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Galapagos Rift Expedition

Submersible Designer

Focus
Deep Sea Submersibles

Grade Level
9-12

Focus Question
How does a submersible's design enable humans to explore the deep ocean?

Learning Objectives
Students will understand that the physical features of water can be restrictive to movement.

Students will understand the importance of design in underwater vehicles by designing their own submersible.

Students will understand how submersibles, such as ALVIN and ABE, use energy, buoyancy, and gravity to enable them to move through the water.

Additional Information for Teachers of Deaf Students
The words listed as key words should be introduced prior to the activity. There are no formal signs in American Sign Language for any of these words and many are difficult to lip-read. If some of these topics have not already been covered in your class, you may need to add an additional class period to teach vocabulary and teach some of the background information to the students prior to the activity.

Materials
- ❒ An aquarium, child's pool, or other large container filled with clear, fresh water for testing and demonstrating model submersibles
- ❒ Materials to build model submersibles, such as PVC pipe, batteries, propellers for model airplanes, rubber-band propellers, bottles, and any other materials to be determined by student teams

Teaching Time
Two class periods of 45 minutes each, one month apart, and a total of 10 20-minute segments of class time once a week during the period of a month

Seating Arrangement
Groups of 2 to 3 students

Maximum Number of Students
30 students

Key Words
Submersible
Autonomous Underwater Vehicle (AUV)
Alvin
ABE
Buoyancy
Neutrally-buoyant
Exploration

Background Information
Anyone who has ever walked across a swimming pool or swam deep below the surface of the

ocean or a lake is aware that water is not an easy substance to move through. Water has many characteristics that make it restrictive to movement and all of these characteristics have to be taken into consideration when designing a submersible. A deep-water submersible, such as the Woods Hole Oceanographic Institution's Alvin, has to be able to move forward and back and left and right, but also thousands of meters up and down in the water column. A submersible must be carefully designed with all of these issues related to movement in water solved before it can enter the water and function safely and successfully.

Because of the cohesive properties and higher density of water in comparison to the atmosphere, it takes much more energy to move through water than air. For this reason, submersibles always have to carry an energy source that can be used to expel force to move the submersible in different directions.

Submersibles can only carry a limited supply of energy with them because of space limitations. For deepwater submersibles, this creates an issue because energy is also required to move the submersible up and down in the water column. Objects that are less dense than water are buoyant. If the submersible is less dense than the water, it will take a great deal of energy to move it down through the water column and keep it there because the submersible will have to resist its buoyancy. If too much energy is used by the submersible in its descent, there may not be enough energy left to conduct the exploration and scientific research planned for the mission. It will take much less energy to ascend to the surface, because the higher density of the water will push the submersible back up. If the submersible is denser than the water, it will sink down with little energy expenditure, but then will require a great deal of energy to return to the surface. Again, providing enough energy to ensure a safe ascent is a challenge in the ocean environment.

Submersible design solves these problems by creating a way to both raise and lower the density of the submersible. Some submersibles were designed with weights that would carry the submersible to the bottom, with the weights being released when it was time to return to the surface. Others have chambers that can be filled with water or air, depending on whether the submersible needs to ascend, descend, or achieve neutral buoyancy. At neutral buoyancy, a submersible has the necessary density such that it no longer ascends or descends, but instead stays at a relatively constant depth in the water column. As you can see, designing a submersible takes a great deal of knowledge both about mechanics and the physical properties of water and by thinking about submersible design, much can be learned about both areas of knowledge.

Learning Procedure

1. Discuss the explorations to the Galapagos Rift with the students. Focus conversations on the Alvin and ABE (see Resources section in this activity for useful websites). Have students brainstorm ideas on how a submersible would have to be designed to travel through water thousands of meters below the surface. Record their ideas on a chart and save the chart for class reflections at the end of the activity.
2. Divide students into groups of two or three students. Tell students that their goal is to work together as a team to design, build, and test a small submersible prototype model that can travel underwater in at least one direction, or to be able to both descend and rise through the water. Tell students they should research working submersibles and their designs to come up with some ideas. Suggest materials such as PVC pipe, batteries, and propellers, but let students know they can use any materials they think will work.
3. Set a date a month away for students to demonstrate and explain their submersible design.
4. Once a week, give teams time in class to give a progress report on their submersible design and to share ideas and resources. During one

of these time periods, have students present a blueprint of their plans for their submersible design.

5. On the set date, have a large container of water available (if a swimming pool is available in the school, this would be ideal) to allow each team to demonstrate and explain their submersible design. Have each team discuss with each other what worked, what did not work, and how they might redesign their vehicle. Have them compare what they have learned about submersible design to their original brainstorm ideas that were listed on the chart during the first classroom period and discuss whether their predictions were accurate.

The BRIDGE Connection

www.vims.edu/bridge – Choose Human Activities, then Technology for information on many different types of submersibles.

The "Me" Connection

Discuss with students how submersibles are important not only for scientific research, but for rescue, salvage, and military purposes as well. Have students research how submersibles have been used in these endeavors.

Connections to Other Subjects

Technology, Social Studies/History

Evaluation

Based on everything they have learned from their own submersible design and the designs of the other teams, have each student write a description of how they might design a full-sized submersible that could meet all the challenges of movement in the underwater environment.

Extensions

Have your students visit http://oceanexplorer@noaa.gov and www.divediscover.whoi.edu with a member of their family each day to keep up to date with the latest Galapagos Rift Expedition discoveries.

Social Studies - Have students research the history of submersible design and create a timeline that shows how submersible design has changed over the years.

English/Language Arts - Have students read the novel 20,000 Leagues Under the Sea by Jules Verne and critique how Verne's predictions of submersible design and travel compares with modern submersible design.

Resources

http://oceanexplorer@noaa.gov and www.divediscover.whoi.edu - Follow the Galapagos Rift Expedition daily as documentaries and discoveries are posted each day for your classroom use. A wealth of resource information can also be found at both of these sites.

www.marine.whoi.edu/ships/ships_vehicles.htm – Information on the submersibles of Woods Hole Oceanographic Institution

www.dsl.whoi.edu/DSL/dana/abe_serious.html – Information on ABE

www.marine.whoi.edu/ships/auvs/abe_description.htm – More information on ABE

www.whoi.edu/home/marine/vehicles.html
Information on submersibles

Van Dover, Cindy Lee. *The Octopus's Garden*, Addison Wesley Longman, Inc.1995. Information on the submersible Alvin

Bohm, Harry and V. Jensen. Build Your Own Underwater Robot and Other Wet Projects.Westcoast Words. 1997. An incredible book that gives the history of underwater exploration and how the vehicles used were developed. It explains what works and what does not. It has detailed instructions for various underwater projects, including an ROV. It is available from www.pitsco.com for $24.00.

National Science Education Standards

Content Standard A: Science as Inquiry

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

Content Standard B: Physical Science

- Motions and forces

Content Standard E: Science and Technology

- Abilities of technological design
- Understandings about science and technology

For More Information

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