ACTIVITY 3: MEASURING LIGHT INTENSITY [LAB]

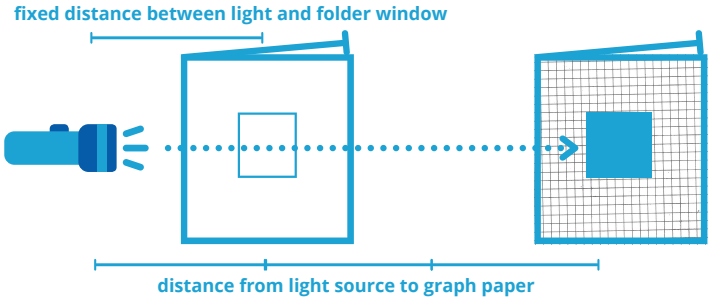

Image Credit: Gary Abud, Jr.

The purpose of this experiment is for students to model how light reaches boats from a lighthouse at different distances. They will change the distance from a light source and measure the area illuminated, which they will correlate to light intensity, at each distance.

Students will need:

- a file folder with a 5cm x 5cm square cut out of the middle of one side (*window*)
- a file folder with a piece of graph paper clipped onto one side (*ship*)
- a light source, like a flashlight (*lamp*)
- a meter stick or centimeter ruler

First, inform students that they will be working with a group to conduct an experiment to model the functionality of a lighthouse. Just as a lighthouse has a lamp and a window a fixed distance apart, and ships can be close or far away from the lighthouse, so this experiment will have a setup representing each of those components. Demonstrate the lab setup for the whole group, moving the grid close to and far away from the light source, asking students what they observe. Help them focus on how the size of the lit up area changes at each distance.

Ask them to inquire: **how might the illuminated area change with distance, e.g., if it were twice or three times as far away from the light source?** Have groups generate a hypothesis for how they think the illuminated area relates to the distance from the light.

Then, either provide them an experimental procedure or, alternatively, this lab can be done using inquiry approaches where students develop the procedure with teacher guidance. Either way, students can have similar procedure steps but can choose their own distances in cm.

Sample Procedure:

1. Choose a starting distance for the setup
2. Shine the light source through the window onto the grid and trace the illuminated area
3. Double the distance by moving the grid farther away, keeping the light source and window stationary.
4. Adjust the location of the grid at the new distance so that the upper left corner of the new lit up area lines up with the first area
5. Trace the new illuminated area on the grid
6. Repeat steps 2-5 for 3x, 4x, etc. distances until students have at least 3-5 traced areas
7. Students should measure the dimensions of each traced region and calculate the area
8. Organize data into a table and line graph of Area (square cm) vs. Distance (cm)

Next, have students come up with a conclusion statement about how the illuminated area changed with distance and compare it to their hypothesis. They should write their statements, table, and graph on chart paper to present their data as posters during the lab debrief.

Last, debrief the lab in a poster presentation format by selecting students to summarize their findings. Sequence student ideas to help them realize that the lit up area increases with the square of the distance, thus distributing the light over a greater area each time and making the light less concentrated, which means the light intensity is decreasing even though the amount of light being shined is staying the same, e.g., luminosity is constant.

Help students connect all these ideas and their findings together so that they arrive at an understanding of the inverse-square law of light intensity, meaning that the light intensity decreases proportionally with the square of the distance, e.g., as the distance doubles, the light intensity decrease by a factor of 4, etc.

Finally, invite them to make connections, between the lab results and the candle demo from the warm up, in order to understand how a lighthouse could increase the intensity of its beam for ships using a lens rather than a light source alone.