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Activity Focus: Saturation Diving / Life Support Mission Proposal: All Missions

Title: Designing an Underwater Habitat for Humans

Focus: Engineering and Life Support

Grade: 5-12

Focus Question:

What is the best design for an underwater research habitat?

Why I want to know this:

Scientists often need to make long-term observations of plant and animal life to get the answers to scientific questions. Limitations on diving time due to decompression problems make this impossible in many cases. By living and working underwater, scientists may have as much time as they need to make their observations. Still, living underwater is not a simple task. Designing a safe, convenient environment to live in underwater can solve many of these problems.

Learning Objectives:

Students will be able to identify the basic needs for human life support in a non-terrestrial environment. They will also be challenged to use critical thinking skills to make the optimum use of a limited space which must provide a base for research and day to day life. Students must also identify and mitigate safety risks.

National Science Standards:

A. Science as Inquiry

- Abilities necessary to do scientific inquiry
- Understandings about science inquiry
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B. Physical Science

- Properties of matter
- Motions and forces

C. Life Science

- Behavior of organisms

E. Science and technology

- Abilities of technological design

Materials Needed:

A design for an underwater research habitat might be presented either on a poster or with a three-dimensional model. Many different materials might be used to design a model habitat, but clear two-liter soda bottles make a good “hull.” Students can cut them in half and insert floorplans, stairs, and small objects representing equipment and ballast tanks. Building blocks such as those made by lego may also be useful, as long as students are not allowed to use pre-designed kits. Clear plastic shoeboxes, pieces of wire and tubing, and a great variety of materials might be used. It is probably best to leave students to select and acquire their own materials after offering a few opening suggestions.

A/V Needs: none required, though an internet tour or video of the Aquarius would be a good starting point, and would be a effective activity to initiate the project.

Teaching Time:

The activity requires a minimum of two class sessions, one to introduce the assignment and present the basic requirements of an underwater habitat, and a second for students to present their models and provide a rationale, either in writing or orally in class. If desired, students can be given class time to work on models, but unless storage space and materials are plentiful, it might be best to assign it as a lengthy home project and have students bring in finished products.

Seating Arrangement:

This activity can be done in any setting which provides room for students to show their posters or models.

Key Words: underwater habitat, life support, saturation diving, decompression, Sealab

Background:

This assignment is simple in principle, but requires students to satisfy a large number of needs with their designs. Providing some historical information on underwater habitats might be helpful start. Large habitats require a huge amount of ballast, which is hard to get in place, so students should be encouraged to make their habitats as small as is practical. The following list of requirements may be presented to students for inclusion in their designs.

Life Support Considerations:

- supply of oxygen
- removal of CO₂
- food storage and preparation
- fresh water, bathroom needs
- decompression plan / equipment
- emergency plans / equipment
- rest and recreation

Work considerations:

- wet and dry storage spaces
- diving equipment to be used
- computers and other instruments
- communications with the surface
- inside work space
- observation capabilities (monitored worksites?)
- needs of specific research projects

Learning Procedure:

- Discuss the needs for extended observations when performing field research. Comparing underwater observation with work in outer space may be helpful in capturing students' interest and giving them perspective on life support design.
- Explain the basics of decompression needs and nitrogen absorption to students. Videos or other materials used in scuba classes may be helpful if the teacher doesn't have a strong background in diving physics.
- Provide a brief overview of one or more historical underwater habitats, such as the Navy's Sealab program, or Jacques Cousteau's Conshelf or Tektite projects.
- Give students background information on the Aquarius habitat, using the website and virtual tour, or a video.
- Give students a guide of requirements for their designs, and discuss some possible materials for their use. Establish a timeline for the projects. You may choose to have students do a brief sketch or abstract of their design before they start the final product. Encourage students to use the handout as a checklist before beginning the construction of their final product.
- When completed projects have been brought in, have students present their projects to the class, and have students critique their peers' designs. A "People's Choice" or "Best Design" award selected by the students may add an element of fun and competition.
- Close with a discussion of some of the advantages and disadvantages of various designs, pointing out that there is no perfect solution or design, but rather different ways to address a variety of needs.

Possible Modifications:

- Assign students to work in teams instead of individually. This will improve quality of designs and products, and will require less time and space for final products and presentations.
- Precede the project with one or more student reports about historical underwater habitats. This will get students looking at existing designs early, and encourage them to think critically about habitat design.

Suggestions for Assessment:

Look for designs which satisfy the basic needs of life support in the smallest possible space, with adequate safety considerations. How do they get out if there's a problem? How do they communicate with the topside support crew? Is there practical space for living and working, without too much attention to recreation or play? You may want to design your own rubric and supply it to students ahead of time to help them include all important design features.

Extensions for students:

- Design methods for production of food and oxygen involving plants underwater.
- Write proposals for actual research projects which would use their habitat.
- Discuss why there were so many underwater habitat programs in the 1960's and 1970's, but only one active research habitat now (the parallels with the space race and the developments in remotely operated vehicles and submersibles play large factors).

Internet Resources:

<http://www.dive.noaa.gov/> for background on scientific diving

<http://www.onr.navy.mil/focus/blowballast/people/default.htm> for background on the US Navy Sealab program and saturation diving

Resources:

Any books on diving will be helpful. The following are a few samples.

Koblick, Ian and James Miller (1984) Living and Working in the Sea. Van Nostrand Reinhold Co.

Shannon, Terry and Charles Payzant (1966) Project Sealab: The Story of the United States Navy's Man-In-The-Sea Program. Golden Gate Junior Books.