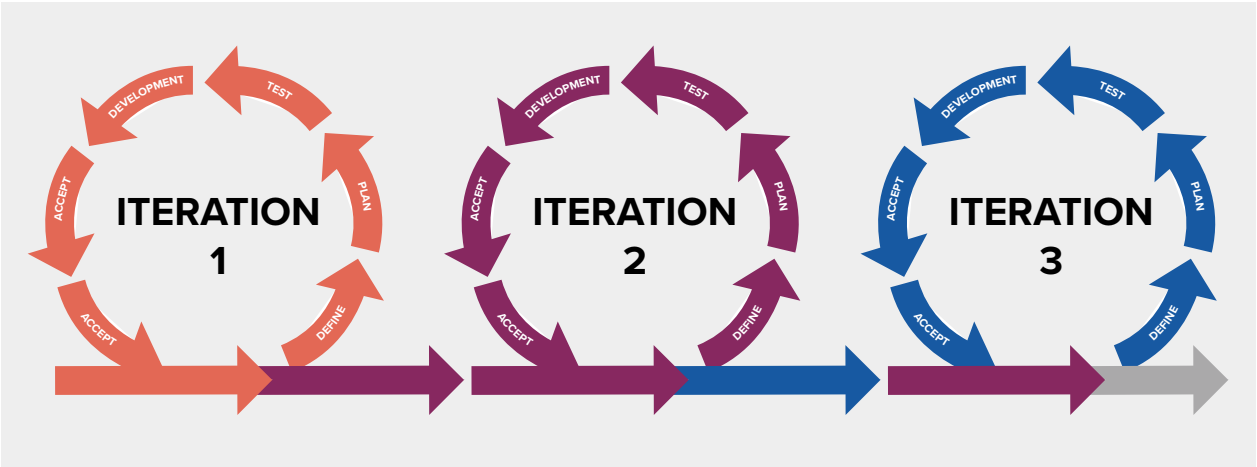
1. Visit https://sdgs.un.org/goals and record important facts you find regarding the global impacts of climate change and pollution.

2. What is the United Nation's plan to address this global crisis?

3. Use a web browser to discover three different causes of climate change around the world. What are the effects on the people who experience them?

Causes of Climate Change	Effects on Humans


1
Identify
& Define
Problem
2
Gather
Information
3
Identify
Possible
Solutions
4
Create
Prototype
5
Evaluate
or Test
6
Refine
7
Communicate
Engineering
Design Process
5
Evaluate
or Test
6
Refine


ITERATION
1
ITERATION
2
ITERATION
3
DEVELOPMENT
TEST
PLAN
DEFINE
ACCEPT

BUILD A PIZZA BOX SOLAR OVEN

Instructions[3]

1. Assemble the pizza box and open it up.

2. Glue aluminum foil to all inside surfaces of the sides except the top of the box, with the shiny surface facing in. This will create a “radiation trap” that will trap, by reflection, invisible (low frequency) radiation that is radiated by the food and air inside the box.

3. On the top flap of the pizza box, draw a square with a marker with edges spaced 1” from the four sides of the box.

4. Cut along three of the lines (on the sides and on the front edge of the box) leaving the fourth line along the box’s hinge uncut. Then fold open the flap, making a crease on the fourth line (see the figure above).

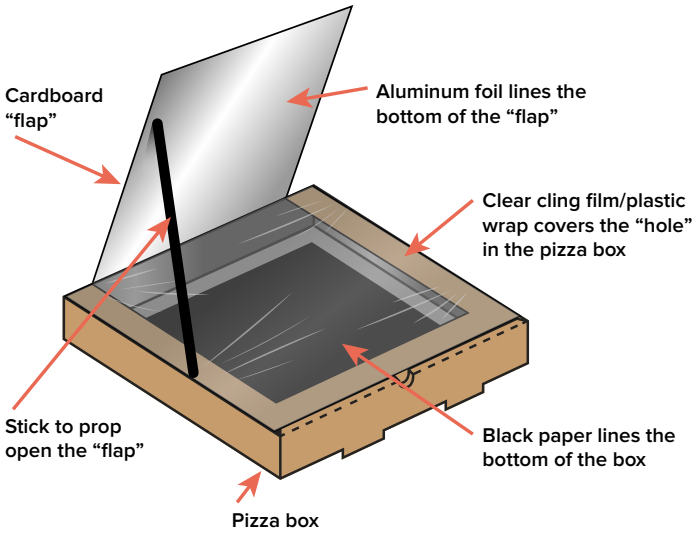
5. Glue aluminum foil, shiny side up, to the inside surface of the top flap. This will form a reflector to reflect sunlight into the oven. Be careful to make as few wrinkles as possible and smooth out whatever wrinkles occur.

6. Tape the black construction paper to the bottom of the box. This will help to absorb the incoming sunlight.

7. Carefully stretch the plastic wrap over the opening of the box. Seal the edges with tape to keep the air in.

8. Cover any air leaks around the box edges with tape. Make sure that the box can still be opened, so you can place food inside the box and remove it later.

9. Go outside in the sunlight and place the oven on a flat, level surface. Place the thermometer inside of the oven and wait until it levels. Note the temperature.



3 https://ualr.edu/gifted/files/2016/03/lesson-7-modification-solar-oven-lesson-plan.pdf

INNOVATING A DESIGN

Innovation

In the box, record your brainstorming on how to innovate the open-source design of a pizza box oven to make it better. This could be an improvement to its cooking ability, a way to retain more heat, a way to produce heat for warming, etc. If you draw a model, be sure to label important parts. Continue to brainstorm on a separate piece of paper if you have more ideas than room.