



Cross Curricular Activity: Traveling on the River

Type of Teacher Tool: Whole class, small group

Targeted Grade Level(s): 5-8

Targeted Curriculum Areas: Transportation, physics, engineering, STEM

Learning Objectives:

The learner will:

1. Explain the basic operation of a dam and lock system.
2. Know that dam and lock systems are used to aid in river navigation.
3. Know that engineers use Pascal's law when designing dam and lock systems.
4. Create a drawing of a lock and dam to demonstrate understanding of the principles involved.

Featured National Standards:

1. NGSS: Next Generation Science Standards - Science
 - Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. (Grades 6 - 8)
2. Common Core State Standards - Math
 - Write, read, and evaluate expressions in which letters stand for numbers. (Grade 6)
3. International Technology and Engineering Educators Association - Technology
 - Knowledge gained from other fields of study has a direct effect on the development of technological products and systems. (Grades 6 - 8)
 - The design and construction of structures for service or convenience have evolved from the development of techniques for measurement, controlling systems, and the understanding of spatial relationships. (Grades 6 - 8)

Resources/Materials Needed:

1. Educate.Today Videos
 - [Environment 19: Rivers and Transportation of Goods](#)
 - [Transportation 21: How Locks and Dams Work on the Mississippi River](#)
 - [Transportation 22: Using Locks and Dams to Maintain Navigational Channels](#)

- **Transportation 23: How Barges Go Through Locks and Dams**

2. KWL chart on the board (Included at the end of this document)
3. Visual of How Dams and Locks systems work (Included at the end of this document)
4. Materials for completing the drawings: paper, pencils, rulers, erasers, and vocabulary definitions.
5. Vocabulary covered:
 - dam: A barrier to obstruct the flow of water, especially one made of earth, rock, masonry and/or concrete, built across a stream or river.
 - engineer: A person who applies her/his understanding of science and mathematics to creating things for the benefit of humanity and our world.
 - gravity: An invisible force of a mass being attracted to another mass. For example, the Earth's mass pulls you down so you stay on the ground instead of flying away.
 - lock: An enclosed chamber in a waterway with watertight gates at each end, for raising or lowering vessels from one water level to another by admitting or releasing water.
 - Pascal's law : A hydrostatics principle that says that for all points at the same absolute height in a body of a fluid, the pressure is the same, even if additional pressure is applied on the fluid at some place.
Pascals Law: $P = \rho gh$
 $P = \text{Pressure (Pa = N/m}^2\text{)}$
 $\rho = \text{Density of Fluid (Water = 1000 kg/m}^3\text{)}$
 $g = \text{Gravity (9.81 m/s}^2\text{)}$
 $h = \text{Depth (m)}$
 - pressure: The exertion of force upon a surface by an object, fluid, etc., in contact with it. Expressed as force per unit area.

Teacher Instructions:

Pose the question: What is a lock and dam system? Have you heard of or seen a system like this? What do you know about it? Record the discussion answers in the K (Know) column of the chart. Move to the W (Want to know) column of the chart and record their responses. For example: they may want to know why a lock and dam is necessary, how the water moves into the chambers...)

1. View the Educate.Today videos that explain how the Melvin Price system of dams and locks operate.
2. Display the Visual and discuss the system, as demonstrated in the Transportation-21 video. (Boats and ships get through a waterway by going into a lock, which is a big chamber in the water with moveable gates at each end, then waiting as a valve is opened and the water from that lock flows into the next lock (or next body of water if just one lock), raising or lowering the boat automatically. The boats continue into the next lock, and so on, until they reach the end of the dam and lock system. A series of locks enable river vessels to "step" up or down a river or canal from one water level to another.)

3. Class Discussion: Ask students the following questions. Listen to their answers and record them in the L (Learned) column them on the board. Make sure the vocabulary is part of the discussion.
- What is the purpose of a dam and lock system? (Answer: To raise and lower boats between stretches of water of different levels on waterways.)
 - How is gravity involved in dam and lock systems? (Answer: Gravity is a factor in how boats move through dam and lock systems by how it moves and drains water, which raises and lowers the boats in the locks.)
 - In what situations might construction of a lock improve river or canal navigation? (Possible answers: Locks help commercial boats and barges navigate past sandbars, rapids, waterfalls, temporarily low water, changing riverbed elevations and dams.)
 - If we didn't have dam and lock systems, how might we move boats through these waterway obstacles? (Possible answer: We could design and build boatlifts, and some places have boatlifts. But, locks make more sense for big ships [imagine cruise ships, ocean tankers, cargo ships] and barges; locks let water and gravity do the heavy work of moving the vessels.)
 - What must engineers consider about water pressure so the dam and lock systems they design are safe, strong and reliable? (Answer: As the elevation of water behind a dam increases, its height and density causes increasingly high pressure at the bottom of the dam. Water pressure also affects the walls and gates of locks. Engineers must estimate and take this pressure under consideration in order to make dam and lock structures watertight and strong enough to stand up to the water pressure forces.)
4. Review Pascal's Law and discuss how it applies to the lock and dam system. Pascal's law describes how water at a given depth exerts the same (equal) pressure in all directions. Something else we know about water pressure — the deeper the water, the greater the water pressure. For example, at a depth of five meters from the surface, the water pressure is half as great as it is at a depth of 10 meters from the surface.
5. Engineering Drawings: Once students understand how lock and dam systems work, ask them to create preliminary drawings as if they were a team of engineers designing a system for their municipality client. Require that the drawings illustrate where along a river the dam and lock structure will be built, the dimensions of the structure and the number of locks in the structure. For an added challenge; constrain the students' designs, tell them that the river is 50m wide and 8m deep, and the largest vessel permitted to pass through is 10m long. Or consider introducing the challenge of preserving the existing natural environment to allow animal and plant species to survive.

Extension Activity Options:

- Students could create a working model of a simple lock and dam system to show how components work together.
 1. The model could be made of cardboard or recycled items such as shoeboxes, plastic cartons, etc. It need not hold water.

- Students could find ways to demonstrate Pascal's Law with everyday objects by experimenting and explaining their reasoning.
 1. Some possibilities include using a clear plastic quart bottle with holes punched at different levels, or showing how a small hole in a ketchup packet allows the ketchup to be pressed out no matter how you squeeze it.

Assessment/Evaluation Options:

1. Drawings should clearly illustrate understanding of the principles listed in the vocabulary, as well as showing creative problem solving and teamwork capabilities. Consider using a rubric like the sample on the next page to evaluate the student's work.

Engineering and Design Process Intermediate Rubric

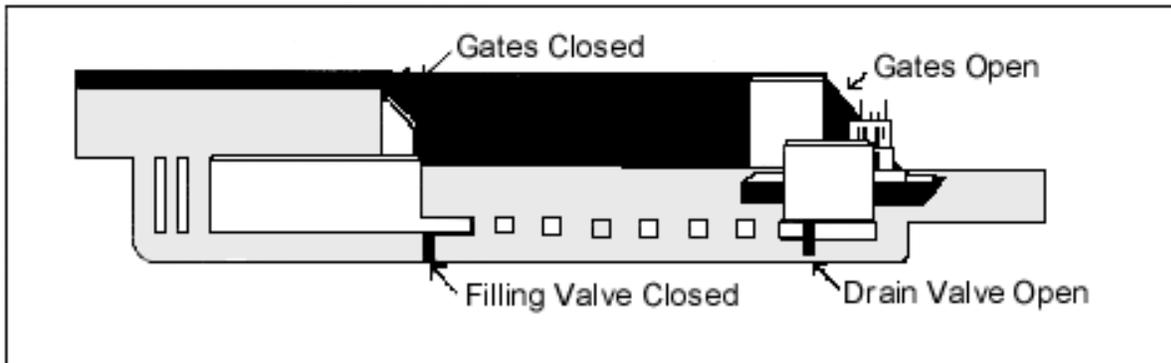
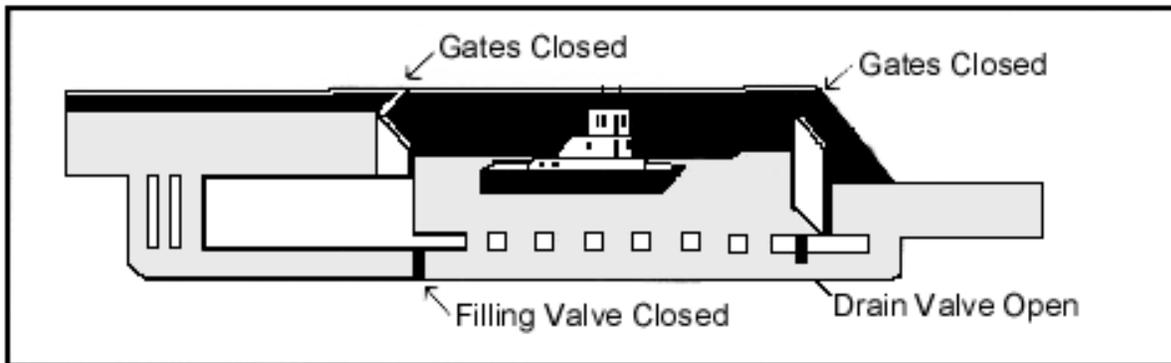
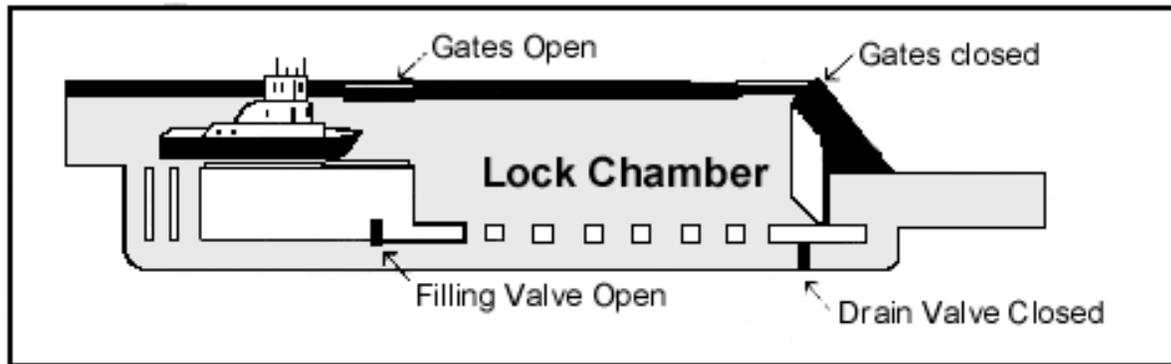
Student's name: _____ Date: _____

Project: _____ Average: _____ out of 4

<u>Key</u> Beginning - experiences difficulty even with teacher prompting Developing - inconsistent and/or requires teacher prompting Accomplished - consistent with little to no teacher prompting Exemplary - consistent and independent	Student Evaluation	Teacher Evaluation
Ask		
Carefully consider the investigation guidelines.		
Thoughtfully discuss multiple relevant and interesting questions for further exploration.		
Determine multiple team or individual goals in response to your questions.		
Imagine		
Without teacher guidance, generate and explore numerous ideas, responses, or solutions.		
Independently generate clever, unique, or unusual ideas.		
Work with teammates to imagine many different possible solutions to the team's questions and the design challenge.		
Independently perceive and accept the team's many differing positions and points of view.		
Plan		
Critically evaluate the purpose of every detail of the design.		
Keep detailed records and sketches of design possibilities, plans, and revisions.		
Conduct research and use prior knowledge as a foundation for prototype plans.		
Create		
Persevere to create a functioning prototype.		
Creatively and responsibly use materials and resources.		
Improve		
Without teacher guidance, self-critique the prototype and analyze all design flaws.		
Suggest multiple solutions to problems, or multiple ways to improve the efficiency or quality of the prototype.		

Source: <https://www.slideshare.net/cmitton/engineering-design-rubric>

How a Dam and Lock System Works



To move a ship or boat going downstream to a lower water level, the lock is filled by opening the filling valve. Then the drain valve and upstream and downstream gates are closed so the chamber water level rises to the upstream level. Then upstream gate opens and the boat moves in. To lower the boat, the gates are closed behind it, the filling valve is closed, and the drain valve is opened. The higher water in the lock chamber drains to the downstream level in a few minutes. Then the downstream gate is opened and the water vessel moves out on the lower water level. The process is reversed for a ship or boat going upstream.

Source: US Environmental Protection Agency, Gulf of Mexico Program, <http://www.epa.gov/gmpo/edresources/locks.html>

Name _____ **K.W.L Chart** Date _____

Topic _____

What I Know	What I Want to Know	What I Have Learned

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