Cargo Loading Challenge
By Angela G. Janda

Subject/Grade: Gr. 2 social studies/science

Lesson Overview
This lesson focuses on the physical science principles of loading cargo in a way that maintain balance and in order to keep a ship afloat on the water. Students gain an awareness that the cost of shipping raw materials (natural resources) is largely based on weight. Therefore, refining and concentrating raw materials before shipping results in a more valuable cargo and reduces unnecessary shipping weight.

Lesson Objectives – begin each phrase with an active verb to make these MEASURABLE Objectives.

- Explain the need for consistent and continual balance during loading and shipping of a water vessel.
- Successfully maintain a balanced vessel during the loading and shipping process in a simulated classroom situation.
- Explain why concentrating raw materials and reducing waste is more energy and cost-efficient, and reduces pollution. natural resources once considered waste material, now have renewed value after undergoing modern refinement processes.
- Demonstrate how “separating” two substances, such that one material is considered waste by-product (taconite), and the other is a valued resource (ie., processed and shaped taconite pellets).

Essential questions

1. Why is a balanced shipping cargo so important? What can go wrong if such a load is loaded incorrectly?
2. How can such heavy cargo be loaded and shipped safely on the Great Lakes? How did you demonstrate safe vessel loading?
3. What is taconite? What does refinement mean? Why is refinement of low grade iron ore a good idea? What do miners do to taconite to make sure that most of the weight being shipped is actually iron ore?

Wisconsin Social Standards Addressed:

Geography, People, Places and Environments
A.2.9-Give examples to show how scientific and technological knowledge has led to environmental changes, such as pollution prevention measures, air-conditioning, and solar heating.

Historical Changes
B.2.3-Gather information/ask questions/discuss information as related to biographies, stories, narratives, and folk tales about important historical people.
B.2.4- Compare and contrast changes in contemporary life with life in the past by looking at social, economic, political, and cultural roles played by individuals and groups.
B.2.8- Compare past and present technologies related to energy, transportation, and communications and describe the effects of technological change, either beneficial or harmful, on people and the environment.

**Economics: Production, Distribution, Exchange, Consumption**

D.2.2- Identify situations requiring an allocation of limited economic resources and appraise the opportunity cost.
D.2.4- Give examples to explain how businesses and industry depend upon workers with specialized skills to make production more efficient.
Gather information about past and present technologies and ask questions regarding effects of technological changes.

**Economics**
D.2.2
Give examples of personal experience spending money/saving for a special object of activity.
D.2.6
Describe how households/families/businesses spend/earn money. Give examples of how businesses affect each other economically.

**Behavioral Sciences**
E.2.11
Investigate stories, folk tales, music, and other cultures.

Wisconsin Math Standards addressed:
A.2.3- Connect math to other subjects, personal experiences, current events, and personal interests.
A.2.5- Explain solutions to problems clearly and logically in oral and written work and support solutions with evidence.
C.2.3- Students will investigate properties and relationships by using physical materials and motion geometry.
E.2.4 Students will explore if future events are certain, impossible, more likely, or less likely to occur.

**Materials Needed**
A water table, large aquarium, or sink filled with several inches of water. (to be shared, one group at a time.) One observation and reflection log to be completed by each student with their team mates as they proceed through the activity.

**Student Readiness**
Students in Manitowoc, WI will have been exposed to the Balance and Motion Foss Science Unit before exploring this lesson. Many of them will also be participating in the Manitowoc Harbor History Unit. They have or will soon be constructing their own small schooner/clipper ship to sail in the Waterways Room at Wisconsin Maritime Museum in Manitowoc, Wisconsin. They are familiar with terms such as balance point and counter weights and they know how to take simple objects and determine whether or
not they have a natural balance point and/or whether the balance point can be changed by adding counter balances.

When first asked, students may think that a boat floats because it is properly balanced. To some extent they are correct. The term displacement will be new to them, and it may be best introduced as it relates to their understanding of balance. From there, it should be briefly explained that the submerged portion of the boat is taking up (has moved or “displaced”) an equally proportionate amount of water. That keeps the boat “balanced” and supported by the water. To keep the boat floating while loading, the boat must continue to displace an equal amount of water evenly across the surface that it is bearing down upon.

**Cultural/historical background**

As far back as the mid 1800's wooden schooners were used to transport various forms of cargo on the Great Lakes. A variety of vessel types have been developed through the years to meet increasing shipping needs. As engineering methods improved, shipping vessels such as wooden steamships, barges, and steel ships including self-unloaders, eventually replaced schooners in the continual quest to ship natural resources, such as iron ore and taconite, more efficiently.

Iron ore, in the form of taconite pellets, along with coal, grain, and stone comprise the highest percentage of dry bulk commodities shipped on the Great Lakes. Many resources and vessels compete for time and space in the Great Lakes Marine Transportation System (GLMTS). Finding ways to reduce the tendency to ship unnecessary material by-products and weight has contributed to the efficiency of Great Lakes shipping in terms of quantity shipped and costs.

Severe weather conditions, particularly in the month of November have historically proven to be a major cause of the early demise of many ships on Lake Michigan. However, a backward glance at history reveals that inclement weather is not always the root cause of shipping disasters.

On its upward journey just north of Whitefish Bay, the Cornell was hit midship by another steamer, the Crete, on September 8, 1936. The Cornell, part of the “College Fleet” of steamers allnamed after prestigious American universities, survived its only accident in a long career service of 60 years. Though the hit caused a major gash in its hull, the Cornell was hit above the water line. It managed to stay afloat and sail down bound to Manitowoc, Wisconsin for repairs.

In contrast, on October 12, 1907, the Cypress met with her own disaster and sunk only two short months after her initial launch (first sailing). The 420 foot long Cypress departed from ore docks at Superior, Wisconsin on October 11, carrying 15,000 tons of iron ore to Buffalo, New York, sailing directly into a storm. The captain of a passing vessel saw that the Cypress was making good time. However, she was leaving a noticeable “red wake” in her trail, which would indicated that water in its cargo hold was washing iron ore dust into the lake through its pumps. Abruptly, it rolled to its side. Years later, coincidentally, in August 2007, the wreck was located near Vermillion Point, almost 100 years after its launching.
Introducing the lesson

Play the ballad: Red Iron Ore (p.75 in Lake Rhymes, by Lee and Joann Murdock.) Ideally, read the ballad together, as well. Students will note new vocabulary in use. Context of the ballad will aid in understanding new vocabulary as well as establish a folk lore connection.

In order to sail safely on Lake Michigan, crews and sailors in times past had to watch their cargoes closely. The cargo on board a schooner in the 1800’s (or a 1,000 footer today) was very heavy and hard to move. Great care was taken to make sure the cargo was evenly loaded within the hold of the schooner. However, once on board a sailing vessel, high winds and choppy waters can move, or “displace” the cargo that is on board. If the cargo was unevenly distributed, this could make the ship list, or hog. The same rules of weight, balance, and displacement are important today when loading and sailing cargo on the Great Lakes Thousand Footers.

You may not know what those two words mean yet, but a sailor or crew member knows that a listing or hogging ship is a dangerous thing! The ship can eventually sink if the situation isn’t corrected! Today you will try your hand at being a sailor or crew member loading a barge. Let’s find out what these words mean, and why crew members, like you, try very hard to keep them from happening.

Background information for instructor

A perfectly displaced object or vessel such as a ship or barge can sink if it is improperly loaded, or unevenly distributed at any time during the loading or sailing venture. Knowing this, years ago, sailors vigilantly maintained their cargoes during transit, sometimes shoveling and/or moving portions of the cargo that shifted possibly due to wind and water turbulence. Turbulent weather was a frequent reason behind shifting cargo. Taconite (a low grade form of ore) has been a common cargo shipped on the Great Lakes throughout the years. Modern engineering efforts have resulted in the pre-shipping composition of taconite pellets that are spherical in shape and roughly ½ in. diameter. Their small size and spherical nature allows the pellets to almost automatically displace themselves during the loading process. However, monitoring the load during transit is still critical.

Student Introduction

Tell students about the wooden, three-masted schooner, The E.C. Roberts, built in Cleveland, Ohio in 1856. The E.C. Roberts sailed more than 50 successful years hauling a variety of good, including iron ore. Play the musical ballad, The Red Iron Ore. Print copies of the ballad so that students can easily follow along, by reading the verses. Some verses make direct reference to the grueling sailor’s job in times past of spreading and leveling the iron ore while it is poured into the E.C. Roberts. Even though today’s refined taconite pellets disperse themselves more easily during the loading process, they must be monitored to maintain a level vessel during the voyage.

Per loading team
1 rectangular sheet of dense Styrofoam (Approx. 4”w X 8”L X 1-1 ½ in. D)

Two or three rolls of pennies, or nickels to substitute as “taconite.” Whatever substitute is chosen, remain consistent and use something that is stackable.

**Team challenge**

Following a group discussion and consensus, each team is given one attempt to load as many pennies or taconite (if available) onto their barge as possible without sinking it. No credit is given if the accumulated load sinks before the team has agreed to stop loading.

**Procedure**

All members of the team must contribute to the initial discussion as well as the loading process. Team members may stop loading at any time to discuss a change of loading procedures if they wish, and only if the (Styrofoam) barge is still afloat. Once submerged, the team loading effort is over.

It is important that all teams use identical materials for loading, and barges that are identical in size and shape. Only in this way can the various teams observe that possible differences in load capacities that they were able to achieve in comparison to competing teams was due to differences in load technique, precision, and or awareness of displacement requirements at the outset of the experiment.

Each team must complete a team survey during the loading process and conduct a tally of their loading results. (See accompanying worksheet: *Cruising With a Cargo Crew.*)

Divide students into groups of no more than four.

This hands on activity allows students to experience the challenge of proper displacement moving cargo has resulted in modern changes.

**Extensions**

Create your own barge using different materials. It must be the same size or smaller (surface space) than the styrofoam barge used. Challenge yourself to create a barge that can hold more cargo (pennies) than the styrofoam barge.

**Assessment**

Assessment is action oriented. Student discussion during and after the activity further reveal what students process and learn along the way. Carefully watch for discussion oriented changes that occur in the student plan for loading. Participating in the cargo loading activity within a small group may reveal the following:

A loading plan, arrived at through group consensus before loading, that demonstrates an understanding of balance needed to keep the barge afloat and able to carry needed cargo (more than 20 pennies) without sinking the barge.
A new or revised group awareness of a displacement and imbalance issue may arise during the loading process. Students may reconvene, and agree to continue the loading process such that the weight is distributed more evenly. They will successfully load more than 20 pennies.

Group awareness of a displacement and imbalance issue may arise during the loading process, but members may not agree on a method to avert the problem. Sometimes, more than one solution is offered, but the group or an influential member of the group will proceed with the incorrect choice.

Listen carefully to group discussion to see if the choices arrived at reflect collective understanding, or if major choices seem to be based on the insights and influence of one individual. If the latter is true, a follow-up class discussion is essential.
Cargo Loading Challenge

Let’s make “cargo crews.” Your crew will have about 4 people in it. Each crew will load a Styrofoam barge with cargo “pennies.” We will see which cargo crew can load the most pennies on the barge. Crew members will take turns loading the pennies. Agree on a plan before proceeding. Everyone must be part of the plan. Everyone must participate in the loading process!

Describe a good plan for loading. Decide on a way to take turns so that everyone gets a chance to help load the cargo. Write the names of your cargo loading crew on the lines below. The written order will also be the loading order.

___________________________ ___________________________
___________________________ ___________________________

Each member on your loading crew must now make a prediction. How many pennies do you think your team will be able to load on the barge? Your members may agree on a number to write down, or you are free to write your own individual prediction, if you have a strong feeling that the group prediction is not correct.

I predict that we will be able to load___________ pennies on the Styrofoam barge before it lists, hogs, or sinks.

Each time a penny is added to the barge, record it with a tally mark. One tally mark per penny loaded:

When your cargo crew has agreed to stop loading, count your tallies and record the actual amount of pennies that you were able to successfully load. (Pennies that fell into the water do not count.)

We were able to load____________pennies. We loaded more/fewer pennies than I predicted. (Circle)

How many more?_____________ How many fewer?__________________

Show your work: (Start here if your prediction was larger than what you really loaded.)

My prediction: _________ Pennies loaded: ___________
Minus (-) _________ Minus (-) ___________
Pennies loaded: ___________ My prediction: ___________
Answer: ___________ Answer: ___________

Extension: If you could load the barge again, would you do anything differently?