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Area(s) of Teaching: Biology, Physical Science

Where You Teach: North Smithfield High School

Please describe your activity goal:

The objective of this activity is to have students analyze collected data in order to draw conclusions about the wavelength of light a particular plant is receiving, its pigment, and its survival. In order to do this, the students will have to "visualize" the collected data by creating a fairly complex line graph with an enhanced X axis which not only contains the wavelength of light (in nm) but the actual color of the light associated with that wavelength (using colored pencils). The data in the data set does not make sense until it is put into a line graph. Here is the planned activity in its entirety:

Designing an Experiment
Rate of Photosynthesis vs Color of Light
Biology

Instructions: Carefully read the brief background story below. After reading the story, examine the "collected data" and generate a line graph from the data. Based on the conclusions you draw from this graph, develop a hypothesis, then make a prediction of the outcome a simple experiment. Answer the questions that complete this lab assignment.

Background Story: During a recent South American jungle expedition, you discovered a unique species of plant. You discovered this plant beneath the jungle canopy growing near a large outcropping of yet unidentified minerals located next to a series of active thermal vents. What made this plant special was the color of its leaves. The leaves were a dull orange color similar to a worn basketball. The stem of the plant was a yellow-orange color. You were able to collect a small number of the plant samples and were able to return them to your lab back in the States.

Back at the lab, you worked to create a proper environment for the plant to grow but even though you exactly matched the soil and nutrient conditions, growing temperature, CO_2 levels and water requirements you soon noticed the plant specimens were beginning to die. You hypothesized that it may be the lighting conditions the plants were exposed to that may be affecting their growth.

1. **State a possible hypothesis concerning the light that the plants are receiving here:**

You next selected a leaf sample from the plant, and you were able to isolate three pigments. Using the lab spectrophotometer, the following data set regarding the absorption spectra was recorded:

Plant Pigment A		Plant Pigment B		Plant Pigment C	
%Light Absorbed	Wavelength (nm)	%Light Absorbed	Wavelength (nm)	%Light Absorbed	Wavelength (nm)
2	400	1	400	1	400
35	430	20	440	20	460
75	480	95	500	45	500
32	510	45	550	75	540
5	580	15	600	25	575
1	625	2	625	3	650
15	650	35	675	10	680
40	700	75	725	15	700
65	725	40	740	20	750
40	750	2	750	5	775

2. **Create a line graph from the data above (% Light absorbed on the Y-axis). Use colored pencils to match the colors of the light to the wavelength along the X-axis (Violet 380-430 nm, Blue 430-480 nm, Green 480560 nm, Yellow 560-610 nm, Orange 610-650 nm, Red 650-750 nm).**

3. After carefully examining the completed graph, what basic conclusion can you make about the % of light absorbed, the colors of light absorbed and the plant pigments?

You then set up an additional experiment where you placed live samples of the plant under different and separated containers holding colored grow lights. The following colored grow lights were used:

Violet   Blue   Green   Yellow   Orange   Red

4. What light color(s) would probably cause the plant to die very quickly? Why?

5. What combination of colored grow lights would allow the plant to grow the best? Why?

6. What is the purpose of the pigments found in plants?

7. What is meant by "an object absorbs all of the colors of the visible spectrum except the colors you see"?

8. Absorbing the energy of visible light is the first step of photosynthesis. In terms of energy, explain why this is an important first step.

9. How does the First Law of Thermodynamics apply to the first step of photosynthesis? (Hint: What is the role of plants in an ecosystem?)

First Law of Thermodynamics: energy cannot be created nor destroyed, but can be changed from one type of energy to another.

What is the intended visualization?

The students will create a complex line graph comparing the % of Light Absorbed for three different plant pigments (called A,B, C) versus the wavelength of light (nm). Once the data set has been graphed the students will clearly be able to see what wavelengths the plant is absorbing and what wavelengths are being absorbed. They should be able to conclude that the plant's survival depends on the light the plant needs to absorb and should adjust the light that the plant is receiving from the artificial light bulbs they are using in their lab.

Please provide the activity wordings presented to the students:

There will be background information given to the students on photosynthesis, light energy, pigments, and a review of absorption and reflection. The wording of the actual activity is in the above paragraph.

Please describe the nature of the activity (e.g. In class activity? Homework? Something else) and the rationale behind your choice:

The nature of this activity is classwork and class discussion. There is a great opportunity to to discuss photosynthesis, light as energy, the first law of thermodynamics, setting up a graph and labeling the parts of a graph, and of course debating the different outcomes of the conclusion. This activity is intended to take up approximately two 50 minute class periods.

Were students engaged?:

This activity will be given in January/February of 2021 to all Biology students, and modified for all levels since I will be teaching all three levels this year.

What is/are the dataset(s) that will be used for the activity? How students will access the dataset(s)?

The data set is embedded in the handout (see above) or on-line document. The data can be tailored to different instructional levels by eliminating pigments B and or C.

What tool(s) are students going to use? How will students have access to the tool(s)?

Initially, the students will use colored pencils, standard graph paper, and rulers supplied by the teacher. Advanced students may input the data and create graphs using Excel or Google Sheets.

How you are going to grade the activity? (e.g. Rubric)

The graph is worth five points (1 pt ea: Title, Proper Label of Y-axis, Proper Label of X-axis, Proper Scale, and a key/legend for each Pigment A,B,C) and 1 point for each of the written answers to the conclusion questions. Later, we will write about plants, pigments, and light in a more formal writing assignment which has its own constructed response rubric.

Do you think you will keep incorporating data visualization in the future?:

Data visualization is a key component of all science classes. We examine different types of visualizations every day, every class.