

Oceans on Acid: Studying the Effects of Carbon Dioxide on Ocean Acidification

Sarah Hopper, Washoe Innovations High School
Grade Level – Grades 10-12

Introduction

This lesson introduces students to the concept of ocean acidification and how carbon dioxide is a major factor in the reduction in pH of the oceans. Many students in the major cities have never been to the ocean and do not realize our connectivity to it, and are hundreds of miles away from it. It is imperative for students to understand that local actions can have global impacts. No matter where we live we are dependent on the ocean and its overall well-being. This lesson will serve as a lead-in lesson to aquatic biodiversity.

Content Objectives

Students will be able to:

1. Create an ocean environment and manipulate the acidity to determine the effect of pH on shells (calcium carbonate).
2. Summarize the process of ocean acidification.
3. Brainstorm ways to reduce our carbon emissions.
4. Work with group members to create a presentation on their experimental results.
5. Write a letter using the RAFT writing activity.

Learning Objectives

After completing this unit on ocean acidification, the student will be able to summarize the process of ocean acidification. The learner will develop a general understanding of the impact of carbon dioxide on the earth's oceans. They will become familiar with the issues associated with a decrease in pH and organisms' ability to survive under these conditions. They will also describe how they contribute to ocean acidification and brainstorm ways they can reduce their carbon footprint after completing EPA's "Carbon Footprint Calculator" online activity. They will gain an understanding of the issues associated with a decrease in pH and organisms' ability to survive under these conditions after reading an article on ocean acidification and by relating their use of fossil fuels to those found in the article.

Nevada State Science Standards

Content Standard N12A

Students understand that a variety of communication methods can be used to share scientific information

N.12.A.2 Students know scientists maintain a permanent record of procedures, data, analyses,



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decisions, and understandings of scientific investigations.

N.12.A.4 Students know how to safely conduct an original scientific investigation using appropriate tools and technology.

Content Standard N12B

Students understand the impacts of science and technology in terms of costs and benefits to society.

N.12.B.1 Students know science, technology, and society influenced one another in both positive and negative ways.

Content Standard L12C

Students understand that ecosystems display patterns of organization, change, and stability as a result of the interactions and interdependencies among the living and non-living components of the Earth.

L.12.C.3 Explain responses to environmental change that enhance or reduce the chances of survival among organisms using examples.

L.12.C.2 Describe the factors necessary for organisms to survive and interact with their physical environment.

Materials

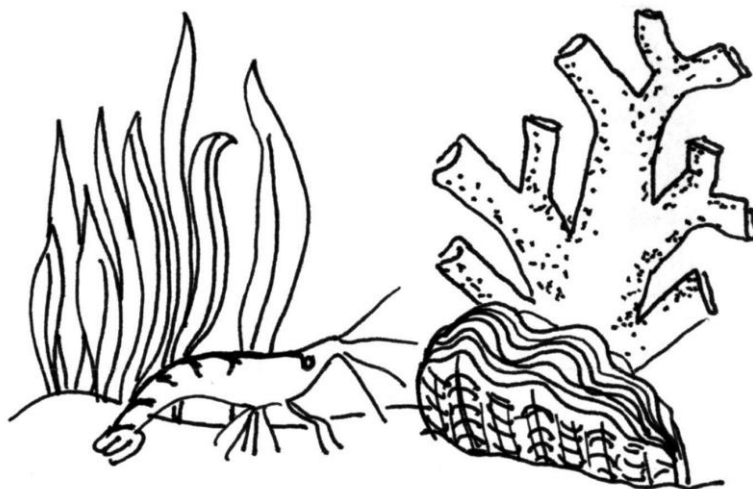
- Pieces of shells, coral, and chicken egg shells (serve as proxy for shells)
- Lemon juice, vinegar, cola, ammonia, water, soap and other household solutions
- pH test strip, pH probe, or red cabbage juice indicator
- A small dish for each sample
- Medicine dropper or plastic pipette
- Scale
- Magnifying lens
- Alkalinity test kit
- CO₂ test kit
- Thermometers

DAY 1: 85 MINUTES

Engagement:

1. Questions

- A. How many of you like seafood? How many of you like seafood such as clams, oysters, fish, or even shrimp?
- B. What if I told you that by burning fossil fuels we are threatening the wellbeing of our oceans and the organisms that live in it? The oceans we know now are not going to be the same as the oceans we know 100 years from now...



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- C. But what if there were things you could do to change the ocean's projected fate? What would you do? What *can* you do?

2. Activities

- **Have students do a quick write in their notebooks to answer the above questions.**
 - ***Introduce ocean acidification topic and show video, ACID TEST: The Global Challenge of Ocean Acidification.***

<http://www.nrdc.org/oceans/acidification/aboutthefilm.asp>

- ***Brainstorm questions to investigate as class***

DAY 2: 85 MINUTES

Engagement:

<http://planetgreen.discovery.com/videos/blue-august-ocean-acidification.html>

Exploration:

1. Students work in groups to complete “Shells and the Impacts of Ocean Acidification” Lab
2. Predict which solution will have a greater impact on dissolution of shell
3. Make observations before, during, and after lab
4. Take various measurements every 10 minutes to see how rapid change occurs.
 - a) Measurements taken: pH of solution, alkalinity tests, CO₂ test, mass of shell, temperature of solution
 - b) Observations taken every 10 minutes until end of class period
5. Informal assessment:
 - a) How are the effects of solution A different from solution B on shells?
 - b) How do you know?
 - c) What do you assume to be true about the effect of pH on your shells?
 - d) What is the connection between ocean acidification and the experiment you are doing right now?

DAY 3: 85 MINUTES

Engagement:

Ocean Acidification: <http://www.youtube.com/watch?v=Wo-bHt1bOsw>

Explanation

1. Briefly cover the process of ocean acidification using PowerPoint Presentation

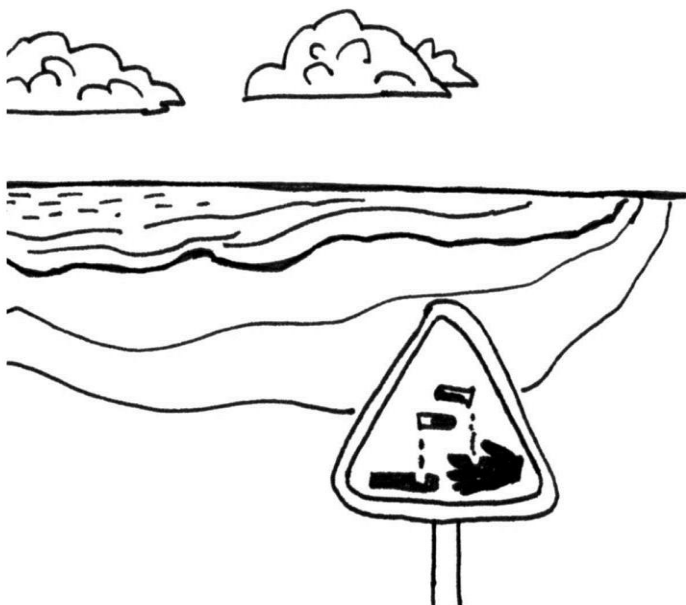


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2. Cover important vocabulary
3. Students will work in groups to create a presentation to give to the class to summarize their observations and discuss their results.
 - Relate experiment to ocean acidification.
4. Hold group discussion and compare results with peers
5. Options for presentation: poster, brochure, or PowerPoint

DAY 4: 85 MINUTES



Extension

1. Students will read the article:
This is your ocean on acid by Brita Bell.
2. Have them relate their fossil fuel consumption to the issues found in the article.
3. Calculate Carbon Footprint for their household.
4. Students will brainstorm ways they can slow the process of ocean acidification by evaluating their own fossil fuel consumption.
5. Record class totals on board.

DAY 5: 85 MINUTES

Review

Teacher will summarize week's learning activities before have students complete RAFT writing activity.

Evaluation

Have students do a RAFT writing activity

1. Role: Clam, Oyster, or Pterapod, (or another fish that is dependent on them for their food source).
2. Audience: Citizens of America.



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3. Format: Letter.
4. Topic: Why they should cut down on CO₂ emissions .

Additional Information

This lesson is best conducted during the general discussion of climate change topics near the end of the school year. It can also be incorporated as an introduction to aquatic biodiversity. The pace of the lesson can be easily adapted for the student population the instructor works with. Since a lot of inner city students struggle with reading and many don't have access to computers outside of class more time should be given to reading activities or implementing technology.

Keep the science of ocean acidification as introductory as possible the first couple of days but on the fourth day there is incorporated an article that does require the reader to have significant understanding of the science behind ocean acidification (though, in essence, it's still very basic). Depending on the level of the students, instructors may wish to choose alternate reading assignments. It can also be done as a read-aloud in some portions and go back and highlight the key points within the article as a whole class because it's imperative to incorporate as much science text as possible even if it is slightly complex.

The other aspect of this lesson that some students may struggle with is the RAFT writing activity. Especially for students that have never had exposure to this style of writing, it is confusing for them. Incorporating more of these writing activities from the beginning of the year would be a good build-up for this more complicated lesson.

The lesson will have a positive impact on how students view their relationship with the ocean even though they don't live by it. This helps tie in the concept of global connectivity when later topics such as sustainability and climate change science are introduced.

Tying in the concept of 'Carbon Footprint', makes students aware of how they are contributing to climate change and brings awareness in how they can reduce their carbon footprint. Encourage them to bring in the items they will need to in order to make this a successful lesson (gas and electric bills, etc...). A beginning can be made on this by doing a preliminary energy use assessment earlier in the year with units on weather, energy or the environment.

Additional Assessment Ideas

The presentation should suffice as a good assessment tool. Having students create posters from which to present increases the differentiation of the assessment. Students can design additional hypotheses and experiments as part of the formal project or for extra credit. Extra credit can also be given for students creating video presentations of the project itself along with their additional experiments complete with results or not.



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Please share your comments about successes with this method with Sarah Hopper, c/o Washoe Innovations High School, 777 W 2nd Street, Reno, Nevada 89503, 775- 333-5150, or by e-mail: Sarah Hopper <shopper@washoeschools.net>

References

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OCEAN ACIDIFICATION SURVEY**Check one:****Name:** __________ **Pre-survey**_____ **Post-survey**

Directions: This survey is both a pre- and post-survey. Put a check mark at the top of this paper next to the survey you are doing (pre- or post-survey). Please answer each question to the best of your ability. Circle the most correct answer.

1. The average concentration of carbon dioxide (CO₂) in the atmosphere has _____ in recent years.

- a. increased
- b. decreased
- c. remained constant

2. When carbon dioxide dissolves in water, it forms a(n) _____.

- a. base
- b. acid
- c. precipitate
- d. metalloid

3. When carbon dioxide dissolves in water, the pH _____.

- a. increases
- b. decreases
- c. stays the same

4. Bread dough rises because yeast in the dough produces _____.

- a. hydrogen (H₂)
- c. carbon dioxide (CO₂)
- d. oxygen (O₂)
- e. nitrogen (N₂)

5. Increasing carbon dioxide (CO₂) in the ocean results in _____.

- a. higher salinity
- b. lower salinity
- c. benefits for reef-building corals
- d. problems for reef-building corals



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6. The pH scale ranges from 0 to 14 and is a measure of how acidic or basic a substance is. Pure water is _____ with a pH of 7. Solutions with a pH less than 7 are _____ while solutions with a pH greater than 7 are _____.

- a. neutral / basic / acidic
- b. acidic / basic / neutral
- c. basic / neutral / acidic
- d. neutral / acidic / basic
- e. acidic / neutral / basic

7. If the pH of a solution changes from 2 to 3, there is a _____ change in acidity.

- a. 1x
- b. 2x
- c. 10x
- d. 20x

8. The salmon fishing industry is a multibillion dollar business that supplies food for a large population of the world. How could ocean acidification affect this industry?

- a. It would not have any impact on the industry
- b. It would increase fishing stocks
- c. It would decrease fishing stocks

9. Please share your opinion and **circle** how you feel about the following statement (question not scored):

Higher levels of carbon dioxide emissions have a negative effect on the ocean environment:

Strongly Disagree

Disagree

Neutral

Agree

Strongly Agree



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