Build a Cargo Ship

GRADE LEVEL: 2-8

TIME: 1-1.5 hrs

SUMMARY

In this lesson, students will learn about the imports and exports of the Port of Baltimore and use recycled materials to build a model cargo ship that will hold weight.

OBJECTIVES

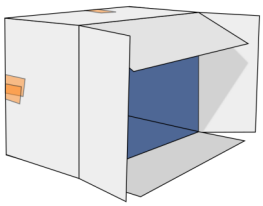
- Students will learn about the importance of bringing cargo into and out of the Port of Baltimore .
- Students will incorporate engineering design to build a cargo ship that supports weight.
- Students will learn about water displacement and draft and how they affect a cargo ship's ability to transport cargo to and from the Port of Baltimore.

VOCABULARY

- **Cargo** - Goods carried on a ship, aircraft, or motor vehicle.
- **Cargo Ship** - A ship that transports goods and materials from one port to another.
- **Chesapeake Bay** - A large body of brackish water located in Maryland and Virginia. The Chesapeake Bay is an estuary, or connection between the Atlantic Ocean and upstream rivers. It is one of the largest estuaries in the world, and provides habitat to thousands of different species.
- **Container Ship** - A ship specially designed or equipped for carrying containerized cargo.
- **Draft-** The vertical distance between the water surface and the bottom of the ship.
- **Dredging** - The process of removing sediment from shipping channels.
- **Dredged Material** - The sediment removed from the shipping channels.
- **Dredged Material Containment Facility -** A placement site for sediment removed from shipping channels. DMCFs are planned, constructed, and monitored by government agencies.
- **Export** - Send (goods or services) to another country for sale.
- **Habitat** - The natural home or environment of an animal, plant, or other organism.
- **Import** - Bring (goods or services) into a country from another country for sale.
- **Island** - A piece of land surrounded by water.
- **Ocean** - A very large expanse of sea, in particular each of the main areas into which the sea is divided geographically.
- **Patapsco River -** Mainstem is a 39-mile-long (63 km) river in central Maryland which flows into the Chesapeake Bay.
- **Restoration** - The act or the process of returning something to its original condition.
- **Sedimentation** - The process by which sediment, or loose particles of sand, silt, and clay, sink to the bottom of a body of water, such as the Chesapeake Bay or Patapsco River.
- **Shipping Channels** - Areas in the water that are maintained to a depth that can accommodate cargo ships. They are marked by buoys and identified on nautical charts (so captains know where to travel).

MATERIALS

- Tub filled with water
- Recycled building Materials and/or craft supplies
- Tape
- Scissors
- Weights
- Shallow Pan



BACKGROUND

The Port of Baltimore brings financial prosperity to the state of Maryland and provides many jobs for residents. In order to keep the Port open for business, shipping channels must be kept deep enough so large ships that typically travel in the ocean can safely reach Baltimore. Placement sites are used to contain the sediment dredged from these channels and are sometimes beneficially used to restore and support habitat. An example is the Poplar Island Ecosystem Restoration Project which uses the sediment to restore remote island habitat within the Chesapeake Bay. This habitat attracts a wide array of animals which benefit from the protection provided by the island's remote location away from mainland predators.

ACTIVITY

1. **Lesson Prep (15-20 mins):**

Materials* for this lesson include:

- **A tub or container filled with water.** If this activity is being done at home, some things to use can be a bathtub, kiddie pool, storage tote, or any water-tight container filled 1-2 feet deep with water. This activity may get messy so make sure to place the water-filled container in an area that can get wet.
- **Building materials.** These can either be crafting supplies or recycled materials. Good craft materials are wooden craft sticks, foam, construction paper, etc. Good recycled materials to use can be cardboard boxes, egg cartons, bottles, aluminum foil, etc. Try to pick out materials that can withstand getting wet.
- **Adhesives.** Can be used to join your materials together, as long as it is safe and appropriate supervision is used for younger participants. Glue can also be a good material to use, however, keep in mind that most glue will take a long time to dry and if the ship is placed in the water too soon the materials may not stick together properly.
- **Scissors.** Age-appropriate scissors for participants while keeping in mind the durability of materials used. Some materials are harder to cut than others and parental supervision or a helping hand might be needed to help students achieve their designs.
- **Weights to put on the cargo ship.** If the activity is being done at home some things you can use are fishing weights, coins, rocks, Legos, wooden blocks, etc. Make sure whatever is used is safe and can get wet.

* Materials are provided if educators come to your site, but feel free to add additional recycled materials.

2. **Engage/Elicit (10-15 mins):**
Ask students if they know of one of the most im-"port"-ant cities in the state of Maryland. There are many different cities in Maryland, but the City of Baltimore is one of the most important not only for the Maryland economy, but also for the economy of the nation as a whole. Ask the students what makes Baltimore so im-"port"-ant. There are plenty of great answers; it is home to the Baltimore Ravens, Johns Hopkins Hospital, the National Aquarium, and many great museums. The answer we are looking for is the most im-"port"-ant one, and that is the Port of Baltimore.

   Ask the students why the Port of Baltimore is so important. It is a place where people, goods, and services are transported in and out of the state of Maryland. The United States is part of a global economy where many goods we use every day come from different places. Ask students if they know of some goods we get outside of, or that are imported into the United States. Examples of goods and where we get them from are:

   - **Cars!** The Port of Baltimore is #1 in the nation for import of small cars and trucks. Car makers like Toyota, Honda, Nissan, and Subaru originate in countries such as Japan. Ferraris can come from Italy, Volkswagens from Germany, etc.
   - **Sugar!** The Port of Baltimore is #1 in the nation for the import of sugar. If you have ever been to Baltimore inner harbor, or one of our Dredge Material Containment Facilities, Masonville Cove, you might have seen the Domino Sugar plant right on the harbor.

   Some other common items for import are:

   - **Coffee!** Something that parents and other adults might need to wake up in the morning. It is imported from many South American Countries.
   - **Clothes!** If you look at the tag on your clothes or shoes it will tell you what country it was made in.
   - **Toys and electronics!** Maybe to some kids most important of all, many toys will have a "Made in…" label or imprint on them that tell us where they were made.

   The Port of Baltimore is also #2 in the nation for the export of **coal.**

   Ask the students how goods are transported to and from the Port of Baltimore. Large boats called cargo

ships bring goods from one place to another. Companies that transport goods want to have cargo ships that can safely hold as much cargo as possible. The more cargo that moves to the Port, the more money and jobs for the State and the people who live and work here.

The Port of Baltimore is the closest port to the American Mid-West; cargo ships calling on the Port of Baltimore can travel 150 miles inland thanks to the Chesapeake Bay and the Patapsco River. Since it's more cost effective to transport goods by water than by land, our Port has a competitive edge over other East Coast ports.

2. **Explore (30-45 mins):**
The student's challenge is to build a cargo ship that will carry the most weight or "cargo"" to the Port of Baltimore. Students will use everyday household recycled materials and craft supplies to build their own model cargo ship. Once completed the students will put their ship in the tub filled with water to see if it floats. Once the ship is floating nicely, weights or "cargo" will be carefully placed one at a time, increasing in numbers to see how much the cargo ship can carry.

   I. (Optional) Engineers with the U. S. Army Corps of engineers (USACE) and the Maryland Department of Transportation Maryland Port Administration (MDOT MPA) will create a design plan of their design and share it with their peers to review. Have the students plan their cargo ship design before beginning. The students can make a list of needed supplies and make a drawing or sketch of what their model cargo ship will look like. If you want, they can share this design with other students to gather constructive feedback.

   II. Have the students gather supplies they will use to build their cargo ships. If in a classroom setting and the students are in groups, it might be easier to have kits made up for each group with general materials like scissors, tape etc. so they are kept in one place and are easy for the students to put back once the activity ends.

   III. Students will then have a set amount of time to use the supplies and build their cargo ship. You may want to let the students test their cargo ship in the water to make sure it floats before cargo is added. Let students build their cargo ships without much guidance from teachers or adult chaperones to allow students to build problem solving skills but be available to keep students on track and to help as needed

   IV. Allow the students more or less time as needed depending on their interest level. Once building time is up, the remainder of class time can be used to clean up and return any extra or unused supplies. If supplies were placed in a kit, have students put supplies back and return kits before the tests begin. This will help keep the kids from continuing to build their ships after time is up, to make sure the area is clean, and will limit extra distractions when testing out the cargo ships in the water

   V. Have the students bring the cargo ship to the water-filled bin one at a time to test their buoyancy. You can have the groups/students present their cargo ship, what they named it, why they built it a certain way, etc. Have the students place the ship in the water to make sure it floats. Place a weight one at a time onto the cargo ship. Have the students count the weights with you to keep them engaged. Keep adding weights until the cargo ship starts to sink or you run out of weights. Do this with each cargo ship until every ship has been tested. For an extra extension, chart the class results on the board or the students can chart them themselves.

3. **Explain (5-10 mins):**

   After all ships have been tested and have been placed either in a safe place to dry or recycled, gather students for a wrap-up discussion. Ask the students what they learned about building their cargo ship. Ask questions such as: Was it easy to build? Harder than they thought? What made it easy/hard? Would they do anything differently?

   Ask the students what happened to the cargo ship when they added weight. Did it stay on the top of the water or did it sink down a little bit. Explain that when it sinks into the water, this is known as water displacement. When the cargo is placed on the ship it gets heavier and the water moves, or is displaced, by the cargo ship, causing water to surround the ship. This distance between the water's surface and the bottom of the ship is called the ship's sailing draft. A ship's sailing draft varies depending on how much cargo it is holding.

4. **Evaluate/Wrap-Up (5-10 mins):**
Explain to students that when cargo ships approach

the Port of Baltimore, they must travel across an Ocean first. The Atlantic Ocean is over 10 thousand feet deep on average. That's plenty deep enough for the cargo ship to safely clear the ocean floor. But once the cargo ship gets closer to Baltimore it must travel through another body of water that is not as deep. Ask students if they know the name of that body of water.

The Chesapeake Bay! Ask students if they know the average depth of the Bay. The average depth of the Chesapeake Bay is 21 feet and the biggest cargo ships need about 50 feet of water in order to travel safely. That would be like having the students' model cargo ships travel through a body of water as deep as a baking sheet. Would the cargo ships be able to get through to the Port of Baltimore? It would not, but we see cargo come in and out of the Port every day, so we were able to find a solution. What was it?

The Port of Baltimore and the US Army Corps of Engineers dredged shipping channels that are deep enough to accommodate cargo ships' 50-foot drafts. These are like an underwater roadway built up and down the Chesapeake Bay.

DIVE DEEPER

To make the Chesapeake Bay and Patapsco River shipping channels deep enough, the sediment at the bottom of the shipping channels needed to be dug out. That created a new issue: what to do with all the dirt, or dredged material, that was dug from the channels? In 2001, Maryland passed the Dredged Material Placement Act. The act requires that dredged material be placed in a way that confines it and keeps it from entering the environment unintentionally. One solution to the challenge of dredged material placement is "Beneficial Use", which uses dredged material to enhance environmental resources such as island restoration in the Bay.

Have students look at the Greenport Resources and Publications page: https://mpa.maryland.gov/greenport/Pages/publications.aspx to research and learn about different ways the Port of Baltimore is using dredged material. You can watch the video "Sediment to Solutions: Channeling Innovation for Beneficial Reuses" https://vimeo.com/396790121. Also look at other programs with the Port of Baltimore Environmental Education Team to learn about how various sites benefit from dredged material.

NGSS ALIGNMENT

Dredging and Habitat Restoration: Build a Cargo Ship

Grade	Performance Expectations	Disciplinary Core Ideas	Crosscutting Concepts	Science and Engineering Practices
K--2	2-PS1-2** 2-PS1-3** K-2-ETS-1*** K-2-ETS-2*** K-2-ETS-3***	PS1.A ETS1.A ETS1.B ETS1.C	Cause and Effect Scale, Proportion, and Quantity System and System Models Structure and Function	Asking Questions and Defining Problems Developing and Using Models Planning and Carrying out Investigations Analyzing and Interpreting Data Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions Engaging in an Argument from Evidence Obtaining, Evaluating, and Communicating Information.
3-5	5-PS2-1** 3-5-ETS-1*** 3-5-ETS-2*** 3-5-ETS-3***	PS2.B ETS1.A ETS1.B ETS1.C	Cause and Effect Scale Proportion, and Quantity	
MS	MS-ETS-1*** MS-ETS-2*** MS-ETS-3*** MS-ETS-4***	ETS1.A ETS1.B ETS1.C	Structure and Function	