

**Summary**

**Grade Level: 10 - 12**

**Teaching Time: Three 40  
minute periods**

**Activity:**

- **Design an investigation using real data to examine a hypothesis.**
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**Objective**

Students will design an investigation into ocean acidification using real data on conditions in the Caribbean study area. Students will use this real data to try to answer a research question of their choosing. In reporting the outcome of their research, students must state what they have learned from the investigation, and use their findings to evaluate, explain, and prove (or disprove) their hypothesis.

**Background**

Coral reefs are the foundation for complex food webs. Abundant algae, sponges, coral, and other invertebrates form the base of the web. Small fish feed along the reef and are, in turn, eaten by larger predatory fish. The coral reefs also protect and support nearby ecosystems, such as mangrove and sea grass ecosystems.

Ocean acidification is one of many threats to coral reefs and their associated, fragile ecosystems. There are other threats to coral reefs associated with global climate change. Rising sea surface temperatures negatively affect coral reefs, as well as lead to rising sea levels. Warmer ocean water also means more storms as well as storms with increased intensity. These storms cause physical damage to the coral reefs. Increased water temperature can cause coral bleaching and stress-related disease, which also decrease the coral's viability. These threats are in addition to other human-caused threats to coral reef ecosystems, such as pollution, overfishing, and runoff from cities and agriculture.

In this activity, students should be encouraged to develop their own research questions and hypotheses. Here is one example:

**Research question:**

Does bicarbonate ion form at the same rate as carbonate ion concentration and aragonite saturation in sea water?

**Possible hypothesis:**

Bicarbonate ion concentration increases as carbonate ion concentration and aragonite saturation levels decrease over time.

## Materials

- Copies of Student Master, Design Your Own Investigation
  - Copies of Student Master, Data Log Sheet
  - Student access to computers with Internet connection
  - Spreadsheet software (optional)
  - Graph paper
  - Ruler
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## Procedure

This activity challenges students to think like scientists by designing a scientific investigation in which data collection and analysis are important parts of the process. Students are asked to use the scientific method, using real data to solve a problem.

1. Students may work individually or in teams of two. Give each student or team a copy of the Student Master, Design Your Own Investigation and the Student Master, Data Log Sheet.
2. Guide student selection of a research question (or have them make up their own) that is appropriate to their academic experience. Review your students' research question choices. You may find it useful to have multiple students/teams exploring the same research question using different or even the same hypotheses.
3. Next, have students develop a plan for designing a research project that will answer their research question. The plan should include: 1) the research question; 2) a testable hypothesis that addresses the research question; 3) a list of additional information needed; and 4) a list of the data that will be collected.

4. Check each research project plan before students begin to make sure that the project aligns with the research question and that the hypothesis is testable using the data resources available. Will your students be able to support or disprove their hypothesis using the data available to them?
5. Students will need to access the Internet to generate and save data maps and graphs. Depending on the setting, this can be done in a computer lab or assigned as homework, assuming your students have access to the Internet at home, at a library, or in a computer center.
6. If students are using spreadsheet software, they may need guidance on setting up their spreadsheet and graphs. Show students that they can get raw data online to use in their spreadsheet by choosing “Data file for spreadsheet” under “Select an output format.”
7. After students complete their research, provide time for them to present their findings to the class.
8. Use student presentations as an opportunity to relate their investigations about ocean acidification to current news and debate about global climate change. Ask: *From your own experience looking at real data, how do you view the question ocean acidification? Is ocean acidification a real problem? Are global climate change and ocean acidification related? Can ocean acidification be addressed without addressing global climate change?* This discussion can form the basis of an extension activity in which students explore the political and social implications of ocean acidification.

## Student Master

# Research Project: Design Your Own Investigation

The oceans' water is normally slightly basic/alkaline. Ocean acidification is the process by which the oceans' pH is lowered (made less alkaline) due to increased amounts of carbon dioxide entering seawater from the atmosphere. As atmospheric carbon dioxide levels continue to increase, the ocean becomes less alkaline. While the water in Earth's oceans will never become truly acidic (or even neutral), the decreased alkalinity threatens marine ecosystem more with each passing year.

You have used real data to begin to understand the phenomenon of ocean acidification, but there is still a lot you can learn from exploring the data. Using what you have learned, develop a research project about ocean acidification. Here are the steps to follow:

### Planning your project:

- 1. Develop a research question. Then form a hypothesis to investigate that helps answer that research question.**

Research Question:

Hypothesis:

- 2. Design a plan to test your hypothesis and answer the research question.**

What do you need?

- a) More information:
- b) Specific data:

- 3. Go online and get the data.**

- a) Visit [www.dataintheclassroom.org](http://www.dataintheclassroom.org), and find the Ocean Acidification module.
- b) Follow the link to "Get Data."
- c) Using the form, select the data and parameters you wish to look at.
- d) Click the "Get Data" button.

- 4. Use the Data Log Sheet to keep a record of the data you select so you can refer to it later.**

Remember to save or print maps and graphs so that they can be used later for data analysis and then shown to your classmates when you present your findings.

- 5. Analyze the data.**

- 6. Draw conclusions.**

**Student Master**

**Data Log Sheet**

As you use the online data access form to select data about conditions affecting reefs in the Caribbean study area, keep a record of the parameters you select on this data log sheet. Your data log will help you remember and keep track of the data you have looked at. Consider whether each new piece of data helps support or disprove your hypothesis.

	<b>Data set</b>	<b>Map or graph?</b>	<b>Region</b>	<b>Date(s)</b>	<b>Notes</b>