Do Size And Color Matter In Solar Energy?
(3rd Grade Outdoor Classroom Activity)

SOLs: Science 3.1 (scientific investigations), 3.11 (different sources of energy – sun), Math 3.17 (read temperatures)

OVERVIEW:
Children will set up a controlled experiment using containers of water and record the water temperatures at 5 minute intervals. 30-40 minutes for the experiment. Students will also observe absorption of heat by different colored materials. The purpose is to create awareness about the sun as an energy supplier, as well as to perform a scientific experiment using hypothesis, observation/investigation, and final conclusions. Over the course of the timed intervals, the greatest temperature change should be in the black pan (Pan 3), followed by the white covered pan (Pan 2), and then the white uncovered pan (Pan 1).

OBJECTIVES:
1) Understand and apply accepted practices of scientific inquiry.
2) Become familiar with concepts that describe properties of matter and energy and the interaction between them.

RESOURCES/MATERIALS:
These materials are in a box marked “Outdoor Classroom Solar Energy Activity” in the garden area. Collect the materials about one-half hour before the scheduled activity time and make sure everything is there:

- Timers
- (3) 250 ml measuring cups
- 9 containers (three black, six white)
- 10 thermometers (extra thermometer to measure ambient temperature)
- clear plastic wrap to cover each container, with rubber bands to secure
- 3 pitchers for water
- 3 clipboards with data sheets
- Pencils and sharpener
- White foam sheet, black foam sheet
- Handout coloring page: "Simple Solar"/ "Super Solar"

ACTIVITIES AND DISCUSSION:

Step	Action(s)	Discussion/Questions
1	a) Review instructions thoroughly before the scheduled day in case you have questions. Confirm location of activity with teacher by email (a good place is on blacktop near outdoor classroom shed). Students will come out altogether but should be divided into 3 groups by the teacher. b) Check in with teacher and notify him/her where you will be. Collect box of supplies and fill pitchers with water at the garden hose.	N/A
2	a) Take materials to the agreed-upon area before students and teacher arrive. b) Set up three stations. c) The containers w/ thermometers should be laid out white, white, black, left to right from students' view, consistent with the columns on the data sheet. Also, general orientation of the containers should be with the numbers facing where the children will be sitting, and the children need to be able to read the temperatures without blocking the sun/casting a shadow on the containers. d) Lay out white and black foam sheets in a sunny area nearby; have other materials within reach.	N/A
3	a) Teacher(s) brings the students out (teacher(s) should stay for activity to help with one group and provide direction as necessary. b) Select an attentive student from each group to pour 250 ml of water (using pitcher and measuring cup) into each container c) Give another member of each group clipboard to record the temperature for each container. d) Cover each pan **except Pan 1** securely with plastic wrap and set the timer for 5 minutes. You might want to use rubber bands, which are in the supply box, to secure the wrap.	Explain that you're going to perform a science experiment to learn about collecting energy from the sun. We can learn some properties about solar energy by using these different containers filled with water. We will use the containers to explore how we can capture energy from the sun.

Step	Action(s)	Discussion/Questions
4	a) During first 5 minute interval, show students the different parts of the data form. b) Have students come up with a hypothesis on data sheet, as well as fill in outside temperature and weather conditions. c) Call students' attention to the black and white foam sheets that you laid out at the beginning of the experiment. Have students touch each one and note generally how warm / cool they felt. Say you'll check them later.	▪ The leader will discuss the experiment and tells the students they will write a group hypothesis. ▪ What is a hypothesis and what should be the hypotheses for this experiment? ▪ What will happen to water in each different container? ▪ Answers to these questions form class hypothesis. ▪ Discuss constants of the experiment: sun, location, ground, wind, air temperature, amount of water, time interval of taking temperature, and variables: size of containers (different surface area and relative depth of water), color of containers, covering.
5	**The timer sounds at the end of the first 5 minutes:** a). Each group reads and records the temperatures in each container '**:OO**' and the timer is reset for 5 minutes. b). At this interval, also observe and record any other changes taking place in the containers. c). Discuss some of the points in the Discussion/Questions column for this step.	▪ Ask students what is solar energy? Light from the sun can be turned into energy. ▪ Solar energy does a lot of good things on earth like making plants grow and warming us up on cool days. Mention how hot the inside of a car can be after sitting in the sun. Why is it warmer than outside the car? Does it sometimes feel good and when? ▪ Applications of solar energy. Scientists are figuring out how to use that same solar energy that gives us heat to also do things like run cars, tvs, even satellites up in space. Why does that seem like a good idea? Sunlight is plentiful, renewable and free. Other fuels we use, like gas and coal, are being used up, which is why we call them non-renewable, took millions of years to make in the first place and are costly to extract. When we burn these fuels we rely on now we are creating pollution.

Step	Action(s)	Discussion/Questions
6	**Timer sounds at end of the second 5 minutes:** a) Each group reads and records the temperatures in each container and the timer is reset for another five minutes. Discuss some of the points in the Discussion/Questions column for this step. b) If you have a solar-powered item, such as a calculator or radio, you can demonstrate it now. There is a solar powered radio in the supply box, with instructions on how to use it for a demonstration. If possible, try it out ahead of time!	▪ How does sunlight turn into energy? We can transform the light of the sun into useful energy by using solar collectors. They can be as simple as big containers full of water designed to maximize heat gain, to heat water for kitchens and bathrooms. People have figured out how to convert light from the sun into electricity by using solar collectors called solar cells and storing it. ▪ If demonstrating the solar radio, explain that the flat, black solar panel on top absorbs sun and powers the radio. The longer the sun shines on it, the longer the radio will work, even when you bring it inside!
7	**Timer sounds at end of the third five minutes:** a) Each group reads and records the temperatures in each container and the timer is reset for another five minutes. b) Have students check foam sheets to see if supports hypothesis about dark vs. light colors. Foam sheets can be passed around to feel the temperature difference. c) Discuss some of the points in the Discussion/Questions column for this step.	▪ Does data so far support hypotheses? Which is heating up more? Are all getting warmer? ▪ Discuss with students how color might be used to help collect solar energy. Based on your observations so far how would you design a solar collector? What effect does covering the container have? Should it be light or dark? How about depth of water? Would deeper water heat up faster or slower? Which end of swimming pool is always warmer? Is covered or open better?
8	**Timer sounds at end of the fourth (final) 5 minutes:** a) Each group reads and records the temperatures. b) Subtract initial from final temperatures and record total temperature change for each container. Record group conclusions. c) Have students check black and white foam sheets to determine which color absorbs more heat and record findings. d) Discuss some of the points in the Discussion/Questions column for this step. e) Before students return to classroom, hand out the "Simple Solar" and "Super Solar" coloring sheet that illustrates some of the concepts in the experiment. Copies of these will be in the cardboard box with the other supplies. Coloring sheet is at http://outdoorclassroom.fallschurchenvironment.org/solar_coloring_sheet.pdf; copies for each class are in the supply box for this activity.	▪ Formulate conclusions of experiment. ▪ Explain the coloring sheet: "Simple Solar" is what happens when the sun is out doing a chore without any help; using "Super Solar" techniques -– a large, flat, black solar panel -- you can collect enough energy to run electric appliances and lights!

Step	Action(s)	Discussion/Questions
9	a) Ensure that all items (emptied and dried, of course!) are returned to the box for the next session and place the box back in the garden area. b) Please email your grade coordinator to let them know how things went as well as any ideas or suggestions for improving the activity. Thanks for your help!!	N/A

Extra activity if you want to have the kids run a little: Select two students, one with a white /light shirt and one with a dark shirt to be "its". Station them about 50 yards from group with their back to the group. Students can run, one or two at a time (relay-style) and tag the two shirts. When they all return take a vote to see which shirt felt warmer. This will work if students have been sitting with their backs to the sun during the experiment! (thanks to Robin Hopes for the good idea!)

ABOVE AND BEYOND FOR THE CLASSROOM:
Continuation of discussion points above. Students can write up results, plot results on graph showing time intervals and temperatures. Data from all classrooms can be collected and compared. Discuss surface area and its relevance.

Activity adapted from St. Clair County Regional Office of Education COIILS project "Collecting Solar Energy" found at http://web.stclair.k12.il.us/splashd/solarexp.htm and "Elementary Exploration: Solar Collectors" at http://www.eia.doe.gov/kids/ classactivities/ SolarCollectorElementaryActivity.pdf 10/17/05

THOMAS JEFFERSON ELEMENTARY OUTDOOR CLASSROOM
SOLAR ENERGY EXPERIMENT DATA TABLE

Class (Teacher's name and grade level):_____

Outside Temperature (C°): _____ Date: _____

General Weather Conditions: _____

Class Hypothesis: _____

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	Temp C° / Time	Pan 1 (no cover) 250 ml	Pan 2 (covered) 250 ml	Pan 3 (covered, black) 250 ml	
1.	:00				
2.	:05				
3.	:10				
4.	:15				
5.	:20				
	Temp Change (Temp.No.5 – Temp.No.1)	-_____	-_____	-_____	

Conclusions:_____

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