Temperature and Deep Ocean Circulation

http://topex-www.jpl.nasa.gov/education/activities/ts1siac1.pdf

Focus on Inquiry

The student will make predictions on the cause of ocean currents and develop models to aid in explanations on the role temperature plays in deep ocean currents.

Lesson Overview

Deep ocean currents are caused by differences in water temperature and salinity (density). In this experiment, the students will hypothesize the cause of ocean currents and then develop a model to help explain the role that temperature plays in deep ocean currents.

Duration	Setting	Grouping	PTI Inquiry Subskills
60 minutes	Classroom or lab	Cooperative groups of 4 students	1.3, 5.3, 5.8, 7.2

Lesson Components	Estimated Time	Inquiry Subskills Used	Technology Used	Level of Student Engagement	Brief Description
Engage	5 min	1.3	None	3	Students look at images and write hypotheses that explain what causes these surface currents.
Explore	20 min	1.3, 5.8	None	3	Students create a model of the Earth's ocean and make hypotheses.
Explain	10 min	5.3	None	3	Students explain their answers based on their observations.
Expand	10 min	7.2	None	2	Students discuss thermohaline circulation and explain their evidence and observations.
Evaluate	15 min	5.3	None	3	Students compare maps to see the difference between current flow directions and ocean topography in the northern and southern hemispheres.

Level of Student Engagement

1	Low	Listen to lecture, observe the teacher, individual reading, teacher demonstration, teacher-centered instruction
2	Moderate	Raise questions, lecture with discussion, record data, make predictions, technology interaction with assistance
3	High	Hands-on activity or inquiry; critique others, draw conclusions, make connections, problem-solve, student-centered

National Science Education Standards – Inquiry

Identify questions that can be answered through scientific investigations.
Think critically and logically to make the relationships between evidence and explanations.
Communicate scientific procedures and explanations.

National Science Education Standards – Earth Science

Global patterns of atmospheric movement influence local weather. Oceans have a major effect on climate, because water in the oceans holds a large amount of heat.

Louisiana Grade Level Expectations – Inquiry

Gr. 8, Inquiry GLE#14 - Develop models to illustrate or explain conclusions reached through investigation (SI-M-A5)
Gr. 8, Inquiry GLE#16 - Use evidence to make inferences and predict trends (SI-M-A5)
Gr. 8, Inquiry GLE#22 - Use evidence and observations to explain and communicate the results of investigations (SI-M-A7)

Louisiana Grade Level Expectations Earth Science

Gr. 8, GLE#25 - Explain and give examples of how climatic conditions on Earth are affected by the proximity of water (ESS-M-A11)

Materials List

- Approximately 9 X 13 X 3 glass dish
- Tap water

- Hot tap water
- Small waterproof plastic bags
- 2 clothes pins (or small clamps)
- 2 different colors of food coloring
- Eyedroppers
- Rock
- Ice cubes or chemical cold pack
- Map of deep ocean currents
- Map of sea surface temperatures

Advance Preparation

1. Print the activity instructions from the activity website.
2. Gather materials necessary to complete lab.
3. Set up one station per group.
4. Provide each group with a check list or supplies and copy of procedure.

Other Information

Objectives

The learner will:

- hypothesize the cause of ocean currents.
- develop a model to explain the role temperature plays in deep ocean currents.

Prior Knowledge Needed by the Students

- None

Procedure

Engage

1. Use the "Engagement" section on the activity website.

Explore

1. Follow the "Activity" section on the activity website.

Explain

1. Students answer questions on handout while completing the activity.
2. Through class discussion, have students explain their answers to step 6 in the Explore section. Make sure that students understand the model they developed did not change the water's salinity.

Expand

1. Challenge the students to explain what would happen if the cold water were saltier.
2. Explain the term thermohaline circulation (when colder, saltier water sinks and displaces water that is warmer and less dense).
3. Ask the students to explain where warm water from the equator flows and what happens to colder denser water from the poles.
4. Explain the term global conveyor belt. (The global conveyor belt is responsible for regulating climate as it transports heat from the equatorial regions to polar regions of Earth. The full cycle can take a thousand years to complete.) Additional resources can be found on website to assist with explaining concepts to students.

Evaluate

1. Have students look at the world maps of geostrophic ocean currents and dynamic ocean topography at the same time (figs. 3 and 4). By studying these maps together, they should develop an understanding of how currents move around highs and lows of dynamic ocean topography. After they have compared these maps, can they see a difference between current

flow directions and ocean topography in the northern vs. the southern hemisphere? Can they explain why this difference might exist?

2. Students can also complete the ***Salinity and Deep Ocean Circulation Activity*** (found on the website). This will help them to understand that deep ocean currents are caused by both density and temperature.

Blackline Master

Student Handout is available on activity website.