Student Activities for Studying Earthquakes in Elementary Schools

Brian K. Peterson
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Staff Report 95-1
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Contents

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INTRODUCTION

In 1993 the Idaho Geological Survey, in cooperation with the Idaho Bureau of Disaster Services, began sponsoring field workshops for teachers on earthquakes and earthquake hazards in the state. To encourage a transfer of knowledge from the workshops into the classrooms, the Survey has developed several guides to student activities that teachers may incorporate into units or lessons in their own curriculum. This set of activities is designed for elementary schools. A companion set has been prepared for secondary schools and is published separately.

We intended the five activities presented here to be appropriately adapted by elementary school teachers to their own students' capabilities. All of these activities emphasize giving students the opportunity to "do science" through constructing experiments, taking measurements, and collecting and analyzing data. By sliding bricks against one another, *Earthquakes and Faults* helps students understand how sudden movement on a fault causes earthquakes. Students can see how real seismographs work by building their own as described in *Making a Seismograph*. Damage caused by earthquakes will be better appreciated when the domino houses fall in *Measuring Earthquake Damage*. An important concept about earthquakes addressed in *Big and Little Earthquakes* is that although many little earthquakes happen all the time, the big ones cause the damage. Lastly, when earthquakes shake the ground sometimes landslides start moving. In *Landslides caused by Earthquakes*, students build their own sand and soil slopes and cause them to slide by shaking.

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[1]University of the Pacific, Stockton, California.

[2]Idaho Geological Survey, Univeristy of Idaho, Moscow, 83844-3014

EARTHQUAKES AND FAULTS

CONCEPTS

How do faults like the Borah Peak fault cause earthquakes? In this activity bricks represent pieces of the earth's crust sliding along a fault. Students observe how earthquakes occur by sudden fault movement and they measure the force that causes the sudden slippage.

OBJECTIVES

Students will

☺ Simulate motion on a fault that causes earthquakes using two bricks.
☺ Compare faults with lateral movement and faults with up-down movement.
☺ Observe how the area of a fault surface affects the size of the earthquake.

MATERIALS

For each small group of students:

Two small bricks
String, about 80 cm long
Scale (small scale used in sport fishing)

PART A: *MOTION ON A FAULT*

Procedure

Instructions to each group:

1. Place a brick, with one of the smooth sides up, on the floor or table.
2. Tie a string the long way around the sides of a second brick.
3. Place the second brick on top of the first one so the smooth sides are together. The top brick should completely cover the bottom one.
4. Pick one of the ends of the top brick and hook the scale onto the string.
5. Now here comes the earthquake! Pull the scale very gently in a horizontal direction, watching as the scale measures how hard you're pulling.
6. Pull until the top brick moves (you may have to hold the bottom brick to keep it from moving). Write down the number the scale reached when the brick moved.

Results

Have each group answer these questions. Discuss the answers with the class.

1. Did the brick move slowly and smoothly or did it jump all of a sudden? (If the friction is great enough, it will move suddenly.) Is an earthquake stronger when the motion on the fault is slow and smooth, or when the motion happens all at once? (Sudden movement causes stronger earthquakes.)
2. What kind of fault is the Borah Peak fault, lateral or up-down? (Borah Peak and its adjacent valley move up and down on either side of the fault.) What kind of fault have you made with the bricks?
3. Does the Borah Peak fault lie flat like the one you made with the bricks? (No.) How could you simulate a vertical fault using the bricks? (Place the bricks side by side and hold them together while running the same experiment.)

PART B: *THE AREA OF A FAULT*

Procedure

Instructions for each group:

1. Now turn the top brick sideways so it forms a cross with the bottom brick. Keep the smooth sides together.
2. Unhook the scale from the string on the <u>end</u> of the top brick and rehook it to the center of the <u>side</u> of the top brick.
3. Pull the scale very gently, watching it to see how hard you're pulling.
4. Pull until the top brick moves and write down the number the scale reached when the brick moved.

Results

Have each group answer these questions. Discuss the answers with the class.

1. Was the area between the two bricks where they touched each other larger or smaller in this part of the experiment compared to Part A? (Smaller.)
2. Was the pulling force measured by the scale larger or smaller in this part of the experiment compared to Part A? (Smaller.)
3. Which part of the experiment produced the larger "earthquake," Part A or Part B? (Part A.) Why? (Greater surface area on the fault to overcome, producing a larger "earthquake.")

MAKING A SEISMOGRAPH

CONCEPTS

How do you measure the energy of the shaking caused by an earthquake?

OBJECTIVES

Students will
- ☺ List the basic parts of a seismograph.
- ☺ Explain how a seismograph works.
- ☺ Distinguish between a **seismograph** and a **seismogram**.
- ☺ Describe the general relation between the size of a wave on a seismogram and the amount of ground motion caused by the recorded earthquake.
- ☺ Describe the general relation between the size of a wave on a seismogram and the Richter magnitude.

MATERIALS

For each small group of students:

Table or desk with a horizontal surface
3 or 4 heavy books (like dictionaries)
String, about 80 cm long
12-inch flat ruler (must be rigid enough to support the cup, pen, and clay)
Metric ruler (cm and mm)
Small paper cup
Ball of clay
Felt-tip pen or marker
Paper
Scissors
Empty cereal box
Tape (masking or transparent)

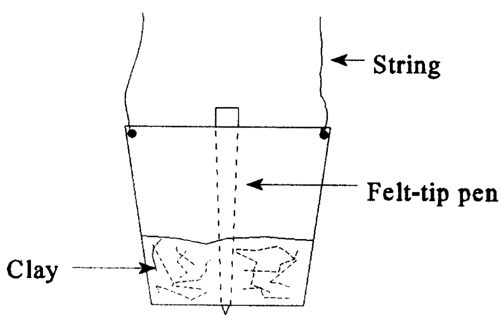
PROCEDURE

Building the Recording Pen and Weight

Instructions for each group:

1. Poke a hole in the bottom of the paper cup with a sharpened pencil. The hole should be just big enough for the tip of the felt-tip pen to fit through.
2. Wrap the ball of clay around the felt-tip pen near the end so that the pen will rest in the bottom of the cup with just the felt tip exposed out the bottom.
3. Insert the pen and clay into the cup so that the felt tip pokes through the hole in the bottom. The clay should fill the space at the bottom of the cup between the pen and the sides of the cup.
4. Poke two holes opposite one another just below the rim of the cup.
5. Tie an end of the 80-cm string through each hole in the side of the cup.

The Recording Pen

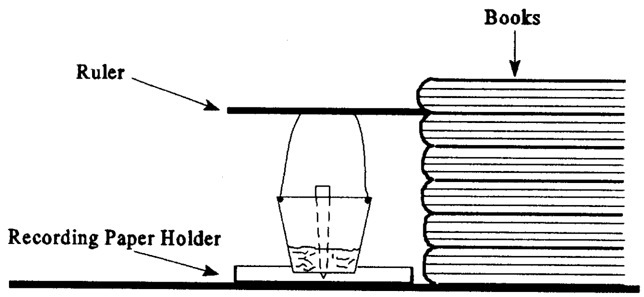


Building the Support Stand

Instructions for each group:

1. Stack the books on a desk or small table.
2. Place the ruler between the top two books, leaving about half of it sticking out.
3. Suspend the cup with the pen in it from the ruler, wrapping the string around the ruler until the tip of the pen just touches the table. (You may also need to add or remove books to do this.)

The Support Stand

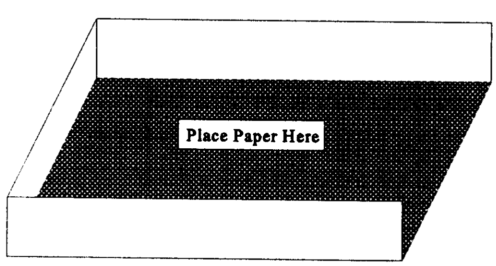


Building the Recording Paper Holder

Instructions for each group:

1. Cut the empty cereal box about 1.25 cm from the bottom. Then cut one end flush with the bottom. This will create a shallow container which is open at one end. This is the recorder and it holds the recording paper.
2. Tape the recorder to the table's surface below the suspended pen so that the pen is about 3 cm from the open end of the recorder and centered from side to side in the recorder.
3. Cut several sheets of paper to fit inside the recorder. With a pencil, draw a centerline lengthwise along each piece of paper. The felt-tip pen should just touch the centerline when a sheet of paper is placed in the recorder. As the table "quakes" and the recording paper is slowly moved, the pen should record the motion on the paper by swinging back and forth across the centerline.

Recording Paper Holder
(Empty Cereal Box)



Operating Your Seismograph

Instructions for each group:

1. As one student gently shakes the table back and forth, another should slowly pull a strip of paper out of the open end of the recorder. The pattern that you get on the strip of paper is called a seismogram.
2. The students may have to adjust their seismograph so the pen freely marks the paper (for example, the string may be too long or too short). They may have to practice shaking the desk in a direction that gets the seismograph to record properly.
3. Practice recording seismograms for gentle, medium, and hard shaking. Gentle shaking just moves the pen, whereas hard shaking produces large swings on the recording paper (but without touching the sides of the recorder!).

Understanding Seismograms

When the students have learned to operate their seismograph properly, have them try the following experiment:

1. Record seismograms for the gentle, medium, and hard shaking. Label each seismogram accordingly.
2. Measure the height of the largest wave on each seismogram in millimeters and write it down.

RESULTS

After the groups have recorded their seismograms, discuss with the class these questions:

1. Which seismogram recorded the greatest height of the wave? (The seismogram recording the hard shaking.)
2. Which seismogram showed the smallest height of the wave? (The seismogram recording the gentle shaking.)
3. The greater the height of the wave on a seismogram, the higher the number on the Richter scale. Which seismogram would have the highest number on the Richter scale? (The seismogram recording the hard shaking.)

MEASURING EARTHQUAKE DAMAGE

CONCEPTS

Will a house closer to an earthquake's epicenter be damaged more than one farther away?

OBJECTIVES

Students will

- ☺ Create shaking from a specific earthquake epicenter.
- ☺ Observe changes in damage, or intensity caused by earthquake shaking.
- ☺ Describe the relation between earthquake intensity and distance from an earthquake's epicenter.

MATERIALS

For each small student group:

6 dominoes
Tennis ball
Pencil
Meter stick
Large cardboard box (about 33 cm x 46 cm x 33 cm)

PROCEDURE

Instructions for each group:

1. Place the cardboard box upside-down on a hard floor (not carpeted).
2. Mark an X on the bottom of the box about 10 cm from one end. The X represents the epicenter of the "earthquake" that you will be creating.
3. Build a small domino house having four walls and a roof by standing four dominoes on end and placing two dominoes on top. Place the house about 10 cm from the epicenter.
4. Now for the earthquake! Drop the tennis ball onto the X from a height of one meter above the box. This causes shaking that spreads outward from the "epicenter."
5. Draw a picture of the domino house after the earthquake.
6. Now re-build the domino house the same way as before but place it 20 cm from the X.

7. Repeat Steps 4 and 5, creating another earthquake at the X and drawing a picture of the damage to the domino house.
8. Once again re-build your domino house the same way as before but this time put it at 30 cm from the X.
9. Repeat Steps 4 and 5.

RESULTS

After the groups have drawn the pictures of the damage to the domino houses at the three different distances from the epicenter, discuss with the class these questions:

1. Compare your three drawings of the domino houses. Which one shows the worst damage, that is, the greatest destruction of the domino house? (The house closest to the epicenter.)
2. Did each earthquake that you created have the same strength? (Approximately.) Why or why not? (Dropping the tennis ball from 1 meter each time should create the same energy, but it is difficult to make each drop exactly the same.)
3. How far from the epicenter was the earthquake intensity the greatest? (10 cm)
4. How far from the epicenter was the earthquake intensity the least? (30 cm)
5. How does the earthquake intensity change as you go farther away from the epicenter of the earthquake? (The earthquake intensity decreases as the distance from the epicenter increases.)

BIG AND LITTLE EARTHQUAKES

CONCEPTS

Earthquakes can be any size, from very small to very large.
Earthquakes cause different amounts of damage.

OBJECTIVES

Students will

- ☺ Construct a model to simulate earthquakes and earthquake damage.
- ☺ Demonstrate that earthquakes have different levels of strength.
- ☺ Compare the movement in the earthquake model to ground movement during an earthquake.
- ☺ Compare different levels of earthquake strength to their effects on people and property.
- ☺ Rank descriptions of earthquake damage from least to most.

☺ Match descriptions of earthquake damage with pictures of earthquake effects.

MATERIALS

For each small student group:

Audiovisual cart on wheels or a small table or desk that moves easily.
Shallow box partially filled with sand or soil.
Assortment of paper plates, cups, and small boxes that can be stacked to form a building.

PROCEDURE

1. Discuss with the class the concept of energy. Establish that energy has many forms (such as mechanical energy, heat, sound, and light) and many different strengths.
2. Have students demonstrate two familiar types of energy.
   a. Have them clap their hands loudly and describe the sound; then clap softly and describe the sound.

      Do you hear a difference? (Yes)

      Why is there a difference? (Soft clapping releases a smaller amount of sound energy than loud clapping does.)

   b. Have the students rub their hands together slowly and describe what they feel; then rub them together quickly and describe what they feel.

      Do you feel a difference? (Yes)

      Why do you feel a difference? (Quick rubbing releases a greater amount of heat energy than slow rubbing does.)

3. Explain to the students that earthquakes are caused by the release of energy stored in rocks, and suggest they make a model for demonstrating earthquakes.

Instructions for each group:

1. Place the large box on the cart, table, or desk.
2. Place the plates, cups, and small boxes on top of each other in the filled box to form a tall structure. (Either have enough materials for each group to construct one model, or have the groups take turns.)
3. Shake the cart, table, or desk very gently, but not enough to disturb the structure.

4. Shake it three more times, increasing the amount of force each time, so that the structure is completely demolished. Adjust or rebuild the structure after the second and third simulations.

RESULTS

After the groups have complete all three simulations, discuss with the class these questions:

1. What caused the buildings to fall down? (The shaking of the table.)
2. What caused the table to shake? (The students who shook it; the simulated earthquake.)
3. What did the shaking give to the table? (Energy)
4. How much energy was used to shake the table the first time? (A small amount.)
5. What happened to the buildings? (Nothing happened.)
6. Are earthquakes always the same? (No. Many are very weak [not felt or slightly felt]; some are somewhat strong [knock down loose objects]; and a few are very strong [cause severe damage to buildings].)
7. Summarize: Different earthquakes have different amounts of energy and cause different amounts of damage.

LANDSLIDES CAUSED BY EARTHQUAKES

CONCEPTS

How can earthquakes cause landslides?

OBJECTIVES

Students will

- ☺ Learn that many landslides are the result of strong earthquake shaking.
- ☺ Construct model hillslopes and measure slope angles.
- ☺ Demonstrate a landslide triggered by an earthquake.
- ☺ Describe some factors that influence earthquake-triggered landslides.

MATERIALS

For each small group of students:

Newspapers to cover work surface

Large tray (such as large meat tray), shallow tub, or cardboard box lid
Local soils of various textures, or potting soil
Builders sand
Pea gravel
Aluminum foil
Water

Note: There is bound to be some mess with this activity, but it can be kept to a minimum by limiting the amount of soil, water, and time. Practice some hill building before class to get the feel of the procedure.

PROCEDURE

Tell your students that they are going to make a model of a landslide and see how easy it is to make it move. Their experiment will depend on how steep the slope is, how wet it is, and how much it is shaken by an earthquake. They should keep records on each of these factors.

Instructions for each group:

1. Cover the work surface with several layers of newspapers. In the tray or shallow box, build a hill from moistened sand or soil (it should hold its shape). Have different groups use different heights and slope angles (one side may be made steeper than the other).
2. Place a sheet of foil on your hill to simulate the slippery layer of rock or soil that allows outer layers to slide off during an earthquake. Record the height of each hill with a ruler and the slope angles of the slippery layer with a protractor.
3. Completely cover the foil with another layer of sand, soil, or gravel. Different groups can use different materials. Record the type of slope material, how wet it is (dry, damp, or saturated with water leaking out), and the angle of the surface slope.
4. Predict the effect of an earthquake on your own model and those of other students by writing answers to these questions:

   On which hills will landslides more likely occur?

   Which parts of each hill will be most affected by an earthquake?

5. Hold the sides of the tray or shallow box on which your hill rests with both hands, and slide it back and forth sharply on your work surface to simulate the shaking of an earthquake.
6. Observe what parts of your hill slid. Record the size of the landslides for each group's

hill.

RESULTS

After all the groups have produced their landslides, observed other groups' results, and finished cleaning up, discuss with the class these questions:

1. How did the shape of the hills affect the landslide? (In most cases, the steeper the slope, the more easily the material will slide.)
2. How did the type of material resting on the foil affect the landslide? (Various answers are possible.)
3. What affect did the wetness of the material resting on the foil have on the landslide results? (Usually landslides are more likely when the soil is waterlogged.)
4. Did some groups shake their hills harder (a stronger earthquake or possibly a closer earthquake)? What affect would the size of an earthquake or the distance from an earthquake epicenter have on the potential for causing landslides?
5. How should the potential of a site for landslides caused by earthquakes affect decisions on locating homes and other structures on or below it? (Such a site would make a poor choice unless it can be reinforced in some way.)
6. What are some events other than earthquakes that can cause landslides? (Heavy rains, freezing and thawing of the ground, steepening of slopes from erosion or artificial excavation.)

SUPPLEMENT

1. Have each small group write a report showing their measurements, describing how they made their hill, what they observed as the earthquake shook the landslide loose, and how their simulation compared to others in the class.
2. Show pictures of famous landslides caused by earthquakes, such as those caused by the 1959 Hebgen Lake earthquake in Montana, and in Alaska during the 1964 earthquake. Students could follow up the activity with library research and present reports on these and other landslide events.