Blatant Displacement: Modeling a Tsunami

Material adapted from:
Discovery Education: Dynamic Earth
http://school.discoveryeducation.com/lessonplans/programs/dynamicearth/
Discovery Education: Understanding Tsunamis
http://school.discoveryeducation.com/lessonplans/programs/tsunami/
Project Oceanography: Tsunamis
http://www.marine.usf.edu/pjocean/packets/sp04/sp04.htm

Introduction:

Tsunamis are open ocean waves generated by the sudden displacement of water from subduction zones on the ocean floor. Tsunami in Japanese is literally translated "harbor-wave". In this class, students will learn the key differences between tsunamis and ocean waves through displacement modeling.

Materials:

(Materials in **bold** are provided by SMILE)

Small Plastic Cups
Large Plastic Cups
Water
Straws
Marbles
Rheoscopic Fluid
Clear Plastic Cup
Aluminum Pie Pans
Plastic Wrap
Tape
Scissors

Handouts/Overheads:

Tsunami Formation Overhead
Cup 'o' Wave Worksheet

Activity 1: Cup 'o' Wave

1. Tell students they will perform an experiment to discover how displacement affects the surface of the water. Divide the class into groups and distribute each size cup, a ruler and the marbles. Have the students fill the narrow cup 2/3 full and the wider cup only half full (this will make sure every cup contains approximately 8 ounces or 1 cup of water).

2. Using a straw, instruct the students to blow air across (no blowing bubbles!) the surface of the water in each of the cups to make waves. Ask them to observe the resulting wave pattern in the cups and sketch an aerial view of these patterns. This model represents waves created by wind blowing across the surface of the ocean.

3. Next, instruct the students to organize their groups so that a marble can be dropped in to each cup simultaneously from equal heights above the cups (using a ruler). Ask the groups to again observe the resulting wave pattern once the marble hits the water and have them draw an aerial sketch of this pattern. If the water in each cup represents an ocean basin, what real-life scenario do the students think this model represents?

4. Ask the students to repeat step 3 with an uneven amount of water in each cups.

Questions to ask students:

- Are the patterns still the same?
- Do they differ between the two width cups?
- What is different about the waves created by dropping the marbles to those made by blowing air across the surface?

5. The previous experiment modeled the creation of a tsunami, where the marble's impact caused a displacement of water and a resultant circular wave pattern spreading outward from the source. Review tsunamis, discussing the causes of a tsunami: underwater earthquakes, landslides and volcanic eruptions, or the impact of a large meteorite in the sea.

Questions to ask students:

- Are they aware the west coast of the U.S. is susceptible to tsunamis?
- Which natural event do they think could cause a tsunami to hit this coast?

Subduction zones are most likely to be the cause of a tsunami occurrence, whereas the other events are more likely to create a mega-tsunami, which are rare.

6. If favored, show a class demonstration of the cup model using the clear plastic cup and rheoscopic fluid. The fluid will show internal movement of the liquid as the marble impacts on the surface and emphasize the concept.

Activity 2: Flick Tank

1.In the same groups, tell the students they are to model how an underwater earthquake in a subduction zone region affects the ocean water around it. Distribute the pie pans, plastic wrap and tape to each group.

2. Get the students to make their flick tank by firstly (and carefully) cutting a small hole (~ 1 ½") in the center of the base of the pan. Next, they must line the pan with plastic wrap, using enough to fold over the edge of the pan, and secure with tape. Ask them to fill the lined pan with 1-2 cups of water.

3. Students should now carefully lift up the pan and notice that the plastic wrap has a small bulge through the cut out hole in the base of the pan with the weight of the water. While one student holds the pan steady, another should GENTLY flick the bulge with their fingers, observing what happens to the water above.
Questions to ask students:

- Does the fluid movement vary with how hard you flick? (Note: Be careful they do not flick too hard otherwise the plastic wrap may break!).
- Is the wave pattern the same with this model as with the last (i.e. is it a circular pattern)?

4. As with the cup model, you can reuse the rheoscopic fluid for a class demonstration in one of the lined pie pans to reiterate the movement of the fluid as it displaces further (and because it's pretty!)

This second model represents a massive displacement of water that occurs as a subduction zone underwater deforms suddenly, causing the tectonic plates involved to 'flick' the seawater upwards and outwards, pushing waves with very long wavelengths out across the ocean basin. Discuss the key differences between tsunamis and ocean

wind waves: very long wavelength; faster, intense and more widespread propagation across an ocean basin; ability to surge upon a shoreline and cause destruction

Class Extensions:

- Ask the students to research past tsunamis caused by subduction zone earthquakes. Where and when did they happen? What similarities do all these tsunamis show (i.e. in wave height, distance traveled, problems caused, etc).

- Using digital cameras, ask the students to record short video clips of the waves produced in both the cups and the pie pans. These clips can be shown in slow motion to the rest of the class via computer and will illustrate the wave motion the water displacement creates nicely.

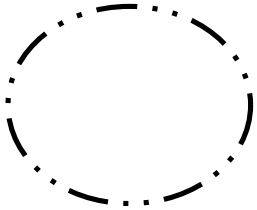
Blatant Displacement – Student Worksheet

1. CUP 'O' WAVE

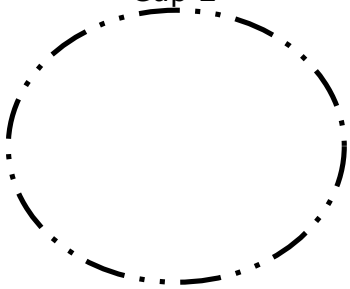
a) Fill a narrow plastic cup 2/3 full of water (cup 1) and a wider cup half full of water (cup 2).

b) Blow air across the surface of the water in each cup using a straw. Observe the resulting waves and draw an aerial sketch of the wave pattern below:

Cup 1



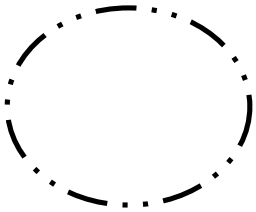
Cup 2



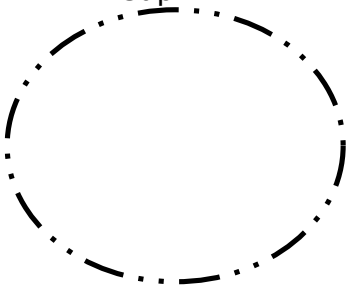
If the water in the cups represents an ocean basin, what might this model represent?

c) Now simultaneously drop a marble into each cup **at the same time and from the same height**. Observe these resulting waves and draw an aerial sketch of the wave pattern below:

Cup 1



Cup 2



If the water in each cup represents an ocean basin, what real-life scenario do you think this model represents?

d) Repeat steps b) and c) above with **uneven** amounts of water in each cup. You do not need to sketch the wave patterns. Are the wave patterns still the same?

What is different about the waves created by dropping the marbles to those made by blowing air across the surface?