Can You Canoe?

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.

Age Levels

8-18.

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 (http://canoemuseum.ca/)
- Wooden Canoe Heritage Association (www.wcha.org)

Recommended Reading

- Building a Strip Canoe (ISBN: 978-1565234833)
- This Old Canoe: How To Restore Your Wood-Canvas Canoe (ISBN: 978-0994863300)

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.

For Teachers: Teacher Resource

Lesson Goal

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Lesson Objectives

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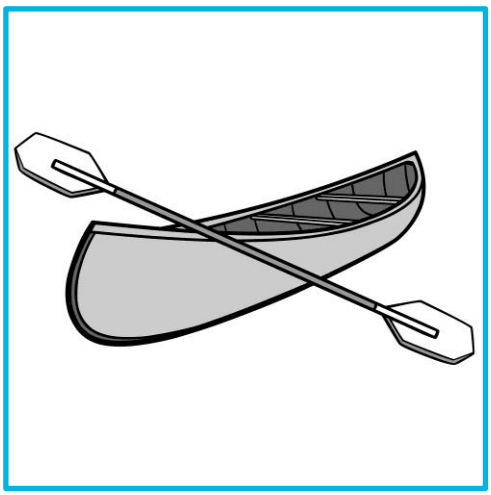


Materials

- 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 8 inches 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.

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

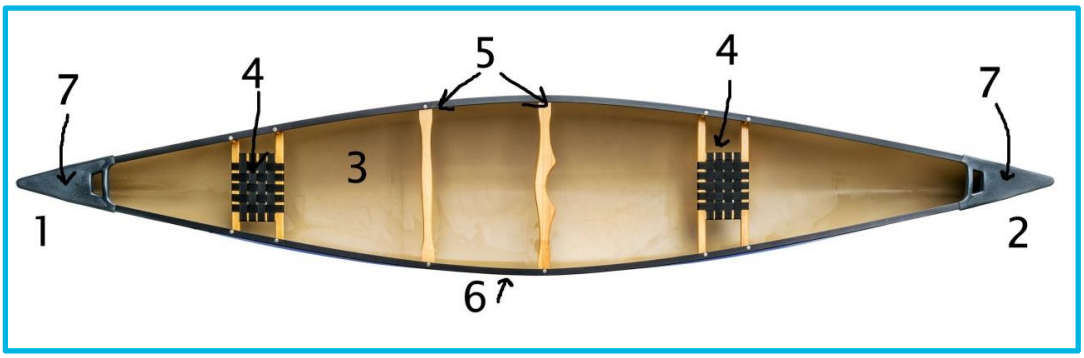
Two to three 45 minute sessions

◆ Tips

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

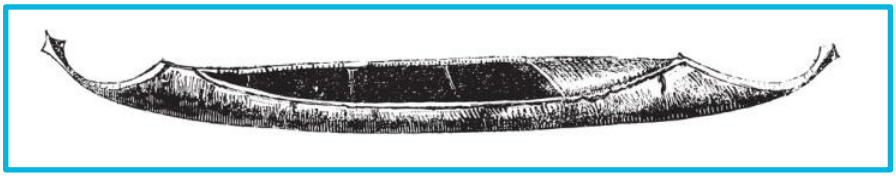
Student Resource: Canoe Structure and Materials

Parts of a Canoe



1. Bow
2. Stern
3. Hull
4. Seat
5. Thwart - a horizontal crossbeam near the top of the hull
6. Gunwale - the top edge of the hull
7. Deck

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!

New Materials

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.

Student Resource:
Canoe Structure and Materials

◆ Engineered Materials

About fifty years ago, new materials such as fiberglass, Kevlar, and carbon fibers 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 maneuver. In addition, different widths and depths were achievable, allowing for canoes customized 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, fiberglass can crack upon an impact. But…fiberglass 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 17.5 feet long, and yet weighs only 50 pounds.

◆ 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.

Student Resource:
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:

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?

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?

For Teachers: Alignment to Curriculum Frameworks

Note: All lesson plans in this series are aligned to the National Science Education Standards which were produced by the National Research Council and endorsed by the National Science Teachers Association, and if applicable, also to the International Technology Education Association's Standards for Technological Literacy or the National Council of Teachers of Mathematics' Principles and Standards for School Mathematics.

◆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
- Understanding about scientific inquiry

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

- 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
- Understandings about scientific inquiry

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

CONTENT STANDARD F: Science in Personal and Social Perspectives

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

- 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
- History of science

For Teachers: Alignment to Curriculum Frameworks

◆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
- Understandings about scientific inquiry

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop

- Abilities of technological design
- Understandings about science and technology

CONTENT STANDARD F: Science in Personal and Social Perspectives

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

- Personal and community health
- Science and technology in local, national, and global challenges

CONTENT STANDARD G: History and Nature of Science

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

- Nature of scientific knowledge
- Historical perspectives

◆Standards for Technological Literacy - All Ages

The Nature of Technology

- Standard 1: Students will develop an understanding of the characteristics and scope of technology.

Technology and Society

- Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.
- Standard 6: Students will develop an understanding of the role of society in the development and use of technology.
- Standard 7: Students will develop an understanding of the influence of technology on history.

Design

- Standard 8: Students will develop an understanding of the attributes of 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 13: Students will develop abilities to assess the impact of products and systems.

The Designed World

- Standard 17: Students will develop an understanding of and be able to select and use information and communication technologies.