the CEED

THE CENTER FOR ENERGY EFFICIENT DESIGN

Reflective Light Surface Investigation

Grade Level	5th	**Subject**	Light Energy

Objective(s): The students will investigate how light is reflected or absorbed by different colors and surfaces. Students will use birdhouses and choose different colors and surfaces for roofs of the houses. They will investigate to determine whether or not this reflection or absorption has an effect on temperature. They will use thermometers to find the internal temperature of the birdhouses at 3 different times each day for 5 days. They will collect data and create a data table at the end of the week to present their findings.

SOL Addressed:

5.1 b,d, e,f,g,h,i, - The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which:

1. accurate measures of temperatures are made
2. hypotheses are formed
3. independent and dependent variables are identified
4. constants are identified
5. data are collected, recorded, analyzed, and communicated using proper graphical representations
6. predictions are made using patterns from data collected, and simple graphical data are generated
7. inferences are made and conclusions are drawn

5.3 The student will investigate and understand basic characteristics of visible light and how it behaves. Key concepts include

d) reflection of light from reflective surfaces

Common Core Standards:

3-ESS3-1. Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.

4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

<table>
<tr><td>Materials Needed Per Class of 30

and

Prior Knowledge</td><td colspan="2">

6 Birdhouse Kits
(These can be purchased from http://www.homedepot.com)
6 Ambient Weather WS-02-4 Indoor/Outdoor Thermometers with Probes
(These can be purchased from http://www.ambientweather.com)
Black paint, white paint, reflective tin sheets, paint brushes, wood glue, sand paper
Science journals and pencils for collecting data

Black and white are not spectral colors. Black is when a material absorbs all the visible light and no light is reflected back. Black is a total absence of reflected light. White is a reflection of all visible light together.
Light travels in straight paths until it hits an object, where it bounces off (is reflected), is bent (is refracted), passes through the object (is transmitted), or is absorbed as heat.

</td></tr>
<tr><td>Ways to differentiate this lesson plan</td><td colspan="2">

EXTENSION for Higher Level Learner

1. Students can research design choices in architecture and how colors and reflective surfaces can be used to assist with heating and cooling choices.
2. Students can research green roofs and the benefits of a green roof. Students could try making a birdhouse with a green roof and investigate the effect of that on temperature.

MODIFICATIONS

Pre-made data collection sheets can be given to students with disabilities to facilitate how to record the data.
Cooperative learning groups can be used in order to equally represent ability levels within teams and specific jobs can be assigned so that all students have the opportunity to participate to the best of their ability.

</td></tr>
<tr><td>Introduction/ Anticipatory Set</td><td>Anticipatory Set: The teacher will review important terms such as visible spectrum, reflection and refraction. The teacher will use the Discovery Education website to download and view with children: Real World Science: Light

Questions to ask students:

How does the surface of an object affect it’s reflective property?
What happens when light energy is not reflected? Does this have any effect on an object’s temperature?
Can light energy be used to create heat energy? How?

</td><td>Introduction:
The students will discuss how surfaces of objects absorb or reflect light energy. They will discuss common examples of this (for example: wearing a black t-shirt on a sunny day versus wearing a white one)

The discussion will continue with how this affects heat energy.

Students will be asked:
If light reflection and absorption does affect heat energy, do you think that the color and surface of your roof has an effect on the internal temperature of your house?</td></tr>
</table>

Guided Practice	• Students will be placed in groups with no more than 5 people in a group. Each group will have their own birdhouse kit. • As a class, students will discuss briefly what will affect the internal temperature of the birdhouse. • Students will build birdhouses and decide on a roofing surface. (If student choice is allowed, then the teacher will need to insure that at least one roof is black, one is white and one is reflective) • At 3 predetermined times during the day for 5 days, the students will go outside and test the temperatures of the insides of the birdhouses using probe thermometers. **Students should make and record predictions:** 1. Will the birdhouses all have the same internal temperatures throughout the day? 2. If not, will the roofing surface affect the temperature? If so, how? 3. If the roofing surface does not affect the temperature, does the time of day affect the temperature? 4. What may cause variations in temperature? Why? 5. How do you think this relates to your own home? Do you think the design of your home affects how well you are able to heat and cool your home? Do you think this information will be helpful to builders and homeowners? How? Explain.
Independent Practice	• Birdhouses will be placed outdoors in a sunny location after construction. Each birdhouse must be evenly placed so that the only variable is the surface/color of the roof. (For younger students, the teacher may want to pre-construct the birdhouses) • At the 3 preselected times daily, the class will go outside. Teams of students will insert the thermometer probes into the birdhouses and leave them there for approximately 5 minutes. • The students will take turns, within their teams, reading the thermometer and inserting the probe. Each student will record the time and temperature of the inside of the birdhouse. (The teacher will give the students the outside temperature at the time of the recording to add to their data) • At the end of the week, students will work in their groups to decide on a data display table to create (such as: graph, chart, etc.)
Closure (Summary of Lesson)	Students will present their data charts or graphs and compare the information with their original predictions. Did the roofing surface have an effect of the internal temperature of the birdhouses? If so, which roofs had the cooler temperatures? Which roofs had the warmer temperatures? How could an architect/home designer use this information to improve a building design?
CEED Building Application/ Sensor Data	Students will view the CEED dashboard daily and compare outdoor temperatures with local temperatures. Students will also note how much solar energy is being harvested during the times of the days when we are making our observations and recordings. Students will be asked to make connections. Students will draw conclusions about solar panels and determine whether they reflect or absorb sunlight. While viewing the CEED dashboard, the students will observe the green roof and note that a benefit of a green roof is that is can offer assistance with cooling the building.

Assessment	Daily student journal entries can be assessed. Students should have a paragraph written to answer the teacher's closure questions. Data charts and graphs can also be assessed. A rubric will be used to track student participation and performance in each group.

INQUIRY LEARNING RESEARCH PROCESS GUIDELINES

The following table is just one guideline to use for developing your own inquiry materials. The seven steps in the Learning Research Process include not only how people learn but also how research is conducted. The heart of the design, the three-stage learning cycle of exploration, concept invention or formation, and application is embedded in the middle. In addition to these three stages, this design takes into account that learners need to be motivated to spend the time required for understanding complex subjects and that learners need to build this new knowledge onto prior knowledge. These are similar to the 5E and 7E learning models.

The Learning-Research Process

Steps in the Learning-Research Process	7E Equivalent	Component of the Activity
1. Identify a need to learn.	Engage	An issue that excites and interests is presented. An answer to the question *Why?* is given. Learning objectives and success criteria are defined.
2. Connect to prior understandings.	Elicit	A question or issue is raised, and student explanations or predictions are sought. Prerequisite material and understanding is identified.
3. Explore	Explore	A model or task is provided, and resource material is identified. Students explore the model or task in response to critical-thinking questions.
4. Concept invention, introduction, and formation	Explain	Critical-thinking questions lead to the identification of concepts, and understanding is developed.
5. Practice applying knowledge.		Skill exercises involved straightforward application of the knowledge.
6. Apply knowledge in new contexts.	Elaborate and Extend	Problems and extended problems require synthesis and transference of concepts.
7. Reflect on the process	Evaluate	Problem solutions and answers to questions are validated and integrated with concepts. Learning and performance are assess

Hanson, D. (2006). POGIL Instructor's Guide to Process-Oriented Guided-Inquiry Learning. Lisle, IL: Pacific Crest