Virtual Earthquake: Travel Time, Epicenter & Magnitude

Lesson source: Geology Labs On-Line at
http://nemo.sciencecourseware.org/eec/Earthquake/

Focus on Inquiry

The student will collect and interpret seismographic data to explain the relationship between S-P Lag time and distance traveled by waves. They will use this knowledge to determine the location simulated earthquake.

Lesson Overview

"Virtual Earthquake" is an inquiry-based activity that teaches how earthquake (seismic) waves are used to locate an earthquake's epicenter and to determine its Richter magnitude. This lesson contains two activities, "Travel Time" and "Epicenter & Magnitude". In the "Travel Time" activity, students simulate creating seismic waves. They collect data and construct a graph for the simulated seismic waves. They then analyze the graph to determine the relationship between the epicenter distance and the amount of time for the seismic waves to travel. In the "Epicenter & Magnitude" activity, students use seismograms located in various locations on a map. They simulate an earthquake and determine the location of the earthquake's epicenter, and then they estimate its Richter magnitude. In both activities, students record their observations and measurements in an online journal.

Duration	**Setting**	**Grouping**	**PTI Inquiry Subskills**
Approximately 2-3 class periods	Classroom or Computer Lab	Individual, pairs, or small groups of 3	**2.1, 3.1, 3.2, 3.3, 3.5, 3.6, 3.7, 3.8, 4.2, 4.3, 4.4, 5.2, 5.3, 5.4, 7.2, 7.3**

Lesson Components	Estimated Time	Inquiry Subskills Used	Technology Used	Level of Student Engagement	Brief Description
Engage	5 min.		Internet: video, images	1	Student discussion about earthquakes, their location and destruction. Teacher show a video clip and images of historic earthquakes.
Explore	100 min.	2.1, 3.1, 3.2, 3.3, 3.5, 3.7, 3.8, 4.2	Internet: Simulation	3	Students go through tutorial and complete "Travel Time" and "Epicenter & Magnitude" interactive activities from activity website. They collect data and record their findings in a journal.
Explain	Part of explore section	3.6, 3.8, 4.2, 4.3, 4.4, 5.2, 5.3, 5.4, 7.2, 7.3	Internet: Simulation	3	Students use data collected during activities to explain the relationship between S-P lag time and distance traveled. Then they will simulate an earthquake and determine the location of the earthquake's epicenter. Students can prepare a presentation to explain their unique scenario to the class.
Expand	50 min.	7.3	Computer and multimedia software (optional)	3	Students create a news report explaining factual information about a historic earthquake.
Evaluate	varies		Internet: Online quiz	3	Students complete an assessment quiz upon completion of activities on website.

Level of Student Engagement

1	Low	Listen to lecture, observe the teacher, individual reading, teacher demonstration, teacher-centered instruction
2	Moderate	Raise questions, lecture with discussion, record data, make predictions, technology interaction with assistance
3	High	Hands-on activity or inquiry; critique others, draw conclusions, make connections, problem-solve, student-centered

National Science Education Standards – Inquiry

Design and conduct a scientific investigation.
Appropriate tools and techniques to gather, analyze, and interpret data.
Develop descriptions, explanations, predictions, and models using evidence.
Think critically and logically to make the relationships between evidence and explanations.
Communicate scientific procedures and explanations.
Use mathematics in all aspects of scientific inquiry.

National Science Education Standards – Earth Science

Lithospheric plates on the scales of continents and oceans constantly move at rates of centimeters per year in response to movements in the mantle. Major geological events, such as earthquakes, volcanic eruptions, and mountain building, result from these plate motions.

Land forms are the result of a combination of constructive and destructive forces. Constructive forces include crustal deformation, volcanic eruption, and deposition of sediment, while destructive forces include weathering and erosion.

Louisiana Grade Level Expectations – Inquiry

Gr. 8, Inquiry GLE#3 – Use a variety of sources to answer questions (SI-M-A1)
Gr. 8, Inquiry GLE#4 – Design, predict outcomes, and conduct experiments to answer guiding questions (SI-M-A2)
Gr. 8, Inquiry GLE#6 – Select and use appropriate equipment, technology, tools, and metric system units of measurement to make observations (SI-M-A3)
Gr. 8, Inquiry GLE#7 – Record observations using methods that complement investigations (e.g., journals, tables, charts) (SI-M-A3)
Gr. 8, Inquiry GLE#8 – Use consistency and precision in data collection, analysis, and reporting (SI-M-A3)
Gr. 8, Inquiry GLE#9 – Use computers and/or calculators to analyze and interpret quantitative data (SI-M-A3)
Gr. 8, Inquiry GLE#11 – Construct, use, and interpret appropriate graphical representations to collect, record, and report data (e.g., tables, charts, circle graphs, bar and line graphs, diagrams, scatter plots, symbols) (SI-M-A4)
Gr. 8, Inquiry GLE#12 – Use data and information gathered to develop an explanation of experimental results (SI-M-A4)
Gr. 8, Inquiry GLE#13 – Identify patterns in data to explain natural events (SI-M-A4)
Gr. 8, Inquiry GLE#16 – Use evidence to make inferences and predict trends (SI-M-A5)
Gr. 8, Inquiry GLE#19 – Communicate ideas in a variety of ways (e.g., symbols, illustrations, graphs, charts, spreadsheets, concept maps, oral and written reports, equations) (SI-M-A7)
Gr. 8, Inquiry GLE#22 – Use evidence and observations to explain and communicate the results of investigations (SI-M-A7)
Gr. 8, Inquiry GLE#27 – Recognize that science uses processes that involve a logical and empirical, but flexible, approach to problem solving (SI-M-B1)
Gr. 8, Inquiry GLE#29 – Explain how technology can expand the senses and contribute to the increase and/or modification of scientific knowledge (SI-M-B3)
Gr. 8, Inquiry GLE#31 – Recognize that there is an acceptable range of variation in collected data (SI-M-B3)

Louisiana Grade Level Expectations Earth Science

Grade 8, GLE#13 – Describe the processes responsible for earthquakes and volcanoes and identify the effects of these processes (e.g., faulting, folding) (ESS-M-A3)

Materials List (per group)

- Computer with Internet Access
- Optional: Projector for whole class instruction

Advance Preparation

1. Teacher should assure that students' computers contain system requirements conducive to the activities provided in the lesson. There are download links to these requirements via the "System Requirements" button on the activity website.
2. Disable any pop-up blocker software that may be running on the computer.
3. Complete the teacher demonstrations, and review the tutorials provided on the activity website.
4. Determine the parts of the activity that students will complete on their own and the parts that will require whole class instruction.
5. Teacher may want to provide an overview of each activity prior to the students completing the activities.
6. At the completion of the activity, student learning is assessed with a quiz. A certificate of completion as a virtual seismologist will be granted once the activity and quiz are successfully completed. The activity does not need to be completed in one sitting. At any time, students may save their work and return later to complete the activity. Teachers can register their classes

(FREE) and students' assessment results are stored in a data base for teachers to analyze students' progress and assessment results. *(Based on overview from activity website)*

Other Information

Learning Objectives

1. Use simulated data to construct a travel-time graph for seismic waves.
2. Explain the relationship between the distance to an earthquake epicenter and the amount of time earthquake (seismic) waves travel.
3. Simulate an earthquake and use seismograms to determine the location of the earthquake's epicenter and estimate its Richter magnitude.

Prior Knowledge Needed by the Students

None

Procedure

Engage

1. Write the word "Earthquake" on the board. Engage students in a class discussion about past earthquakes, their locations, and the destruction caused by the earthquakes.
2. Show students a video clip of an earthquake (http://video.nationalgeographic.com/video/player/environment/environment-natural-disasters/earthquakes/) and the images of various historic earthquakes from the activity website (http://nemo.sciencecourseware.org/eec/Earthquake/). Ask students what causes earthquakes and how do scientists determine the magnitude of an earthquake and to locate its epicenter.

Explore

1. Students should go through the tutorials on the website to learn about S-P lag time, latitude, and longitude. Teacher has the option to allow students to complete the tutorials on their own or as a whole group.
2. Students complete the "Travel Time" activity on the Activity Website. In this activity, students set the locations of five seismic stations on a map, initiate an explosion at the known location, measure the distance to each station from the site of that explosion, measure S-P lag time on each station's seismogram and finally construct a graph for the S-P lag time versus distance traveled. *(Description taken from activity website)*
3. Students complete the "Epicenter & Magnitude" activity on the Activity Website. In this activity, students use triangulation to locate an earthquake's epicenter. In sequence, students will place seismic recording stations on a map, initiate an earthquake at an unknown location, measure the S-P lag time on the seismograms of each station, use a travel-time tool to determine the epicentral distance from each station, use a graphing tool to manually locate the epicenter, and then estimate the latitude and longitude of the epicenter. *(Description taken from activity website)*

Explain

Note: This section is integrated with the explore section.

1. Students complete a journal during their data collection for each activity.
2. In the "Travel Time" activity, students use their graph to explain the relationship between S-P lag time versus distance traveled.
3. In the "Epicenter & Magnitude" activity, each student will explain their unique solution to their simulated earthquakes. They will explain the location of their simulated earthquake's epicenter.
4. Upon completion of the activities, students will receive a certificate from the activity website.

Expand

1. Students research an historic earthquake and create a news article/report containing factual information. The information should include, but is not limited to, the location of the earthquake, epicenter location, magnitude, destruction, possible causes, and pictures.

Evaluate

1. The “Earthquake” activity includes an online quiz so that instructors can determine how well learning objectives are met. The quiz will be displayed after students complete their second activity. You can also have the students access the Quiz at a later class by clicking on the Epicenter and Magnitude activity and click on “Take Quiz Now” located below the “Start” button. Teachers can register for class codes for students to use before they take the assessment quiz in order to access a database of students’ results.

Blackline Master

1. Epicenter and magnitude of the earthquake

Supplementary Resources

USGS Science for a changing world
http://earthquake.usgs.gov/eqcenter/

This site contains general information about earthquakes. It also provides the location, time, and magnitude of earthquakes that occurred over the last seven days.

Name: _____ Date: _____ Class Hour: _____

What is the Epicenter and Magnitude of the Earthquake?

Please use this worksheet to take notes as you watch the tutorials and complete the activities.

The S-P Lag Time Tutorial

One Station Demo

The S-P lag time is _____

Two Stations Demo

The closer station showed _____S-P lag time and _____ S-wave amplitude.

Latitude and Longitude Tutorial

Latitude: _____

Longitude: _____

Travel Time Activity

What is the relationship between the distance of the stations and the S-P lag time?

_____

Epicenter and Magnitude Activity

What is the relationship between the distance of the stations and the S-wave amplitude?

_____

What are needed in order to determine the magnitude of an earthquake?

_____

_____