Lesson Plan

Aquarius Technology: Building an Underwater Habitat

Focus

Teaching students about how technology enables science through building Aquarius Habitats.

Focus Questions

- Why build an underwater habitat?
- How does technology enable science underwater?
- How do scientists live underwater?
- How does the habitat stay underwater?
- How do aquanauts communicate underwater?

Learning Objectives

Students will learn to work as a team to design and build a model of an underwater habitat. Through this exercise, they should be able to describe and communicate their ideas, as well as recognize that their ideas may have constraints, such as cost, materials, time, space or safety.

Students will communicate their findings through drawings, journals, and oral presentations to the classroom.

Grade Level

4-6 (Science and Technology)

Materials

Paper (construction and white)- One really large piece of white for each group
Rulers
Pencils
Erasers
Large container to hold water (aquarium, or square bucket)
Plastic cups
Small weights (fishing sinkers will work)
String
Air pump (fish tank, bicycle pump)
Journal question sheet
Glue

Teaching Time

45-60 minutes (could also be a two day lesson), depending upon how much time provided to the team to design and build the habitat, evaluation of the group's work, and what changes they would make.

Seating Arrangement

Groups of 4-6 students seated around tables

Maximum Number of Students

For discussion purposes, the entire group should probably be limited to no more than 30.

Key Words

Aquarius
Aquanaut
Ambient Pressure
Atmospheric Pressure
Water Pressure
Saturation Diving
Technology
Life Support Buoy

Background Information

Aquarius is an undersea habitat located at Conch Reef in the Florida Keys National Marine Sanctuary located in approximately 63 feet of water three and half miles off of Key Largo, Florida. Aquarius is owned by the National Oceanic and Atmospheric Administration, and run by the National Undersea Research Program through the University of North Carolina Wilmington's (UNCW) National Undersea Research Center. The Aquarius Habitat was deployed off of Key Largo in 1992, but after 20 missions funding constraints caused it to be brought up. The habitat was then re-furbished and re-deployed in 1998 where it remains today.

Aquarius works as a three-part system, that includes the 85-ton habitat that supports living and working space for the six-person crew, the 30 ft diameter **Life Support Buoy**, and 120-ton base plate that acts as the weight system to hold the habitat to the bottom of the sea floor. The Life Support Buoy relays all air to breath, and technology for all communications to and from shore for the crew inside the habitat. The lab is equipped with computers networked to shore, Internet, telephones, radios, and video conferencing equipment. Without this **technology**, the habitat would not be able to sustain life underwater.

Aquarius is an **ambient pressure** habitat, which means the interior atmospheric pressure is equal to the surrounding water pressure. Its main entrance in the Wet Porch remains open to the ocean. Water is kept out of the habitat by the equivalent air pressure inside, much like an air pocket inside an inverted glass prevents water from completely filling when immersed. The pressure of 47 feet of seawater is about 2.5 times greater than the atmospheric pressure found at sea level. At this depth and pressure, visitors to Aquarius have only about 80 minutes to complete their stay and return to the surface before they risk experiencing decompression related illness.

However, the mission inhabitants of Aquarius, known as **"aquanauts,"** can stay indefinitely and have nearly unlimited bottom time during their scuba dives from Aquarius because of a special technique called **saturation diving**. The most serious threat conventional divers face is called "decompression sickness" or the "bends". Bubbles that form in the blood and tissues when divers stay down to long at a given depth, and then ascend to the surface too fast cause this sickness. The bubbles get caught in joints and vessels causing many symptoms that can include pain, paralysis and even death. Instead of coming to the surface after diving, scientists who use Aquarius return directly to the undersea laboratory. The aquanauts use special dive tables to greatly increase their bottom time- to nearly ten times over what they typically have using regular dive tables. At the end of a mission, aquanauts undergo a 17–hour decompression that is conducted within Aquarius itself, while on the bottom. At the end of decompression, Aquanauts exit Aquarius and scuba dive back to the surface.

To live in Aquarius scientists must submit proposals for the unique opportunity to study coral reef systems full submerged for a 10-day mission. Aquarius scientists are able to long-term research studies on the coral reefs that surround the habitat. Without Aquarius, these scientists would have to depend on multiple dives of short bottom time leaving them vulnerable to the complication of multiple boat trips, unpredictable weather, and frequent deep dives that increase the likelihood of getting the bends. Aquarius is a technology that greatly increases the success of the science that takes place around the habitat.

Preparation

Make sure each group has 4 pieces paper, 4 pencils, 4 erasers, 4 ruler, 4 plastic cups, 4 pieces of string, and 4 weights. Fill the water tank with water and place it either in the middle or the front of the classroom.

Learning Procedure

The object of *Aquarius Technology: Building an Underwater Habitat* is for students to learn how to work together as a team to design a habitat that will sustain life underwater,

and to learn how technology enables science in many ways.

1. Provide a full class lesson on pressure. There are many good lessons on the web, but a few examples are provided below.
    a. http://www.iit.edu/~smile/ph8904.html
    b. http://www.eduref.org/cgi-bin/printlessons.cgi/Virtual/Lessons/Science/Physical_Sciences/PHY0061.html
    c. http://www.iit.edu/~smile/ch9101.html
2. Put students into teams of 4-6 with all the materials needed to design their Aquarius. Have them brainstorm these questions:

What does your habitat need to sustain life?
According to Wikipedia, underwater habitats are fixed underwater structures in which people can live for extended periods and carry out most of the basic human functions of a 24-hour day, such as working, eating, breathing, attending to personal hygiene, and sleeping. Have the students think about how these things need to be incorporated into the design of their habitat. Discuss with the students how these needs might be met.

Where will their habitat operate?
Water depth determines the thickness of the walls and windows (view ports), they types of fittings for the connections and plumbing that is installed. Depth also determines what kind of breathing gas system is required. Have them keep in mind that at depth you cannot necessarily breath the same air as at the surface. Both nitrogen and oxygen cause problems when the pressure is at a high level. Will the habitat be submerged in fresh or salt water?

How will their habitat operate?
Aquarius consists of three systems to make it fully functional. The habitat itself if full of air, and floats! Therefore a 120-ton base plate is attached to the habitat to keep it at depth. There is also a buoy called the LSB (Life Support Buoy) that is moored above the Aquarius. The LSB contains generators (for power) and compressors (for air). It is connected to Aquarius by an umbilical-wires and hoses wrapped together with a cover. The buoy also has radios and wireless communications that can send signals from Aquarius to the mission control center-over nine miles away in Key Largo, FL. Have the students discuss these functions and the importance of the three components of the habitat.

Design a Habitat
Have the students answer the above questions as a team, and then review the answers as an entire class. Have the students then take their plastic cups and test them in the tank of water. Here is the layout for how to run this part of the lesson:

1. Have them test one cup upside down. Does the cup fill with water?? Explain to them why the cup floats.

2. Have them go back to their desks and add sinkers to the cup in different positions- two on either side as a test, then four surrounding the cup to see the balance difference. The benefit of the plastic cup is to see the air level with the water.

3. Now that they have their cup level, have them add air with either the bicycle pump or the fish tank pump. Make them relate this exercise to how air is pumped to Aquarius. The habitat always needs fresh air for the Aquanauts to breath.

4. After they have tried these experiments and understand the concepts, have them go back to their desks and design their habitat. Provide each group with one large piece of white paper, and lots of construction paper. Have them design their habitat with three things in mind: 1. How will the habitat be held on the bottom of the ocean, 2. How will they receive the air and communications? 3. What will the habitat look like and contain to sustain the lives of the Aquanauts?

5. At the end of the exercise, have each group get up and explain their habitats. Where they will be located, how they will be built, and why they chose the design they did.

6. Pass out to each student a journal sheet. Have them answer the questions first by themselves and then as a team. What would they do differently, and how would they make the changes to their design?

The Bridge Connection
http://www.vims.edu/bridge/technology.html

The "ME" Connection

Instruct students to write a letter to the Director of Aquarius Otto Rutten asking to be chosen as an Aquanaut for the next Aquarius mission. For more information, have them go to the Aquarius website and look at the biographies of past Aquanauts to help them write their own biographies. Have them think about why they should be chosen, and what they would do if they were to saturate. What type of science would they do to make a change for the reef? Would they choose to educate people about what they are doing? What makes their role important?

Evaluation

Review the student's habitats to ensure they are keeping in mind the main components that sustain life. Were they creative in developing their habitats? Did they work as a team to build their habitats? Have the students grade their habitats to teach them how to ask questions about what worked, and what did not. How would they modify their designs based on the results of their evaluations?

Extension

Suggestion #1: Have students research the International Space Station. What are the similarities and differences between astronauts living in this "outerspace" center, versus aquanauts living in the Aquarius or the "innerspace" center. Have the students develop a chart of the comparisons to understand how technology allows humans to live in inner and outerspace.

Suggestion #2: Make the connection between man made habitats, and naturally made habitats. Have the students explore their backyards or playgrounds to find habitats that are found in nature. Have them compare what they found to Aquarius.

Suggestions #3: Put a large piece of paper up on a wall in your classroom or school hallway. Have the students design as a class a habitat with many different materials from around the classroom. The mural will them act as a life size habitat for the whole school to admire.

Resources

http:// www.uncw.edu/aquarius/

This is the home website for the Aquarius Habitat run by the University of North Carolina Wilmington and the National Undersea Research Center.

http://www.scienceunderthesea.org

This website provides excellent lesson plans and extensions based on the Aquarius Mission with Philippe Cousteau of Earth Echo International and the University of North Carolina Wilmington.

National Science Education Standards

Content Standard E: Science and Technology

- Abilities of technological design
- Understandings about science and technology
- Abilities to distinguish between natural objects and objects made by humans

For More Information

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Credit

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Journal

1. **How did you design your habitat??**

2. **What are the three main parts to your habitat??**

3. **What are the main parts of your habitat that help the Aquanauts live??**

4. **What would you change about your habitat design?**