5: BUILD YOUR OWN UNDERWATER EXPLORATION VEHICLE

Grade Level: 6-8
Time: 45-60 minutes

SUMMARY:
This lesson provides a hands-on way to introduce students to the challenges of underwater research. In groups, students will design and build underwater exploration vehicles from common household/craft materials, and then compete to see which group can successfully retrieve "undersea samples" from a model ocean (2 L bottle full of water) in the fastest time. In doing so, students will learn which shapes, sizes, and features work best to carry out this underwater task – and which don't! This lesson is an introduction to robotic technology in oceanography and to the applications that these vehicles have to biologists, chemists, geologists, and physical oceanographers.

OBJECTIVES:
Students will:
- Design and build their own underwater exploration vehicle using household materials.
- Identify the challenges encountered when designing a vehicle for underwater exploration.
- Determine what shapes and designs are optimal versus those that need alteration.

STEM APPLICATIONS:
- **Science (oceanography)** – Students learn about the tools oceanographers use to conduct scientific research.
- **Technology** – Designing tools to complete a specific task will show students how technology can be used to achieve goals.
- **Engineering** – Students will use critical thinking and structural analysis skills to effectively design a tool ("vehicle") that is capable of retrieving objects from a model ocean.

NGSS ALIGNMENT:
- **Practice 1.** Asking Questions and Defining Problems
  - **6-8 –** Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.
- **Practice 3.** Planning and Carrying Out Investigations
  - **6-8 –** Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation.
  - **6-8 –** Evaluate the accuracy of various methods for collecting data.
- **Practice 6.** Constructing Explanations and Designing Solutions
  - **6-8 –** Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints.
  - **6-8 –** Optimize performance of a design by prioritizing criteria, making tradeoffs, testing, revising and re-testing.

VOCABULARY:
Underwater Exploration Vehicle (UEV) – Any of several types of vehicles used to conduct research or carry out tasks underwater.
Human Occupied Vehicle (HOV) – A vehicle used for underwater exploration that can hold one or more people inside of it.
Remotely Operated Vehicle (ROV) – Another type of vehicle used by scientists to study the ocean. An ROV is attached by a cable to a boat floating on the surface, and can be controlled from there.
Automated Underwater Vehicle (AUV) – A third, more advanced type of underwater exploration vehicle that can be programmed or controlled, but does not need to be attached to a boat or external source of power in order to operate.
Marine Engineer – A person who designs equipment or machinery, including exploration vehicles, for use in working with or studying the ocean.
Hydrodynamic – Designed to be able to move through water quickly and efficiently, without much resistance.

MATERIALS:
- 2 L bottle with the top cut off (use masking tape around the rim to protect students from sharp plastic edges)
- 1.7 L water
- Duct tape
- Rubber cement
- Scissors
- "Deep-Sea Samples" – these can include beads, paper clips, dried beans, pennies, crumpled pieces of paper, erasers, or any other (relatively) waterproof objects. These can either sink or float – it works best to use a variety of shapes and sizes.
- Tool-making supplies – pipe cleaners, string, small paper cups, sticky tack, rubber bands, washers, film canisters, electrical tape, popsicle sticks, and/or any other items easily acquired that can be used to build underwater exploration vehicles!

BACKGROUND:
Believe it or not, 50% of all species on earth live in the ocean, and oceans cover about 70% of our planet, but only about 5% has been explored so far!

The use of robotic technology in oceanography has helped scientists access areas of the ocean that would otherwise be impossible to reach. A variety of sensors can be added to such vehicles that measure the concentration of certain chemical compounds, salinity, temperature, water pressure, light levels, and the presence of microscopic life. Unlike humans, robots can dive deep, stay underwater for extended periods of time, endure extreme temperatures and harsh conditions, and don't get seasick!

Coming up with designs for these underwater exploration vehicles and testing how well they work for underwater research is a significant challenge faced by marine engineers. Scientists like marine biologists, chemists, geologists, and physical oceanographers use robotic technology to collect samples, visually explore ocean environments, and track current speed and direction, and there are many more applications for this kind of technology in marine science. In this lesson, students will be able to design and test underwater exploration vehicles, and discover which designs are best for the collection of "undersea samples" from a model ocean!

ACTIVITY:

1. Engage/Elicit

To begin this activity, ask students, "Why do we study the oceans?" Answers may include: to discover new species and forms of life, to uncover geologic time records that help us learn about earth's history, that shipwrecks can be found on the ocean floor and contain important anthropological artifacts, or to find new and unknown biological and chemical environments, such as hydrothermal vents. Of course, answers can go beyond this! Encourage students to think about interesting facts they've learned about the oceans, and how those kinds of discoveries were made.

Now, ask the students to think about some of the major challenges of ocean exploration – what makes studying underwater organisms or phenomena difficult for us as human beings? How can we overcome these challenges? The idea is to get the students thinking about how humans are not well suited for oceanic conditions. Our lungs are not designed to breathe water or withstand pressure that increases with ocean depth, our bodies are not fit for the darkness or extreme temperatures at the bottom of the ocean or at hotspots like hydrothermal vents, etc.

You can also ask the students to describe what adaptations a human being would need in order to be able to effectively study in these challenging environments. At this point, you can bring up the utility of robotic technology in solving some of these problems, and address the shortfalls of studying unaided. Robots enable us to access places on earth and in the oceans that we would otherwise be unable to get to!

2. Explore

Divide the students up into groups of 3-4 and give each group a model ocean – a 2 L bottle filled about ¾ of the way with water. Place your deep-sea samples in the model ocean before starting the activity. It is ok if not all objects sink, as it will be a challenge to pick up the floating ones too!

Provide the tool-making supplies and allow students to come up in groups to take those that they find necessary to build their vehicles. Allow students time to discuss their design ideas, given the materials they have, and then encourage them to start building!

For the first part of this activity, the students will test out their respective designs in their model oceans and attempt to recover all of the deep-sea samples using the tools they have built. The rules are as follows: no part of the students' bodies may go under the water at any time, and the model ocean must stay upright. When each group has successfully collected all (or most) of their samples, move on to the second part of the activity: the Collection Competition!

The Collection Competition: for this activity, each group will get to use their one best design to retrieve the samples again, but this time the objective is to collect them all (without damaging them) before any other group does. You, as the instructor, may decide to permit the use of multiple tools, but limiting the students to one tool causes them to consider how to innovate for multiple different shapes and sizes of samples. Dump all of the samples back in each of the model oceans, and when all groups have selected their best design and are ready to go, start the competition! Whichever group can show that their samples are all collected and undamaged wins!

3. Explain

During the activity, ask students what some advantages and disadvantages are to using robotic technology as part of scientific investigations. How do you think explorers decide which tools to use on a given expedition?

You can also discuss what the different kinds of samples you provided might represent in the actual ocean. For example, a round bead that sinks to the ocean floor could bear resemblance to a rock or artifact from a shipwreck. Explore these comparisons and discuss which methods might work to retrieve these objects.

4. Evaluate/ Wrap-up

To Wrap-up this activity, discuss the questions below. As the students answer, have them provide evidence for their opinions based on their experience with designing and testing their vehicles. Go around the room and encourage each group to share their designs with the class, especially when talking about the size and shape and other design features that worked well to complete the task.

· What was the easiest part of this activity? What was the hardest part?

· What size and shape of AUV was the best at retrieving the samples? Why do you think this is?

· What materials were best to work with? Which weren't so good?

· Which samples were most difficult to pick up? How did you solve this problem?

5. Dive Deeper

This lesson is adapted from a lesson published in the Immersion Presents: Ocean Exploration lesson packet created by the Sea Research Foundation.

Ever wonder what the vehicle that discovered the Titanic looked like or how it operated? Want to see how scientists aboard real-life HOVs conduct research and make important oceanic discoveries? Check out Woods Hole Oceanographic Institution and the famous HOV, Alvin, at www.whoi.edu/main/hov-alvin. To view a more modern design and breakthrough technology, check out the Deepsea Challenger, the one-person HOV donated by James Cameron after he dove into the deepest known part of the ocean, the Marianas Trench! Visit www.whoi.edu/main/deepseachallenger.

For more activities and information on ocean exploration please visit www.namepa.net/education.