Power and Energy of a Canoe Paddle

Big Ideas	Specific Expectations
Identify forces that act on and within structures and mechanisms and describe the effects of these forces on structures and mechanisms. Use scientific inquiry/experimentation skills to determine how the physical properties of materials make them useful for specific tasks	**C2.3** describe how different forces applied to an object, including forces of varying magnitude, can cause the object to start, stop, or change its direction, speed, or shape **C1.1** assess the impacts on society and the environment of various processes used in the manufacture of common products

Description

This lesson weaves traditional ecological knowledge and the scientific principles of power and energy as they apply to a canoe paddle. The activity will explore how a paddle moves a canoe, what type of lever a paddle is, and will expand our understanding of how the principles of force and energy were used by Indigenous Peoples to create tools and resources.

Materials

- Scooter boards **OR** Invite 2-4 students to bring in their personal skateboard.
- Provide a variety of classroom materials to create paddle:
  - Cardboard
  - Broom stick
  - Tape / glue
  - Scissors
- Optional:
  - Weight(s)
  - Paper
  - Etc.

Introduction

Aanii/Hello, my name is Shaylene Restoule. I am an Indigenous STEM Communicator at Science North, and I am also completing my Indigenous Studies degree at Laurentian University. I am an Anishinaabekwe from Wikwemikong Unceded Territory located on Manitoulin Island. I have gained a lot of knowledge throughout my years growing up with my Indigenous culture and how we can live in balance and harmony with the land and people around us.

Traditional Ecological Knowledge

Indigenous Peoples have used their ingenuity to create tools, resources, and transportation which are crucial for their survival and success on the land. The traditional ecological knowledge of Indigenous

Peoples plays a significant role in the cumulative body of knowledge associated with their ecological relationships and technical advancements.

Traditional ecological knowledge is a way of approaching the interactions between humans and the health of the environment around us which is based on information and tradition which has been passed down through generations. It is important to consider traditional ecological knowledge because of the holistic and long-term nature of the approach.

Traditional Ecological Knowledge vs. Western Science

- Traditional Ecological Knowledge
  - Oral tradition
  - Holistic approach
  - Environment is a part of social and spiritual relations
- Western Science
  - Written tradition
  - One way of thinking
  - Hierarchical structured environment

Explaining Force and Levers

Force is a push or pull resulting from an interaction between two objects. Force only exists when there is an interaction. In this case, when the paddle is pulled backwards through the water, the canoe move forward, which is an example of Newton's Third Law of Motion: every action has an equal and opposite reaction.

A lever is a machine made of a beam and a fulcrum. The fulcrum is the point in which the beam pivots. The effort (input force) and load (output force) are applied to each end of the beam. When effort is applied on one end, load is applied on the other. The location of the effort, load, and fulcrum will determine the type of lever and mechanical advantage.

Three Classes of Levers

In a **first-class lever,** the fulcrum is located between the load and the effort. When the fulcrum is closer to the load, less effort is needed (ex. crowbar, pliers, teeter-totter).

In a **second-class lever,** the load is located between the effort and the fulcrum. If the load is closer to the fulcrum, then less effort will be required to move (ex. wheel barrel, pushups, nail clippers)

In a **third-class lever,** the effort is located between the load and the fulcrum. If the force is closer to the load, it would be easier to lift (ex. shovels, baseball bat).

Action

Step 1: Discussion

- Watch a short clip of a canoe and paddle at work;
  - Video will be found on the website. How to Paddle a Canoe.

- Ask students to think about the energy and force needed to move a canoe. Where does the energy come from? How is the energy transferred?
    - Force is a push or pull resulting from an interaction between two objects. Force only exists when there is an interaction. In this case, when the paddle is pulled backwards through the water, the canoe moves forward, which is an example of Newton's Third Law of Motion: every action has an equal and opposite reaction.
- Review the terms lever, pulleys, fulcrum, input and output effort, and load.
- Discuss the different canoe paddle styles (see handout – Paddle Blade Styles) and why they are all different. Why are they shaped this way?
    - Canoe paddles can be shaped differently depending on the water conditions, and the kind of control the paddler needs. These needs may depend on the depth of the water they are on or the distance in which they are travelling. For example, you would need a short and wider paddle for shallow waters. For those travelling a long distance, a lighter paddle with a longer blade can help control the canoe effectively without exhausting the paddler.

Step 2: Activity

- After discussing why some canoe paddles are shaped differently, invite students to an engineering challenge to design the best paddle based on what will help them maneuver their wheelie rollers or skateboards. (Students can pair up to work together on a paddle).
    - The best paddle will determine what will give them the greatest distance on a single push; what will let them travel from one end of the gym to the other fastest, or which uses the fewest paddle strokes to travel from one end of the gym to the other; or which will let them make a sharp turn.
    - Remind students that the paddles we have looked over are shaped that way due to having to move in the water and have them design it according to their different conditions.
- Give students a set time in which to construct their paddle prototype.
- Prior to testing out their paddle have students explain why they shaped their canoe paddle that way and why they think this shape will support them in moving their board forward.
    - Ask students to use terms such as load, effort, force, fulcrum, and beam to discuss their energy transfer when paddling. How is force being used? What ideas emerge?
- Now have them test their paddle while on their scooter board.

Step 3: Review

- Following the activity have students review which paddles worked best.

- Were there canoe paddles that were shaped the same? How many were different? Which one worked effectively? What kind of paddle works for which condition? Why were some designs more successful than others?

Consolidation/Extension

- In what ways do traditional Indigenous peoples' technologies demonstrate their understanding of power and force?
- Discuss the different paddle strokes mentioned in the video below and how each of these strokes helps maneuver the canoe differently.
  - https://www.youtube.com/watch?v=szUr_ilbd_g

Additional Resources

https://www.fnesc.ca/science-first-peoples/