NATIONAL GEOGRAPHIC

RESOURCE LIBRARY
ACTIVITY : 50 MINS

Oceanic Impacts

Students make and evaluate predictions related to increases in global ocean temperatures, sea level rise, and ocean acidification, using evidence from physical demonstrations. They then watch a video to identify the causes and consequences of climate change on the oceans.

CONTENTS
1 PDF, 2 Videos, 1 Link

OVERVIEW

Students make and evaluate predictions related to increases in global ocean temperatures, sea level rise, and ocean acidification, using evidence from physical demonstrations. They then watch a video to identify the causes and consequences of climate change on the oceans.

For the complete activity with media resources, visit:
http://www.nationalgeographic.org/activity/oceanic-impacts/

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DIRECTIONS

This activity is part of the Climate Change Challenge unit.
Introduce the concept of sea level rise with a video and debrief discussion.

- Distribute the *Ocean Impacts* handout.
- Preview with students the two questions in Part A, Sea Level, before showing the video *Global Climate Change Through the Lens of Changing Glaciers* (6:52).

- After viewing the video, solicit volunteers' responses to the questions on the handout.
- Transition to the next step by asking students:

    - *Why might glaciers be melting in Iceland, where M. Jackson works?* (Glaciers here and elsewhere are melting because Earth's atmosphere is warming.)
    - *Do you know of any other effects that carbon dioxide might be having on Earth's oceans?* (Students may or may not have prior knowledge of sea temperature rise or ocean acidification).

Support students as they read to understand the concept of ocean warming.

- Distribute copies of the article *Ocean Warming Explained* to each student.
- Support students as they read and annotate the article in pairs.
- Ask students to respond to the questions in Part B of the *Ocean Impacts* handout, Sea Temperature, as a Think-Pair-Share.
- Prompt students to reflect on the connections between the impacts in Part A and Part B by asking:

    - *How might sea temperature rise contribute to sea level rise?* (Sea temperature rise causes thermal expansion, in which water takes up more space as it heats.)

Initiate a physical demonstration to inform students' hypotheses about ocean acidification.

- Ask: What *are some sources of carbon dioxide in our atmosphere?* (Students will likely name the burning of fossil fuels.)
- Ask*: What is the gas that you exhale in greater concentrations than you breathe in?* (Carbon dioxide. Note that human breath is not a significant contributor to global warming, but it does have a higher percentage of carbon dioxide than the air we breathe in.)
- Initiate a demonstration consisting of two clear-walled containers with identical amounts of water and a pH indicator (see *Setup* for more information on how to conduct this demonstration).

    - Explain that the color of the water comes from a chemical indicator that will show how acidic or basic the water is.
    - Water itself is roughly neutral. When it becomes more acidic (like lemon juice) or more basic (like bleach), the chemical indicator will change to one color or another. Write

these color changes in a visible location. (The type of indicator you choose for this demonstration will determine the colors you mention and record here.)
    - Write the pH scale on the board with the colors of the indicator at different pH values noted for students.

- Record the initial color of the water from both containers in the first row ("Prior to breath") of a chart similar to the one in Part C of the *Ocean Impacts* handout.

    - The colors of this initial reading should match, and indicate that the pH is around 7.

- Ask students to make a prediction and record it in Part C of the *Ocean Impacts* handout:

    - *What is your prediction for how the colors will compare after we breathe carbon dioxide into one container?* (Students' predictions may vary, but should include a statement regarding the relative colors of water in the two containers, and a justification based on their understanding of pH levels and how to interpret indicators.)

- Request a volunteer to blow bubbles through a straw (preferably compostable!) into the "breath" container.

    - They may have to blow for a few seconds, but in less than a minute, the color should change. The color should not change in the "no breath" container if it is left undisturbed.

- Chart the final colors in the "After breath" row, and discuss the complete demonstration with the class, asking students to answer the following questions:

    - *How did the color in the "breath" container change as a student blew bubbles into it? Why did this happen?* (The color changed from x to y when the student blew bubbles into it because the pH became more acidic.)
    - *How do you think the oceans are changing as we add more and more carbon dioxide to the air?* (The oceans are getting more acidic.)
    - *Was your expectation about the colors from earlier correct?* (Students' responses will vary, depending on their initial hypotheses.)
    - Have students reflect on their expectations and again note what they learned from this demonstration. Specifically, in response to the: *How did the data prove or disprove your expectation?* prompt in the *Ocean Impacts* handout.

- Look for novel incorporation of information related to ocean acidification under global warming as students revise their understanding.

Support students as they identify causes and consequences of climate change on the oceans.

- As a class, review the three main elements of climate change impacts on the oceans (sea level rise, sea temperature rise, and ocean acidification) and ask students to brainstorm together some possible consequences of these impacts.
- Explain that the video *Climate 101: Oceans* (2:38) will illuminate these three phenomena in detail. Show the video and prompt students to take notes as they watch in Part D, Causes and Consequences, for the *Ocean Impacts* handout.
- Revisit the class *Know and Need to Know* chart, adding any new insights or questions regarding the impacts of climate change on the oceans.

Modification

Step 3: If time and supplies are available, you can conduct the ocean acidification demonstration in this activity as a lab. As a lab, students manipulate the setup and collect data in pairs or small groups, rather than as a class. If supplies for the demonstration are not available, students can still collect data on this phenomenon by watching an online video of *Bromothymol Blue Respiratory Physiology Experiment* (2:52) changing color after exposure to breath.

Tip

Step 3: If you need to introduce the concept of pH to students, this *NOAA resource* has a helpful chart with common examples of materials at different pH values.

Tip

Step 3: Student misconceptions may arise unless it is clear that human breath is not a significant contributor to global warming. However, it does have a higher percentage of carbon dioxide than the air we breathe in. In this demonstration, breathing into the water is simply a proxy for the addition of carbon dioxide to oceans from carbon sources.

Informal Assessment

Informally assess students' developing understanding of sea level rise, sea temperature rise, and ocean acidification by examining their *Ocean Impacts* handout.

Extending the Learning

Step 3: If time is available, you may wish to involve students in preparation for the demonstrations of changing ocean conditions.

OBJECTIVES

Subjects & Disciplines

Learning Objectives

Students will:

- Generate and evaluate predictions related to global warming and climate change's impacts on oceans.
- Identify causes and consequences of global warming and climate change on the oceans.

Teaching Approach

- Project-based learning

Teaching Methods

- Demonstrations
- Discussions
- Inquiry

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Information, Media, and Technology Skills

    - Information, Communications, and Technology Literacy
  - Learning and Innovation Skills
    - Critical Thinking and Problem Solving
  - Life and Career Skills
    - Flexibility and Adaptability
- 21st Century Themes
  - Environmental Literacy
  - Global Awareness
- Critical Thinking Skills
  - Analyzing
  - Applying
  - Evaluating
  - Understanding
- Science and Engineering Practices
  - Constructing explanations (for science) and designing solutions (for engineering)
  - Engaging in argument from evidence

National Standards, Principles, and Practices

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

• **CCSS.ELA-LITERACY.RST.6-8.7:**
Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

NEXT GENERATION SCIENCE STANDARDS

• **Crosscutting Concept 2: Cause and Effect:**
Cause and effect relationships may be used to predict phenomena in natural or designed systems.
• **MS-ESS2-6:**
Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.
• **Science and Engineering Practice 2:**
Developing and using models
• **Science and Engineering Practice 6:**

Constructing explanations and designing solutions

Preparation

What You'll Need

MATERIALS YOU PROVIDE

- Paper cups
- Bromothymol blue (10 drops) in water or red cabbage juice
- straws

REQUIRED TECHNOLOGY

- Internet Access: Required
- Tech Setup: 1 computer per classroom, Monitor/screen, Projector, Speakers

PHYSICAL SPACE

- Classroom

SETUP

Step 3: For the ocean acidification demonstration, you may wish to use bromothymol blue (a commercially available pH indicator) or red cabbage indicator (the water from ½ of a red cabbage head boiled for 1 minute in enough water to cover). If using bromothymol blue, place ~5 drops of this chemical into two cups with 25 mL of water in each. Label one cup "breath" and the other cup "no breath." As a volunteer blows bubbles through a straw into the "breath" container (remind them not to drink this!), the solution will slowly grow more acidic, turning from blue to green and then yellow. If using red cabbage indicator, similarly label one cup with 25mL of indicator "breath" and the other cup with 25mL of indicator "no breath." As a volunteer blows bubbles through a straw into the "breath" container, the solution will turn from bluish purple to pink. Volunteers may pause as needed during their bubble blowing, and the readings for both indicators should be taken after the solution stops changing color for approximately 20 seconds.

GROUPING

- Large-group instruction

- Large-group learning
- Small-group learning
- Small-group work

BACKGROUND & VOCABULARY

Background Information

Climate change is having a variety of impacts on the world's oceans. Globally, the sea level is rising, the ocean temperature is increasing, and the pH of water is dropping, or becoming more acidic. These effects combined can result in challenges to the Earth's marine ecosystems, as well as danger to humans.

Currents carry the Earth's ocean water around the planet, moving it between the five major basins, the Atlantic, Pacific, Arctic, Indian, and Southern oceans. These currents are driven by factors such as density differences, wind, and gravitational attraction. Ocean currents are also responsible for determining local weather patterns, even over dry land.

Prior Knowledge

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Recommended Prior Activities

- Carbon All Around
- Global Trends
- Heating Up
- Local Emissions
- Meteorological Models
- Now and Then
- Our Greenhouse
- Plot It!
- Weather Interconnections
- Weather, Meet Climate

Vocabulary

Term	Part of Speech	Definition
carbon dioxide	*noun*	greenhouse gas produced by animals during respiration and used by plants during photosynthesis. Carbon dioxide is also the byproduct of burning fossil fuels.
climate change	*noun*	gradual changes in all the interconnected weather elements on our planet.
global warming	*noun*	increase in the average temperature of the Earth's air and oceans.
ocean acidification	*noun*	decrease in the ocean's pH levels, caused primarily by increased carbon dioxide. Ocean acidification threatens corals and shellfish.
pH	*noun*	measure of a substance's acid or basic composition. Distilled water is neutral, a 7 on the pH scale. Acids are below 7, and bases are above.
sea level	*noun*	base level for measuring elevations. Sea level is determined by measurements taken over a 19-year cycle.
temperature	*noun*	degree of hotness or coldness measured by a thermometer with a numerical scale.

For Further Exploration

Instructional Content

- National Geographic: Resource Library: Collection: Climate Change
- National Geographic: Resource Library: Collection: Climate
- National Geographic: Resource Library: Collection: Catastrophic Weather Events
- National Geographic: Resource Library: Collection: Weather