Environmental Science Institute
THE UNIVERSITY OF TEXAS AT AUSTIN

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Cooking with the Sun

Lesson Plan for Grades __6__
Length of Lesson: _1hr classroom time (Note: Experiment may take 2 days.)

Authored by: __Maisha Rumman_ for UT Environmental Science Institute
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Subject area/course: Science

Materials:

- Cardboard box
- Box knife or scissors
- Aluminum foil
- Clear tape
- Plastic wrap or other clear material that is similar (such as a plastic bag)
- Black construction paper or other black material such as a black cloth or black cardboard paper
- Newspapers or other insulating materials
- Ruler, or wooden spoon
- Sticky notes

TEKS/SEs:

Grade 6 TEKS

(1) Scientific investigation and reasoning. The student, for at least 40% of instructional time, conducts laboratory and field investigations following safety procedures and environmentally appropriate and ethical practices. The student is expected to:

- (B) Practice appropriate use and conservation of resources, including disposal, reuse, or recycling of materials.

(7) Matter and energy. The student knows that some of Earth's energy resources are available on a nearly perpetual basis, while others can be renewed over a relatively short period of time. Some energy resources, once depleted, are essentially nonrenewable. The student is expected to:

- (A) Research and debate the advantages and disadvantages of using coal, oil, natural gas, nuclear power, biomass, wind, hydropower, geothermal, and solar resources.

Lesson objective(s):

- Students will design a solar oven.
- Students will research solar energy, and the advantages and disadvantages of its use.
- Students will investigate the scientific concepts associated with building a solar oven, including reflection and insulation.
- Students will write a product description and identify target audience to sell the product to.

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Differentiation strategies to meet diverse learner needs:

- Students with learning disabilities as well as ELL students should have multiple forms of instruction including visual and written instruction sheets as well as a verbal instruction and demonstration.
- Since this lesson involves a construction of a solar oven, it would help students having trouble with attention to assign group roles.

ENGAGEMENT

- Students will be given a problem scenario: if there was no electricity and no wood (or candles) to start a fire, what is another way they can cook food, given the materials they already have in their house and the natural environment?
- Students will be given 5 minutes to brainstorm some possibilities and discuss with their group.
    - They will write down their ideas on a sticky note.
    - Teacher will walk around the room at this time and ask students to describe in detail how they would go about cooking. For example, a simple answer such as "I would use water from a hot spring" will not be accepted. Students will have to describe *how* they will use a hot spring, or some other method to cook.
        - An example of a complete answer would be: I would use water from a hot spring and put it in a big pan and then put my food in a thin plate that would be warmed by the water.

EXPLORATION

- Students will be given materials and instructions on how to build a solar oven.
- This is a product that they will be selling and their peers will get to evaluate the product.
- They may tweak the instructions in order to maximize the effectiveness of their solar ovens. If they choose to do this, they must provide a reason for why they chose to tweak the procedure.
- While they are building, evaluating, and reflecting on the solar oven, they will be answering their worksheet (for the concept questions, they will use this link to fill out answers: https://www.collierschools.com/candi/msia/DOCUMENTS/Math_&_Science_of_Solar_Cooking.pdf)

Procedure for building a solar oven:

1. Choose a rectangular box provided by the teacher (note for teachers: this can be a box of any size as long as it is longer than 5 inches for the height and width and aim to provide boxes the size of a shoe box or bigger).
2. Cut a rectangle in a box to make a flap (reference figure in http://www.hometrainingtools.com/a/build-a-solar-oven-project), it must be cut 1 inch from the 3 sides and still be attached to one of the sides.
3. Cover the flap (the side that faces the inside of the box) with aluminum foil (or other reflective material).
4. Line the opening of the box with a clear wrap or other clear material (such as a plastic bag).
5. Wrap the bottom of the inside of the box with black material (such as black construction paper or black cloth).
6. Wrap the sides of the inside of the box with insulating material (newspaper, cotton, etc).
7. Test the oven by placing the flap at an angle which reflect most light and prop it up with a ruler (or anything that will let it stand at an angle).

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8. Lastly, heat up your food of choice for 15 minutes in an area outside with lots of sunlight (the whole class will test the same food, and place their ovens in the same general location).
    a. Suggestion for food: have students toast bread with cheese.
    b. Suggestion for duration of heating: teachers can choose to increase or decrease the 15 minute duration. For example, if the food hasn't "cooked" or toasted in that time, the duration can be increased. Consequently, if the food doesn't take very long to be cooked, the duration can be decreased.
    c. Effectiveness of each oven can be evaluated using how much cheese melts (this is a qualitative method) or a thermometer can be placed in the oven and whichever oven has a higher temperature will be the more effective oven (quantitative method).
    d. Make sure to only test the oven on a sunny day.

Procedure was developed from this link: http://www.hometrainingtools.com/a/build-a-solar-oven-project.

EXPLANATION

- Student will present test their solar ovens and then present to their class, and how they built their ovens (if it was in a different way than in the instructions) and if their oven was effective. They will explain to the class why they think their oven worked effectively or not.
- After students have presented on how they built their ovens, they will come up and present on the concepts involved in making the solar oven better, based on the work they did on their worksheet. Concepts include absorption/conversion of light, reflection, as well as insulation.

ELABORATION

- What are the advantages and disadvantages of using solar energy? Students will be given some news pieces or can search the Internet by themselves to figure out the definition of solar energy, including its uses and disadvantages. (When thinking about advantages and disadvantages, think about who can use this product and in what part of the world.)
- If you could modify your product, would you do so, and why or why not?

EVALUATION

- Students will be evaluated on their presentation, product design, effectiveness, and completion of worksheets.

SOURCES AND RESOURCES

- Dr. Michael Webber's Hot Science – Cool Talks Lecture #94
- Concepts: https://www.collierschools.com/candi/msia/DOCUMENTS/Math_&_Science_of_Solar_Cooking.pdf
- Procedure: http://www.hometrainingtools.com/a/build-a-solar-oven-project
- http://scienceline.ucsb.edu/getkey.php?key=1464

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EXPLORATION ACTIVITY or ACTIVITIES

Purpose
The purpose of this exploration is to build and test a solar oven

Materials
- Cardboard box
- Box knife or scissors
- Aluminum foil
- Clear tape
- Plastic wrap or other clear material that is similar (such as a plastic bag)
- Black construction paper or other black material such as a black cloth or black cardboard paper
- Newspapers or other insulating materials
- Ruler, or wooden spoon

Safety Information
Students should use gloves when handling hot food
Students should be careful when using box knife or scissors (or teacher may choose to complete this step for the students)

Procedure
1. Choose a rectangular box to make the oven with.
2. Cut a rectangle in a box to make a flap (reference figure in http://www.hometrainingtools.com/a/build-a-solar-oven-project), it must be cut 1 inch from the 3 sides and still be attached to one of the sides.
3. Cover the flap (the side that faces the inside of the box) with aluminum foil (or other reflective material).
4. Line the opening of the box with a clear wrap or other clear material (such as a plastic bag).
5. Wrap the bottom of the inside of the box with black material (such as black construction paper or black cloth).
6. Wrap the sides of the inside of the box with insulating material (newspaper, cotton, etc).
7. Test the oven by placing the flap at an angle which reflect most light and prop it up with a ruler (or anything that will let it stand at an angle).
8. Lastly, heat up your food of choice for 15 minutes in an area outside with lots of sunlight (the whole class will test the same food, and place their ovens in the same general location).

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TEACHER PAGES

Building your solar oven: Discuss with your group and come up with a plan for how you plan to build your solar oven. Be very detailed, describe your procedure, and include all materials you plan to use (especially if it is different from the materials listed in the directions).

Answers will vary.

Testing your solar oven

Temperature reached after duration _____ (minutes): _____ °C
What percentage (approximately) of cheese on your bread melted? ____answers vary__ %

Concepts: Describe how the concepts below relate to how you built your solar oven and how incorporating these concepts made your solar oven more effective.

Reflection:
Reflection is relevant to this project because it will direct the rays from the sun to the food inside the cooker. We incorporated this concept by using aluminum foil, if this foil wasn't used then the sun's rays would just be absorbed by the box instead of directed towards the food.

Conversion/Absorption of heat:
Some materials absorb more heat than others. For example, materials that are black in color will absorb more heat compared to light colored materials because the color that you see in a material is an indication of what color of light they are reflecting (and absorbing all other colors). For example, a green object is reflecting green and absorbing other colors of light. In our case, the black material is absorbing many wavelengths of light and reflecting none, which means that it can absorb more heat. The black construction paper we use in lining our box will serve this purpose of capturing light from the sun and absorbing it as heat.

Insulation/heat retention:
Once the heat is absorbed, it needs to be retained in the area of interest. For this project, the heat needs to be retained inside the solar cooker so that the food can be heated. Some materials will retain heat more readily than others and the material we will use to insulate our solar cooker is newspaper or whatever students choose as their insulation material. This newspaper serves the purpose of keeping the heat inside the solar oven.

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Reflection Questions

1. What are the advantages and disadvantages of using solar energy? Students will be given some news pieces or can search the Internet by themselves to figure out the definition of solar energy, including its uses and disadvantages. (When thinking about advantages and disadvantages, think about who can use this product and in what part of the world and at what time)

Answers will vary.
The advantage of solar energy is that it's better for the environment and it is renewable. However, one of its disadvantages is that it can't be used in certain places with little sunlight and during times when the sun isn't out during nighttime.

2. If you could modify your product, would you and why?

Answers will vary.
Example of a good answer:
I would change the angle I used for the flaps of box because there is most likely an optimal level at which it will angle the rays to heat the food. To find the best angle, I would test different angles and record the amount of time it took to heat the food and how well it was cooked. I might also use different materials to insulate the box.

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Scoring Rubric

	Meets Minimal Requirements	Meets Requirements	Exceeds Requirements
Creativity of design	Solar oven had no creative aspects since the designers did not choose to make one with minimal changes. **(1 Point)**	Design of solar oven had materials and construction with some changes. These changes were incorporated with the intent to increase the effectiveness of the solar oven and clear rationale. **(3 Point)**	Design of solar oven incorporated many changes, which were innovative and different from the original instructions by the teacher. These changes were based on evidence that suggests that these changes would lead to a more effective solar oven. **(5 Points)**
Effectiveness of solar oven	The solar oven could not effectively melt the cheese on the bread at all. There was little temperature change inside the oven. **(1 Point)**	Solar oven was able to melt a portion of the chees on the bread. There was a significant amount of temperature increase inside the oven. **(3 Points)**	The solar oven was able to effectively melt all of the cheese on the bread. Additionally, the increase in temperature inside the oven was large. **(5 Points)**

Total points: _____

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STUDENT PAGES

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Testing your solar oven

Temperature reached after duration _____ (minutes): _____ °C
What percentage (approximately) of cheese on your bread melted? _____ %

Concepts: Describe how the concepts below relate to how you built your solar oven and how incorporating these concepts made your solar oven more effective.

Reflection:

Conversion/Absorption of heat:

Insulation/heat retention:

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2. If you could modify your product, would you and why?

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Total points: _____