Engineer a Dam

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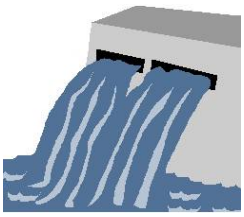


Lesson Focus

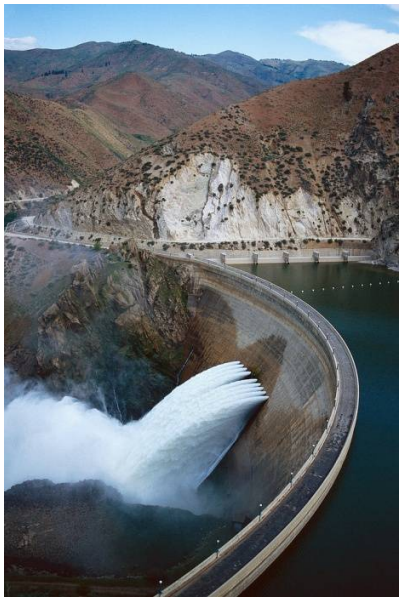
Lesson focuses on the different uses of dams and how they are engineered. Students work in teams to develop a system of damming water in a trough. The system must completely hold back the water and also have a way of executing a controlled release.

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.

Year Levels

Year 7 – Term 2 (Forces), Term 3 – (Renewable resources); Year 8 – Term 3; Year 10 – Term 3



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 (www.nationalgeographic.com/resources/ngo/education/geoguide/dams/)
- Hydroelectric Power (www.eia.doe.gov/kids/energy.cfm?page=hydropower_home-basics)
- Curriculum links (www.acara.edu.au)

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.**

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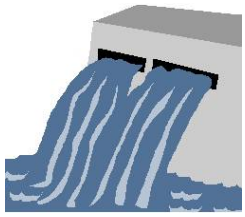

For Teachers: Teacher Resources

◆ 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 litres 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.

Engineer a Dam

Student Resource: Dams

Dams can be formed by people, natural causes, or by animals such as beavers. 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.

Hydro Electricity has a history of development in Australia and is currently the largest supplier of Australia's renewable energy. Tasmania and The Snowy Mountains have Australia's largest Hydro Electricity operations.

There is still scope within Australia for deployment of small scale hydro electricity plants that can generate power from streams and rivers without requiring a dam. Small scale hydro electricity stations can be constructed on pre existing dams or use water diverted from a flowing river. The small scale application of hydro electricity can have less impact on river and stream systems because a dam may not be required.

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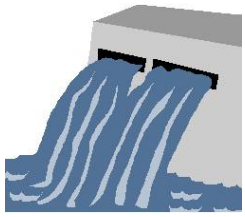
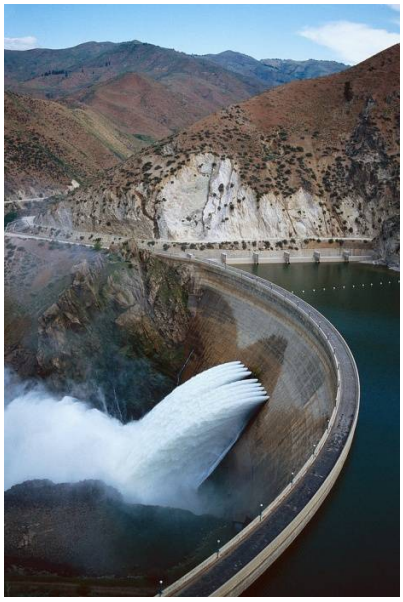


Student Worksheet:
Applying Technology to Solve Problems

◆ Engineering Teamwork and Planning



You are part of a team of engineers given the challenge of building a system to dam up 5 litres 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

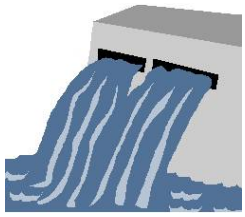
If internet access if available, explore the forces, materials, loads, and shapes lab at the Building Big - All about Dams website and have them consider that they learn before developing their dam design. (www.pbs.org/wgbh/buildingbig/lab)

◆ 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:

Engineer a Dam



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 litres 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: _____

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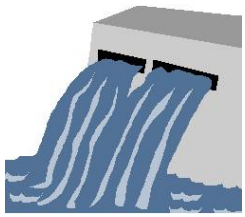

Student Worksheet:

◆ **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?

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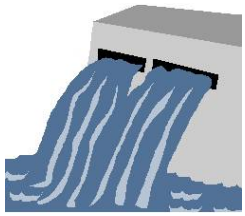

For Teachers:
Alignment to Curriculum Frameworks

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◆Australian Curriculum – Science (Year 7)

Science Understanding

ACSSU117 – Change to an objects motion is caused by unbalanced forces acting on the object

ACSSU116 – Some of Earth's resources are renewable, but others are non-renewable

ACSSU222 – Water is an important resource that cycles through the environment

Science as a Human Endeavour

ACSHE223 – Science knowledge can develop through collaboration sand connecting ideas across the disciplines of science

ACSHE120 – Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other e=areas of society and involve ethical considerations

ACSHE224 – People use understanding and skills from across the disciplines of science in their occupations

Science Inquiry Skills

ACSIS125 - Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed

ACSIS126 – In fair tests, measure and control variables, and select equipment to collect data with accuracy appropriate to task

ACSIS130 – Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions

ACSIS131 – Reflect on the method used to investigate a question or solve a problem, including evaluating the quality of the data collected, and identify improvements to methods

ACSIS133 – Communicate ideas, findings and solutions to problems using scientific language and representations using digital technologies as appropriate

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For Teachers:
Alignment to Curriculum Frameworks

◆Australian Curriculum - Science (Year 8)

Science Understanding

ACSSU155 – Energy appears in different forms including movement (kinetic energy), heat and potential energy, and causes change within a system

Science as a Human Endeavour

ACSHE226 – Science knowledge can develop through collaboration sand connecting ideas across the disciplines of science

ACSHE135 – Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other e=areas of society and involve ethical considerations

ACSHE227 – People use understanding and skills from across the disciplines of science in their occupations

Science Inquiry Skills

ACSIS140 - Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed

ACSIS141 – In fair tests, measure and control variables, and select equipment to collect data with accuracy appropriate to task

ACSIS145 – Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions

ACSIS146 – Reflect on the method used to investigate a question or solve a problem, including evaluating the quality of the data collected, and identify improvements to methods

ACSIS148 – Communicate ideas, findings and solutions to problems using scientific language and representations using digital technologies as appropriate

◆Australian Curriculum - Science (Year 10)

Science Understanding

ACSSU190 – Energy conservation in a system can be explained by describing energy transfers and transformations

Science Inquiry Skills

ACSIS204 - Use knowledge of scientific concepts to draw conclusions that are consistent with evidence

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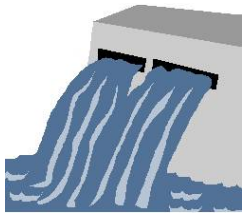

For Teachers:
Alignment to Curriculum Frameworks

Mathematics Links with Science Curriculum (Skills used in this activity)	General Capabilities	Cross-Curriculum Priorities
	• Literacy • Numeracy • Critical and creative thinking • Personal and social capacity • ICT capability	• Sustainability

Science Achievement Standards

Year 7

By the end of Year 7, students describe techniques to separate pure substances from mixtures. They represent and predict the effects of unbalanced forces, including Earth's gravity, on motion. They explain how the relative positions of the Earth, sun and moon affect phenomena on Earth. They ***analyse how the sustainable use of resources depends on the way they are formed and cycled through Earth systems***. They predict the effect of environmental changes on feeding relationships and classify and organise diverse organisms based on observable differences. Students describe situations where scientific knowledge from different science disciplines has been used to solve a real-world problem. They ***explain how the solution was viewed by, and impacted on, different groups in society***.

Students identify questions that can be investigated scientifically. They plan fair experimental methods, identify variables to be changed and measured. They select equipment that improves fairness and accuracy and describe how they considered safety. Students ***draw on evidence to support their conclusions***. They ***summarise data from different sources, describe trends and refer to the quality of their data when suggesting improvements to their methods***. They communicate their ideas, methods and findings using scientific language and appropriate representations.

Year 8

By the end of Year 8, students compare physical and chemical changes and use the particle model to explain and predict the properties and behaviours of substances. ***They identify different forms of energy and describe how energy transfers and***

transformations cause change in simple systems. They compare processes of rock formation, including the time scales involved. They analyse the relationship between structure and function at cell, organ and body system levels. Students examine the different science knowledge used in occupations. They ***explain how evidence has led to an improved understanding of a scientific idea and describe situations in which scientists collaborate to generate solutions to contemporary problems***.

Students identify and construct questions and problems that they can investigate scientifically. They consider safety and ethics when planning investigations, including designing field or experimental methods. They identify variables to be changed, measured and controlled. Students construct representations of their data to reveal and analyse patterns and trends, and use these when justifying their conclusions. They explain how modifications to methods could improve the quality of their data and apply their own scientific knowledge and investigation findings to evaluate claims made by others. They ***use appropriate language and representations to communicate science ideas***, methods and findings in a range of texts types.

Year 10

By the end of Year 10, students analyse how the periodic table organises elements and use it to make predictions about the properties of elements. They explain how chemical reactions are used to produce particular products and how different factors influence the rate of reactions. They ***explain the concept of energy conservation and represent energy transfer and transformation within systems***. They apply relationships between force, mass and acceleration to predict changes in the motions of objects. Students describe and analyse interactions and cycles within and between Earth's spheres. They evaluate the evidence for scientific theories that explain the origin of the universe and the diversity of life on Earth. They explain the processes that underpin heredity and evolution. Students analyse how the models and theories they use have developed over time and discuss the factors that prompted their view.

Students develop questions and hypotheses and independently design and improve appropriate methods of investigation, including field work and laboratory experimentation. They explain how they have considered reliability, safety, fairness and ethical actions in their methods and identify where digital technologies can be used to enhance the quality of their data. When analysing data, selecting evidence and developing and justifying conclusions, they identify alternative explanations for findings and explain any sources of uncertainty. Students evaluate the validity and reliability of claims made in secondary sources with reference to currently held scientific views, the quality of methodology and the evidence cited. They construct evidence-based arguments and select appropriate representations and text types to communicate science ideas for specific purposes.