NAVAL HISTORY STEM-H LESSON PLAN

TEACHER HELP GUIDE

LESSON PLAN: Ship, Submarine, and Sea Creature Sounds in the Sea

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2012 NAVAL HISTORICAL FOUNDATION STEM-H TEACHER FELLOWSHIP

INSTRUCTIONAL GOAL: Explore sound waves and their applications, discovering the many aspects of sonar technology to understand how sonar signals help submariners determine where they are, without seeing, and also to find the location of other ships and submarines. This is a similar process to whales and dolphins navigating their ocean world. In this unit lesson the student will:
practice creating and measuring a model of an ocean seabed or sea floor;
practice measuring depth;
use descriptive words for what they created and what they observed from a depth model;
use tactile (hands-on) strategies, as well as calculating logarithms, graphing logarithmic equations, and calculating radical equations used in submarine sonars.

BACKGROUND: Similar to radar, instead of sending out radio waves, researchers and sonar technicians use active sonar by sending out (transmitting) sound waves and listening for a return echo. In measuring the time it takes for these sound waves to travel to an object, bounce off (reflect), and then return to the sonar transmitter (hydrophone), it is possible to calculate distances. Active sonar detection can also be used to accurately map about 2/3 of the Earth that is underwater. Only about 5% of the underwater surface of the earth (topography) has been accurately mapped.

SONAR stands for **SO**und wave **N**avigation **A**nd **R**anging. RADAR stands for **Ra**dio wave **D**etection **A**nd **R**anging. SONAR and RADAR are two methods that submarines and ships can determine their position as well as determine another ship's position. Passive sonar, evaluating only the sound emissions from another ship, submarine or sea creature, can also be used to determine the position of the other ship, submarine or ocean dweller. Active sonar can also be used in very cold waters where ice and icebergs are present, to safely navigate underwater by displaying the underwater topography on computer screens.

For a U.S. Navy Sonar Propagation tutorial, see the toolkit document ***"Sonar Propagation".***

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RESOURCES:

US Navy, www.navy.mil

US Navy Museum: Cold War Museum, www.usnavymuseum.org

The Naval Sea Systems Command, coloring books, posters, STEM information,

www.navsea.navy.mil/Outreach.aspx

Microwave, Radar and Sonar, www.kidsgeo.com

Whale Sounds, www.whaleacoustics.com

Association for Unmanned Vehicle Systems International (AUVSI), Start a RoboSub

Competition Team, www.auvsifoundation.org

US Navy Sonar Room, Sonar Room, www.youtube.com

STANDARDS: Common Core Mathematics Standards:

STANDARD IA 1.2 Connect algebra with other branches of mathematics.

STANDARD IA 1.6 Understand how algebraic relationships can be represented in concrete models, pictorial models, and diagrams.

STANDARD IA 4.9 Carry out a procedure to solve radical equations algebraically.

STANDARD IA 4.10 Carry out a procedure to solve logarithmic equations algebraically.

STANDARD IA 4.11 Carry out a procedure to solve logarithmic equations graphically.

INSTRUCTIONAL PROCEDURES FOR LESSON: Introduce the unit with eye openers or interest points in the US Navy and military career programs. The teacher could survey the class on what the students' interests are in the STEM-H field. Survey the students on what they know about submarines and how they were used in the Cold War era. Inquire if any of the students had any relatives or family friends who were in the US Navy during 1945 through 1991. Ask if the students have any relatives or family friends who served in the US Navy, and if they are still in the service now.

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This is a great unit to work with your school guidance counselor and recruiting officers in the community. Teacher might want to bring in US Navy: Cold War memorabilia; post cards, local library books, model ships and vessels, magazines on the Cold War and US Navy. Asking in the school community if there are any US Navy retired service people who would like to come and volunteer a couple of hours discussing the US Navy with your class, especially if they were in the Navy around 1945 – 1991. Teacher may also want to view US Navy short segmented clips on submarines used in the Cold War years and US Navy today. Video clips should have significant value to how submarines used Sonar or Radar to help detect other vessels during the Cold War. Short clips can be found on www.youtube.com. You can also check in www.teachertube.com.

INSTRUCTIONAL PROCEDURES FOR ACTIVITIES:

For Activity #1, the key to this unit is to prepare in advance. Have the students beforehand collect clean tin cans, or small tissue boxes until you have enough for each student. If you do not want to use playdoh or clay, you can use paper-maché strips of flour, water, newspaper to create a quick drying ocean floor bed to measure. Paint is not needed but if your students want to add color to their ocean floor models, they can. Students can take food coloring and dilute it to get a variety of inexpensive paint coloring. Have students measure the area of the container they are using. Students can even calculate the volume of the container using Volume of a cube formula, $V = s^3$; volume of a rectangular prism, $V = lwh$; volume of a cylinder, $V = \pi r^2 h$, etc.

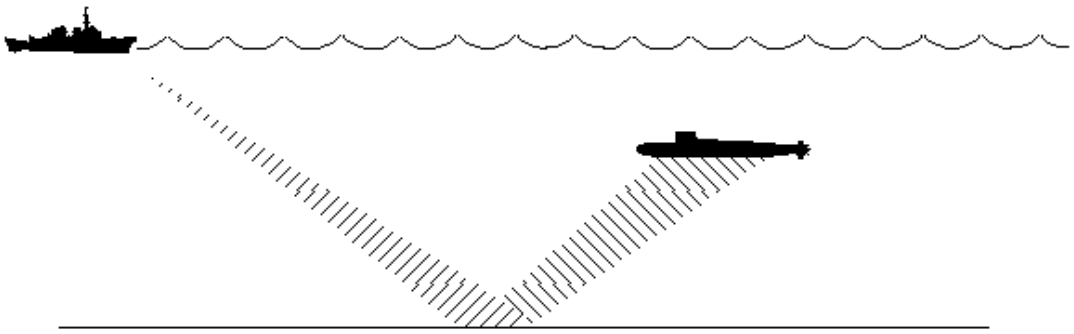
For Activity #2: In the back of most high school math texts there are logarithm tables. Scientific graphing calculators have a logarithm key. Discuss before high technology, people had to use the logarithm tables found in the math text's index pages. Demonstrate how to use the log tables and demonstrate how to use the scientific graphing calculators. Ask students which strategy they prefer. Relate to the students that the oceans and seas contain a large volume. When one is dealing with large numbers or a wide range of distance in the ocean, you can see more data on a smaller scale (sonar receiving equipment). A sonar technician on a submarine has to be able to predict where the noise is coming from, what type of noise it is, and the distance between the noise and ship. All are important when working on a submarine.

For Activity #3: In this activity, the student will practice solving a radical expression algebraically. Students always ask and question when they will need to know or learn something that is part of the curriculum. In Sonar equations for a submarine operation, they might come across radical expressions that need to be solved either by technology or by hand, if the technology goes astray at a crucial moment. Practicing simplifying radical expressions, helps the navigator and sonar tech be more prepared and ready in case of a technological malfunction.

For Activity #4: In this activity, the student will graph logarithmic equations used in ship detection while at sea. Sound waves, water waves, and light waves and radar involve exponential and logarithmic functions. Graphing your equation outcome can help you in finding density, velocity and fluid flow inside a membrane. In this activity, you want your students to be able to derive that when there is more information being assessed like sounds in the ocean . The ocean is so vast, that when you input this information into a receiver you need to minimalize the data so that the receiver can give a diagram or crunch the numbers to give a better estimated distance to where the vessels or live sea life is coming from.

An example of this is Bottom Bounce. This is when the sound is reflected from the ocean floor. The rays tend to converge (come together from different locations). This information ties into the next level of math after Trigonometry which is called Calculus or PreCalculus. Converging and Diverging directions and distances are very important in this field of mathematics. Finally the last type of propagation occurs in when the sound is strongly reflected from the ocean floor. The rays tends to converge near the surface, resulting in a reduced transmission loss. This is called *bottom bounce* propagation. Rays from bottom bounce can be identified from the others because of the larger angle of incidence. Typical bottom bound comes into the sonar at angles of more than 30^{o} from horizontal

Figure 17. Bottom bounce.



In this unit the student will be exposed to information on the Cold War, as well as information in Math, Science, Engineering Concepts, and History. The STEM-H concept is that the student will see how all this ties into his/her academia life.