Harmful Algal Blooms

Good algae vs bad algae

Grade Level: 9th – 12th

Lesson Summary:

Harmful algal blooms are the result of bacteria and phytoplankton obtaining far too many nutrients from fertilizers, sewage, and other pollutants. This lesson explains the causes and effects of these blooms in depth, and students will consider solutions for reducing blooms around Florida. This lesson involves a classroom discussion of the costs and benefits involved in reducing harmful algal blooms, and how science can be used to inform policy.

Standards:

SC.912.N.4.1 – Explain how scientific knowledge and reasoning provide an empirically-based perspective to inform society's decision making.

SC.912.N.4.2 – Weight the merits of alternative strategies for solving specific societal problem by comparing a number of different costs and benefits, such as human, economic, and environmental.

SC.912.L.17.4 – Describe changes in ecosystems resulting from seasonal variations, climate change and succession.

SC.912.L.17.12 – Discuss the political, social, and environmental consequences of sustainable use of land.

SC.912.L.17.14 – Assess the need for adequate waste management strategies.

SC.912.L.17.16 – Discuss the large-scale environmental impacts resulting from human activity, including waste spills, oil spills, runoff, greenhouse gases, ozone depletion, and surface and groundwater pollution.

Project Activity Assessment

In 2018, coastal waters in southwest and southeast Florida suffered from intense red tides and cyanobacteria blooms. Brown tides have repeatedly caused fish kills in the Indian River Lagoon. This activity will require students to read about these blooms and think critically about what is involved in preventing such blooms from occurring.

Procedure:

- Students should read the "Harmful Algal Blooms" document prior to class, taking notes and referring to the vocabulary listed at the bottom of the reading. As they read the document, they should answer the first set of questions on the "Guiding Questions" page. The first set of questions should be handed in at the start of class.
- The teacher should lead a group discussion on the second set of guiding questions. The major goals of this discussion are:
    1. to clarify what HABs are, their effects, and their causes;
    2. to discuss ideas to prevent HABs;
    3. to think critically about what shapes environmental policy, using the costs and benefits to resolving the HAB problem as an example;
    4. and to consider how science influences policy.
- The first question should act as a review of the reading, and help clarify any questions students may have had.
- The second question should start a discussion about costs and benefits of environmental policy. Students will suggest different things that are producing nutrient runoff and explain how they might be impacted from laws reducing such runoff. For every item students suggest, encourage them to think about broad impacts, for example:
    - Student might suggest agriculture produces lots of fertilizer runoff, therefore laws would limit the amount of fertilizer they use. Push them to consider that this would cause plants to grow more slowly, and maybe increase produce prices.
- Continue to discuss how these costs could be mitigated. For the fertilizer example, a student might suggest that restoring grasslands or other nutrient-filtering ecosystems could stop some of the fertilizer from reaching the ocean.

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Resources:

National Oceanic and Atmospheric Administration (NOAA) educational page with lots of graphics and information about HABs: https://www.noaa.gov/what-is-harmful-algal-bloom

National Institute of Environmental Health Sciences (NIEHS) educational page about HABs:https://www.niehs.nih.gov/health/topics/agents/algal-blooms/index.cfm

Procedure Continued:

- The final question should be a brainstorming session among the class to think of things that might mitigate HABs. Encourage the students to think logically, considering the costs (both monetary and negative effects) and the benefits of their ideas. There is no correct answer here, and you may want to emphasize that. This is a problem that has not been solved yet because it is complex.
- Students may also come up with questions that need to be answered before they can come up with a solution. In this case, encourage them to do some research and see if the answer has a solution. In this case, they may plan a scientific study to answer this question.
- The discussion can be considered complete and successful when the in-class question section has been answered and the goals listed above have been met.

Expansion:

You may expand this activity by assigning the last in-class discussion question as a one-page essay. The question would then require deeper consideration and an adequate discussion of:

- The suggested solution and the supporting science (how do we know the solution would work?)
- The benefits of the suggested solution
- The monetary costs and the negative impacts of the suggested solution

If proposing a scientific study, students should discuss:

- A brief summary of the scientific study
- What question the study would answer
- How the information learned from the study would lead to less HABs

You may also ask students to create a budget for the research or solution they have proposed. This is a significant activity that will take lots of time and research on their part, and requires the students to carefully think about every step of what they have proposed.

Classroom Discussion Rubric

AREA	1 Does Not Meet Expectations	2 Partially Meets Expectations	3 Meets Expectations	4 Exceeds Expectations
Science Content	NONE. Student does not demonstrate understanding of the causes and effects of harmful algal blooms.	SOME. Student exhibits a basic understanding of causes and effects of harmful algal blooms, but is unclear on specifics.	MOST. Student understands the causes and effects of harmful algal blooms but there is minor confusion between the types of HAB.	ALL. Student fully understands causes and effects of all types of harmful algal blooms.
Use of Scientific Vocabulary	NONE. Student does not use any introduced concept or use scientific vocabulary to form thoughts and narrative.	SOME. Student attempts to use scientific jargon, but fails to use it properly or in context. Shows some mastery of science language, but fails to use effectively.	MOST. Student uses significant scientific jargon, but fails to identify all principles and concepts. Student exhibits some mastery of scientific concepts and vocabulary.	ALL. Student effectively communicates using scientific jargon and vocabulary to convey narrative. Student has achieved mastery of vocabulary and concepts.
Participation	NONE. Student did not participate in the discussion or indicate any form of engagement.	SOME. Student participated in the discussion, but only briefly, and only answered direct questions that did not involve critical thinking (i.e., only regurgitated information).	MOST. Student participated in the discussion, and though maybe briefly, the student was able to offer a thoughtful idea or opinion that indicated that they were engaged, OR student actively participated but did not listen to other students.	ALL. Student actively participated in the discussion and consistently offered thoughtful ideas or opinions, AND student listened carefully to other students.
Conventions	NONE. Student did not demonstrate critical thinking skills or an understanding of costs and benefits to environmental policy.	SOME. Student demonstrated some critical thinking skills and a basic understanding of costs and benefits to environmental policy.	MOST. Student demonstrated some critical thinking skills and a strong understanding of costs and benefits to environmental policy.	ALL. Student demonstrated strong critical thinking skills and a strong understanding of costs and benefits to environmental policy.

Written Questions Rubric

AREA	1 Does Not Meet Expectations	2 Partially Meets Expectations	3 Meets Expectations	4 Exceeds Expectations
Science Content	NONE. Student does not demonstrate understanding of the causes and effects of harmful algal blooms.	SOME. Student exhibits a basic understanding of causes and effects of harmful algal blooms, but is unclear on specifics.	MOST. Student understands the causes and effects of harmful algal blooms but there is minor confusion between the types of HAB.	ALL. Student fully understands causes and effects of all types of harmful algal blooms.
Use of Scientific Vocabulary	NONE. Student does not use any introduced concept or use scientific vocabulary to form thoughts and narrative.	SOME. Student attempts to use scientific jargon, but fails to use it properly or in context. Shows some mastery of science language, but fails to use effectively.	MOST. Student uses significant scientific jargon, but fails to identify all principles and concepts. Student exhibits some mastery of scientific concepts and vocabulary.	ALL. Student effectively communicates using scientific jargon and vocabulary to convey narrative. Student has achieved mastery of vocabulary and concepts.
Writing Fluency	NONE. Writing flow and errors in sentence structure are multiple, distracting from clear communication and narrative lacks thesis-driven structure	SOME. Writing flow is broken by ill-defined thesis and awkward sentence structure, making narrative hard to follow. Writing lacks sophistication and higher order thought.	MOST. Writing flow is clear and thesis is present. Sentence structure and clear transitions are present.	ALL. Writing flow and thesis are clear and direct. Narrative is easy to follow and author exhibits higher order of thought and understanding of scientific principles.
Completeness	NONE. The majority of questions were not answered completely or at all.	SOME. Most questions were answered, but many were not answered completely OR some questions were not answered.	MOST. All questions were answered, but some answers were not complete or were missing important information.	ALL. All questions were answered and answers were complete, and all important information was present in the writing.