Children do not have to live near the coast to experience effects of water waves. They can throw stones into a pond and see the waves ripple outward, bob up and down while floating in a swimming pool, and splash water about while in a bathtub. As students discover how waves form and move, they can apply this understanding to other types of waves such as sound waves, light waves, and microwaves.

Making Waves

Where do ocean waves come from?

An earthquake or a boat's wake can create waves. However, the most common cause of ocean waves is wind. Wind blowing across water creates friction and forms patches of tiny ripples on the surface. As the wind continues, the waves grow larger. The size of the waves depends on how far, how fast, and how long the wind blows. But even when you feel no wind at all, you may notice large swells of water. These swells are the effects of distant storms from days earlier.

How do waves move?

From the shore, it may seem like a wave is water moving toward you, but actually the water is traveling very little. As a wave moves through water, energy is passed from one water molecule to the next, causing the water particles to move up and down in a circular motion and return to their original position. Water at the surface moves upwards and forwards as the peak of the wave passes by, then downwards and backwards as the *trough* or ditch of the wave passes by. This circular movement becomes less pronounced the deeper you descend. As depth increases, the effects of waves slowly decrease until completely disappearing about half a wavelength below the surface. So what, then, is traveling through the water? A wave is the movement of energy through water and it is that disturbance we see moving toward us when standing on the shore.

Why do waves crash near the shore?

As surface waves reach shallow water, their behavior changes. Waves slow down, grow taller, and change shape. Near the shore, water particles in the low point of the circular path slow down as they hit against the bottom. Water particles at the top of the wave begin to pile up into a *breaker*. When the water gets even more shallow, the wave can't support itself and falls forward, crashing into the shore. Have you ever noticed that waves always break parallel to land even though they may have approached at an angle? This occurs because waves slow down and bend toward shallow water. This is also why waves rotate around headlands and travel into sheltered bays.

In the Making Waves activity, students determine how waves move through water and model the process of energy transfer.

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Making Waves:

How does energy move through water?

Materials:

- Jump rope
- Masking tape
- Food dye

Supply one set of the following materials for each group of three or four students:

- Large, shallow pan (e.g., jelly roll pan or tray with sides)
- Bucket or container to fill pan with water
- Scissors
- Drinking straw for each student
- Pencil and paper
- 6 marbles
- Magazine or book that will remain open when laid flat

Objectives:

- To understand that energy is transferred through water
- To understand that waves pass through water but do not carry water with them

Grade Level: 3–5

Engage:

Ask students where they have seen waves or wavelike movement (at the beach, when throwing rocks into water). Discuss how some types of waves are visible, but others, such as microwaves or sound waves, we are not able to see. A wave is a way in which energy travels from one place to another.

Select two students to demonstrate how energy moves along an outstretched jump rope. Ask each student to hold one end of the rope and stand far enough apart so that it almost touches the ground between them. Instruct one child to make a quick up-and-down jerk from one end of the rope. *How did the snap of the rope travel?* (As a back-and-forth movement along the rope.) Explain that this rise-and-fall movement is called a *wave.* Mark one spot on the rope with masking tape and instruct the students to watch how the marked spot moves when the rope is snapped. (Students may notice that the marked point moves up and down as a wave travels through the rope.) The jump rope is displaced up and down as the wave travels from one end to the other, but the rope itself does not move forward. Explain that they will be working in groups to investigate how waves move in a similar manner through water.

Explore:

1. Ask group members to gather the first set of materials: pan, bucket of water, straws, and drawing paper. Each group fills a shallow pan with water. Have students take turns tapping the surface of the water gently with a pencil. *What do you notice about the direction of the waves?* (They spread out away from the pencil in widening bands.) *What happens when two waves meet each other, such as when two pencils tap the water from either end of the pan?* (The waves create an overlapping pattern. Although it may look harmless here, when such an event occurs in the ocean, monster waves are formed.) Have students sketch pictures and write descriptions of the wave movements.
2. Allow the water in the pan to become still. Place a piece of a straw (about 3 cm) in the center of the water. Hit the surface of the water with a pencil or finger in order to cause shallow waves. *What do you observe happening to the straw as you create waves?* (The straw may bob up and down, but mostly stays in the same place. The straw does not travel with the wave.)
3. Rotate among the groups and place a drop of food coloring in the center of each pan of still water. Each child takes a turn to blow through a (separate) straw onto the surface of the water. *What happens to the water that has been colored?* (The surface of the water may drift with the breeze, but dye that has sunk to the bottom will remain still.)

4. After 5–10 minutes, stop the class to briefly discuss what students have observed. Suggest and elicit additional questions for investigation. *How do obstacles in the water affect wave movement? How do waves change when one end of the pan is raised so that water is deeper at the other end?*
5. Allow time for groups to conduct additional investigations.
6. Discuss questions, processes, and observations. Explain that as a wave moves through water, energy is passed through small parts of the water that are too tiny for us to see. These tiny parts are called *molecules.* We can see the effects of such energy transfer by using marbles as our model.
7. Give each group of students a set of marbles and a magazine. Students should open the magazine and line five marbles in the center ditch so they are touching. Ask students to predict what will happen if the sixth marble is flicked into a marble at one end of the row. Record predictions.
8. Have students conduct the investigation several times while changing the number of marbles that are flicked into the rest. *What happens to the marbles? Does the number of marbles in the line affect the way they move?* (When a marble hits the last marble in line, only the marble at the front of the line will appear to move. When two marbles hit the line, the front two marbles will move forward.) Explain that we can think of energy moving through water molecules as marbles hitting each other and passing energy forward.

Extension/Application:

Ask questions to help students connect the concept of energy transfer to the investigations. *How is the movement of the last marble like the movement of water particles?* (The energy is moving through the marbles in order for the first marble in line to react to the "hit.") *How is it different?* (In a wave, the molecules keep hitting other molecules…there isn't a last "marble"; in a wave that moves through water there is also an up-and-down motion.) *What is a wave?* (A disturbance or movement through a medium like we observed happening in the water and jump rope.) *How does energy move through water?* (It moves as a wave, bumping from one water molecule to the next.) *What happens to objects that are floating on the surface of the water?* (They may move ahead slightly, but mostly bob up and down as the waves pass through the water.) Students should be able to describe waves as a means of transmitting energy.

K–2 Adaptation:

This lesson can enhance a unit on motion as young children become familiar with the idea that movement can happen by pushing and pulling. Although they may have experienced the idea that one object can transfer energy to another object (such as in miniature golf, air hockey, or bumper cars), young children may have little understanding of how energy travels through water. Wave movements are more easily observed in a water-filled glass pan placed on an overhead projector. The waves appear as shades of light and dark. Discuss how the waves move away from the area where the straw tapped the water.

Resources

Museum of Science: Boston
www.mos.org/oceans/index.html

National Research Council (NRC). 1996. *National science education standards.* Washington, DC: National Academy Press.

Wave Simulator
www.nationalgeographic.com/volvooceanrace/interactives/waves/index.html

Connecting to the Standards

This article relates to the following *National Science Education Standards* (NRC 1996):

Content Standards

Standard B: Physical Science
- Properties of objects and materials (K–4)
- Motions and forces (5–8)

Standard D: Earth and Space Science
- Properties of Earth materials (K–4)