STEM IN THE LAB

innovate. explore. discover.

Idaho National Laboratory

OUR MISSION

INL's K-12 STEM Program works to inspire Idaho's future STEM workforce, impact students, teachers and families by integrating best practices in STEM education, and empower employees to become STEM mentors to transform K-12 STEM into a driver for innovation.

PLASTIC EGG SUBMARINE

In 1953 the Submarine Thermal Reactor marked the birth of America's nuclear navy. The prototype reactor was built at Idaho's Naval Reactor Facility. The prototype reactor was cooled and moderated by pressurized water and the propulsion equipment. They lived inside two hull sections duplicating the size and specifications of the USS Nautilus, the navy's first nuclear powered submarine. For decades, the reactor aided in the testing of advanced designs and provided training for sailors. INL still works on submarines today at NRF. Students will get to use the engineer design process to build a submarine which aligns with INL's submarine thermal reactor.

SCIENCE BEHIND IT

A submarine is a distinct vessel or ship that can go underwater. Inside is has massive tanks that hold water. These are called, ballasts. The sub comes equipped with a power source. The power source can be an engine, nuclear power, batteries or a combination of the three. Submarines use sonar equipment to find their way through the dark oceans. This puts out a sound wave. When a sound wave hits an object it bounces back a signal to the submarine. Other equipment inside the submarine provide clean water and air for the crew members.

VOCABULARY

SUBMARINE: *is a special vessel or ship that can go underwater.*
POWER SOURCE: *Where energy comes from. Biomass, Nuclear Power, and Geothermal are three examples of a power source.*
NUCLEAR POWER: *is used to make electricity. Inside a nuclear reactor, atoms from a fuel called uranium are split by neutrons (nuclear fission). This energy is released as heat, which changes water into steam, which then turns turbine generators.*
BATTERIES: *a battery is a type of container that stores energy until it is needed. Chemicals inside the battery store the energy. When the battery is used, the chemical energy changes into electric energy.*
ENGINE: *a machine for converting any of various forms of energy into mechanical force and motion.*
SOUND WAVES: *sound is made up of vibrations, or sound waves, that we can hear. These sound waves are formed by objects vibrating (shaking back and forth). Sound waves travel through air, water, and solid objects as vibrations. When they reach our ears, these waves make the delicate skin of the eardrums vibrate.*

MATERIALS

- *Papa's Mechanical Fish" Children's Book For Engagement Piece*
- *Large Plastic Eggs*
- *Electrical Insulation Tape*
- *Blue Tac*
- *Straws*
- *Money (coins) or small stones*
- *Permanent Marker Pens*
- *Small fish bowl or plastic container*
- *Water*
- *Blue, green and yellow food coloring*

RESEARCH AND DESIGN PROCESS

Apart of the engineering design process is for students to research and sketch a design. Like a real engineer, students will sketch out a design of their submarine. You may display the materials for students to look at to spark their imagination and curiosity. Allow students time to share their designs with other students and provide feedback. If time, students may "Think Pair Share" problems that may arise with their submarines and how they may fix the problems if they shall occur.

PROCEDURES/STUDENT LED

- *Allow students to explore and play with materials.*
- *Have students figure out what to do with the money or small rocks. Prompt with questions:*
    - *"Where do you think the money or rocks should go in your submarine?"*
    - *"What will make your submarine sink?"*
    - *"What will make your submarine heavy?"*
    - *"How will the submarine go under water?"*
- *Once students have found a place for their money or rocks, have students cut their straws so they are left with just the bendy part. Prompt with questions:*
    - *"What do you think you will use the straw for?"*
    - *"What will help the submarine see underwater?"*
    - *"What material will you use to attach your straw to your submarine?"*
    - *"How will you get the straw to stay on your submarine?"*
- *After students have attached their straws to their submarines, allow students to use a small amount of electrical tape and permanent markers to decorate their submarine. Prompt with questions:*
    - *"What does a submarine need to see underwater?"*
    - *"What does a submarine look like?"*
    - *"If you were in a submarine what would you need to survive?"*
- *Once time is up, allow students to do a museum walk to observe each other's submarines.*
- *Place students in groups with a small fish bowl or plastic container filler with water. Allow students one at a time to place their submarine into the water.*

HELPFUL GUIDELINES/TIPS AND TRICKS FOR TEACHERS

- *Take a plastic egg and fill any holes with blue tac.*
- *Add money and small stones to the plastic egg.*
- *Take a straw and cut off the end so you are left with the bendy part. Place the straw in the plastic egg with the majority of it sticking outside the egg and close the egg up.*
- *Place a small amount of blue tac around the base of the straw.*
- *Use electrical tape and permanent marker pens to decorate your submarine.*
- *Fill up small fish bowls or plastic containers with water.*
- *Add yellow and green food coloring or blue to make the water look like an ocean.*

EXTENSIONS

- *Teacher or student can read the story "Paps's Mechanical Fish".*
- *When students are finished submerging their submarines in the water, give them time to collect data on their submarines. Students can collect data on whether the submarines in their group floated or sank using tally marks and then can create a graph.*
- *Students can try using plastic bottles and cups at home to create a larger submarine to test in a sink, pool, or bathtub.*

STANDARDS

K-2 NGSS ENGINEERING STANDARDS

- *K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.*
- *K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.*
- *K-2-ETS1-3. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.*

FIRST GRADE:

- *1-PS4-1. Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.*
- *1-PS4-4. Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.*

RESOURCES

https://c03.apogee.net/contentplayer/?coursetype=kids&utilityid=demo&id=16167
http://adventuresandplay.com/plastic-egg-submarines/?COLLCC=4011584205
https://www.dkfindout.com/us/science/sound/
http://www.scienceforkidsclub.com/submarines.html
https://www.nextgenscience.org/sites/default/files/K-2%20ETS-ED%207.1.13.pdf
https://inl.gov/article/inl-celebrates-70-years-of-achievements-looks-to-the-future/
https://factsheets.inl.gov/FactSheets/52-reactors.pdf