

Lesson 2: Cost Comparison of Maritime Shipping vs. Semi-Truck Transportation

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Science and Language Arts
Target grade: 6-8 science
One class period



Lesson overview: The following lesson is aimed at teaching about the shipping industry, the geography of Lakes Superior and Huron, the geology of iron ore, and math as an extension exercise. This lesson is written for the science portion, but with not much effort, could be expanded into full language arts, and social studies units.

Objectives:

Students will :

1. Examine taconite pellets,
2. Compare costs of shipping vs. truck.
3. Find and read the ships' statistics so that they can determine the boats' length, cargo, age, and etc.

Safety considerations: Students will need to wear safety goggles when breaking the taconite pellets with the hammer. They will need to hammer on a hard surface. The taconite will need to be placed in a baggie before it is broken. Students will need to know the proper use of a microscope. Care should be taken when preparing the slides.

Materials:

1 per person:

taconite pellet, baggies, hand lenses, safety goggles
1 per class:
hammer, slides, microscope

State of Michigan Middle School Science Benchmarks

I.1.MS.1

Generate scientific questions about the world based on observation.

I.1.MS.2

Design and conduct scientific investigations.

I.1.MS.3

Use tools and equipment appropriate to scientific investigations.

I.1.MS.5

Use sources of information in support of scientific investigations

I.1.MS.6

Write and follow procedures in the form of step-by-step instructions, formulas, flow diagrams, and sketches.

II.1.MS.2

Describe limitations in personal knowledge.

II.1.MS.3

Show how common themes of science, mathematics, and technology apply in real-world contexts.

II.1.MS.4

Describe the advantages and risks of new technologies.

II.1.MS.5

Develop an awareness of and sensitivity to the natural world.

II.1.MS.6

Recognize the contributions made in science by cultures and individuals of diverse backgrounds.

III.5.MS.6

Describe ways in which humans alter the environment.

IV.1.MS.1

Describe and compare objects in terms of mass, volume, and density.

IV.3.MS.3

Describe the non-contact forces exerted by magnets, electrically charged objects, and gravity.

V.1.MS.5

Explain how technology changes the surface of the Earth.

V.2.MS.2

Describe how water in Michigan reaches the oceans and returns.

Vocabulary:

- Banded iron formations are a distinctive type of rock often found in old sedimentary rocks. The structures consist of repeated thin layers of iron oxides, either magnetite or hematite, alternating with bands of shale and chert.
- Bentonite a type of clay
- Chert a silica rich rock
- Flux a mineral added to the metals in a furnace to promote fusing or to prevent the formation of oxides.
- Hematite an iron oxide material
- Iron ore are rocks and minerals from which metallic iron can be economically extracted.
- Magnetite an iron oxide material
- Oxidize the loss of an electron. In iron, this causes rusting.
- Precambrian A geologic time period occurring about 5 billion to 570 million years ago. Precambrian time includes 80% of the earth's history.
- Shale a rock composed of layers of claylike, fine-grained sediments.
- Silica a hard, glassy mineral

Background Information: Taconite is an iron-bearing, high-silica, flint-like rock. It is a Precambrian sedimentary rock referred to as a banded iron formation due to the typical alternating iron-rich layers and shale or chert layers. The very finely dispersed iron content, present as magnetite, is generally 25 to 30%. In the late 19th and early 20th centuries, iron ore was of such high quality that taconite was considered an uneconomic waste product. After World War II, most of the high-grade ore in the United States had been mined out, and so taconite was turned to as a new source of iron. To process taconite, the ore is ground into a fine powder, the iron is separated from the waste rock by using strong magnets, and then the powdered iron concentrate is combined with bentonite clay and limestone as a flux and rolled into pellets about one centimeter in diameter that are approximately 65% iron. The pellets are heated to very high temperatures to oxidize the magnetite (Fe_3O_4) to hematite (Fe_2O_3) for further processing.

The Mesabi Iron Range region in Minnesota is a major production area. The taconite iron concentrate is shipped by railroad through Silver Bay, Two Harbors and the Twin Ports of Duluth, Minnesota and Superior, Wisconsin, all on Lake Superior. The ore is generally shipped to other locations on the Great Lakes. Many steel making centers are located near Lake Erie. From about 1900 through 1992, great machines called Hulett ore unloaders performed the task. Self-unloading ships later made the Huletts obsolete. (from <http://www.answers.com/topic/>)

Pre-assessment: Have students answer the focus question, then discuss their opinions as a class. Write down responses on the board. Students should include trucking, boats, railroad, etc. In the Great Lakes, shipping by boat is called Maritime Shipping.

Focus question: What do you think of when you hear the word, “shipping?”

Attention getter: Hand out samples of taconite to every student. Have them examine it with hand lenses and try to determine what it is.

Describe activity: Students will answer the focus question and discuss their answers as a class. They will then be given taconite pellets to examine. Write down their responses on the board. Eventually, they will be told that these are the same kind of iron ore pellets that were in the Edmund Fitzgerald when it went down in 1975.

Students will place their pellets in a baggie, break them with a hammer and examine them using hand lenses and microscopes. The teacher may either prepare slides to save time, or allow students to practice their skills at making their own slides. Students will write down their observations and then discuss them as a class.

Students will be given the following math question:

One boat can carry cargo equivalent to 5-6 trains, or 500-600 train cars. Each train car holds the equivalent to 3 semi truckloads. 1800 semis = 1 boat. Boats get 45-50 gallons per mile.

1. Determine the miles per gallon of a ship.
2. If a truck could get 10 mpg, how does the gas mileage compare between semis and ships?
3. Which is more economically feasible?

- Students can extrapolate that into how many semis could be removed from the freeways and be replaced by a single boat, then think about the traffic congestion and potholes, car/truck accidents, lines at the bridge, etc.
- If ships at capacity can normally carry that much cargo, but are forced to NOT load to capacity due to low water levels, what can be done? (Raise water levels, or lower the lakebed - dredging the lakes.) Where do they put the dredged materials? (On shore in a confined area, which can later be built upon as a new dock or for recreation, housing, etc.)

Once students have answered that question, they may be encouraged to write a class letter to their state representative or Carl Levin, one of our state senators who supports the shipping industry, about how they support dredging of the Great Lakes.

Extensions:

Students may:

- visit duluthport.com to watch the ships come into Duluth Harbor.
- view the images of ships being loaded and unloaded and discuss the methods used.
- find how many crew is on board one of these huge vessels.
- determine the cargo and where it is going by using the websites given.

Assessment: Focus question answers, teacher observation, student reflections, math accuracy.

Resources:

<http://www.answers.com/topic/> - Site for definitions.

<http://duluthport.com/> shipping news and links as well as many photos of the ships loading or unloading cargo.