Galapagos Rift Expedition

Designing Tools for Ocean Exploration

Focus
Ocean Exploration

Grade Level
9-12

Focus Question
What types of tools and technology are used in ocean exploration?

Learning Objectives
Students will understand the complexity of ocean exploration.

Students will understand the technological applications and capabilities required for ocean exploration.

Students will understand the importance of teamwork in scientific research projects.

Students will develop abilities necessary to do scientific inquiry.

Adaptations for Deaf Students
- Teacher performs duties of Chief Scientist as well as captain. This eliminates the need for the mission log.
- All students work in one group and perform all samples
- Pre-teach vocabulary
- Chief Scientist prepares dive schedule and grid prior to beginning of lesson
- Lesson will require three days

Materials
Simulated Ocean (per class)
- ❐ 1 Container - (Garbage Can or Tupperware Container or Cooler (Min. 12" Deep and 2 feet by 2 feet square)
- ❐ 1 Sampling Grid the size of container (mark on the edges of the container as shown below to make the borders of the grid)
- ❐ Sand/Rocks/Gravel/Bricks – mixed together and place in the bottom of the container enough to cover the bottom to about 2-3 inches deep)
- ❐ Water (add salt if desired) - enough to fill the container to several inches from the top
- ❐ 3 bottles of dark food coloring - (at least three colors to make water dark)

Bottom-dwelling "Organisms" (per class)
- ❐ 10 - 20 "simulated clams" - buttons, pennies, or tinfoil (rolled into a ball the size of a pea)
- ❐ 10 - 20 "simulated worms" - wire, fishing line, small springs 1-2 inches in length
- ❐ 20 - 40 "simulated crustaceans" - rice, beans
- ❐ 1 bottle "simulated foraminiferans" – glitter or small beads

Supplies to Make Ocean Exploration Tools * (per class)
- ❐ 1 roll of wire
- ❐ 1 roll of fishing line
- ❐ 1 pair of panty hose
- ❐ 1 box of washers
- ❐ 3 garden hose sections
- ❐ 15 fishing weights
- ❐ 10 paper cups

❒ 1 box of paper clips
❒ 3 PVC pipe 1" diameter x 6" long sections
❒ 1 box plastic or paper straws
❒ 1 roll of duct tape
❒ 3 - 6 plastic soda bottles (20 oz.)
❒ 3 - 6 magnets
❒ 1 roll of string
❒ 10 toilet paper or paper towel rolls
❒ 3 - 6 pens/pencils
❒ 3 - 6 pair of scissors
❒ 10 corks
❒ 10 film containers
❒ 3 bottles of glue/rubber cement

** You may add or delete materials. These are suggestions of items that can be used by students to design sampling tools.*

Printed Materials - See attachments
❒ 3 - 6 copies of Mission Statement
❒ 3 - 6 copies of Chain of Command
❒ 1 copy of Job Description Cards
❒ 1 copy of Mission Log
❒ 3 - 6 copies of Dive log
❒ 1 copy of Dive Schedule
❒ Overhead of Chain of Command diagram

Audio/Visual Equipment
❒ Overhead projector

Teaching Time
Two 45-minute periods

Seating Arrangement
Cooperative groups of three to five

Maximum Number of Students
30 students

Key Words
Chief Scientist
Principal Investigator (PI)
Technician
Chain of Command
Mission
Mission Log
Dive Log
Core Sample
Sediment
Submersible
Topography
Species
Exploration
Deployment
Retrieval
Sample
Grid
Foraminiferans
Crustaceans
Infauna
Interstitial water
Diversity
Habitat
Biotechnology

Background Information
How did the ocean form? Where does it get its power? Why is it blue, brown, or green? What is living in it? Why do marine plants and animals look the way they do? What do they eat and where do they come from? Why do marine organisms change color and shape as they grow? How do they protect themselves? How do they reproduce and what do their young look like? Certainly these are some of the questions asked thousands of years ago before explorers had access to what we consider, at best, extremely primitive instrumentation and ocean-going vessels.

Today, we have sophisticated technological capabilities that have made the ocean more "visible" and more accessible than it has ever been before. As a result of "new technological eyes," hundreds of new species and new ecosystems have been discovered—some of which may hold the keys to the origin of life on Earth, cures to life-threatening diseases, and knowledge about presently-unknown metabolic pathways for obtaining and using energy to support life here on Earth.

Even though we live on an Ocean Planet, approximately two-thirds of which is covered by water, approximately 95% of the ocean remains unexplored. Recent progress in technology permits us to completely rethink how we conduct exploration and oceanographic studies. Developments in biotechnology, sensors, telemetry, power sources, microcomputers, and materials science now permit the U.S. to dream of rivaling space exploration and our ability to go to and study the undersea frontier. We need not be limited by weather and blind sampling from ships, but like the true explorers, can immerse ourselves in new places and events. The great challenge is getting to the frontier. Once there, we can use many of the same tools and technologies used by scientists studying terrestrial habitats.

Learning Procedure

Day 1: *The activities of Day 1 are to choose the Investigation Teams, to design the sampling tools and to test the sampling tools in the Simulated Ocean.*

Pre-class Teacher Set Up:

Set Up Simulated Ocean

1. Arrange sand, rocks, gravel, and/or bricks on the bottom of the container to create "bottom topography."
2. Arrange "critters" on the bottom and in the sand.
3. Slowly add water, leaving several inches open at top.
4. Mix three colors of food coloring to make the water dark so students cannot see the bottom.

Set Up Ocean Exploration Supplies

1. Divide supplies for making ocean exploration tools into 3 groups. Each group of students should have a wide variety of materials to use, however they may not use all of these supplies. Place material into a box or on a tray to give to each Chief Scientist.

Procedure:

1. Choose Chief Scientist.
2. Create groups of three to five students. One student in each group will be the Principal Investigator. One group will sample and study infauna, one group will sample and study sediments, and one group will sample and study water. Each group will first design and test sampling tools for their specific subject of interest.
3. Hand out and review Science Mission Statement
4. Hand out and review Chain of Command worksheet
5. Hand out Job Description Cards to each group
6. Students perform their specific jobs.

a. Each Principal Investigator leads his/her team in the development of a Team Name.

b. Captain (teacher) hands out ocean exploration supplies to the Chief Scientist, who should distribute the materials to each Principal Investigator.

c. The Chief Scientist describes exploration supplies to the Principal Investigators.

d. The Principal Investigators and Technicians assemble materials to make exploration tools for data collection. There are many materials from which students can choose to design the sampling tools. Tools should be designed and then tested in the Simulated Ocean. The Principal Investigator must get permission from the Chief Scientist to perform the tests.

e. The Chief Scientist develops the dive plan and grid scheme for each Principal Investigator. This information is then written onto the Dive Schedule sheet. The Chief Scientist must decide in which grids each group will sample and decides when the different groups can sample. The actual sampling will most likely be carried out on the second day of the activity. The Chief Scientist will announce the dive plan at the Science Team Meeting at the beginning of the second day. The Captain (teacher) should remind the Chief Scientist that each group should collect several samples from various grid locations within the Simulated Ocean.

Day 2:

Teacher Set Up:

Simulated Ocean should still be set up from the previous day. Student sampling tools should be ready to use to collect actual samples.

Procedure:

1. Students perform specific jobs for the day.
   a. Have a Science Team Meeting (whole class) where the Chief Scientist announces the dive plan for the day and shows the Dive Schedule. Each team is assigned grids and times in which to collect their samples.
   b. Each Principal Investigator executes their Mission. Each Team should report to the Simulated Ocean at the assigned times with their sampling tools and with a container in which to store their samples. Teams should analyze their collected samples. The Principal Investigator for each group is responsible for completing the Dive Log for his/her Team. This Dive Log is then given to the Chief Scientist.
   c. The Chief Scientist may adjust the dive schedule as necessary.
   d. Have a Science Team Meeting where each Principal Investigator reports the findings of the day.
   e. The Chief Scientist compiles the Dive Logs into one final report called the Mission Log. These reports are all then turned over to the Captain.

The BRIDGE Connection

www.vims.edu/bridge/technology.html

Learn more about ocean technology by going to the BRIDGE Website and highlighting "Technology." Learn about the submersible ALVIN, watch a video about students building a Remotely Operated Vehicle, learn about the underwater habitat Aquarius and more.

The "Me" Connection

Ask students to investigate career opportunities as ocean explorers, ocean scientists, and others whose careers support ocean science research and exploration, such as technicians, ocean engineers, and research vessel crew members.

Connection to Other Subjects

Mathematics
Language Arts
Art/Design

Evaluations

Students will write a paragraph summarizing what they learned, including a list of other equipment that might have made the mission more successful.

The teacher will review each group's Dive Log handed in by the Chief Scientists.

Extensions

- Ask students to write a story describing a day on a research vessel, including themselves in the crew.
- Ask students to investigate significant events from the past in ocean exploration.
- Ask students to act as if they were the pilots operating a deep sea submersible.
- Ask students to create a "survival kit" for a deep-sea mission.
- Ask students to investigate technologies of the past used in previous ocean exploration initiatives.
- Visit the Ocean Exploration Web Site at www.oceanexplorer.noaa.gov
- Visit the National Marine Sanctuaries web page for a GIS fly-through of the Channel Islands National Marine Sanctuary at http://www.cinms.nos.noaa.gov/

National Science Education Standards

Science as Inquiry - Content Standard A:

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Earth and Space Science – Content Standard D
- Structure of the Earth system

Science and Technology – Content Standard E:
- Abilities of technological design
- Understandings about science and technology

Science in Personal & Social Perspectives – Content Standard F:
- Risks and benefits
- Science and technology in society

History and Nature of Science – Content Standard G:
- Science as a human endeavor
- Nature of science
- History of science

For More Information

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http://oceanexplorer.noaa.gov

Student Handout

Mission Statement

We are on a scientific mission in Hydrographers' Canyon. The Chief Scientist's proposal is to sample the sediment type, infauna, and water in the axis of Hydrographers' Canyon. The purpose of this is to study species and habitat diversity in the area. To accomplish this, the Principal Investigators, with the assistance of their Technicians, will be taking core and water samples. The water depth is greater than 2,000 meters, the topography is rugged, and we wish to sample microhabitats; including mounds, burrows, and wave features. As such, your core samples will be taken from an occupied submersible.

Student Handout

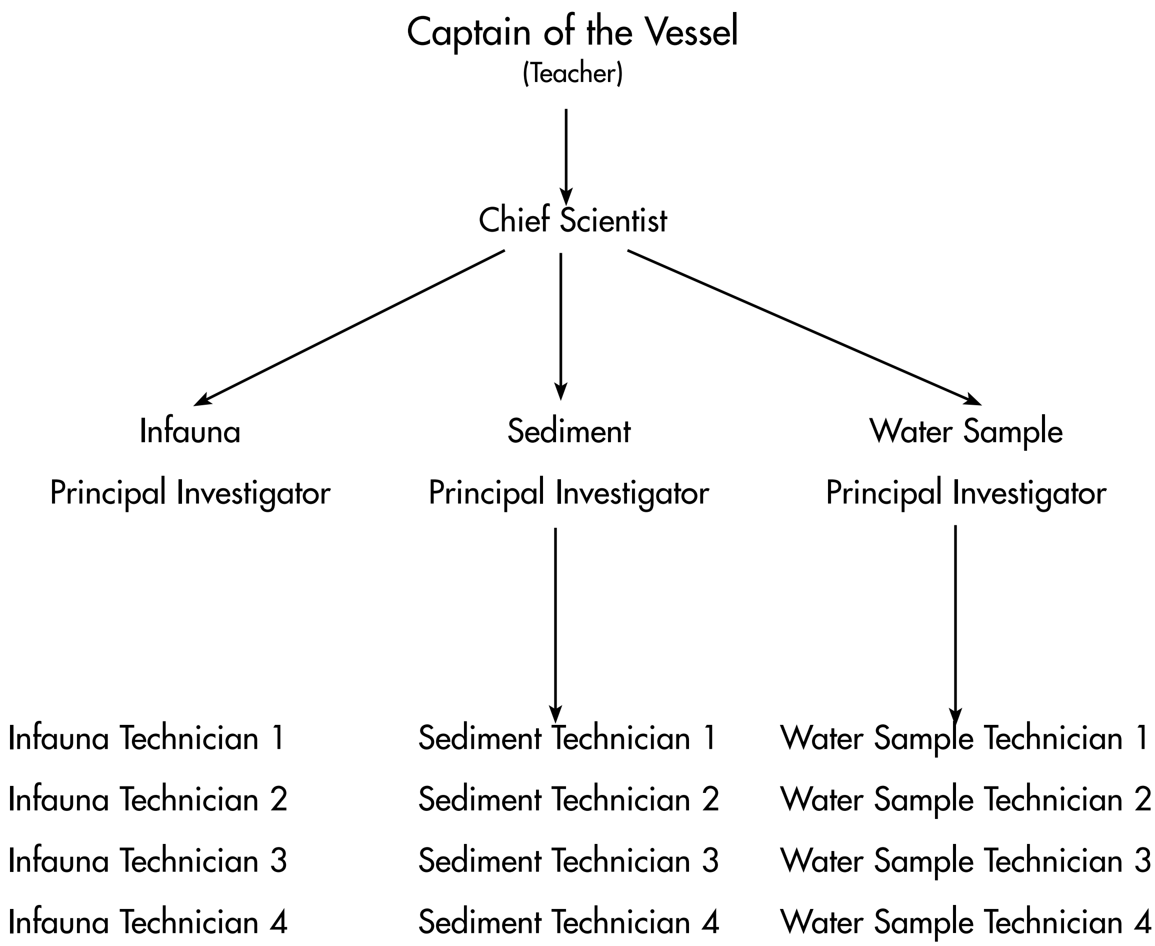
Dive Schedule

To be completed by the Chief Scientist

Team/PI Name	Date and Time	Grid Location

Student Handout

Chain of Command



Note to Teacher:
Divide the class evenly among the three Technician groups once you have determined the Chief Scientist and the Principal Investigators.

Student Handout

Chief Scientist

- Serves as principal spokesperson for all scientists on board the vessel
- Responsible for assuring completion of research mission
- Responsible for dive schedule
- Responsible for personnel assignments
- Responsible for creating grid for dive site
- Responsible for overseeing activities at the dive site
- Responsible for compiling all Dive logs
- Responsible for completing Mission log

Infauna Principal Investigator (Infauna PI)

- Serves as main person for execution of mission to gather infaunal samples
- Responsible for completing dive log
- Responsible for obtaining supplies necessary for development of exploration tools
- Responsible for overseeing development of exploration tools
- Responsible for obtaining dive log from Chief Scientist
- Responsible for overseeing the deployment of exploration tools

Infauna Technician

- Serves as main person for construction of exploration tools for infauna extraction
- Serves as main person for deployment and retrieval of exploration tools
- Responsible for storing collected samples

Infauna Technician 1

- Serves as main person for construction of exploration tools for infauna extraction
- Serves as main person for deployment and retrieval of exploration tools
- Responsible for storing collected samples

Student Handout

Infauna Technician 2

- Serves as main person for construction of exploration tools for infauna extraction
- Serves as main person for deployment and retrieval of exploration tools
- Responsible for storing collected sample

Sediment Principal Investigator (Sediment PI)

- Serves as main person for execution of mission to gather sediment samples
- Responsible for completing dive log
- Responsible for obtaining supplies necessary for development of exploration tools
- Responsible for overseeing development of exploration tools
- Responsible for obtaining dive log from Chief Scientist
- Responsible for overseeing the deployment of exploration tools

Sediment Technician 1

- Serves as main person for construction of exploration tools for sediment extraction
- Serves as main person for deployment and retrieval of exploration tools
- Responsible for storing collected sample

Sediment Technician 2

- Serves as main person for construction of exploration tools for sediment extraction
- Serves as main person for deployment and retrieval of exploration tools
- Responsible for storing collected sample

Sediment Technician 3

- Serves as main person for construction of exploration tools for sediment extraction
- Serves as main person for deployment and retrieval of exploration tools
- Responsible for storing collected sample

Student Handout

Water Sample Principal Investigator (Water Sample PI)

- Serves as main person for execution of mission to gather water samples just above the ocean floor
- Responsible for completing dive log
- Responsible for obtaining supplies necessary for development of exploration tools
- Responsible for overseeing development of exploration tools
- Responsible for obtaining dive log from Chief Scientist
- Responsible for overseeing the deployment of exploration tools

Water Sample Technician 1

- Serves as main person for construction of exploration tools for water extraction
- Serves as main person for deployment and retrieval of exploration tools
- Responsible for storing collected sample

Water Sample Technician 2

- Serves as main person for construction of exploration tools for water extraction
- Serves as main person for deployment and retrieval of exploration tools
- Responsible for storing collected sample

Water Sample Technician 3

- Serves as main person for construction of exploration tools for water extraction
- Serves as main person for deployment and retrieval of exploration tools
- Responsible for storing collected sample

Student Handout

Mission Log

(To be completed by the Chief Scientist)

Project Title: ______________________________

Chief Scientist Name: ______________________________

PI Names: ______________________________

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Team Names: ______________________________

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Date and Time: ______________________________

Grid Locations and Depths: ______________________________

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Tools Used: ______________________________

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Tasks Performed: ______________________________

Water: ______________________________

Sediment: ______________________________

Infauna: ______________________________

Attached:

Dive Schedule, Dive Logs, and Dive Grid

Student Handout

Dive Log

(To be completed by the Principal Investigator)

PI Name: ______________________________

Team Name: ______________________________

Dive Task: ______________________________

Dive Depth: ______________________________

Dive Time and Location: ______________________________

Tool Design: ______________________________

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Dive Plan: ______________________________

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Dive Results: ______________________________

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