Discovering Life Below the Seafloor: An Introduction to how science works and the Science Flowchart

Background

Students describe what science is, then complete a simple "warm up" activity that helps them identify elements of science. Students highlight these elements in a reading about a marine microbial biochemist named Beth Orcutt to learn how she conducted her science. Students are then introduced to the Science Flowchart and plot the steps Beth took to see an example of how science is a non-linear process that involves creativity, new invention, collaboration, and more. Finally, students explore *How Science Works – Discovering Life Below the Seafloor* poster.

This activity is adapted from *http://undsci.berkeley.edu/lessons/introducing_flow_hs.html.*

Lesson concepts

- The process of science involves testing ideas about the natural world with data from the natural world.
- Scientific understanding improves as new evidence and perspectives emerge.
- The process of science is non-linear.
- The process of science involves observation, exploration, discovery, testing, communication, and application.
- Scientists test their ideas using multiple lines of evidence.
- Test results sometimes cause scientists to revise their hypotheses.
- Scientists are creative and curious.
- Scientists work together and share their ideas.

National Science Education Standards

- Science as Inquiry
- History and Nature of Science
- Life Science – Diversity and Adaptations of Organisms
- Earth Science – Structure of the Earth System

Ocean Literacy Principles

- The ocean supports a great diversity of life and ecosystems.
- The ocean is largely unexplored.

Grade span: 6–13

Time: One 90-minute class period

Materials

- Index Cards – *one per student*
- Introduction to Science activity such as:

  Mystery Tubes: *http://undsci.berkeley.edu/lessons/mystery_tubes.html*

  Mystery Boxes: *www.indiana.edu/~ensiweb/lessons/mys.box.html*

  The Great Fossil Find: *www.indiana.edu/~ensiweb/lessons/gr.fs.fd.html*

  Checks Lab: *www.indiana.edu/~ensiweb/lessons/chec.lab.html*
- Copies of Reading: Discovering Life Below the Seafloor – *one per student*
- Copies of the simple version How Science Works Flow Chart – *one per student*
- Highlighters – *one per student*
- Copies of the detailed version How Science Works – *one per student*
- How Science Works – Discovering Life Below the Seafloor Poster

Procedure

1. Have students record on a 3 × 5-inch card their response to the question "What is science?" Cards should then be set aside.
2. Select one of the recommended Introduction to Science activities listed above to use with students. At the close of the activity, ask students *Were you doing science?* Discuss responses, then as a class record descriptions of what they did that indicated they were doing science, for example, *ask questions, make hypotheses, work together*. These phrases should be prominently displayed so they can be referred to later.
3. Pass out *Discovering Life Below the Seafloor*. As students read the passage, they should look for evidence that Beth was doing science.
4. Ask students *Was Beth Orcutt doing science? How do you know?* With a partner, students should go through the reading again and highlight all of the words or phrases that indicate Beth was doing science. Students should also document the sequence by placing #1 in the margin next to the first set of words they highlighted, #2 next to the second set of words, etc. This will help students keep track of the order in which Beth proceeded.
5. Hand out the simple *How Science Works Flow Chart*. Explain to students that this is one way to depict the process of science. Discuss briefly their first impressions. Ask students to identify at least one thing that they highlighted in Beth's story that might fit in Explorations and Discovery. Repeat for *Testing Ideas, Community Analysis and Feedback, and Benefits and Outcomes*.
6. Suggest that they highlighted quite a number of phrases within the story and that science is complex. Pass out a copy of How Science Works – The Process to each student. Go through each section with the students.
7. Have students return to Beth Orcutt's story and their numbering. Ask students to place each of the numbers in the correct place on the Flow Chart. You may want to get them started. For instance, you may write "1" on the arrows moving into Exploration and Discovery because Beth's love for chemistry and curiosity inspired her to become a scientist. Let students know that it is OK if their interpretations differ from other students.
8. Once students have placed all of the numbers where they think they belong, have them connect the numbers with arrows. The resulting pathway reflects the scientific journey of Beth Orcutt. Ask the students if all of their pathways were the same. Why not? *Do you think that the pathway of all scientists would be the same? Why not?* Emphasize to students that there is no single "correct" path through science or a single "correct" way to chart a path. Many of the paths are just the beginning of much work to be done in the future.
9. In the boxes to the right of the flow chart, have students write or draw relevant and/or interesting details about the process that Beth experienced, what she learned, and what is in store for the future.
10. Ask students to return to their original definitions of science they wrote on their notecards. Would they now make any changes? Discuss.
11. Students can also explore the *How Science Works – Discovering Life Below the Seafloor* poster to see Beth in action.

Reflection Ideas

- Discuss how the Science Flow Chart differs from the Scientific Method that we tend to see in most textbooks.
- Have students review a lab they completed earlier in the year, and then trace the pathway they took.

Extensions and Related Resources

- Visit the *JOIDES Resolution* website (*www.joidesresolution.org*) to read scientist blogs and view videos about more science being conducted on the research vessel.
- Visit the Center for Dark Energy Biosphere Investigations (*www.darkenergybiosphere.org/*) to learn more about microbial research taking place below the seafloor.
- Have students learn one method for identifying microbial diversity using the *Tagging a Microbe* activity (*www.oceanleadership.org/education/deep-earth-academy/educators/classroom-activities/grades-9-12/tagging-a-microbe/*).
- Visit Understanding Science website for more information and other activities for teaching how science works (*http://undsci.berkeley.edu*).

Author

Jennifer Collins, Deep Earth Academy. Adapted from "Introducing the Understanding Science Flowchart," written by Deb Farkas, Stan Hitomi, and Judy Scotchmoor at *undsci.berkeley.edu/lessons/introducing_flow_hs.html*.