Visibility: The Light/Dark Box

Grade: 4th

Lesson Overview: Students will conduct an investigation into how light is needed in order for us to see things. They will gather observational data that will be used to support their reasoning for how we see things either as a result of something being a source of or reflecting/interacting with light from some other source. They will then use this information to develop a model to illustrate how light is

- **Standard 4.P.4:** The student will demonstrate an understanding of the properties of light and sound as forms of energy.
    - **4.P.4A. Conceptual Understanding:** Light, as a form of energy, has specific properties including color and brightness. Light travels in a straight line until it strikes an object. The way light reacts when it strikes an object depends on the object's properties.
        - **Performance Indicator 4.P.4A.3:** Obtain and communicate information to explain how the visibility of an object is related to light.

Science and Engineering Practice:

- **SEP 4.S.1A.8:** Obtain and evaluate informational texts, observations, data collected, or discussions to (1) generate and answer questions, (2) understand phenomena, (3) develop models, or (4) support explanations, claims, or designs. Communicate observations and explanations using the conventions and expectations of oral and written language

Crosscutting Concepts:

- Cause and Effect: Mechanism and Prediction
    - Students should be able to recognize, describe, and illustrate the cause and effect relationship between the behavior of light and visibility.

Materials:

- Flashlights with batteries
- Shoe Boxes (one for each group plus 1)
- Black Construction Paper cut into 2"x2" squares (one for each group)
- Heavy Tape (Duct Tape, Gaffers Tape, Electrical Tape, etc…)
- Science journals
- Small objects to put in each box (one for each group)
- Small battery-powered light

Teacher Directions:

1. Before class, prep one light/dark box for each student group:
    a. Cut a small hole in one of the shorter sides of the shoebox. The hole should only be about ½ inch wide.

    b. Cut a small hole in the shoebox lid. The hole should only be about 1 inch wide.
    c. Drop the small object into the box
    d. Tape the lid to the box with the heavy tape. Every edge must be sealed with the heavy tape so that no light can get into the box through the edges of the lid.
    e. Tape the black construction paper over the hole in the top of the box.
2. Prep one additional box different from the others in the following ways:
    a. Do not place an object in it
    b. Do not cut a hole in the top
    c. Do not seal it with tape
3. In class, group students into small groups of 2-4 each.
4. Direct each group to shake the box gently and listen for evidence that there is something in the box. Direct them to NOT look in the hole yet. Ask the groups to speculate about what might be inside the box, writing down their speculations in their science journals.
5. Have each student in a group look through the hole in the side of the box. In their science journal, have the students write down what they see in the box.
    a. Teacher Note: It may be helpful to dim the lights in the room for this activity.
6. Ask students if they saw something in the box (they should not have been able to see anything). If they insist they saw something, ask them what shape it was and what color it was and what it was made out of. Ask students what would be needed in order to answer all of those questions.
7. After the groups suggest that they need light to be able to see what is in the box, direct students to the students carefully remove the square of black construction paper covering the hole in the top of the box. Distribute a small flashlight to each group.
8. Direct students to shine the flashlight through the hole in the top of the box and to write down in their journals what they see and the answers to the earlier questions about shape, color, material.
9. In their groups, have students respond to the following prompts (and write their responses in their journals):
    a. What was different between the first and second attempt to see what was in the box?
    b. How did the presence of the light allow us to use our eyes to see the object?
    c. Where did the light come from and how did it interact with the object to allow us to see it?
10. Have groups share their ideas about these prompts.
11. Ask each group to draw a picture showing what the light in this investigation did in order to make the object visible to their eyes. Be sure to prompt them to include the source of light, the object, and their eyes in their conceptual models.
    a. This will be the beginning of their preliminary models illustrating the behavior of light.
12. Using the other box you prepped without a hole in the top, place the small battery-powered light in the box (turned on) and pass the box around to each group, asking them if they see something in the box. Once everyone has seen inside the box, ask the groups to discuss the following prompts (and write their responses in their journals):
    a. Were you able to see something in the box?
    b. What was different between this observation and the observation with the flashlights?
    c. How did the light behave in this observation to allow us to use our eyes to see it?

13. Ask each group to draw another model illustrating what the light in this observation did in order to allow them to see it. Be sure to prompt them to include the source of the light and their eyes in their models.
14. Wrap up the class with a discussion on what is needed for something to be visible, what are the two ways we can see something, and how does light behave to make something visible.

Evidence of understanding: Students should be able to use evidence from their observations and models to explain that we need light in order to see things and that without light, we cannot see what is there. They should also be able to use their models to describe how light comes from some source and either travels to the observer's eye or interacts with some object that then bounces off and travels to the observer's eye. They should be able to support this reasoning with examples from their observations.