Identifying Seismic Waves Lab

Lindsay Bowen

Goal of Lesson from EarthComm: (60 minutes)

1. Generate and describe three types of waves, this knowledge will be used in following lessons focusing on reading seismograms, which determine the magnitude (size) of the earthquakes (E3.4B).
2. Determine the relative speeds of compressional and shear waves, which introduce the effects of earthquakes on humans (E3.4C).

Michigan Content Expectations

E3.4B Describe how the sizes of earthquakes and volcanoes are measured or characterized.
E3.4C Describe the effects of earthquakes and volcanic eruptions on humans.

Special Education IEP Goal: The learner will retell through concise summarization the main idea(s) of the lesson.

Knowledge Needed

Completed previous unit on Plate Tectonics, specifically understanding the different types of plate boundaries and the impact of each to the Earth
Ability to follow verbal and written instructions
Ability to work in cooperative groups – assume given role in group
Ability to use a stop watch, measuring in seconds – 1 group member
Ability to make and record observations
Ability to summarize learned information

Useful Websites:

EarthComm website on Activity 1 - Earthquakes
http://www.agiweb.org/earthcomm/geosphere/earthquakes/index.html?State=MI
USGS Earthquake Website
http://www.usgs.gov/science/science.php?term=304
1st Slide -Simple visual of how P and S waves travel through the Earth
http://aspire.cosmic-ray.org/labs/seismic/seismic.swf
Information/Lesson Plans/Video on Earthquakes
http://web.ics.purdue.edu/~braile/educindex/educindex.htm

Vocabulary

Earthquake – A sudden motion or shaking in the Earth caused by the abrupt release of slowly accumulated strain.
Seismic (Earthquake) Waves – A general term for all elastic waves in the Earth, produced by earthquakes.
Primary Wave (P Wave) – A seismic wave that involves particle motion (compression and expansion) in the direction in which the wave is traveling.
Shear Wave/Secondary Wave (S Wave) – A seismic wave produced by a shearing motion that involves vibration perpendicular to the direction in which the wave is traveling. It does **NOT** travel through liquids, like the outer core of the Earth.
Surface Wave – A seismic wave that travels along the surface of the Earth. There are two kinds; one creates an up-and-down rolling motion of the ground, very much like a wave on a water surface. The other kind shakes the ground sideways.

Materials/ Technology:

Materials for whole class instruction

Document Reader/ Projector/Screen – Can substitute overhead projector

Computer with internet access that can be projected onto screen (optional in the elaborate section)

Materials for each 4 person group to complete lesson

4 EarthComm books, pages G128 - 129

1 Slinky – found in district provided blue totes

1 Stop Watch – found in district provided blue totes, or ask gym teacher to borrow a few

4 Seismic Waves Lab Worksheets – attached at end of lesson plan

Procedure/Instructions:

Engage: (≈ 15 minutes)

1. Projected using the document reader or written on the white board:

   If you have ever experienced an earthquake, describe your most vivid memory. If you have not experienced an earthquake, what would you expect to see, feel, and hear?

Give students about **3-4 minutes** of "think time" to write down thoughts in their notebooks. Circle the classroom to ensure that each student has at least one thought written.

2. At the end of the think time give students **one minute** to pair share with someone sitting next to or behind them. Focus your attention on a couple of groups and listen to what they are sharing, possibly interjecting questions for them to ponder which add onto what is already being discussed.

3. Move into about an **8-10 minute** whole class discussion, using the accountable talk framework. Call on students to share one piece of their memory or one thing they would expect during an earthquake. Write student responses on paper broken down into see, feel, and hear categories under document reader. Emphasize these as beginning ideas; nothing is being set in stone as right or wrong at this point.

*****Ask guiding questions during the discussion that lead towards students expecting to experience or having experienced the ground shaking, if they do not bring it up on their own, as this is the basis for the lesson. Potential questions: Do items fall off shelves or walls crack? What causes this to happen? or How do we know an earthquake has occurred?

After discussion is complete, walk up to a table or desk in the front of the classroom unsuspectingly, and flip it over. Ask students what the table being flipped over simulated, if they felt anything, to describe what they felt, and what caused them to feel something. Make sure to ask students from different places in the classroom, those near the table and those in the back corner too. Note student responses on discussion paper, letting students know that we are going to try and figure out why different people felt different vibrations/movements.

Explore: (25 - 30 minutes)

1. After the discussion is complete hand out Seismic Waves Lab Worksheets and rubrics to each student, go through listed procedures explaining that this will be a four person group assignment. Next explain student roles within the group. The groupings may be previously assigned by the teacher or have students pick their own.

   *As you go through listed procedures have a copy of the lab worksheet on the document reader for students to follow you along on. Model the Primary Wave demonstration with one student helping hold the slinky as you tap the end, ask students to repeat the directions or summarize what you have said as you are explaining to check for understanding.

Seismic Waves Lab Member Roles

Getter/Scribe: Gather and return all materials from teacher (slinky and stop watch) and report travel time of seismic waves on whiteboard.

Recorder: Use stop watch to determine different travel times of the seismic waves and record data on lab worksheet.

Slinky holders (2 people): Responsible for creating the three types of seismic waves according to the lab worksheet and holding the slinky at the appropriate distance.

2. Dismiss students to their groups, during this activity students will be spread around the classroom, so make sure to have open areas on the floor or long rows of desks or tables for the students to complete the lab on.

As students work in their groups, walk around the classroom making yourself available to aid groups in setting up the lab correctly, reading lab procedures, using the stop watches, and most importantly asking rigorous questions.

Questions to ask:

- What do you expect the slinky to do when you hit it with the palm of your hand? Why do you expect that to happen?
- Does the speed of the seismic waves change depending on how you move it/hit it? Why do you think that happens? What have you noticed influences the speed of the seismic wave?
- How do you think this lab relates back to me flipping the table over earlier?
- What have you noticed about the movements of the slinky? Does it always move in the same direction? Why or why not?
- Has each slinky movement created the same seismic wave? How are the waves different from each other?

Misconceptions students may have:

- When an earthquake hits the earth breaks into two pieces
- Earthquakes occur randomly around the earth
- If you don't feel the ground shake then an earthquake did not occur
- The crust of the earth only moves one way during an earthquake, there are not different motions associated with different seismic waves.

3. Make sure the "Getter/Scribe" returns the group materials to designated spot at end of the lab and record their group's time data on the white board or chart paper before returning to their desk.

Explain: (≈15 minutes)

1. Make sure each student has their lab worksheet out and begin by going over the different types of seismic waves the groups should have created during the lab.

* After asking each question demonstrate, with another student, what the groups should have seen during the lab with the slinky. Who can share their description of the slinky motion when you hit the slinky with your fist? When you moved the slinky back and forth (left to right)? When you moved the slinky up and down? What do you think these movements represent?

2. Secondly, look at the matching section on the lab worksheet. Ask students to volunteer one match at a time, using evidence from the book to support their answer.

3. Finally, look at the data chart created by each group on the white board/chart paper. Notice the similarities and differences in the times between the same and different seismic waves. Focus the discussion around how quickly the waves travel.

*What do you notice about the travel times of the seismic waves across the data table?

* What does this information tell us about earthquakes?

Elaborate:
Videos from youtube.com could be shown to further demonstrate the travel speed and motion each seismic wave creates.
Understanding and Applying What You Have Learned Questions (G 129) #1-3 could be completed individually
Students could use the class laptops to further investigate any unanswered questions or wonderings they may still have
Students could draw a picture depicting the three different motions seismic waves create, labeling each wave type along with a brief definition of each wave.

Evaluate:
Evaluation of student understanding is ongoing informally throughout the lesson from the opening accountable talk discussion all the way through the explanation of the lesson. To formally assess students I would collect their lab worksheets to check for understanding, focusing my attention on the matching section as well as the fourth short answer question asking them to summarize their findings. Asking simple and rigorous questions throughout the lesson, watching the groups work collaboratively to complete the lab, and re-teaching when necessary also should be completed through the lesson as an evaluation of student understanding.
The rubric for the lab worksheets should be used as a more formal assessment of student learning throughout the lesson. Display high student achievement around the classroom after showing it to students as a review the following class period. This not only affirms those who did very well but allows students who did not score as well an opportunity to see how to achieve a better grade on the next assignment. Also, look for misconceptions within student work to address during the next lesson.

Assessment Rubric:

	4 = A	**3 = B**	**2 = C**	**1 = D**
Data Collection	**Well organized info, detailed measurements, and correct vocabulary**	**Organized, measurements complete, most science vocabulary correct**	**Some organization, most measurements, some science vocabulary**	**Very little organization, some measurements, no scientific vocabulary**
Written Scientific Concepts	**Well organized info, detailed descriptions, and correct vocabulary**	**Organized, complete thoughts, most science vocabulary**	**Some organization, mostly correct thoughts, some science vocabulary**	**Very little organization, some correct concepts, no scientific vocabulary**
Summary	**Summary included all 3 types of seismic waves and all time measurement data with details given**	**Summary included all 3 types of seismic waves and all time measurement data but no details**	**Summary included 2 types of seismic waves and some time measurement data**	**Summary included 1 type of seismic wave and little time measurement data**
Group Participation	**Worked very well with group, completed all of assigned roll**	**Worked well with group, completed most of assigned roll**	**Worked okay with group, completed about 50% of assigned roll**	**Did not work well with group, completed minor part of assigned roll**

Seismic Waves Lab Worksheet Name:
EarthComm - Earthquakes – Activity 1 Hour:

Lab Goal: Work with your group members to generate and describe three types of seismic waves and determine the relative speed of each seismic wave.

Materials needed per group: 1 slinky, 1 stop watch, 1 Seismic Waves Lab Worksheet per person

Group Member Roles

Getter/Scribe:_____ Recorder:_____
Slinky Holder 1:_____ Slinky Holder2:_____

Lab Procedures (adapted from page G124 in EarthComm)

Step 1: Place your slinky on the floor. Slinky holder 1 and slinky holder 2 each hold one end. Back away from each other so that the slinky stretches **about 12 feet long**.

Step 2: Slinky holder 1 **holds the end of the slinky in a fist** and once hit the back of their fist with the other hand**. The palm should be facing the slinky**. **Start** the stop watch when the palm hits the back of the fist. The timing ends when the seismic wave has reached the opposite end of the slinky. Slinky holder 2 will say **"STOP"** when the seismic wave reaches them. Observe the motion of the slinky and the speed of the wave.

Describe Slinky Motion 1:

_____
_____
__

Time of vibration from one end to the other:_____seconds
Draw a picture to show the slinky motion:

Step 3: With the slinky still stretched out **about 12 feet on the floor**, slinky holder 1 will **quickly jerk the end of the slinky once back and forth (left to right)**. **Start** the stop watch the first time the slinky moves left to right. The timing ends when the seismic wave has reached the opposite end of the slinky. Slinky holder 2 will say **"STOP"** when the seismic wave reaches them. Observe the motion of the slinky and the speed of the wave.

Describe Slinky Motion 2:

_____
_____
__

Time of vibration from one end to the other:_____seconds
Draw a picture to show the slinky motion:

Step 4: With the slinky still stretched out about 12 feet in the air, slinky holder 1 will quickly jerk the end of the slinky once up and down. **Start** the stop watch the first time the slinky moves up and down. The timing ends when the seismic wave has reached the opposite end of the slinky. Slinky holder 2 will say **"STOP"** when the seismic wave reaches them. Observe the motion of the slinky and the speed of the wave.

Describe Slinky Motion 3:

_____
_____
__

Time of vibration from one end to the other:_____seconds
Draw a picture to show the slinky motion:

Read pages G128-129 in your EarthComm book. You may read this individually or as a group. After reading, be ready to match the slinky motions you observed today to their scientific names.

____ Surface Wave — **A.** Slinky Motion 1 – compressional wave

____ Primary Wave (P Wave) — **B.** Slinky Motion 2 – left to right

____ Secondary Wave (S Wave) — **C.** Slinky Motion 3 – up and down

Reflecting Questions (Answer as a group)

1. What determines if the wave travels the length of the slinky? Do you think this is why not every class member felt the vibrations in the floor when the table was flipped? Why?

2. How do the slinky coils (loops) change as the wave passes? Did the coils react the same way in each trial?

3. Rank P waves, S waves, and surface waves in order from fastest to slowest.

4. Summarize your findings. Make sure to include the three different wave movements you saw as well as the speed of the seismic waves.