Can You Canoe?

Provided by TryEngineering - www.tryengineering.org

Lesson Focus

Lesson focuses on how canoes, which have been hand built for centuries, have been impacted by engineered materials and manufacturing processes over the years. Student teams design and build a canoe frame and then cover their frame with everyday materials and test their design in a basin. Student canoes must be able to float. As an extension activity, older students may be required to develop a canoe that can hold a minimum weight. Students then evaluate the effectiveness of their canoes and those of other teams, and present their findings to the class.

Lesson Synopsis

The "Can You Canoe?" lesson explores how engineering has impacted the manufacturing of canoes over time, including the development of new, durable, and lighter materials. Students work in teams of "engineers" to design and build their own canoe out of everyday items. They test their canoes on water, evaluate their results, and present their findings to the class.

Year Levels

Year 5 – 10 Science Inquiry Skills and Science as a Human Endeavour

Objectives

- Learn about materials engineering.
- Learn about engineering design.
- Learn about planning and construction.
- Learn about teamwork and working in groups.

Anticipated Learner Outcomes

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

- structural engineering and design
- problem solving
- teamwork

Lesson Activities

Students learn how canoes have been built over time, and how materials engineering has made canoes less expensive, more durable, and lighter. Students work in teams to design and build a canoe model out of everyday items, then test their canoe, evaluate their own results and those of other students, and present their findings to the class.

Resources / Materials

- Teacher Resource Documents (attached)
- Student Worksheets (attached)
- Student Resource Sheets (attached)

Alignment to Curriculum Frameworks

See attached curriculum alignment sheet.

Internet Connections

- TryEngineering (www.tryengineering.org)
- The Canadian Canoe Museum (www.canoemuseum.net)
- Wooden Canoe Heritage Association (www.wcha.org)
- Curriculum links (www.acara.edu.au)

Recommended Reading

- Building a Strip Canoe (ISBN: 0899333494)
- The Wood and Canvas Canoe: A Complete Guide to Its History, Construction, Restoration, and Maintenance (ISBN: 0884480461)

Optional Writing Activity

- Write an essay or a paragraph about how engineering has changed cargo ships over the past 100 years.

Extension Ideas

- Explore local "Concrete Canoeing Competitions." Global lists may be found at www.concretecanoe.org.

Can You Canoe?

For Teachers:
Teacher Resource

◆ Lesson Goal
Lesson focuses on how canoes, which have been hand built for centuries, have been impacted by engineered materials and manufacturing processes over the years. Student teams design and build a canoe frame and then cover their frame with everyday materials and test their design in a basin. Student canoes must be able to float. As an extension activity, older students may be required to develop a canoe that can hold a minimum weight. Students then evaluate the effectiveness of their canoes and those of other teams, and present their findings to the class.

◆ Lesson Objectives
- Learn about materials engineering.
- Learn about engineering design.
- Learn about planning and construction.
- Learn about teamwork and working in groups.

◆ Materials
- Student Resource Sheet
- Student Worksheets
- Water, large basin or sink, measuring cup or pouring device
- One set of materials for each group of students:
  - Popsicle sticks, wooden spoons, small wooden (balsa) pieces, bendable wire (such as florist or craft wire), string, paperclips, rubber bands, toothpicks, aluminum foil, plastic wrap, tape, wooden dowels, or other materials, glue.

◆ Procedure

1. Show students the various Student Reference Sheets. These may be read in class, or provided as reading material for the prior night's homework.
2. Divide students into groups of 2-3 students, providing a set of materials per group.
3. Explain that students must develop their own working canoe from everyday items, and that the canoe must be able to float for three minutes without falling apart in order to be a success. (Note: For older or more advanced students, consider requiring a weight or cargo that the canoe must hold, such as a stack of coins.)
4. The canoe must be at least 20 centimetres in length.
5. Students meet and develop a plan for their canoe. They agree on materials they will need, write or draw their plan, and then present their plan to the class.

Can You Canoe?

For Teachers:
Teacher Resource (continued)

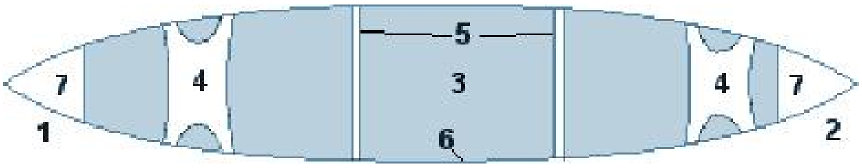
6. Student teams may request additional quantities of any of the materials provided, up to two sets of materials per team. They may also trade unlimited materials with other teams to develop their ideal parts list.
7. Student groups next execute their plans. They may need to rethink their design, request other materials, trade with other teams, or start over.
8. Next….teams test their canoes in a large basin with water. The canoe must be able to float for three minutes.
9. Teams then complete an evaluation/reflection worksheet, and present their findings to the class.

◆ Time Needed
Two to three 45 minute sessions

◆ Tips
For older students, require teams to develop a canoe that can float while holding a load, such as a stack of coins.

Student Resource: Canoe Structure and Materials

◆Parts of a Canoe



1. Bow
2. Stern
3. Hull
4. Seat (whitewater canoes may have a foam 'saddle' in place of a seat)
5. Thwart - a horizontal crossbeam near the top of the hull
6. Gunwale (pronounced gunnel) - the top edge of the hull
7. Deck (under which a flotation compartment or foam block may be located which prevent the canoe from sinking if capsized or swamped)

◆The First Canoe Materials

The earliest canoes were made from available, natural, and usually local materials. The earliest canoes were made of wood, sometimes hollowed-out tree trunks. Wooden canoes are more frequently made in a "wood strip" process, where strips of wood are bent and attached to form a frame. The frame would originally be covered by birch bark, or other natural materials. Many indigenous peoples of the Americas built canoes of tree bark, sewn with tree roots and sealed with resin. The indigenous people of the Amazon commonly used Hymenaea trees. In temperate North America, white cedar was used for the frame and bark of the Paper Birch for the exterior, with charcoal and fats mixed into the resin to help waterproof it.

This type of canoe is still made by hand today, and for some is the preferred canoe. There are some who still cover with bark, and others who use canvas instead. However, the amount of time and the craftsmanship required to build a wooden canoe can make the end product very expensive. They can be considered works of art!

◆Aluminum?

Over the years, many companies have developed or incorporated new materials to help improve durability, decrease weight, and change the performance of canoes. Aluminum canoes were first made by the Grumman Company in 1944, when demand for airplanes for World War II began to drop off. Aluminum canoes were much lighter and potentially durable than wood canoes. But, aluminum had drawbacks too! Capsized aluminum canoes will sink unless the ends are filled with flotation materials. And, aluminum canoes can be very noisy, and would scare away wildlife and even make it difficult to talk with others nearby.

Can You Canoe?

Student Resource:
Canoe Structure and Materials

◆Engineered Materials

About fifty years ago, new materials such as fibreglass, Kevlar, and carbon fibres began to be used in canoe construction. The new engineered materials were much lighter than wood, very strong, and resulted in a canoe that was easier to manoeuver. In addition, different widths and depths were achievable, allowing for canoes customised for various functions. For example, wider, lightweight canoe could be selected by recreational canoers with little experience -- the wider canoe would be more stable and less likely to capsize. More streamlined versions for racing or stronger more experienced canoers were also developed. The new materials were also more resistant to the weather, and could handle harsh winters left out of doors. There were drawbacks to the new materials as well. For example, fibreglass can crack upon an impact. But…fibreglass can be repaired too! Often repair kits are brought along on trips in rough terrain.

Many materials and new methods have been used to improve canoe performance, reduce costs, and boost safety. But, some companies still offer both the hand crafted wood and canvas canoes alongside the new materials. For example, Old Town Canoes (Old Town, Maine, USA) has been in business for more than a century, but recently introduced a new innovation in composite canoes. According to the company, the new "Koru"™ blends the performance features of Native American hunting canoes with aerospace composite technology and modern design features. The "Koru" can be bumped, and then will bump back into its original shape. It can also be crafted with very sharp entry and exit points that make the canoe quicker in the water than other shapes. The engineered materials allowed for a canoe that is 5.5 metres long, and yet weighs only 22.5 kg.

◆Engineered Shapes!

And…engineering isn't limited to new materials! For example, while many people like to bring their pets on boats, having one ride on a kayak was a little challenging. But recently designers at Old Town Canoe introduced what they call the "Sidekick" -- a companion platform for non-paddling passengers – with two legs or four.

Can You Canoe?

Student Worksheet:
Design Your Own Canoe

You are part of a team of engineers who have been given the challenge to design your own canoe out of everyday items. Your canoe will need to be able to withstand a three minute water test, without sinking or capsizing. You've been given a selection of materials from which to build your canoe. You may exchange materials with other teams if you like.

◆ Planning Stage

Meet as a team and discuss the problem you need to solve. Then develop and agree on a design for your canoe. You'll need to determine what materials you want to use -- and the steps you will take in the manufacturing process. Keep in mind that many of your parts will be exposed to water. Draw your design in the box below, and be sure to indicate the description and number of parts you plan to use. Present your design to the class. You may choose to revise your teams' plan after you receive feedback from class.

Materials Needed:

Can You Canoe?

Student Worksheet (continued):

◆ Construction Phase

Build your canoe. During construction you may decide you need additional materials or that your design needs to change. This is ok -- just make a new sketch and revise your materials list.

◆ Testing Phase

Each team will test their canoe in a classroom basin. Be sure to watch the tests of the other teams and observe how their different designs worked.

◆ Evaluation Phase

Evaluate your teams' results, complete the evaluation worksheet, and present your findings to the class.

Use this worksheet to evaluate your team's results:

1. Did you succeed in creating a canoe that floated for three minutes? If not, why did it fail?

2. Did you decide to revise your original design or request additional materials while in the construction phase? Why?

3. Did you negotiate any material trades with other teams? How did that process work for you?

4. If you could have had access to materials that were different than those provided, what would your team have requested? Why?

Can You Canoe?

Student Worksheet (continued):

5. Do you think that engineers have to adapt their original plans during the construction of systems or products? Why might they?

6. If you had to do it all over again, how would your planned design change? Why?

7. What designs or methods did you see other teams try that you thought worked well?

8. Do you think you would have been able to complete this project easier if you were working alone? Explain…

9. If you were designing a new, full scale, canoe -- what features would you like to design in? Would this require new materials?

Can You Canoe?

For Teachers:
Alignment to Curriculum Frameworks

Science Inquiry Skills

Year 5

With guidance, select appropriate investigation methods to answer questions or solve problems (**ACSIS086**)

Use equipment and materials safely, identifying potential risks (**ACSIS088**)

Suggest improvements to the methods used to investigate a question or solve a problem (**ACSIS091**)

Year 6

With guidance, select appropriate investigation methods to answer questions or solve problems. (**ACSIS103**)

Use equipment and materials safely, identifying potential risks (**ACSIS105**)

Suggest improvements to the methods used to investigate a question or solve a problem (**ACSIS108**)

Year 7

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

In fair tests, measure and control variables, and select equipment to collect data with accuracy appropriate to the task **(ACSIS126)**

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

Year 8

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

In fair tests, measure and control variables, and select equipment to collect data with accuracy appropriate to the task **(ACSIS141)**

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

Year 9

Plan, select and use appropriate investigation methods, including fieldwork and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods **(ACSIS165)**

Select and use appropriate equipment, including digital technologies, to systematically and accurately collect and record data **(ACSIS166)**

Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the data **(ACSIS171)**

Year 10

Plan, select and use appropriate investigation methods, including fieldwork and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods **(ACSIS199)**

Select and use appropriate equipment, including digital technologies, to systematically and accurately collect and record data **(ACSIS200)**

Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the data **(ACSIS205)**

Science as a Human Endeavour

Year 5

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena **(ACSHE081)**

Scientific understandings, discoveries and inventions are used to solve problems and directly affect people's lives **(ACSHE083)**

Year 6

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena **(ACSHE098)**

Scientific understandings, discoveries and inventions are used to solve problems and directly affect people's lives **(ACSHE100)**

Year 7

Science knowledge can develop through collaboration and connecting ideas across the disciplines of science **(ACSHE223)**

People use understanding and skills from across the disciplines of science in their occupations **(ACSHE224)**

Year 8

Science knowledge can develop through collaboration and connecting ideas across the disciplines of science **(ACSHE226)**

People use understanding and skills from across the disciplines of science in their occupations **(ACSHE227)**

Year 9

Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries **(ACSHE158)**

Advances in science and emerging sciences and technologies can significantly affect people's lives, including generating new career opportunities **(ACSHE161)**

Year 10

Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries **(ACSHE192)**

Advances in science and emerging sciences and technologies can significantly affect people's lives, including generating new career opportunities **(ACSHE195)**

Mathematics Links with Science Curriculum (Skills used in this activity)	General Capabilities	Cross-Curriculum Priorities
• Process data using simple tables • Data analysis skills (graphs) • Analysis of patterns and trends • Use of metric units	• Literacy • Numeracy • Critical and creative thinking • Personal and social capacity • ICT capability	• Sustainability

Science Achievement Standards

Year 5

By the end of Year 5, students classify substances according to their observable properties and behaviours. They explain everyday phenomena associated with the transfer of light. They describe the key features of our solar system. They analyse how the form of living things enables them to function in their environments. Students discuss how scientific developments have affected people's lives and how science knowledge develops from many people's contributions.

Students follow instructions to pose questions for investigation, predict what might happen when variables are changed, and plan investigation methods. They use equipment in ways that are safe and improve the accuracy of their observations. Students construct tables and graphs to organise and identify patterns. They use patterns in their data to suggest explanations and refer to data when they report their findings. They describe ways to improve the fairness of their methods and communicate their ideas, methods and findings using a range of texts.

Year 6

By the end of Year 6, students compare and classify different types of observable changes in materials. They analyse requirements for the transfer of electricity and describe how energy can be transformed from one form to another to generate electricity. They explain how natural events cause rapid changes to the Earth's surface. They decide and predict the effect of environmental changes on individual living things. Students explain how scientific knowledge is used in decision making and identify contributions to the development of science by people from a range of cultures.

Students follow procedures to develop investigable questions and design investigations into simple cause-and-effect relationships. They identify variables to be changed and measured and describe potential safety risks when planning methods. They collect, organise and interpret their data, identifying where improvements to their methods or research could improve the data. They describe and analyse relationships in data using graphic representations and construct multi-modal texts to communicate ideas, methods and findings.

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 9

By the end of Year 9, students explain chemical processes and natural radioactivity in terms of atoms and energy transfers and describe examples of important chemical reactions. They describe models of energy transfer and apply these to explain phenomena. They explain global features and events in terms of geological processes and timescales. They analyse how biological systems function and respond to external changes with reference to interdependencies, energy transfers and flows of matter. They describe social and technological factors that have influenced scientific developments and predict how future applications of science and technology may affect people's lives.

Students design questions that can be investigated using a range of inquiry skills. ***They design methods that include the control and accurate measurement of variables and systematic collection of data and describe how they considered ethics and safety. They analyse trend in data, identify relationships between variables and reveal inconsistencies in results. They analyse their methods and the quality of their data, and explain specific actions to improve the quality of their evidence***. They evaluate others 'methods and explanations from a scientific perspective and use appropriate language and representations when communicating their findings and ideas to specific audiences.

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.