Web Unit Plan

Title: The Earth Moves Under My Feet

Description: Students are assigned to task forces with the mission to develop a comprehensive emergency earthquake plan for the "slice" of Earth they have been assigned. Each task force collects real-time seismic data and uses that information and other research as a basis for recommendations for a specific area.

At a Glance

Grade Level: 6–8

Subject sort (for Web site index): Science

Subject: Earth Science

Topics: Earthquakes, Dynamic Processes, Physical Geography, Data Analysis

Higher-Order Thinking Skills: Analysis, Interpretation, Investigation

Key Learnings: Frequency of Physical Events, Science Measurement, Classification Systems, Collecting and Organizing Information

Time Needed: 3 weeks, 50-minute classes, daily

Background: Montana, United States

Unit Summary

In an effort to understand the nature and processes of earthquakes, students monitor seismic data on the Web and plot geographic coordinates of real-time earthquake activity. This activity demonstrates that earthquakes are not random but appear in clusters, and further research causes students to discover the relationships between seismic events and the movement of Earth's tectonic plates. Students create surveys of people's experiences with earthquakes, and organize, represent, and analyze the data using spreadsheet software. Students use this information to develop Earthquake Preparedness Plans for specific areas. Following this exercise, students study the lithosphere in terms of landform processes and geologic history.

Curriculum Framing Questions

- **Essential Questions**
  How does change affect the future?
- **Unit Questions**
  Could an earthquake happen here?
  How can we prepare for safety in the event of an earthquake?
- **Content Questions**
  How are locations of earthquakes related to the location of the tectonic boundaries?
  Are there patterns to the occurrence of earthquakes?
  How is earthquake data organized and measured?
  What are the relationships between earthquakes and other natural disasters?

Assessment Processes

View how a variety of student-centered assessments are used in the The Earth Moves Under My Feet Unit Plan. These assessments help students and teachers set goals; monitor student progress; provide feedback; assess thinking, processes, performances, and products; and reflect on learning throughout the learning cycle.

Instructional Procedures

Prior to Instruction

Prior to this study, students should have an understanding of how map projections are developed to represent the Earth's sphere, and learn to plot geographic coordinates of latitude and longitude on maps. Prepare flat world maps that show latitude and longitude with dimensions of at least 11 x 17 inches.

Provide each student with a science journal to write observations, reflect on discussions and questions, and record thoughts throughout the unit. Besides designated places for journal writing, consider allowing students to write freely in their journals whenever they choose to reflect on the unit's topics.

Session 1: Introducing the Unit

Visibly display the Essential Question, *How does change affect the future?* Have students write in their journals for five minutes on this question. Introduce the topic of earthquakes by showing a video of earthquakes in action and the damage they cause. Authentic news clips reporting recent earthquake disasters also connects students to the topic they are about to study. Ask the following questions:

- *How much notice do you think the people in the videos had that an earthquake was coming?*
- *How can we prepare for safety in the event of an earthquake?*
- *Could an earthquake happen here?*
- *How do scientist find out?*

Conduct as a class discussion or organize group discussions. These questions should spark others. Have students meet in small groups to discuss their ideas. Each group chooses a recorder and develops questions they would like to pursue relating to earthquakes. The recorder writes the questions on 4 x 6 inch file "inquiry" cards.

Reconvene the group and discuss the questions. Remove inquiry cards with duplicate questions and then organize the cards into logical categories. Categories may include causes, superlatives (worst, most, strongest), history, classification systems, geology, and others. Grouped by topic, the questions and the answers to them can be a part of the group project for the unit.

Session 2: Collecting Data

Ask students how many earthquakes they believe can be perceived by humans somewhere on Earth in a day. Record their predictions, and ask, *What do you think the chances are that a damaging earthquake could occur right here in the next year? In the next 100 years?* Have students record their predictions in their journals to compare with other data later in the unit.

Assign students to groups and have the groups develop survey questions they can use to poll people's experiences with earthquakes. Reconvene and sort the questions into a final survey. Questions might include the following:

- *Have you ever felt an earthquake?*
- *If so, where were you?*
- *When did it occur?*
- *Do you know what magnitude it was?*
- *Was damage caused?*

- *With what percent likelihood would you predict a damaging earthquake will occur here in the next year? In the next 100 years?*
- *Where was the world's last damaging earthquake?*
- *Where do you think the next damaging earthquake will occur?*
- *What earthquake do you know most about?*
- *What type of demographic data (such as age, gender, or nationality) was involved?*

As a homework assignment, have each student poll 10 people of varying ages (locally or remotely) using the class-created survey. Instruct students to write a summary with conclusions based on the data they collect.

Session 3: Organizing, Representing, and Analyzing Survey Data Results
If students are not familiar with spreadsheet software, introduce them to the spreadsheet as a tool for organizing, representing, and analyzing data. Using a projector, provide students with a spreadsheet overview, showing them how to:

- Create a new worksheet
- Type in a title
- Enter headings and data
- Create charts

In teams of four, ask students to choose several quantifiable responses and combine their homework poll data into a spreadsheet. Provide each group with a copy of the Earthquake Poll Spreadsheet Worksheet to aid them in creating their spreadsheets of combined survey data.

Using a projector, have each group share their graphs representing their poll data. Discuss as a class the similarities and differences among the groups' data, including types of graphs/charts students used, patterns and trends in the data, and new questions the data raises for them.

Pinpoint on a world map the locations reported by those polled and discuss whether conclusions can be derived about patterns or frequency of earthquakes.

For homework, have students choose one or more questions from their group's combined poll that they did NOT use in today's spreadsheet and create an individual spreadsheet. Ask the students to choose at least two different kinds of charts or graphs to represent their data, write an explanation of the pros and cons of each graph in terms of how it represents their data, explain which graph best represents the data, and why that is so.

Session 4: The Basics
Use the Earthquake 101* Web site to teach the fundamentals of earthquakes and review types of geological maps.

Explain the classification systems for earthquakes (magnitude and depth). The Richter Magnitude* site helps explain. Teach the concept of order of magnitude* as it relates to base systems (since we use base 10, a 4.6 magnitude earthquake is 10 times greater than a 3.6 magnitude earthquake).

Session 5: The Project

Assign students into task forces. Each task force is responsible for developing a comprehensive earthquake preparedness plan. Hand out and discuss the project rubric. This rubric can be used to guide the process.

Divide the world into plots, giving each task force a "slice" of the Earth. For example, one eighth of the Earth north-to-south from the equator to the north pole, and east-to-west from about Central America to the international date line can be described as 0^{o}-90^{o} N latitude and 90^{o}-180^{o} W longitude.

Ask the Unit Questions, *Could an earthquake happen here?* and *How can we prepare for safety in the event of an earthquake?* and discuss briefly.

Each plan must contain the following components:

- Public service announcement and emergency broadcast system
- Soil analysis and building structure guidelines
- Description of equipment used for predictions
- Prediction data and seismic data for the area shown on maps with a classification system
- Analysis of any patterns in occurrences that emerge
- History of activity in the area, visually represented
- Research on the relationships among earthquakes and other natural disasters

Tell groups they need to divide the tasks and create a plan of action. The group needs to clearly identify who is doing what and by when. They should use the chart provided in the project rubric to document individual assignments. Once tasks are divided, give each student an accountability rubric. These rubrics help students asses how accountable they are for their own learning. Review the rubric and answer any questions. Each task force must also choose the format(s) in which they will present their plan. Check in with groups periodically to monitor progress, and meet one-on-one with students to assess how they are collaborating with the group. Review the accountability rubric with them and monitor their work on their individual tasks. Redirect or review certain skills in order for them to stay on task, complete their part of the project successfully, and keep accountable for their own learning.

Sessions 6 through 11: Work Days and Mini-Lessons

Show students how real-time seismic data is presented by the United States Geological Survey (USGS)*. Have groups spend 20 minutes per day for 10 days plotting seismic data using geographic coordinates. Encourage students to divide up the data so that one or two students are working on the data recording and the rest of the group is working on the project. Students can find this information on the USGS* Web site. Groups should sign up for e-mail notification* on real-time seismic data for anywhere on the Earth. To help students understand the data they will be reading, direct them to Finding an Earthquake's Location*, which demonstrates how earthquake data is derived.

Mini-lessons (10 minutes or less) about landforms relating to seismic shift (volcanic and fault action) can be interspersed over the next few days using the teacher presentation resources found in the "Internet Resource" section.

Session 12: Patterns Emerge

Photocopy and combine the separate group maps with seismic data and discuss the students' observations. Over time, a pattern of the tectonic plate edges should emerge. Demonstrate this paleomaps site*, which uses animations to show ancient

Earth landforms and tectonics through time, and have students compare their maps to the maps on the site. The USGS Web site offers many manipulative materials, such as a three fault model that students can make to see a visual representation. As a home project, individual students may want to build some other models on the site to enhance their group project for an extra grade.

Session 13: Making Comparisons and Conclusions

As a class, compare predictions from the second session with the actual data from the presentations on seismic data. Look at the original list of questions from the first session and assess how many of the questions were answered through the project. The following are some examples of typical questions that are answered in the project:

- *What kinds of structures survive earthquakes?*
- *What kinds of soils are best to build on in earthquake zones, and what is liquefaction?*
- *What are the P and S waves?*
- *Where can I go in my region to see examples of seismic activity (faults, volcanoes, earthquake damage, and so forth)?*
- *Can I make my own seismometer?*
- *How do people decide whether they should buy earthquake insurance?*
- *Can nuclear explosions cause earthquakes?*
- *What is the tsunami risk in my favorite beach town?*
- *What would I put in an emergency kit if I lived in an earthquake prone place?*
- *I have never felt an earthquake; why does my school hold earthquake preparedness drills?*

Session 14: Assess Learning

Have students present their data and final earthquake preparedness plans. Plans are assessed on the individual pieces that students complete as well as the plan as a whole using the project rubric.

Following this phase of study, students use their experiences with surveys and real-time data plots to answer the following essay questions:

1. *Describe what earthquakes are, and explain how the Earth's surface is changed by them. How do these changes affect the people who live on Earth?*

2. Earth scientists use models, tools, and systems to describe seismic activity. Explain the work of earthquake scientists, including how they organize and measure earthquake data.

3. *Could an earthquake happen here? Based on your observations, which location has the least potential for earthquakes: Seattle, WA; Long Island, NY; Tampa Bay, FL; Tokyo; or Sydney, Australia? Why?* Use the vocabulary of Earth science and geography as you explain your reasoning.

4. *What are the relationships between earthquakes and other natural disasters?*

Sessions 15 through 21: Continue to Assess Learning , Follow Up on Data, and Wrap up

Note: Only 20 minutes per day is needed for these sessions, and only one or two students per group per day need to record the data. The rest of class time can be used for the next unit.

Have students continue recording seismic data for 20 minutes per day until the tenth day. When all data is in, repeat **Session 12** and reevaluate the data. Have students answer the Content Questions, *How are locations of earthquakes related to the location of the tectonic boundaries?* and *Are there patterns to the occurrence of earthquakes?*

Finally revisit the Essential Question to see how their views have changed over the course of the unit. Ask students to reflect again in their journals, but this time answer the question in light of their new understanding and insight into the topics studied in the unit.

Prerequisite Skills

- Skill with spreadsheets (can be taught in several quick lessons if necessary)
- Ability to read various types of geographic maps
- Familiarity with reading latitude and longitude measurements

Differentiated Instruction

Much of the work in this unit can be done at a variety of academic levels.

Resource Student

- For the group project, allow a teaching assistant to assist any groups with a resource student to help the student contribute meaningful work
- Break assignments up into small, manageable activities and write these on a checklist
- Select specific Web sites for their readability level and mark them so the student has more meaningful sites in which to research
- If technology exposure is low, partner the student with another student who is proficient

Gifted Student

- Encourage the student to investigate more complex information concerning earthquakes and contribute that information to the group project
- Direct the student to the USGS* site, which offers many high-level projects in which the student can build and conduct experiments; these projects could also support the group project
- Encourage the student to include more advanced technical attributes in the presentation

English Language Learner

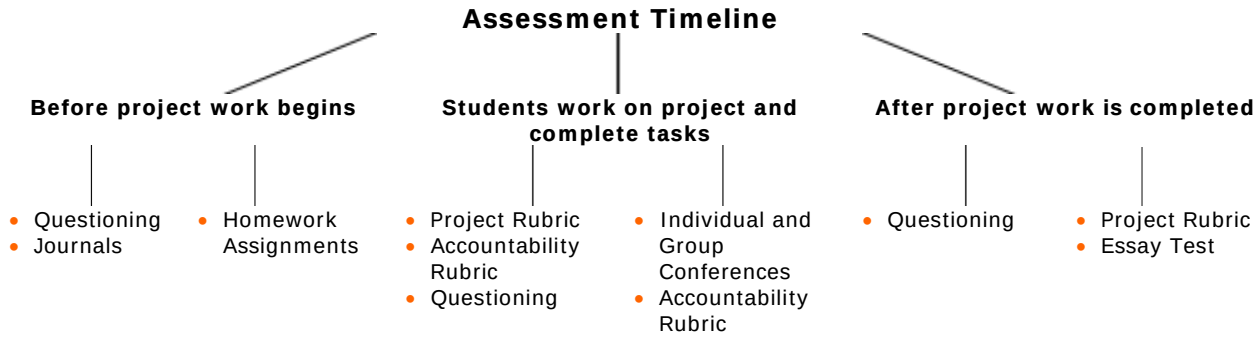
- During the group project, make sure any group that has an ELL student is assigned a section of Earth that contains the student's country of origin so the ELL student can share information about the country and experiences
- Create templates/graphic organizers for the student to fill in when there is appropriate material to do so
- Partner the student with others during project work when the language load indicates this, while completing visual parts of the project independently (spreadsheets, graphs, illustrations, and so forth)
- Shorten the requirements for oral speaking and reading activities
- Allow the student to prepare materials in the student's first language and then translate it into English with the help of an ELL assistant

Credits

A teacher participated in the Intel® Teach Program, which resulted in this idea for a classroom project. A team of teachers expanded the plan into the example you see here.

THINGS YOU NEED (highlight box)

Assessment Plan



The quality of journal entries and homework assignments help both teacher and students to monitor progress and understanding of content. Questioning is used throughout the unit to help students develop their higher-order thinking skills and process content. Individual and team group conferences are used to help monitor progress and answer any questions. The accountability rubric is used for students to asses how accountable they are for their own learning and can be used by the teacher to assess individual performance within the task force. The written essay test assesses students' learning of the content and thinking independent of the group. Ask students to use the project rubric to help them self- and peer-assess their work on their Earthquake Preparedness Plans prior to completion. Use this same project rubric to assess and grade the final project and presentation. Individual pieces can also be graded as separate items in addition to the group grade.

Targeted Content Standards and Benchmarks

Targeted National Content Standards

National Geographic Standards: Grade 8

3) Understand how to analyze the spatial organization of people, places, and environments on Earth's surface.
7) Understand the physical processes that shape the patterns of Earth's surface.
12) Understand the processes, patterns, and functions of human settlement.
15) Understand how physical systems affect human systems.

Student Objectives

Students will be able to:

- Understand that the Earth is dynamic and ever-changing
- Discuss broad concepts of physical geography related to the Earth's composition and plate tectonics
- Understand the relationship between seismic action and landforms
- Understand the relationship between seismic events and the effect on human settlement

- Use instruments, measurement, and classification systems of Earth science
- Plot real-time data using the Richter scale classification system
- Apply knowledge to answer questions about the likelihood of seismic events
- Use computer spreadsheet software to manage data and develop charts and graphs
- Analyze data and draw conclusions

Materials and Resources

Printed Materials

- Booth, B. (1992). *Earthquakes and volcanoes*. New York: New Discovery Books.
- Booth, B. (1994). *Volcanes y terremotos* (*Earthquakes and volcanoes,* Spanish). Mexico D. F.: Fernandez Editores.
- Christian, S., & Antonia, F. (1997). *Shake, rattle, and roll: The world's most amazing volcanoes, earthquakes, and other forces*. New York: John Wiley & Sons.
- Van Rose, S. (1992). *Volcano & earthquake*. New York: Knopf, distributed by Random House.
- VanCleave, J. P. (1993). *Janice VanCleave's earthquakes: Mind-boggling experiments you can turn into science fair projects*. New York: John Wiley & Sons.

Internet Resources

- Exploratorium Earthquake Studio
  www.exploratorium.edu/ls/pathfinders/earthquakes*
  Very kid-friendly general information about earthquakes containing many visuals and animations
- United States Geographic Survey
  http://earthquake.usgs.gov*
  The most comprehensive site about earthquakes with many links for teachers and students as well as real-time data on earthquakes
- Center for Improved Engineering and Science Education Online Classroom Projects
  www.k12science.org*
  Several real-time data project-based units, including one on earthquakes
- Fault Motion Illustrations
  www.iris.edu/gifs/animations/faults.htm*
  Animations showing types of faults move
- Forces of Nature: Earthquakes
  http://library.thinkquest.org/C003603/english/earthquakes/earthquakestrength.shtml*
  General information associated with earthquakes

Technology—Hardware

- Computer(s) to research information about earthquakes, view simulations, use online tutorials, and complete multimedia projects
- Internet connection to conduct research during projects and receive e-mail messages about earthquake data
- Color printer to print maps and earthquake data

- Projection system for instruction when presenting lessons as well as teaching the technology
- DVD for viewing video clips about earthquakes and news reports covering earthquakes

Technology—Software

- Database or spreadsheet to input survey and earthquake data
- Desktop publishing to design Web pages
- Encyclopedia on CD-ROM to access quick information on new vocabulary surrounding the unit
- Image processing to process media documents from Internet sites
- Internet Web browser for Internet research and to receive real-time data about earthquakes
- Word processing for completing written work during the project