Lesson Focus

Lesson focuses on the different uses of dams and how they are engineered. Students work in teams to develop a system of damming water in a trough. The system must completely hold back the water and also have a way of executing a controlled release.

Lesson Synopsis

The "Engineer a Dam" activity explores the function and engineering of dams and how they have many uses and solve many problems in the world. Students work in teams to engineer their own dam structure in a classroom water trough that has the ability to release water in a controlled manner, as might be used in irrigation. Students present their plans to the class, execute and test their dams, and reflect on the experience.

Age Levels

8-18.

Objectives

- Learn about dams.
- Learn about engineering design and redesign.
- Learn how engineering can help solve society's challenges.
- Learn about teamwork and problem solving.

Anticipated Learner Outcomes

As a result of this activity, students should develop an understanding of:

- dams
- structural design and engineering
- engineering design
- teamwork

Lesson Activities

Students explore the multiple uses of dams and how they solve problems. They learn about different types of dams, consider material options, build a dam in a classroom water trough, test it, and share their experiences with the class.

Resources/Materials

- Teacher Resource Documents (attached)
- Student Resource Sheet (attached)
- Student Worksheet (attached)

Alignment to Curriculum Frameworks

See curriculum alignment sheet at end of lesson.

Internet Connections

- TryEngineering (www.tryengineering.org)
- Building Big - All About Dams (www.pbs.org/wgbh/buildingbig/dam)
- GeoGuide: Dams (geoknow.net/pages/dams.html)
- Hydroelectric Power (www.eia.doe.gov/kids/energy.cfm?page=hydropower_home-basics)
- Tennessee Valley Authority (www.tva.gov/Energy/Our-Power-System/Hydroelectric)

Recommended Reading

- Dams (Library of Congress Visual Sourcebooks) (ISBN: 978-0393731392)
- Hoover Dam: An American Adventure (ISBN: 978-0806122830)
- Hydroelectric Power: Power from Moving Water (ISBN: 978-0778729341)

Optional Writing Activity

- Write an essay or a paragraph about how dam construction can impact the environment. What are the ethical considerations an engineering team must consider when constructing a dam or any other structure that has an impact on the environment.

Optional Extension Activity

- Have older or more advanced students should explore how hydroelectricity is generated and consider how they might generate power from the release of water in their classroom dams.

For Teachers: Teacher Resource

Lesson Goal

The "Engineer a Dam" activity explores the function and engineering of dams and how they have many uses and solve many problems in the world. Students work in teams to engineer their own dam structure in a classroom water trough that has the ability to release water in a controlled manner, as might be used in irrigation. Students present their plans to the class, execute and test their dams, and reflect on the experience.

Lesson Objectives

- Learn about dams.
- Learn about engineering design and redesign.
- Learn how engineering can help solve society's challenges.
- Learn about teamwork and problem solving.

Materials

- Student Resource Sheets
- Student Worksheets
- Classroom Materials: water, measuring cup
- Student Team Materials: water trough or long plastic planter, gravel or sand (for "river" base), cardboard, pvc pipes, tape, foil, plastic wrap, cups, straws, paper clips, wooden dowels, cotton balls, plastic sheets, clothes pins, wire, string, screen, fabric, springs, other readily available materials.

Procedure

1. Show students the student reference sheets. These may be read in class or provided as reading material for the prior night's homework.
2. To introduce the lesson, discuss how engineers solve problems and how a dam can create an energy source as well as redirect water to areas of greater need. Talk about how redirecting or holding back water may impact the environment in a local area. Discuss ethical considerations engineers must consider before building any structure.
3. If possible, have students explore the forces, materials, loads, and shapes lab at the Building Big - All about Dams website and have them consider that they learn before developing their dam design. (www.pbs.org/wgbh/buildingbig/lab/)
4. Teams will consider their challenge and draw a diagram of their planned dam.
5. Teams next construct their dams within their trough -- the base of the trough will have a layer of gravel or small rocks that must not be removed. Teams may request additional materials or parts which surface during the construction process.
6. Teams test their dams with teacher supervision, and must hold back 5 liters of water. Dams must also allow for a controlled release of some of the water. Teams must be able to demonstrate allowing water to flow, then stop, then flow again.
7. Students complete a reflection sheet and share their experiences with the class.

Time Needed

Two to three 45 minute sessions.

Student Resource: Dams

Dams can be formed by people, natural causes, or by animals such as beavers. They serve Dams serve many purposes including storing water to be used later for drinking or irrigation; diverting water from one place to another, such as from a stream to a river; detention to contain sediment or other unwanted materials. Sometimes dams are used to keep water in, and sometimes to keep water out! Some people construct emergency dry dams to keep water out of basements during a heavy rainstorm or flood.

Sometimes when a new dam is created, the people who lived in the surrounding area must be displaced. Millions of people have been displaced to make way for the construction of dams around the world. Of course, many more people have benefited from clean water, crops that have enough water, and the power generated from hydroelectric power plants.

Some dams include "fish ladders" so that fish that migrate can still get to their destination. They are constructed to help fish get up-stream over a dam or a natural barrier so they can reach spawning grounds. You can see an example to the right.

Other dams feed water in a controlled flow to hydroelectric power plants. In a simple sense, the way this works is that a dam is built on a river -- usually one with a drop in elevation so that water released from the dam uses gravity to support the water flow. At the bottom will be a water intake area that leads to a turbine propeller. The propeller moves when the force of the moving water hits it and a shaft from the turbine goes up into the generator, which produces power that is then delivered to homes and businesses via power line. You can read more about hydroelectric power on the Tennessee Valley Authority website (www.tva.gov/Energy/Our-Power-System/Hydroelectric).

Student Worksheet: Applying Technology to Solve Problems

◆ Engineering Teamwork and Planning

You are part of a team of engineers given the challenge of building a system to dam up 5 liters of water in a classroom trough. You'll have lots of materials to use such as cardboard, PVC pipes, tape, foil, plastic wrap, cups, straws, paper clips, wooden dowels, cotton balls, plastic sheets, clothes pins, wire, string, screen, fabric, springs, other readily available materials.

You have a base of gravel at the bottom of the trough which simulated the rocky or sandy bottom of a river bed. You'll need to not only stop the water, but develop a system so that you can release a little at a time in a controlled way. You'll need to stop the water, let a little come through, and stop it again.

◆ Research Phase

If internet access if available, explore the forces, materials, loads, and shapes lab at the Building Big - All about Dams website and have them consider that they learn before developing their dam design. (www.pbs.org/wgbh/buildingbig/lab)

◆ Planning and Design Phase

Think about the different ways you can use the materials provided to stop the water flow. Also, consider what mechanism you might create that would allow a little water to come through when you want it to. On a separate piece of paper, draw a diagram of your planned dam. In the box below make a list of the parts you think you might need. You can adjust this later and also add more materials during construction.

Material Needed:

Student Worksheet:

◆ Construction Phase

Build your dam in your water trough or plastic flower box. You can test it with a little water before the full 5 liters are poured in by your teacher. Make any adjustments during construction that you like, including asking for additional materials you might need. You can also trade materials with other teams if they have extra items you need.

◆ Classroom Testing

Your teacher will test each of the dams created in your class. They will look to see if any water escapes through the dam and also if you are able to stop - start - and stop the flow. Be sure to watch as the dams made by other teams are tested so you can evaluate their designs and see what methods worked best. Complete the chart below showing your results -- 30 points is the highest score.

Engineer a Dam Scoring

1. Did your dam hold the water back?

- ☐ 10 points: yes…no water escaped
- ☐ 5 points: some water escaped but less than a liter
- ☐ 0 points: dam did not hold

2. Were you able to release water and then stop it again?

- ☐ 10 points: yes
- ☐ 0 points: no

3. Did your team work collaboratively on this project with everyone sharing in the planning and construction?

- ☐ 10 points: yes
- ☐ 0 points: no

Total Score: _____

Student Worksheet:

◆ Evaluation

Complete the evaluation questions below:

1. How similar was your original design to the actual dam you built?

2. If you found you needed to make changes during the construction phase, describe why your team decided to make revisions.

3. If you had a chance to do this project again, what would your team have done differently?

4. Do you think you could have achieved the goal of this lesson using fewer parts or pieces of material than you did?

5. Do you think that this activity was more rewarding to do as a team, or would you have preferred to work alone on it? Why?

6. If you could have used one additional material (tape, glue, wood sticks, foil -- as examples) which would you choose and why?

7. Can you think of any possible negative effects of a new dam on the ecosystem of a region?

For Teachers: Alignment to Curriculum Frameworks

Note: Lesson plans in this series are aligned to one or more of the following sets of standards:

- U.S. Science Education Standards (http://www.nap.edu/catalog.php?record_id=4962)
- U.S. Next Generation Science Standards (http://www.nextgenscience.org/)
- International Technology Education Association's Standards for Technological Literacy (http://www.iteea.org/TAA/PDFs/xstnd.pdf)
- U.S. National Council of Teachers of Mathematics' Principles and Standards for School Mathematics (http://www.nctm.org/standards/content.aspx?id=16909)
- U.S. Common Core State Standards for Mathematics (http://www.corestandards.org/Math)
- Computer Science Teachers Association K-12 Computer Science Standards (http://csta.acm.org/Curriculum/sub/K12Standards.html)

◆National Science Education Standards Grades K-4 (ages 4-9)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- Abilities necessary to do scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of the activities, all students should develop an understanding of

- Properties of objects and materials
- Position and motion of objects

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop

- Abilities of technological design
- Understanding about science and technology
- Abilities to distinguish between natural objects and objects made by humans

CONTENT STANDARD F: Science in Personal and Social Perspectives

As a result of activities, all students should develop understanding of

- Science and technology in local challenges

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of

- Science as a human endeavor

◆National Science Education Standards Grades 5-8 (ages 10-14)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- Abilities necessary to do scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of their activities, all students should develop an understanding of

- Motions and forces
- Transfer of energy

CONTENT STANDARD E: Science and Technology

As a result of activities in grades 5-8, all students should develop

- Abilities of technological design
- Understandings about science and technology

For Teachers: Alignment to Curriculum Frameworks

◆National Science Education Standards Grades 5-8 (ages 10-14)

CONTENT STANDARD F: Science in Personal and Social Perspectives

As a result of activities, all students should develop understanding of

- Populations, resources, and environments
- Risks and benefits
- Science and technology in society

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of

- Science as a human endeavor

◆National Science Education Standards Grades 9-12 (ages 14-18)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- Abilities necessary to do scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of their activities, all students should develop understanding of

- Motions and forces
- Interactions of energy and matter

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop

- Abilities of technological design

CONTENT STANDARD F: Science in Personal and Social Perspectives

As a result of activities, all students should develop understanding of

- Personal and community health
- Natural resources
- Environmental quality
- Natural and human-induced hazards
- Science and technology in local, national, and global challenges

◆Next Generation Science Standards Grades 2-5 (Ages 8-11)

Engineering Design

Students who demonstrate understanding can:

- 3-5-ETS1-1.Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- 3-5-ETS1-2.Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- 3-5-ETS1-3.Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

For Teachers: Alignment to Curriculum Frameworks

◆Next Generation Science Standards Grades 6-8 (Ages 11-14)

Engineering Design

Students who demonstrate understanding can:

- MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

◆Next Generation Science Standards Grades 9-12 (Ages 14-18)

Engineering Design

Students who demonstrate understanding can:

- HS-ETS1-2.Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

◆Standards for Technological Literacy - All Ages

The Nature of Technology

- Standard 1: Students will develop an understanding of the characteristics and scope of technology.
- Standard 3: Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

Technology and Society

- Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.
- Standard 5: Students will develop an understanding of the effects of technology on the environment.

Design

- Standard 9: Students will develop an understanding of engineering design.
- Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

Abilities for a Technological World

- Standard 11: Students will develop abilities to apply the design process.
- Standard 13: Students will develop abilities to assess the impact of products and systems.

The Designed World

- Standard 16: Students will develop an understanding of and be able to select and use energy and power technologies.
- Standard 20: Students will develop an understanding of and be able to select and use construction technologies.