Building a Solar Oven using Design Thinking

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Target Grade: 6th Grade Science

Time Required: 240 minutes

Standards

- MS-PMS-PS3-3 Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

Lesson Objectives

Students will:

- Use the Design Thinking framework to design, build, test, and improve a solar oven.
- Demonstrate an understanding of energy transfer in their choices, description, and improvements of their design.

Central Focus

Students will apply their learning of energy and energy transfer in the design, build, and test of a solar oven. This lesson is a way of using a summative task as an assessment for learning. Students will work in small groups to solve problems, give quality feedback, conduct research, and build and test a prototype.

Background Information

Before this lesson, students should have an understanding of the different types of energy and energy transfer. This includes:

- Kinetic and potential energy
- Types of kinetic energy
- Types of potential energy
- Energy transformation
- Conductors
- Insulators

Materials

- Design Thinking Solar Oven Template
- Technology for research
- Solar oven materials: cardboard, paper, glue, aluminum foil, plastic wrap, paper plates, other craft supplies or recyclable materials. Teacher may ask students to bring in any "special" items they would like to use.
- Heat/plant lights or outdoor area that gets sunlight
- S'mores ingredients: chocolate, marshmallows, graham crackers (Be aware of any food allergies and/or dietary restrictions. Gluten free, gelatin free, dairy free options are available. Often parents will be happy to help locate and purchase these items.)
- Ziploc/sandwich bags
- Thermometers

Instruction

1. Hand out a copy of the Design Thinking Solar Oven template to each student or to a grouping of students. I suggest no more than 4 students to a group.
2. Have students answer the two questions in the "Empathize" section of the document.
3. Discuss student answers with the class and help students make a personal connection with what they will be doing. This helps answer the common question, "Why do I need to learn this?"
4. Tell students that they will be designing, building, and testing a solar oven to cook s'mores.
5. Remind students that it is important that they work through each part of the process, taking care not to skip ahead. It is important that they keep their focus on one step at a time.
6. Have students conduct research to complete step 2 "Define". Before students conduct research, there should be instruction on identifying reliable resources. Students should be looking to see what solar oven designs already exist. Have them make note of the materials used, if certain shapes are common, and if there are any other patterns they can identify with existing designs.
7. As a class, have students discuss their findings and compare the information each student/group found.
8. Inform students that they will need to create their own unique design for a solar oven. They can use ideas they found during research, but their design should not be a copy of something that already exists. Students should be able to identify the improvements or modifications to any existing design.
9. Have students complete Step 3 "Ideate" by brainstorming 4 different designs. They will need to draw a rough sketch and write a short description of what they have drawn.

10. Once students finish, ask them to move to step 4 "Prototype" and choose their favorite design or combination of designs. All students in the group should come to a consensus on the design they will build.
11. Their plan should be drawn out in detail and include measurements, labels, and any special instructions.
12. They will also need to list the materials they would like to use and what quantity they will need.
13. After students get teacher approval of the design and materials, have them build their prototype based on the chosen design.
14. Students should test their prototype.
15. Depending on facilities and weather conditions, the teacher may choose to conduct testing outside in a sunny spot or set up heat/plant lamps.
16. It is suggested that s'mores supplies be pre-packaged into s'more kits for easy distribution.
17. Initial testing can be done with thermometers and/or marshmallows only. The teacher can choose one specific testing day to use the actual s'more supplies. You may want to ask for parent volunteers to pass out supplies so you can focus on student work.
18. As students test their prototypes, they should be collecting and recording data. They will need to make at least one modification and note the affect this modification had on the performance of their design. In later steps, students will modify, rebuild, and retest their oven with actual s'mores.
19. Have a discussion with the class about the process of testing their designs.
    a. Which designs worked best?
    b. Which materials worked best?
    c. What do they wish they had done?
    d. How could the design be better?
    e. What energy transformations took place? Don't forget chemical energy in the food if they eat it and mechanical energy used in chewing.
20. Have students complete the end reflection and share during a class discussion.

Differentiation

Students who struggle with the concepts of energy and energy transformation may need access to reference materials or cue cards.

Larger print templates should be made available to students with limited hand dexterity or vision issues.

Teacher may decide to group based on skill sets and ability level.

Because this lesson's focus is more on process and application of learning, students are able to work at different levels without much differentiation of the actual process.

Assessment

This lesson is designed as a summative task assessment of previous learning. The teacher may choose to grade the different components of the template in different ways, using some sections as formative assessments.

Solar Oven: Design Thinking Template

EQ: How can I use everyday materials to create a solar oven?

Step 1: Empathize

Why might people want to be able to cook without the use of electricity?

Why is it important for you to be able to design and build a solution to a problem?

Step 2: Define

Challenge: Design, build, and test a solar oven using common household/classroom materials.

Research what has already been done to solve this problem. Cite your research sources.

Step 3: Ideate (Imagine)

Think about how you might solve the problem you've chosen. Describe and draw your ideas for how you could solve it. Brain storm **4 different** possible solutions. This should be a rough sketch.

Description (words)	Drawing

Step 4: Prototype

A. Select the best idea or combination of ideas from your brainstorming in step 2. **Draw** the idea below in detail and **label** all of the parts of your device. Make sure to give measurements for the size of your prototype. Include any specific directions for building.

B. Identify materials needed (add more lines if necessary).

Material	Quantity

Build Your prototype: Get teacher approval, gather your supplies and build your prototype.

Step 5: Test

Test and evaluate your design at least 3 times (you can do more if needed).
Complete the table below to show the results of your testing.

Trial #	Results/Changes Needed and Made
1	
2	
3	

Improve

Modify and retest your oven.
What improvements were made to your design?

How did your modification change the oven's performance?

Reflection:

A. What did you learn about the way that engineers work from working through this process?

B. What would you do differently if you were to create another device?

C. Why would you do the thing that you described in question B above?

D. What challenges did you encounter and how did you overcome them?

E. What success did you have and why?

F. What is the intended benefit of your technology?

G. What are some possible unintended consequences of your technology?

H. What learner profile best describes you during this process and why?