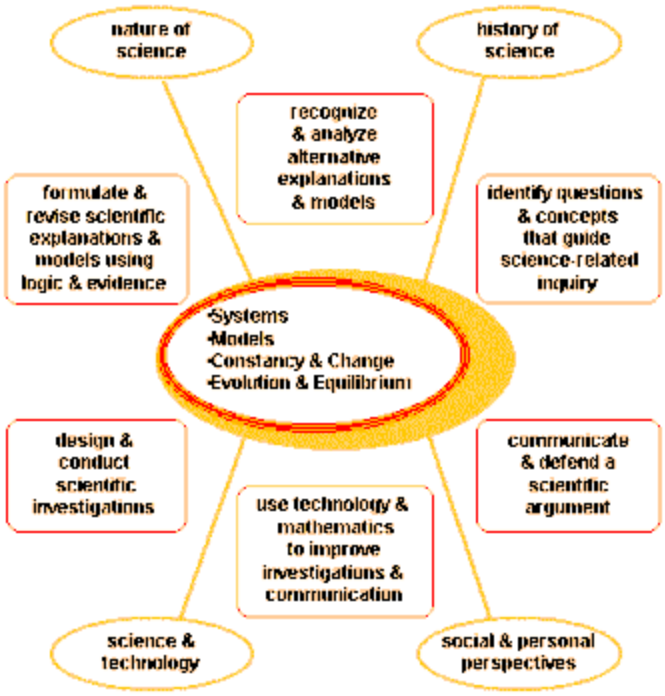
Marine Bulk Cargo Transportation Design

LEARNING AREA: Mathematical Concepts
EDUCATIONAL LEVEL: High School
CONTENT STANDARD: Technical Applications

STANDARD:

*Demonstrate knowledge of computational technology.
*Create a set of plans to design a product.
*Construct a model to mathematical specifications.
*Analyze product for optimizing function.

LARGE PROCESSES/CONCEPTS:



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ASSESSMENT TASK: Marine Bulk Cargo Transportation Design

DESCRIPTION: Design and build a functional scale model marine bulk cargo transportation container (barge). Evaluate the barges performance, determine its full capacity by weight and volume and it's flow efficiency.

PRODUCTS/EVIDENCE OF LEARNING:

-Create a scale drawing.
-Construct a paper prototype.
-Construct a working model.
-Field engineering of product.
-Analyze field engineering data.
-Comparison of results with others.
-Demonstration of knowledge of vocabulary relevant to marine transportation and mathematical computations.

OVERVIEW:
Each student will design and build a scale model barge which would float a load from one point to another. Floatation factors of an empty container and a maximum filled container as well as various forms of materials with varying densities, positions of loads will also be evaluated for buoyancy and flow efficiency. In the design process, the restriction of water depth and widths and lengths of a typical lock system controlled by the US Army Corps of Engineers will need to be considered.

The barge could be made of various materials such as; wood, plastic (Styrofoam, sheet plastic-vacuum forming, composites), or metal. Waterproof adhesives will be required for glued models, soldering or welding could be methods of assembling and waterproofing metal models.

PROCEDURES:

1. Research data relevant to marine transportation and support systems from Minneapolis to Winona.(see reference suggestions).
2. Define common marine terminology listed on the vocabulary sheet. See figure 1 below.
3. Complete the size limitations section of the data sheet. See figure 2 below.
4. Create a design, sketch and scale drawing of a barge.
5. Complete the design specification section of the data sheet (fig. 2).
6. Select type and quantity of materials for model construction.
7. Determine method of construction of selected material.
8. Complete a safety test for the use of tools and equipment required to build model.
9. Construct model.
10. Complete the test section of the data sheet for the following:

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a. Determine dry weight of barge.
b. Select cargo type to be transported for ex; sand, sugar, salt, marbles.
c. Determine volume and weight of cargo material.
d. Determine weight per given volume(ex: fill a small paper cup).
e. Test barge for seaworthiness(does it leak!)
f. Measure draft of empty barge.
g. Determine flow efficiency of empty barge.

1. Fill with water in a long enough container to allow for a measurable distance.
2. Attach a spring scale to the container to record the force applied as it is pulled through the water.
3. Using a stop watch, record the time it takes to travel the predetermined distance.

h. Add cargo in determined amount of unit increments as cargo is added.
i. Keep adding cargo until the barge becomes unstable(it sinks).
j. After achieving optimum buoyancy stabilization do another flow test and record your findings on the data sheet.

11. Remove all cargo and clean up the area.
12. Calculate the test data using the formula for power. **Force x Distance / Time.**
13. Write a brief summary of observations of design, buoyancy and flow efficiency.
14. Compare findings with classmates and evaluate optimum hull designs.

FIGURE 1
Marine transportation terms:

Draft
Hull
Displacement hull
Bow
Stern
Port
Port side
Starboard side
Lock
Dam
Cargo

FIGURE 2
DATA SHEET
Limitations:

Waterway depth _____

Lock width_____
Lock length_____

Design specifications:

Width _____
Length _____
Draft _____
Volume _____
Weight _____

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TEST RESULTS:

Empty

Distance covered _____
Time elapsed _____
Force required _____
Distance x Force / Time =_____(power)

Full

Distance covered _____
Time elapsed _____
Force required _____
Distance x Force / Time = _____(power)

CHECK LIST: Marine Bulk Cargo Transportation Design

STUDENT	TEACHER	
_____	_____	**1.** List of references researched
_____	_____	**2.** Sketch of barge
_____	_____	**3.** Scale drawing of barge
_____	_____	**4.** Tool/equipment use safety test
_____	_____	**5.** Model constructed
_____	_____	**6.** Completed data sheet
_____	_____	**7.** Written analysis and summary of weight and draft data
_____	_____	**8.** Written evaluation of vocabulary and mathematical computations

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