Shake A Minute

***Putting Down Roots*, p. 14**

Idaho State Standards:

8th/9th Earth Science 1.2.1, 1.8.1
8th Mathematics 1.3.1, 5.1.1
9th Mathematics 1.1.2

Objectives:

Students will:

1. Demonstrate how long an average earthquake lasts.
2. Compare duration of different historical earthquakes.
3. Correlate earthquake duration with intensity.

RATIONALE

This activity is teacher-directed and a good "hook" or opening for instruction on hazards associated with ground shaking. Most people caught in earthquakes have a feeling of helplessness. Especially if they have never experienced an earthquake, students have no idea how long one will last or what to expect during such an event. During an earthquake, people often overestimate the length of time that the shaking of an earthquake lasts.

FOCUS QUESTION(S):

- How long do most earthquakes (ground shaking) last?
- What type of damage would occur to the classroom from a long duration earthquake?

TEACHING CLUES AND CUES

Instruct students to shake with care, so they don't hurt themselves or anyone around them. The most recent data indicates that the Borah Peak earthquake lasted approximately 9 seconds. **Do not tell students this yet**. Many factors play into ground shaking duration and intensity. These three factors are:

- Magnitude of the earthquake--in general, the larger the quake, the stronger the shaking and the larger the area affected,
- Distance to the earthquake--the closer to the source of the quake, the stronger the shaking, and
- Type of ground material and soils--may amplify or change characteristics of the shaking relative to hard bedrock.

*Page 14, *Putting Down Roots*, see diagram at the bottom left of the page or go to http://www.bhs.idaho.gov/pages/Preparedness/Hazards/NaturalHazards/Earthquake.aspx and then scroll down and click on the booklet cover. A PDF version will open and you can project the diagram in the classroom.

The only accurate way to determine the length of time that the earthquake lasted is to take the information directly from the seismogram. The seismogram however will show longer ground motion than what can be detected by humans. The 9 second value given for this activity is a time of ground shaking that could be detected by humans. The seismogram for the Borah Peak main shock shows a value of 30 seconds.

MATERIALS:

for teacher

- Large clock with a second hand or stop watch
- White board/chalk board and markers/chalk
- *Optional*: Computer with internet connection and Projection equipment if doing any of the Extension activities

for the students: (work in pairs)

- Pencil/pen
- Paper

PROCEDURE:

Teacher Preparation

Form teams of two students.

Instruct students to shake with care, so they don't hurt themselves or anyone around them.

A. Introduction

Ask students to estimate on a piece of paper how long they think an earthquake lasts. How long will the ground shake? Collect the estimates. Explain to students that in most earthquakes, shaking rarely lasts for as long as a minute in any one area. Strong shaking from a major quake usually lasts from 30 to 60 seconds. For example, the 1906 San Francisco earthquake lasted about 40 seconds. In the 1964 Alaskan earthquake, the shaking lasted 180-240 seconds (3-4 minutes) – an extremely long time. This does not happen very often.

B. Lesson Development

1. Collect the estimates and list them on the board.
2. Steps 3-7 are optional. If classroom time is limited, skip to Step 8.
3. Tell students that they are going to estimate how long a one-minute earthquake is without looking at the clock. Have them break up into pairs. One of each pair will be the timekeeper and recorder, while the other is the "earthquake."

4. When you give the signal, the earthquakes (students) are to begin shaking, and the timers are to begin timing. Ask the quakes

whose backs should be to the chalkboard or whiteboard to continue shaking until they think that a minute has passed.

5. Once the timing and shaking start, write the time elapsed on the board every five seconds. The timers, who can see the board, should record the last time listed when their partners stop shaking. Instruct the timers not to share the time with the earthquake students yet.

6. Ask the timers to report the actual times that each "quake" lasted. Write all of the times on the board. Have the class compare the times:

- How long was the shortest "earthquake"?

- How long was the longest?

- What was the average time for this group?

7. Have partners switch roles and repeat steps 4, 5, and 8. Ask the class:

- Did the second group come closer to one minute than the first?

- If the answer is yes, why? *Perhaps because the second pair of students had the advantage of observing the first pair.*

8. Now have everyone in the class shake for one minute at the same time. Tell them when to start and stop, but ask them not to watch the clock. Then ask:

- Did the time you shook seem like more or less than a minute? *Explain that even though an earthquake is over in a short time, Idaho = 9 seconds, it usually seems much longer to those people experiencing it. Why?*

- What might happen to objects in this classroom if the ground shook strongly for a minute? *Answers will vary.*

C. Conclusion

Summarize the information about ground shaking and how different factors can result in different ground shaking times (duration).

Adaptations and Extensions

Have students go on-line to determine the duration of some of the more recent earthquakes worldwide, such as Sumatra-Andaman Islands on December 26, 2004 or Tohoku, Japan, near the coast of Honshu, on March 11, 2011.

Go to the USGS site at http://earthquake.usgs.gov/earthquakes/world/historical.php to get a list of recent or historic earthquakes that have occurred in the United States or in other places throughout the world.

- You may sort by magnitude to arrange from largest to smallest or by date.
- On the left side bar, select "Seismogram Display." A map of North America with seismic symbols will load. Below, there is a list of sites you can open to display seismograms. Either click directly on one of the locations on the map or select from the list.
- A screen with "Recent Heliocorder Displays" lists a series of dates for different locations within that state. To see how it works, select the first date in the list (Broadband Vertical) and look at the seismogram displayed (click on the image to enlarge).
- Go back and select the same date from the Short Period Vertical list below and display.
- Finally go to the Long Period Vertical list and display this seismogram. It will allow you to display the same earthquake but at different frequencies of ground motion. Students can read directly off of the seismogram for the duration of the shaking by looking for the P-wave signal and the end of the L-wave signal.

Another great site for pulling up seismograms and reading the duration of detectable ground motions from around the world can be found at Global-IRIS-Rev at http://rev.seis.sc.edu/. It is possible to compare seismograms of the same earthquake, but from different stations side by side.

At the bottom of the home page of the REV site are some educational "Links of Interest." One of the best sites is the DLESE Teaching Boxes site at http://www.teachingboxes.org/earthquakes/#extraRev(), an outstanding repository of teacher resources for all areas of Earth Science and grade level. All lessons/activities on this site have been evaluated for their scientific accuracy and educational pedagogy in the classroom. From this page, scroll down to the section "EXTRA: Rapid Earthquake Viewer Lessons" to find a list of REV lessons follows, as well as a tutorial on using REV.

For more DLESE lesson boxes go to http://www.teachingboxes.org/index.jsp for a list.

Teacher Background Material

A Comparison of Magnitude and Rupture Length for Earthquakes in the United States

Magnitude	Date	Location	Rupture Length (kilometers)	Duration (seconds)
9.2	March 27, 1964	Alaska	1,000	420
7.9	November 3, 2002	Denali, AK	300	90
7.8	January 9, 1857	Fort Tejon, CA	360	130
7.7	April 18, 1906	San Francisco, CA	400	110
7.2 - 7.8	February 7, 1812	New Madrid, MO	40 - 100	13 - 30
7.3	June 28, 1992	Landers, CA	70	24
7.3	August 17, 1959	Lake Hebgen, MT	44	12
7.0	October 17, 1989	Loma Prieta, CA	40	7
6.9	October 28, 1983	Borah Peak, ID	34	9
6.8	February 28, 2001	Nisqually, WA	20	6
6.7	January 17, 1994	Northridge, CA	14	7
6.4	March 10, 1933	Long Beach, CA	15	5
5.9	October 1, 1987	Whittier Narrows, CA	6	3
5.8	June 28, 1991	Sierra Madre, CA	5	2
5.2	September 3, 2001	Yountville, CA	4	2

Source: Southern California Earthquake Center (SCEC), “Putting Down Roots Handbook,” Separating Fact from Fiction, April 11, 2011.