Harmful Algal Blooms using Kool-Aid

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SUBJECT/GRADE LEVEL
Subject Area: Algebra I, ELA
Science: Environmental Engineering, Chemistry

Grade Level: High School

Materials
- Vernier Colorimeter plus 15 cuvettes; eaieducation.com $117.95
- Disposable Cuvettes (100); Fireflysci.com $58
- (IDEAL) Portable Pipet-Aid XP Pipette Controller; Item #4-000-101; shopdrummondsci.com $430
- (IDEAL) epT.I.P.S. Singles Pipette Tips 50-1000 uL (1000); online-shop.eppendorf.us $166
- (PROBABLE) 5 mL Transfer Pipette (500); Model #S-24319; Uline, Inc $30
- Kool-Aid packets (Lime flavor)
- Water Source (DI water if possible)
- Beakers
- Laptop
- Graphing Calculator
- Lab Notebook (Composition Book)

STANDARDS
Next Generation Science Standards
- HS-PS4-5: Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.
- HS-LS2-1: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
- HS-LS2-2: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

Mathematics Standards | Common Core State Standards
- CCSS.MATH.CONTENT.HSA.CED.A.2: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- CCSS.MATH.CONTENT.HSF.LE.A.1: Distinguish between situations that can be modeled with linear functions and with exponential functions.
- CCSS.MATH.CONTENT.HSS.ID.B.6.A: Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

English Language Arts Standards | Common Core State

- CCSS.ELA-LITERACY.SL.11-12.1.A: Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.
- CCSS.ELA-LITERACY.RST.9-10.1: Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
- CCSS.ELA-LITERACY.W.9-10.2.A: Introduce a topic; organize complex ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
- CCSS.ELA-LITERACY.W.9-10.2.B: Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
- CCSS.ELA-LITERACY.W.9-10.2.D: Use precise language and domain-specific vocabulary to manage the complexity of the topic.

LESSON OBJECTIVE(S)

Students measure and graph the absorbance of several samples of Kool-Aid and DI water in a variety of concentrations using a colorimeter to determine the concentration of an unknown Kool-Aid.

CAREER CONNECTION(S)

Mentor Background: Dr. Arthur Lee has a BS, Masters, and PhD in Environmental Engineering at Pennsylvania State University. He worked 20 years of commissioned service with the US Army as an environmental science and engineering officer, 18 years of working as a contractor on Department of Defense public health projects as a Subject Matter Expert and Executive Director, and Assistant professor at the Uniformed Services University of the Health Sciences. His dissertation topic was the Removal of Volatile Organic Compounds from Water using Hydraulic Jet Aspiration.
STEM Careers: Chemist, Chemical Engineer, Environmental Engineer

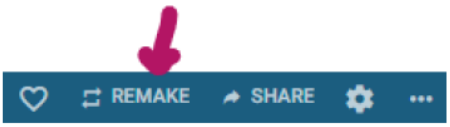
ENGAGEMENT

Brief Description: What Are Harmful Algal Blooms (HABs)? In both face-to-face learning and virtual learning, this question could be asked across curricula with pictures of the HABs on the beaches and in the waters of lakes, ponds, and oceans across America. If possible, invite a chemist from a research lab to discuss their work on HABs or other similar real-world problems.

Procedures:

In 2019, the beaches of the Gulf of Mexico were closed due to serious cases of HABs. What causes HABs? Would you like to swim in water covered w/ HABs? Would HABs make humans ill? Would HABs make domesticated animals or wildlife sick? How do HABs affect the economy? What ecological problems do HABs cause?

If you would prefer to use a digital platform for discussion, you can use the padlet below for student engagement. It has similar questions to the ones listed above and more can be added by creating your own copy of the padlet and modifying the questions. To create a copy of the padlet click the remake icon in the top right corner.



At the Engineering Research and Development Center (ERDC) in Vicksburg, MS, chemists are studying which treatment technologies remove and/or kill the algae, the toxins, or both. Presently they are studying the effects of Graphene (G), Graphene Oxide (GO), and composites of Chitosan (pronounced Kite O Zan) and Graphene (CSG) and Chitosan and Graphene Oxide (CSGO) on samples of HABs taken from lakes in New York. It appears that some of these are effective, but it must be determined how one could distribute the treatment in the field and would this cause more economic or ecological problems.

Depending on the length of each class, this discussion would require one to two days.
Students will read Article: Freshwater Harmful Algal Blooms 101 in preparation for answering questions and writing their report.

EXPLORATION

Brief Description: In both face-to-face learning and virtual learning, students could explore HABs from the websites below along with other articles they may find.

Procedures:

Students should be able to answer the questions from the Engagement section of the lesson plan. Since this is a real-world problem, a rich discussion could be held live and/or through Google Meet concerning what you would do as a consumer or as a business owner on the beach. How would you handle this problem?
Article: Algae's toxin makes its way into brains of sea lions, with tragic results
Article/Video: Want to know if Cayuga County beaches have toxic algae? You'll have to call

EXPLANATION

Brief Description: An experiment would be conducted in Science and the data used in Algebra I.

Procedures:

In an Environmental Engineering or Chemistry class for face-to-face learners, a Colorimeter could be used to find the absorbance of different concentrations of green Kool-Aid to DI water (if available). Prior to class, the instructor would mix a full concentration of Kool-Aid with DI water. Each packet holds 5 grams of Kool-Aid powder so depending on the availability of different-size beakers, 2.5 grams could be mixed w/ 1 liter of water. This would be full strength. The instructor would use that mixture and mix w/ additional water in a beaker making it 50% Kool-Aid mixture to 50% water. Other containers could hold ¼ Kool-Aid mixture to ¾ water, ⅛ Kool-Aid mixture to ⅞ water, and 1/16 Kool-Aid mixture to 15/16 water. The instructor would also make additional mixtures w/ the concentrations known only to him/her. Each group would have a different concentration. Using either style of pipettes, students would work in groups to measure the absorbance of three samples of each concentration (15 total samples) and record data in their lab notebook. If only one Colorimeter was available, groups could rotate measuring samples and the entire class would record the data.

Virtual learners could 1) observe the procedures above through Google Meet and record the data in their lab notebooks, or 2) use prepared data such as the information in the Elaboration section to run their calculations.

In Algebra I class, having learned about scatter plots and lines of best fit at an earlier time, students would use the acquired data from Science class to plot the points either on Excel or their TI-84 graphing calculators. Either method would draw the line of best fit for the students and calculate the equation in slope-intercept form. The teacher could provide a formative assessment by asking such questions as: What is the slope? What does the slope mean in this situation? What is the y-intercept? What does the y-intercept mean in this situation?

The instructor would provide a real-world scenario (ex. The Kool-Aid is algae and the chemist failed to label the concentration. Using the given absorbance and the line of best fit/equation, find the concentration. Or a pharmacist is mixing medicines for you, your grandmother, or a small child and he needs to know the concentration of this medicine.) A summative assessment would include the graph, line, equation, and determination of the concentration of the unknown.

ELABORATE

Brief Description: An experiment was conducted at ERDC while Martha Hebert was assisting in the lab. The following formula was used: ppm = parts per million = mg/L = micrograms/mL

Procedures: Virtual and/or face-to-face learners could use the following information/data:
If the Kool-Aid packet holds 5 g, then we could use 2.5 g/L which equals 2500 mg/L which equals 2500 ppm.

Using a UV-Viz set at 430 nm, the green Kool-Aid samples were measured to calculate the absorbance.

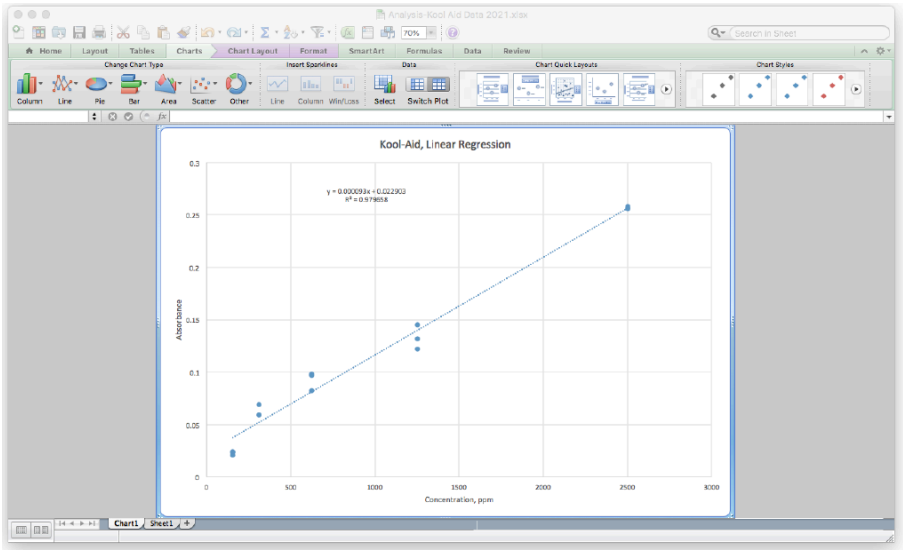
The calculations are below:

Sample	Concentration	Absorbance
Full Concentration 1	2500	.258
Full Concentration 2	2500	.256
Full Concentration 3	2500	.256
Half Concentration 1	1250	.145
Half Concentration 2	1250	.132
Half Concentration 3	1250	.122
One-fourth Con. 1	625	.098
One-fourth Con. 2	625	.097
One-fourth Con. 3	625	.082
One-eighth Con. 1	312.5	.059
One-eighth Con. 2	312.5	.059
One-eighth Con. 3	312.5	.069
One-sixteenth Con. 1	156.25	.024
One-sixteenth Con. 2	156.25	.023
One-sixteenth Con. 3	156.25	.021

The data was entered into Excel. A TI-84 Graphing Calculator will do the same process. The averages (means) of each concentration were taken along w/ the standard deviation. The standard deviation was not used in this experiment, but the instructor could expand the project and use the standard deviation. The means of the absorbances are as follows:

Full Concentration	0.25667
Half Concentration	0.133
One-fourth Concentration	0.0923
One-eighth Concentration	0.0623
One-sixteenth Concentration	. 0.022667

The graph shown was created from the raw data w/ Concentration on the x-axis and Absorbance on the Y-axis:



Equation is as follows:
y = 0.000093x +0.022903
As an example, the instructor could ask: If the absorbance is .090, what is the concentration?

Answer is 721.47 ppm.

EVALUATION

Brief Description: Both formative and summative assessments would be given throughout and at the culmination of this lesson.

Procedures:

For ELA, the summative assessment would be the written report on HABs. The summative assessment of Science would include the absorbances of all concentrations while the graph, line, equation, and determination of the concentration of the unknown would be the summative assessment for Algebra I.

REFERENCES

- https://prezi.com/t2zcj0j8sor3/beers-law-kool-aid-experiment/