IOWA CORE CURRICULUM

Subject: Earth Science
Developer Name: Gail B. Wortmann

Unit Title: Earthquake!
Location: Iowa Learning Online

Course Description:

This is a beginning level, high school earth science unit designed to serve all abilities of students in a school. This sequence of activities would be appropriate for high school level, or an Honors science class at the eighth grade level.

Unit Context:

This unit was designed to allow students to investigate evidence of earthquakes using seismographic and GPS data. The experiences provided in this unit will strengthen student understanding of internal sources of energy in the earth system resulting in earthquakes. Previous knowledge of geodesy and GIS/GPS systems is required for successful completion and understanding of the experiences presented in this unit. In addition, students will use and strengthen inquiry skills that have been practiced and refined since the beginning of the course. The success of this unit depends to a large extent on the students' abilities and confidence in the laboratory and on their abilities to carry out those skills identified as "inquiry" skills.

Length of Unit:

1 ½ - 2 weeks

Iowa Tests Core Content Standards and Benchmarks

Core Content Standards and Benchmarks
• Students can understand and apply the processes and skills of scientific inquiry. • Students can draw conclusions, make inferences, and deduce meaning. • Students can reason quantitatively. • Students can interpret data from a number of sources. • Students can analyze and interpret scientific information. • Students can make inferences based on data presented in a variety of ways.

ICC Essential Concepts and Skills

Concepts
• Understands and applies knowledge of internal sources of energy in the earth system
Skills
• Identifies questions and concepts that guide scientific investigations • Designs and conducts scientific investigations • Uses technology and mathematics to improve investigations and communications • Formulates and revises scientific explanations and models using logic and evidence • Recognizes and analyzes alternative explanations and models • Communicates and defends a scientific argument

Big Ideas Addressed in Each Activity

Activity 1: Sizing Up a Seismograph
◦ Students will be able to develop a testable question using a student-made seismograph. ◦ Students will be able to correctly set up and follow lab directions to determine how a seismograph works. ◦ Students will be able to design an appropriate data table in which all necessary data is recorded.
Activity 2: Movers and Shakers
◦ Students will determine what variables (types of earth movements) affect a seismograph. ◦ Students will be able to design and carry out a well-controlled experiment that will successfully answer the question posed. ◦ Students will be able to design an appropriate data table in which all necessary data is recorded. ◦ Students will be able to follow safety guidelines.
Activity 3: Earthquakes! What do we know?
◦ Students will be able to do online research about earthquakes, seismographs, and fault types. ◦ Students will be able to successfully use the skills of analysis and synthesis to relate the concepts of earthquakes, seismographic readings, and fault types.
Activity 4: It's Not Your Fault
◦ Students will be able to compare and contrast movements on either side of the San Andreas Fault using GPS data. ◦ Students will be able to calculate the amount of movement of a tectonic plate over a period of time. ◦ Students will be able to describe the processes involved in the occurrence of earthquakes along the San Andreas Fault.
Activity 5: Live Dangerously?
◦ Students will successfully relate unit information to a realistic decision-making situation. ◦ Students will be able to employ the internet to gather information for data-based decision-making. ◦ Students will be able to evaluate and defend their choice.

Rigor & Relevance Plot: Earthquake!

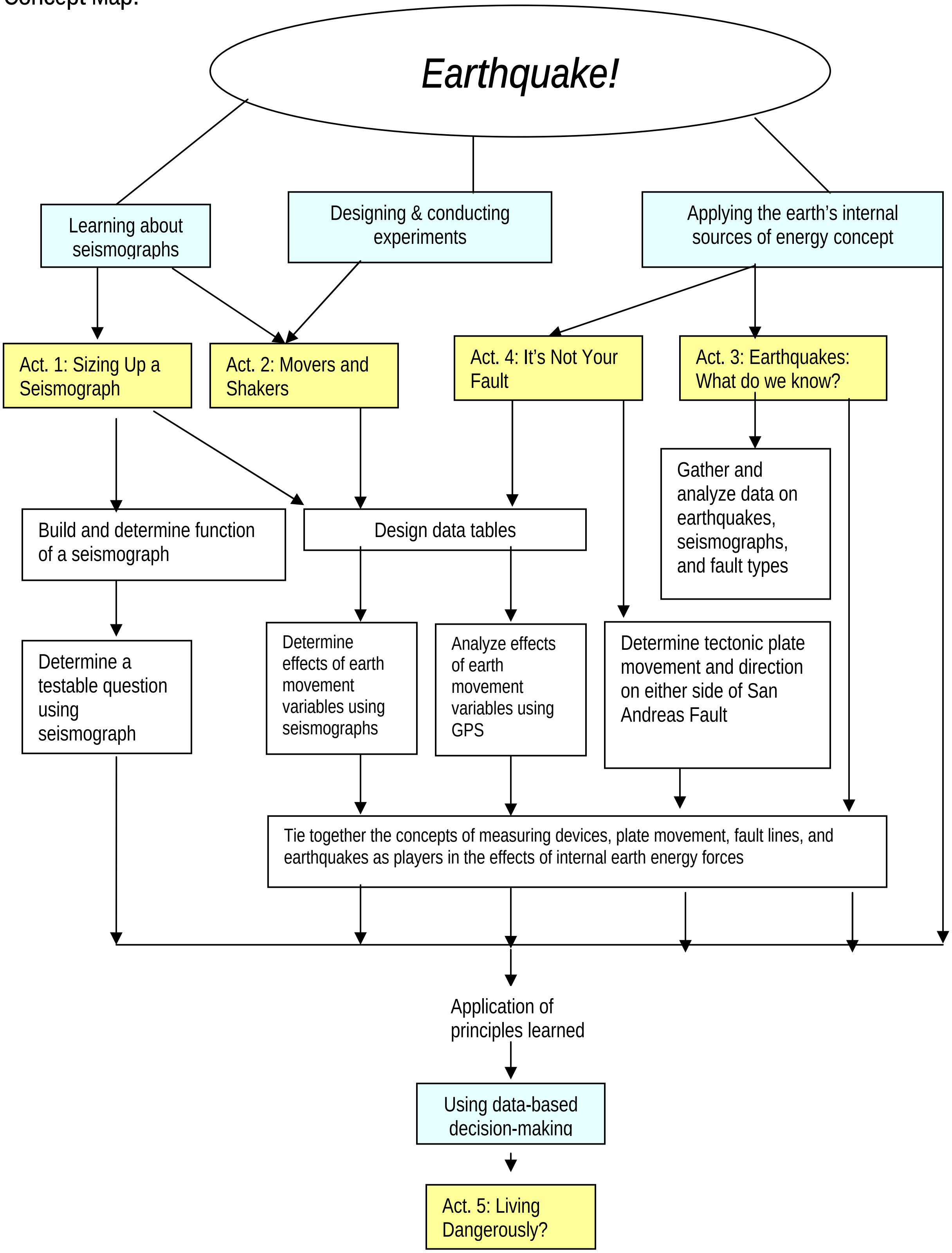
RIGOR (Knowledge, Comprehension, Application, Analysis, Synthesis, Evaluation)

Activity #4: It's Not Your Fault *(Elaborate)* Students compare and contrast GPS data on either side of the San Andreas Fault and calculate the amount of tectonic plate movement over time. QUADRANT C	**Activity #5: Live Dangerously** *(Evaluate)* Students will analyze and evaluate seismographic data/information and determine the safest place to move their "family." Students must defend their choice and give references. QUADRANT D
Activity #3: Earthquakes – What do we know? *(Explain)* Students do online research, connecting knowledge about earthquakes, seismographs, and previously studied fault types. The teacher facilitates a discussion tying concepts together. **Activity #1: Sizing Up a Seismograph** *(Engage)* Students will be introduced to information about the 1906 San Francisco Earthquake and will construct a simple seismograph to investigate its function. QUADRANT A	**Activity #2: Movers and Shakers** *(Explore)* Students design and carry out an experiment in which they investigate variables measured by seismographs. QUADRANT B

Knowledge in one discipline · *Application in one discipline* · *Interdisciplinary application* · *Real-world predictable application* · *Real-world unpredictable application*

RELEVANCE

Concept Map:


Earthquake!
Learning about seismographs
Designing & conducting experiments
Applying the earth's internal sources of energy concept
Act. 1: Sizing Up a Seismograph
Act. 2: Movers and Shakers
Act. 4: It's Not Your Fault
Act. 3: Earthquakes: What do we know?
Gather and analyze data on earthquakes, seismographs, and fault types
Build and determine function of a seismograph
Design data tables
Determine a testable question using seismograph
Determine effects of earth movement variables using seismographs
Analyze effects of earth movement variables using GPS
Determine tectonic plate movement and direction on either side of San Andreas Fault
Tie together the concepts of measuring devices, plate movement, fault lines, and earthquakes as players in the effects of internal earth energy forces
Application of principles learned
Using data-based decision-making
Act. 5: Living Dangerously?

ACTIVITY 1

Activity 1 Overview: Sizing Up a Seismograph *(Engage)*

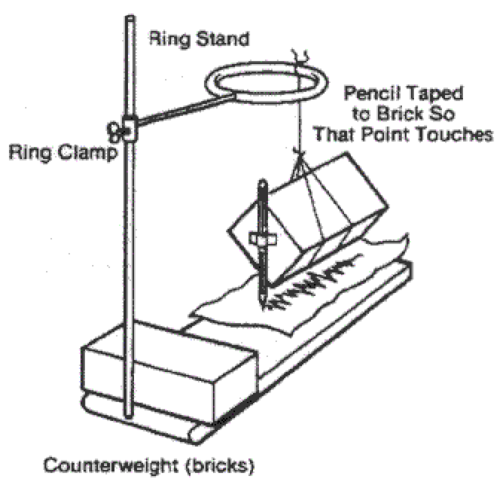
Iowa Core Curriculum Essential Skills/Concepts:	o Understands and applies knowledge of internal sources of energy in the earth system					
Big Ideas	o In this activity students will build a seismograph which will serve as a tool for exploring the relationship between movement and the recording of seismic data. o Students will develop testable questions to be answered using their seismograph and will be able to design and carry out a well-controlled experiment that will successfully answer their questions. This will require the determination of variables affecting the seismograph and the design of data tables in which to record their findings.					
Characteristics of Instructional Core	x	Encourages collaboration in learning	x	Teaches for understanding		Develops global perspectives
	x	Student centered	x	Develops conceptual and/or procedural knowledge		Provides authentic learning
	x	Teaching through problem solving and inquiry		Assesses for learning		Incorporation of current technology
Cognitive Domain	x	Remembering		Applying		Evaluating
	x	Understanding		Analyzing		Creating
Connections to Students' Lives	x	Isolated within discipline		Connected to other disciplines		Connected to student lives
	x	Connected within discipline		Has value beyond school purposes		
Support for Literacy	x	Using the literacy process for inquiry		Increasing reading volume		
		Increasing access to print	x	Engaging students with texts		
	x	Involving students in discussion		Reading aloud in content areas		
		Increasing reading fluency		Explicitly instructing in vocabulary and comprehension		
		Writing to learn across content areas				
Class Time	1-2 class period(s)		45-60 total minutes			

Materials & Set-up:

<u>Materials:</u>

- Ring stand
- Ring support
- 2 bricks
- String
- Pencil
- Tape
- Adding machine paper

Apparatus from:
http://mceer.buffalo.edu/infoservice/images/education/dect3.gif



Students need to tie the brick in two locations rather than one to keep the brick from spinning during use. The students also need to pull the adding machine tape at a steady pace of about 1 cm/second. A steady pull makes it easier for students to analyze their data.

Students should work in small groups to construct and investigate the seismographs. Roles could be assigned to make sure everyone in the group is a responsible, working member. These roles might include a recorder, equipment manager, and paper puller. It is suggested that the group size be kept at 2-3 students, or some students will not have a task. The main idea of this activity is to allow students to figure out how seismographs work so they can generate researchable questions to be done in a subsequent open inquiry investigation. This is an introductory activity to familiarize them with the equipment and how it works.

Teaching Tips:

Identify students' prior knowledge by asking them to write in their journals/notebooks what they know about seismographs. Be sure to use the prior knowledge of the students to frame the discussions in this unit.

Engage: To engage students in the subject of earthquakes and seismographs, read the following excerpt from the diary of a survivor of the San Francisco earthquake of 1906. These are excerpts from letters that Percy H. Gregory wrote to his mother from his place on Flora Street in San Francisco's Bayview district. He was an Australian immigrant who started out as a butcher in San Francisco and became a carpenter after the earthquake,

> *May 29, 1906*
>
> *Poor old Frisco has been visited by an earth quake and fire. ... Between two and three hundred thousand people are homeless. The people line up in the Arcades every day for rations -- all Butcher shops fell over into the Bay when the big quake came ... so that I lost my job right there.*
>
> *The Hills rolled like great billows, and cracked open, houses sank between seven and eight feet, in places. All the Big cheap lodging houses collapsed with all the people in them. Then the fire which started in one hundred places. ... The flames spread like fury, jumping six and seven blocks at once, 450 blocks were burnt to the ground in all.*
>
> *... The fire was a beautiful sight -- at night miles of sky scrapers being gutted or burnt to the ground. Hundreds of millions of dollars going up in smoke.*
>
> *... I have been working ever since the earthquake, but in a new line of business. Have turned carpenter again. Have lots of work ahead of me for months to come, at four and a half dollars a day. Have one four roomed house nearly completed. Another two roomed house to start on and three more houses after that, as soon as I can get a line on this class of work I will start taking contracts. Carpenters are in great demand. All the new sky scrapers are to be built like war ships with steel frames and steel plates so that they cannot be burnt or shaken down by earthquake.*

Discussion Questions to Follow Reading: The 1906 San Francisco Earthquake began an era in the study of earthquake seismology. Following the earthquake, direct observation of surface damage and movement combined with analysis of land deformation led to a thorough study of the effects of energy changes within the earth. The seismic readings of the 1906 quake have been well documented; readings of that earthquake were recorded at 96 different stations around the world.

1. Why would studying seismic readings from the San Francisco earthquake be important?

2. What is a seismic reading? How does one go about getting a seismic reading? How does a seismograph work?
3. What does seismic information tell you about fault breakage? How do you tell which way the ground moved and how much it moved? Why does that information matter?

Source:
San Francisco Chronicle. (2006). The great quake: 196-2006: Earthquake Diaries: Percy H. Gregory. *The San Francisco Chronicle*, http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2006/04/18/MNGQDIARIES18.DTL (accessed October 12, 2007).

*If the teacher chooses, information about the shaking patterns of the 1906 earthquake could be shared with the class. They are available on the United States Geological Service website:
http://earthquake.usgs.gov/regional/nca/1906/simulations/classroom.php

Teacher Tasks	Student Tasks
• Teacher sets the stage by reading the earthquake diary paragraph and introducing the thought questions.	• Students write in their journals describing their prior knowledge about seismographs.
• Teacher acts as a facilitator as much as possible, allowing students to construct, investigate, and generate questions.	• Students manipulate the materials, build the seismographs, collect, record, and analyze their data.
• Teacher circulates around to each group checking on progress and asking probing questions. Make sure data is being collected and analyzed.	• Students complete the *Summing Up* questions.
• Teacher leads a class discussion on the *Summing Up* questions for concept development.	• Students contribute to the class discussion and help the class identify researchable questions for the next day's investigation.
• Teacher helps class generate a list of researchable questions. Once the list has been generated, the teacher can help the groups choose from the list for the next day's investigation.	• Students choose a researchable question from the class list for their group.

Differentiation Tasks

<u>Less-Than-Proficient</u>
Prioritized vocabulary, skills, concepts: seismograph,
Suggestions for supplemental instruction

- The teacher could set up a partial or full seismograph for students who have difficulty with manipulatives.
- Prepare some "fake" seismographs and ask students to rank them from strongest earthquake to weakest.
- Use strategic partnerships by placing students who are at similar levels of understanding together. When one student easily understands while the other does not, both students tend to proceed even

though understanding has not been achieved.

- By doing a search for “earthquake webquests” you will find an extensive list of both lower level and challenging materials to supplement instruction.

Highly Proficient

Suggestions for supplemental instruction

- Challenge students who need more rigor to design and build their own seismograph or suggest and apply improvements to the design provided.
- Some students may enjoy completing some of the more challenging webquests that can be located on earthquakes.

Assessment:

Formative Assessments:

- There are several formative assessments that happen during this activity. Monitoring student engagement throughout the activity makes active involvement an explicit part of the assessment.
- Provide ongoing guidance and feedback to individual students as points of confusion are observed. Asking probing questions, even to those students who appear to have a strong understanding of the concepts being taught, will help strengthen understanding. For example, by asking students questions about the direction of the movement and how that is recorded on the seismograph, students will be able to be better attuned to the variables which are most important in this activity.

Summative Assessments:

- Student responses to the *Summing Up Questions* serve as the assessment for this activity.
- Participation in the class discussion when generating researchable questions will also allow the teacher to evaluate student thinking.
- Sample Answers to the Summing Up:
  1. Pencil lines show the effects of the bumping and shaking of the table because they give you visual data about these motions on the paper strip and it can be read as changes in motion over time.
  2. The pencil lines differ when the direction of the shake is changed because the seismograph is only measuring in a one-axis direction. If you change the direction of the shake, you do not get readable results because you are now in a non-measured axis.
  3. The pencil lines differ when the intensity of the shake is changed. With more intensity, larger crests and troughs appear in the wave lines.
  4. One direction of bumping/shaking made a more noticeable pencil line than did other directions. The more noticeable lines were along the axis that is being measured.
  5. If the entire room were shaking instead of just the table, the seismograph lines would look just like the one when the table was shaking. If the seismograph is in motion, then the readings would be inaccurate. The seismograph must remain stationary even though the earth is moving underneath to get accurate readings.

6. In order to compare one group's findings with another group's findings if both groups were measuring earth movement at different locations on the earth, you would need precise date and time recordings, along with precise location information (latitude and longitude) including elevation.
7. Student responses will vary as to what variables they would like to investigate using their seismograph and what questions they have. Their responses might include investigating time of day, location, and rate of pull of paper to get the most accurate results.
8. Student design improvement ideas will vary. They are likely to suggest objects to use in place of the brick or a different system of attachment.

Reflect:

Results from this activity were not very "seismograph-looking," but students still got the idea of vibrations causing motion which can be used as data. The sensitivity of the measuring device is very limited. This activity does provide a nice introduction to earthquakes because it gets kids thinking about the earth movements. Devoting a single class period to this activity is well worth the time investment.

The questions students write in response to *Summing Up* question #7 will serve as the basis for Activity 2: Movers and Shakers. Tell students this ahead of time so they can begin to consider the constraints that might impact their data gathering.

Attachments:

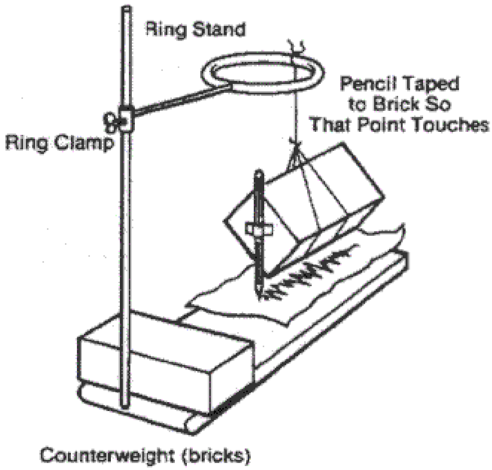
Student Page/Handout

Sizing Up a Seismograph
Engage

Problem: What is the function of a seismograph? How does it work?

Working in groups, construct a simple seismograph (an instrument used to record the intensity of an earthquake) and investigate its function.

Materials:
Ring stand
Ring support
2 bricks
String
Pencil
Tape
Adding machine tape or something equivalent



http://mceer.buffalo.edu/infoservice/images/education/dect3.gif

Procedure:
1. Set up a ring stand with a ring support attached.
2. Place a brick on the bottom of the ring stand near the upright. This brick is used as a counterweight.
3. Tie string to the outer edge the ring of the support. Use several strings to secure one of the bricks so the brick hangs from the ring support. Come up with a tying system that will prevent the brick from spinning as it moves. Tape a pencil to the end of the brick near the ring stand so it just touches the surface. The pencil will be used to record the movement of the brick on the adding machine tape.
4. The adding machine tape should be placed so the paper can be slowly and steadily pulled beneath the lead of the pencil.
5. Someone in your group needs to bump or shake the table as you pull the paper strip under the dragging pencil. Continue bumping/shaking the table from various directions as the paper strip is steadily pulled. Analyze the data. Investigate until your group understands how a seismograph works. Be sure to record directly on the tape the type of motion you are causing.
6. Identify a relationship (two variables) you'd like to investigate using your seismograph. You will be able to leave the classroom to do your investigations as long as you act responsibly and stay within the school grounds.

Summing Up:

1. How do the pencil lines show the effects of the bumping and shaking of the table?
2. How do the pencil lines differ when the direction of the shake is changed?
3. How do the pencil lines differ when the intensity of the shake is changed?
4. Did one direction of bumping/shaking make a more noticeable pencil line than others? Explain.
5. What would the seismograph lines look like if the entire room were shaking instead of just the table?
6. What might you need in order to compare one group's findings with another group's findings if they were measuring earth movement at different locations on the earth?
7. What variables would you like to investigate using your seismograph? What questions do you have?
8. What design changes can you suggest to improve your seismograph?

ACTIVITY 2

Activity 2 Overview: Movers and Shakers *(Explore)*

Iowa Core Curriculum Essential Skills/Concepts:	o Identifies questions and concepts that guide scientific investigations o Designs and conducts scientific investigations o Formulates and revises scientific explanations and models using logic and evidence o Recognizes and analyzes alternative explanations and models o Communicates and defends a scientific argument					
Big Ideas	o In this activity students will use the seismograph they built in Activity 1. This will serve as a tool for exploring the relationship between movement and the recording of seismic data. o Students will develop questions to be answered using their seismograph and will be able to design and carry out a well-controlled experiment that will successfully answer their questions. This will require the determination of variables (types of earth movements) affecting the seismograph and the design of data tables in which to record their findings. o Students will be able to follow safety guidelines.					
Characteristics of Instructional Core	x	Encourages collaboration in learning	x	Teaches for understanding		Develops global perspectives
	x	Student centered	x	Develops conceptual and/or procedural knowledge	x	Provides authentic learning
	x	Teaching through problem solving and inquiry	x	Assesses for learning	x	Incorporation of current technology
Cognitive Domain		Remembering	x	Applying		Evaluating
	x	Understanding	x	Analyzing	x	Creating
Connections to Students' Lives		Isolated within discipline		Connected to other disciplines		Connected to student lives
		Connected within discipline	x	Has value beyond school purposes		
Support for Literacy	x	Using the literacy process for inquiry		Increasing reading volume		
		Increasing access to print		Engaging students with texts		
	x	Involving students in discussion		Reading aloud in content areas		

		Increasing reading fluency		Explicitly instructing in vocabulary and comprehension
		Writing to learn across content areas		
Class Time	1-2 class period(s)	45-90 total minutes		

Materials & Set-up:

Students will be using the seismograph they constructed in Activity 1.

Teaching Tips:

Explore: The idea of this activity is for students to spread out through the school/grounds and find areas that have natural or man-made ground motions (near a street, in the gym, around heavily trafficked stairs, by heating/cooling equipment, or on an elevator.

Students will be using the researchable questions generated in the previous activity. They will write their own experiment to investigate their chosen variables. It is suggested that students begin by identifying their variables and then use those variables to write a testable problem statement. Problem statements should include both variables, seek a relationship between the variables, and be posed as a question.

Successfully completing this lab requires a combination of good data collection skills and problem-solving skills. By working in groups, students can collaborate in brainstorming ideas for how to capture seismographic data in a real-world setting. Resist the urge to give students hints on how to proceed. If time allows, students can move from one area of “shaky ground” at your school to another to gather data that can be compared.

Teacher Tasks	Student Tasks
• Teacher provides students with materials they request for their group designs if different from the original materials.	• Working in groups, students brainstorm the problem, thinking about data they will need to collect and how they might effectively gather seismographic data.
• Teacher checks students' experimentation tables.	• Students fill out the experimentation table and have it checked by the teacher.
• Teacher seeks agreements from students to follow school rules while out of the classroom and respect other classrooms while they are collecting data.	• Students prepare a data table and list of final procedures.
• Teacher circulates around to each group checking on questions, asking probing questions, and monitoring student behavior.	• Students agree to abide by school rules and respect other classrooms while collecting data.
• Teacher directs student to gather data, analyze, and prepare for reporting out.	• Students make sure their seismographs are in good working condition and begin collecting data.
• Teacher facilitates the reporting out session, drawing out student understandings and	• Students evaluate the effectiveness of their design, make modifications and gather data at

misconceptions with appropriate questioning.	more than one location if possible.
	• Students analyze data and prepare to report to the class.

Differentiation Tasks
<u>Less-Than-Proficient</u> **Prioritized vocabulary, skills, concepts:** seismographic data, controlled (dependent) and manipulated (experimental) variables. **Suggestions for supplemental instruction** • Students who need supervision should stay near the teacher or have adequate adult help sent with them or if co-teaching, have one of the teachers accompany groups who may need more facilitation. • Some students may need assistance in deciding how to design their experiment. This can be addressed by helping them choose a testable question from the class list of the day before. The students can then focus on what data they will need to collect. Graphic organizers might help students see possible connections. • Rather than preparing a special data table, give students colored pencils to use for recording times and locations directly on their adding machine tapes. <u>Highly Proficient</u> **Suggestions for supplemental instruction** • Students who need less supervision can be encouraged to gather data from several possible locations. • Students who gather data efficiently should be expected to analyze the data and possibly suggest a scale for standardization of that data like the Mercalli or Richter Scales.

<u>Assessment:</u>

Formative Assessments:

- Monitor student engagement throughout the activity to make active involvement an explicit part of the assessment. Continually communicate with students on an individual basis regarding their progress.
- Provide ongoing guidance and feedback to individual students as points of confusion are observed. Ask probing questions, even to those students who appear to have a strong understanding of the concepts being taught; this will help strengthen understanding. Address points of confusion related to the functioning of seismographs and analysis of its data. For example, confusion is likely to arise as students experiment with up and down versus sideways motion. By asking questions as students encounter these situations, students will be more likely to gain a more thorough understanding of earthquake motion. Misunderstandings may also become evident through student journals. Take a look at the student journals to see how the conceptual understandings are developing and ask probing questions related to any apparent misunderstandings.

Summative Assessments:

- The assessment for this activity will be the student reports to the class of their findings. A rubric is included for assessing this assignment.

Reflect:

This was a good inquiry activity that built directly upon Activity 1. The results of this lab were very dependent-variable defined. The data from some groups was zero movement which is still data and should not be ignored. Unlike medical data, a flat line can be a good thing! The time of day the data was taken was very important for this lab. Students took data at a main stairwell (to the cafeteria) between classes and again during passing time. The location stayed the same (controlled variable) but the time of day changed (experimental variable) and so did the results. It allowed students to see the importance of recording time with seismographic data. Students discussed a further investigation. They wanted to see the effect of elevation in tall buildings on seismographic data. Students thought of putting seismographs in the same corner of a tall building (northeast corner for example), but check it on the first floor and again on the top floor. Tall dormitory towers at universities would be interesting to check. Rumor has it that the water in the bathroom stools sloshes during high wind storms at both the Iowa State and University of Northern Iowa towers although this is likely due to the swaying of the water tower which alters the water pressure. Its effects can occasionally be seen in homes as well.

Verbal result sharing was very effective for this lab. Students created posters which included their seismographic strips and conclusions, then shared that information with other students. Data charts were difficult to make, so students used their seismograph strips as the data chart and added precise time readings to them. The strips served as the data chart. Having students struggle with the data chart concept was a good higher order thinking and problem-solving activity.

Attachments:

Student Page/Handout

Movers and Shakers

Explore

Use your seismograph to investigate a question you have identified in your previous activity. You will be able to leave the classroom to do your investigations as long as you act responsibly and stay within the school grounds. Fill in the following chart and have it approved by your instructor prior to leaving the classroom.

Seismographic Investigation: Movers and Shakers	
Experimental variable:	
Dependent variable:	
Problem Statement:	
Experimental Control:	
Hypothesis:	
Materials:	
Safety guidelines:	

Make sure you keep track of your data. Design a data chart appropriate for collecting your data before you begin work. You may modify the data chart as you go if you find it is insufficient for the task.

Be prepared to share your discoveries with the class. Make sure you discuss the grading rubric before preparing your visual for class publication of the results of your investigation. You will be assessed (graded) according to the rubric. How you go about covering the rubric requirements is up to you and your group. Make sure all group members participate in the reporting out preparation.

Rubric

Grading Rubric: *Movers and Shakers* Reporting Out

	Exceeds Expectations	Meets Expectations	Below Expectations	Needs to be Redone
Experimentation Essentials	Problem statement seeks a relationship between variables; experimentation chart elements are included and correct; a digital picture of the seismograph used is included	Problem statement is present; experimentation chart elements are included; a digital picture of the seismograph used is included	Problem statement is present but incorrect; experimentation chart elements are included but may need correction; a digital picture of the seismograph used is included	One or more of the elements are not present; must be redone and resubmitted before grading occurs.
Data and Analysis	Data chart is well-designed and contains rich data; graph shows relationship of data from the data chart; conclusions are	Data chart is adequately-designed and contains adequate data; graph shows relationship of data from the data chart;	Data chart is poorly-designed and contains inadequate data; graph attempts to show relationship of data from the data chart; conclusions	One or more elements are not present; must be redone and resubmitted before grading occurs.

	drawn and supported with evidence from the data	conclusions are drawn and supported with rationale	are drawn	
Writing, Visual Presentation	Correct spelling, punctuation & grammar; visually interesting, making effective use of color, spacing, and visuals	2-3 errors in spelling, grammar or punctuation; somewhat visually interesting, making some use of color, spacing and visuals	5 or more errors in spelling, grammar or punctuation; visually uninteresting, poor to no use of color.	Many errors in spelling, grammar, or punctuation; visuals are not present; must be redone and resubmitted before grading occurs.
Participation	Student signatures appear beside the elements with which they helped; all student signatures appear in equitable amounts; when questioned, students are in agreement everyone helped equally	Student signatures appear beside the elements with which they helped; all student signatures appear in equitable amounts	Student signatures appear beside the elements with which they helped; student signatures appear in inequitable amounts	Student signatures are not present; must be redone and resubmitted before grading occurs.

Students should have a chance to view the results of each group's work with a discussion following to summarize the results of the class. Summaries could be written in the students' science journals/notebooks.

ACTIVITY 3

Activity 3 Overview: Earthquakes! What Do We Know? (Explain)

Iowa Core Curriculum Essential Skills/Concepts:	o Understands and applies knowledge of internal sources of energy in the earth system					
Big Ideas	◦ Students will be able to do online research about earthquakes, seismographs, and fault types. ◦ Students will be able to successfully select big ideas about earthquakes and record that information in a concise and organized fashion. This will include concepts of earthquakes, seismographic readings, and fault types.					
Characteristics of Instructional Core	x	Encourages collaboration in learning	x	Teaches for understanding	x	Develops global perspectives
	x	Student centered	x	Develops conceptual and/or procedural knowledge		Provides authentic learning
		Teaching through problem solving and inquiry	x	Assesses for learning	x	Incorporation of current technology
Cognitive Domain	x	Remembering		Applying		Evaluating

	x	Understanding		Analyzing		Creating
Connections to Students' Lives	x	Isolated within discipline		Connected to other disciplines		Connected to student lives
	x	Connected within discipline		Has value beyond school purposes		
Support for Literacy	x	Using the literacy process for inquiry	x	Increasing reading volume		
	x	Increasing access to print	x	Engaging students with texts		
		Involving students in discussion		Reading aloud in content areas		
		Increasing reading fluency		Explicitly instructing in vocabulary and comprehension		
		Writing to learn across content areas				
Class Time		1-2 class period(s)		45-90 total minutes		

Materials:

Students will need access to a computer and printer for this activity.

Teaching Tips:

Students should revisit their summaries from *Movers and Shakers* and collectively identify what it is they know about seismographs. For this activity, students will use available resources to gather information about earthquakes, seismographs, fault types, and plate tectonics. The internet is the suggested resource for this activity so students can actively participate in searching and researching relevant information.

If possible, have students take digital notes, making sure they cite the websites they are using for information. Students can work with double windows open – one window can be for their preferred internet browser, the other can be a word processing document where they copy and paste carefully selected notes from websites. These notes are for the purposes of a shared class discussion, not writing a formal paper, so information gathering is the goal, not proper referencing. A discussion about plagiarism may be appropriate here to differentiate between gathering learning pieces and using other's work as one's own in a publication.

If needed, help the students generate a keyword list to facilitate internet searching. A keyword list might include any or all of the following:

> Seismographs, seismology, seismogram, USGS, earthquakes, quakes, plate tectonics, plate movement, faults, fault lines, geologic faults, slip strike fault, normal fault, reverse (thrust) fault, Richter, Mercalli

Pose the following challenges to students:

1. Do an online search to augment your knowledge of how seismographs are used.
2. What are the different kinds of faults and how do the workings of the seismograph relate to the different kinds of faults?
3. How do seismographs, faults, earthquakes, and plate tectonics relate to each other?
4. After your note taking, write a two to three sentence summary in your own words about each big idea.

Facilitate a discussion about fault movements, earthquakes, and plate tectonics, connecting this information with previous lessons in the Dynamic Earth unit.

Teacher Tasks	Student Tasks
• Set the stage by posing some general questions: "What is the pattern of earthquake distribution on earth?" " What does this pattern have to do with the fault types we have studied previously?"	• Students work individually or in groups to search internet sites for information about seismographs, earthquakes, faults, and plate tectonics.
• Pose the challenge questions prior to internet research time.	• Students take digital notes and cite references as they work.
• Circulate around to each group checking on progress and asking probing questions.	• Students summarize the information they have gathered.
• Assist students having difficulty searching internet sites effectively.	
• Challenge students to follow links found in one website to connect to relevant information found on other websites.	
• Direct students to prepare to contribute to a class discussion tying the target concepts of seismographs, earthquakes, fault types, and plate tectonics together.	• Students prepare to use their notes to contribute to a class discussion tying the target concepts together.
• Facilitate the discussion bringing the target concepts together to construct the bigger picture concept of plate tectonics and internal sources of energy in the earth system.	

Differentiation Tasks

Less-Than-Proficient

Prioritized vocabulary, skills, concepts: epicenter, fault, Richter scale, tectonic plates, aftershock,

Suggestions for supplemental instruction

- Some students will have difficulty finding appropriate websites and will need assistance. Previously identified websites will facilitate note-taking for these students.
- Samples of appropriate note-taking for information gathering will help struggling students do higher level work.
- For students who struggle to write, copying and pasting carefully chosen notes from websites may facilitate their note-taking. They may need assistance to attain this skill.

Highly Proficient

Suggestions for supplemental instruction

- Ask students to post good websites for the use of the whole class.
- Students that finish early can assist students that may be having difficulty locating good sources of information.
- For students in need of a greater challenge, encourage them to follow conceptual understanding links as they put together the bigger picture of plate tectonics.

- Ask students to prepare to facilitate the culminating small or large group discussions, tying the target concepts together.

Assessment:

Formative Assessments:

- Provide ongoing guidance and feedback to individual students as barriers to effective internet searching surface throughout the activity. Ask probing questions, even to those students who appear to have a strong understanding of the concepts being taught.
- In cases where student notes seem sketchy, point out the shortfalls and give them the opportunity to add additional information.

Summative Assessments:

- Digital notes from students will be used as the assessment for this activity. The format of the digital notes depends on the school's digital literacy level. Students could email the notes to the instructor, save them to the teacher's flash or thumb drive, upload them in a Moodle site (or something equivalent), beam them via handheld devices, or print them and hand them in. Ideally both the students and teacher have access to a copy of the notes. Points can be given for quality or quantity of notes, the breadth or depth of knowledge covered, the citing of references, the succinctness of the note-taking, or other criteria. Assess student's understanding of the big ideas rate the summary sentences they prepared of the big ideas.

Reflect:

This lesson worked well and required 2 class periods. A keyword search list was created by the students and included most of the terms listed in the teacher tips for this lesson. If the keyword list is extensive, students can volunteer or be assigned words to cover for the sake of the class.

The first part of the lesson was spent on the skills needed for digital note-taking – how to read and assess information on a website, choose the most relevant information, images, graphs, etc. and move them to a digital note page (a Word document, for example). The class discussed how the "rules" for digital note-taking were different than for paper-writing research – the information is gathered for the edification of the student, not for citing in a paper. (Plagiarism is not an issue if the information is not quoted further.) In addition, the class discussed how to choose respected websites such as .edu web addresses (educational institutions), governmental agency cites, major encyclopedic sites, and geologic institution websites. Although using Wikipedia is not recommended for research papers, it was a great place to use for digital note-taking if the references were checked. Links at the bottom of any Wikipedia page was a great place to find additional references.

After the students finished their searching, they went back to their digital notes and organized them – putting in bold-faced titles, adding sub-headings, and highlighting pertinent information. Students were told they should gather around 6 pages of digital notes and that amount seemed to work well for giving them a target expectation.

Attachments:

Example of student work:

STUDENT EXAMPLE:

Earthquakes

Fault lines http://library.thinkquest.org/03oct/00758/en/disaster/earthquake/faultlines.html

- **San Andreas Fault**

The San Andreas fault is the 800 mile long boundary between the Pacific and North American Plates. It is the main fault of an intricate network of faults spanning the California coastal region. At its deepest, the San Andreas extends 10 miles beneath the ground. The San Andreas fault is a right-lateral transform fault meaning that if one was to stand on one side of the fault and look across to the other, the opposite site would appear to move to the right. This means the Pacific Plate is moving northward while the North American Plate is moving southward.

- **Mid-Atlantic Ridge**

The Mid-Atlantic Ridge is a 10,000 mile long north-south mountain chain occupying the center of the Atlantic Ocean and passing through Iceland. It is the most extensively studied divergent plate boundary, dividing the North and South America Plates from the Eurasian and African Plates. In the divergent plate boundary, molten magma continuously rises from the mantle to the sea floor to fill in the gap formed by the diverging plates, and thus creating seafloor spreading. It is estimated that the Atlantic Ocean sea floor expands at a rate of 0.5 to 4 inches annually.

In addition to its divergent plate boundaries, the curving of the ridge also creates a number of transform fault lines. Occasionally, these transform faults are the site of seismic activity as the adjacent plates move in northern or southern directions.

Tectonic Plates **http://en.wikipedia.org/wiki/Tectonic_plate**

Plate tectonics is a theory of geology that has been developed to explain the observed evidence for large scale motions of the Earth's lithosphere. The theory encompassed and superseded the older theory of continental drift from the first half of the 20th century and the concept of seafloor spreading developed during the 1960s.

The outermost part of the Earth's interior is made up of two layers: above is the lithosphere, comprising the crust and the rigid uppermost part of the mantle. Below the lithosphere lies the asthenosphere. Although solid, the asthenosphere has relatively low viscosity and shear strength and can flow like a liquid on geological time scales. The deeper mantle below the asthenosphere is more rigid again. This is not due to cooler temperatures but due to high pressure.

The lithosphere is broken up into what are called *tectonic plates*—in the case of Earth, there are seven major and many minor plates. The lithospheric plates ride on the asthenosphere. These plates move in relation to one another at one of three types of plate boundaries: convergent or collision boundaries, divergent or spreading boundaries, and transform boundaries. Earthquakes, volcanic activity, mountain-building, and oceanic trench formation occur along plate boundaries. The lateral movement of the plates is typically at speeds of 0.65 to 8.50 centimeters per year.

Richter Scale http://www.ag.uidaho.edu/disaster/quake/earth.html

The Richter Scale provides a measure of the magnitude of the earthquake in terms of energy released, measured in equivalent tons of TNT. Each unit represents a 10-fold energy release. An earthquake of Richter 2.5 or less is usually ignored. Dishes rattling and china shaking occur at 3. The Modified Mercalli Intensity Scale is a more subjective accounting or survey of behavior and damage based on observation at the site. Depending on the intensity of ground vibrations, the elasticity of buildings and structures, and how well structures are connected to their foundation, falling or collapsing objects and structures accompany earthquakes. Structural instability, such as dam failures, can trigger flash floods. Fires have been the greatest cause of damage in the past. Offshore earthquakes may cause tsunamis.

Seismographs http://vulcan.wr.usgs.gov/Glossary/Seismicity/description_seismic_monitoring.html

The mainstay of volcano monitoring is the continuous recording of seismic activity. Virtually all Hawaiian eruptions are preceded and accompanied by an increase in the number of shallow earthquakes. As magma moves into the reservoir during inflation, it must make room for itself by rupturing or crowding aside the solidified lava that surrounds the reservoir. Such underground ruptures produced seismic waves that travel through the volcano and are recorded by a network of seismometers placed on the volcano's surface. Ground motions sensed by the seismometer are converted into electronic signals, which are transmitted by radio and are recorded on seismographs located at the volcano observatory. The seismic data are analyzed to determine the time, location, depth, and magnitude of the earthquakes. Mapping the earthquake activity allows HVO scientists to track the subsurface movement of magma.

Aftershock http://www.usgs.gov/newsroom/article.asp?ID=1218

When is a badly damaged, but stable building safe to enter after an earthquake? That is a question that safety-response and building-department officials have to answer in order to let occupants retrieve important possessions and business records, and to let contractors begin emergency repairs. The obvious time to stay out of a building is immediately following the earthquake and until the aftershocks subside. But those aftershocks can last for days or weeks, as evidenced by recent large earthquakes in Turkey and Taiwan. And so, the dilemma for earthquake survivors is knowing how soon they can go in and how long they may safely stay in the structure in order to search for survivors and retrieve possessions. Scientists at the USGS began forecasting aftershocks, following the 1989 Loma Prieta earthquake. Now, following an earthquake in California of magnitude 5 or larger, the USGS posts the probability of strong aftershocks on its Web site at http://quake.wr.usgs.gov.

Here are some general facts about aftershocks:

* The greater the magnitude of the earthquake and the stronger and longer the shaking, the greater the chances for strong and numerous aftershocks.
* If damage was heavy in the main shock, the site is more likely to experience additional damage from aftershocks.
* A main shock large enough to cause damage will probably be followed by several felt aftershocks within the first hour.
* Aftershocks decrease in number and magnitude, with time. Generally speaking, the second day will have approximately half the number of aftershocks as the first day and one-tenth as many on the tenth day.
* Except for life-saving rescues, entry into seriously damaged buildings should be avoided during the first 24 hours following a main shock.
* If a damaged building must be entered following a strong main shock, the time inside should be kept at a minimum.

* As a general rule, following a 6.5 or greater earthquake, three days should elapse before a damaged building should be occupied for up to eight hours at a time. Five additional days should elapse before the building is occupied for 24 hours at a time.

Volcanoes http://www.usgs.gov/hazards/volcanoes/

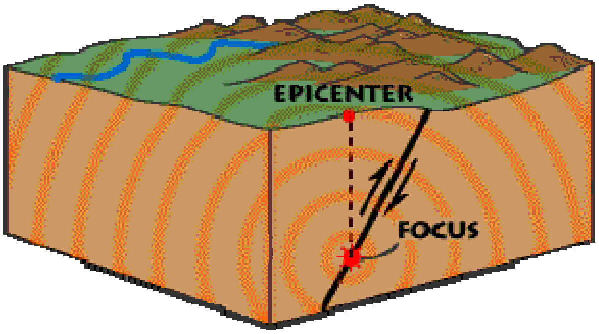
When the violent energy of a volcano is unleashed, the results can be catastrophic. The risks to life, property, and infrastructure are escalating as more and more people live, work, play, and travel in volcanic regions. To help keep communities safe, it is essential to monitor hazardous volcanoes so that the public knows when unrest begins and what hazards can be expected.

The USGS has greatly advanced its ability to evaluate volcanic risks and hazards through research and monitoring programs. USGS real time volcano-monitoring tools collect and transfer large amounts of data from remote volcanoes for analysis and interpretation. USGS's analyses and interpretations help the public, policymakers, and emergency managers make informed decisions on how to prepare for and react to volcano hazards and reduce losses from future volcanic eruptions and debris flows.

Strike slip faults http://geology.wr.usgs.gov/parks/deform/gfaults.html

Strike-slip faults have a different type of movement than normal and reverse faults. You probably noticed that the blocks that move on either side of a reverse or normal fault slide up or down along a dipping fault surface. The rocky blocks on either side of strike-slip faults, on the other hand, scrape along side-by-side. The movement is horizontal and the rock layers beneath the surface haven't been moved up or down on either side of the fault. A picture of a slip fault shows where the fault has ruptured the Earth surface. It is easy to see that pure strike-slip faults do not produce *fault scarps*. There are other changes in the landscape that signal strike-slip faulting. Where the two massive blocks on either side of a strike-slip fault grind against each other, rock is weakened. Streams flowing across strike-slip faults are often diverted to flow along this weakened zone.

Epicenter http://geology.wr.usgs.gov/parks/deform/geqepifoc1.html



VISUAL GLOSSARY

EARTHQUAKE
EPICENTER
FOCUS

Earthquake-A sudden ground motion or vibration produced by a rapid release of stored-up energy.
Epicenter-The point on the Earth's surface located directly above the focus of an earthquake.
Focus-The location where the earthquake begins. The ground ruptures at this spot, then seismic waves radiate outward in all directions.

ACTIVITY 4

Activity 4 Overview: It's Not Your Fault (Elaborate)

Iowa Core Curriculum Essential Skills/Concepts:	Understands and applies knowledge of internal sources of energy in the earth system					
Big Ideas	◦ Students will be able to compare and contrast movements on either side of the San Andreas Fault using GPS data. ◦ Students will be able to calculate the amount of movement of a tectonic plate over a period of time. ◦ Students will be able to describe the processes involved in the occurrence of earthquakes along the San Andreas Fault.					
Characteristics of Instructional Core	x	Encourages collaboration in learning	x	Teaches for understanding		Develops global perspectives
	x	Student centered	x	Develops conceptual and/or procedural knowledge	x	Provides authentic learning
	x	Teaching through problem solving and inquiry	x	Assesses for learning	x	Incorporation of current technology
Cognitive Domain		Remembering	x	Applying	x	Evaluating
		Understanding	x	Analyzing	x	Creating
Connections to Students' Lives		Isolated within discipline		Connected to other disciplines		Connected to student lives
		Connected within discipline	x	Has value beyond school purposes		
Support for Literacy	x	Using the literacy process for inquiry		Increasing reading volume		
		Increasing access to print	x	Engaging students with texts		
		Involving students in discussion		Reading aloud in content areas		
		Increasing reading fluency		Explicitly instructing in vocabulary and comprehension		
		Writing to learn across content areas				
Class Time	3 class period(s) 135 total minutes					

Materials:

Computer with internet access and a working email account (if computer access is not available, you may use the data sets included in "Tracking Plate Movement – Answers")

- Copies of "Using CORS Data," one for each student or student group
- Copy of "Using CORS Data – Teacher's Guide" for teacher's reference
- Copies of "Student Sheet Tracking Plate Movement Along the San Andreas Fault," one for each student or student group.
- Calculator or spreadsheet program, such as Microsoft Excel.
- Metric ruler, one for each student or student group.
- Copies of either "Geodesy Review" (fill-in-the-blank version, with or without word bank) or Geodesy Review Crossword Puzzle, one copy for each student or student group

The fully developed lesson, “It's Not Your Fault,” will be used for this activity. This lesson was developed by NOAA (National Oceanographic and Atmospheric Agency) to study earthquakes in more depth using GPS data. This lesson is in the public domain and can be downloaded from the website.
http://www.oceanservice.noaa.gov/education/kits/geodesy/lessons/geodesy_tectonics.pdf

Fully developed background materials, teaching guides, etc., are included in the lesson.

Teaching Tips:

Teacher Tasks	Student Tasks
• The teacher poses the focus question, “How can we measure the relative motions of the Pacific Plate and the North American Plate along the San Andreas Fault?	• Students review “using CORS Data.”
• The teacher briefly introduces the concept of measuring displacements in the Earth's crust using geodetic data, and describes the overall structure and location of the San Andreas Fault and the adjoining tectonic plates.	• Students get data for one or more of the given dates listed in the activity.
• The teacher goes over “Using CORS Data” with students to familiarize them with how to retrieve needed information from the NGS-CORS website.	• Students submit their files to OPUS.
• The teacher leads a discussion of the students' results using the teacher's notes section as a guide.	• Students extract the latitude and longitude elevation information from each OPUS solution, plot positions, and calculate latitude and longitude changes.
• While students are gathering data from the web sites and graphing that data, the teacher will need to lend help to those students who are having difficulty with excel or in deciding which pieces of data to use for analysis.	• Students share data with their group members for the change in latitude and longitude of each CORS site.
	• Students graph the changes in latitude and longitude on different dates and draw movement of their CORS site over time.
	• Students answer the worksheet questions and write a short essay explaining how much importance they would attach to earthquake probability when deciding on a place to live.

Differentiation Tasks

Less-Than-Proficient

Prioritized vocabulary, skills, concepts: Global Positioning System (GPS). San Andreas Fault, plates, transform plate boundary, North American Plate, Pacific Plate, Continuously Operating Reference Stations (CORS), and Online Positioning User Service (OPUS)

Suggestions for supplemental instruction

- Ask students to research ways to design structures to perform well during an earthquake.
- Due to the complexity of this lesson, a conversation with a special educator/inclusion teacher would be wise prior to this lesson to make sure struggling students have the assistance they need to actively participate in this lesson.
- Students needing additional support might work in pairs on this assignment rather than individually.
- Coordinate with the language arts instructors for struggling students and align writing persuasive letters in language arts with this assignment, possibly using this assignment to satisfy requirements in both classes.

Highly Proficient

Suggestions for supplemental instruction

- Challenge students to investigate the kinds of information that can be obtained through geodesy.
- There are numerous links listed on this NOAA site that provide opportunities for in depth learning.

Assessment:

Formative Assessments:

- Provide ongoing guidance and feedback to students as they work through the activity. Ask probing questions, even to those students who appear to have a strong understanding of the concepts being taught.
- Rather than waiting to assess student's final product, check student work as they progress through the different phases of this activity. If errors are made early in the process, they are likely to be due to using the wrong data or incorrectly plotting changes. It is best to ask probing questions to allow students to discover these errors and make appropriate corrections.

Summative Assessments:

- The assessment for this activity is the "Tracking Plate Movement Along the San Andreas Fault" worksheet. Answers to this activity are included in the "It's Not My Fault" lesson packet.

Reflect:

In my district, accessing student email accounts was a difficulty. A class email account is a possibility for students to use if set-up is requested of the technology coordinator in advance. This lesson is recommended for upper level students and is quite rigorous. It might be difficult for beginning high school students. Students were intrigued by the use of real scientific data, but frustrated by the process. If there are teaching assistants or co-teachers, the lesson should be discussed thoroughly beforehand. As suggested in the NOAA instructions, if using the internet to access the data becomes a barrier to success, use the tracking information included with this lesson from the website.

Attachments:

Student Page/Handout: Included in the "It's Not My Fault" lesson packet. At http://www.oceanservice.noaa.gov/education/kits/geodesy/lessons/geodesy_tectonics.pdf

ACTIVITY 5

Activity 5 Overview: Live Dangerously? (Evaluate)

Iowa Core Curriculum Essential Skills/Concepts:	o Understands and applies knowledge of internal sources of energy in the earth system					
Big Ideas	◦ Students will successfully relate the knowledge they have learned in this unit to a realistic decision-making situation. ◦ Students will be able to employ the internet to gather information for data-based decision-making. ◦ Students will be able to evaluate and defend their choice using scientific data.					
Characteristics of Instructional Core	x	Encourages collaboration in learning	x	Teaches for understanding	x	Develops global perspectives
	x	Student centered	x	Develops conceptual and/or procedural knowledge	x	Provides authentic learning
	x	Teaching through problem solving and inquiry	x	Assesses for learning	x	Incorporation of current technology
Cognitive Domain		Remembering		Applying	x	Evaluating
		Understanding	x	Analyzing	x	Creating
Connections to Students' Lives		Isolated within discipline		Connected to other disciplines	x	Connected to student lives
		Connected within discipline	X	Has value beyond school purposes		
Support for Literacy	x	Using the literacy process for inquiry		Increasing reading volume		
	x	Increasing access to print	x	Engaging students with texts		
		Involving students in discussion		Reading aloud in content areas		
		Increasing reading fluency		Explicitly instructing in vocabulary and comprehension		
	x	Writing to learn across content areas				
Class Time	1-2 class period(s) 45-90 total minutes Length of class time needed for this lesson depends on whether the written part of the assignment is done in class or assigned as homework with an appropriate due date.					

Materials & Set-up:
Students will need access to the internet to investigate information about specific geologically active sites around the world. Students will work individually on the written part of this assignment, but they could work together to investigate background information.

Students are given the following information:

> You work for the USGS (United States Geological Survey). You are one of their seismologists, so you gather and study earthquake data. When you first began this job, you were the only one you had to worry about. Things have changed in your life over the years, and you now have a family with 2 small children. You have been promoted and are no longer the rookie seismologist which

means you now have a choice of where you are going to live and work. You and your family are world travelers, so you do not have a particular preference for a country – you are willing to live in any country. You do, however, have a concern about the safety factor of where you live – your spouse is far more concerned about keeping the family safe than his/her geographical location.

You have been given six choices as possible posts for your job. Using any seismology and earthquake history data available, choose one of the places to live. Use a Risk/Benefit Chart to help you analyze and evaluate your collected data and cite your references. Defend your choice, giving evidence you can share with your spouse. Your evidence should tell not only why you chose as you did, but why you did not choose the other sites.

San Francisco Bay Area, California
Fairbanks, Alaska
Sumatra, Indonesia
Taiwan, Japan
Lima, Peru
Kashmir Area, Pakistan

Write a persuasive letter to your spouse, trying to convince him/her to accept your choice. Use a GUM guide to help you maintain good grammar, usage, and mechanics as you write your letter.

Students are to use a Risk/Benefit Chart to gather information helpful in making their decision. The Risk/Benefit Chart will be handed in along with the culminating letter to his/her spouse.

Teaching Tips:

Teacher Tasks	Student Tasks
• The teacher observes and interacts with students as they are locating sources, addressing individual concerns or issues and gathering relevant data.	• Students research the six geologically active areas and gather data on seismic activity and historical geologic events.
• The teacher provides ongoing guidance and feedback for individual students and the class.	• Students evaluate their data and determine which area is the safest for a family to live.
• The teacher directs students to use the Risk/Benefit Chart to help them with data-based decision-making.	• Students use a Risk/Benefit Chart to help them make a data-based decision.
• The teacher functions as an on-the-move editor, reminding students to meet GUM guides for grammar, usage, and mechanics as they write their persuasive letters.	• Students write a persuasive letter to their spouse using evidence to try and convince them of a safe choice for family living.

Differentiation Tasks
<u>Less-Than-Proficient</u> **Prioritized vocabulary, skills, concepts:** fault, Richter scale, probability, analysis of data, presentation of data. **Suggestions for supplemental instruction** • Some students will have difficulty finding appropriate websites and will need assistance. Previously

identified websites will facilitate decision-making for these students.

- Guide students in preparing an outline of their letter. Using the rubric, help students develop a list of what should be included in each paragraph of the letter. In extreme cases, prepare a template of a letter ahead of time that contains lists of the important components of the letter. This can be prepared using the rubric as a guide.
- Use strategic partnerships by placing students who may struggle with students who are easily able to navigate the internet in search of earth information.
- Some students learn better with visuals. To accommodate this, provide the option of including a world map with the risks and benefits of each location included.

Highly Proficient

Suggestions for supplemental instruction

- Ask students to post good websites they have found on a list to be made available to others in the class.
- Encourage students who need more challenge to support their decision with statistics and evidence.

Assessment:

Formative Assessments:

There are several formative assessments that happen during this activity. These are informal and happen during work time. They include the following:

- Observe and interact with students as they are locating sources, gathering information and data, and filling out their Risk/Benefit Charts. Asking probing questions of individuals, especially regarding the specificity of the risks and benefits they are including on their charts will deepen student learning.
- Provide ongoing guidance/feedback for individual students as they progress during workshop time.
- Informally assess and give editorial advice to students as they write their persuasive letters. Guiding students in how to use the rubric to help guide their letter writing will ensure student understanding not only of the concepts, but of the importance of the use in data in presenting compelling arguments.

Summative Assessments:

- The assessment for this activity includes the Risk/Benefit Chart and the persuasive letter. Because the Risk/Benefit Chart is used as a decision-making tool, it can be given points for completion because the content will be different for each student based on the evidence they found and the criteria by which they make their decision for safe living. The persuasive letter should be assessed using the rubric included on the student page.

Reflect:

This lesson was intriguing and interesting for students. We did the Risk/Benefit chart as a class project, dividing up the research which became more time-efficient than everyone working separately. Everything was done as a group project except for the writing assignment, which was done and graded individually. A number of students presented letters that were lacking in several of the components included in the scoring rubric or Risk/Benefit charts with missing components. In most cases it was the benefits that students had the most difficulty with. Insisting that the assignment be redone to include these components helped to ensure that each student was getting the most out of this activity and provided a good indicator of the learning that occurred.

Attachments:

Student Page/Handout:

Live Dangerously?

Evaluate

You work for the USGS (United States Geological Survey). You are one of their seismologists, so you gather and study earthquake data. When you first began this job, you were the only one you had to worry about. Things have changed in your life over the years, and you now have a family with 2 small children. You have been promoted and are no longer the rookie seismologist, meaning you now have a choice of where you are going to live and work. You and your family are world travelers, so you do not have a particular preference for a country – you are willing to live in any country. You do, however, have a concern about the safety factor of where you live – your spouse is far more concerned about keeping the family safe than his/her geographical location.

You have been given six choices as possible posts for your job. Using any seismology data available, choose one of the places to live. Use a Risk/Benefit chart to help you analyze your collected data and cite your references. Defend your choice, giving evidence you can share with your spouse. Your evidence should tell not only why you chose as you did, but why you did not choose the other sites.

San Francisco Bay Area, California
Fairbanks, Alaska
Sumatra, Indonesia
Taiwan, Japan
Lima, Peru
Kashmir Area, Pakistan

Write a persuasive letter to your spouse, trying to convince him/her to accept your choice. Take special care to comply with all of the proper conventions of writing for usage, grammar and mechanics. Use the rubric to help guide the content of your letter.

Live Dangerously Risk/Benefit Chart

Risk/Benefit Chart: Live Dangerously?			
	Seismographic Data	Risks	Benefits
San Francisco, CA	Frequency of quakes: Strength of quakes: Distance from epicenter: Type of terrain:		
Fairbanks, Alaska	Frequency of quakes: Strength of quakes: Distance from epicenter: Type of terrain:		
Sumatra, Indonesia	Frequency of quakes: Strength of quakes: Distance from epicenter: Type of terrain:		
Taiwan, Japan	Frequency of quakes: Strength of quakes: Distance from epicenter: Type of terrain:		
Lima, Peru	Frequency of quakes:		

	Strength of quakes: Distance from epicenter: Type of terrain:		
Kashmir Area, Pakistan	Frequency of quakes: Strength of quakes: Distance from epicenter: Type of terrain:		

Rubric

Rubric for Persuasive Letter: Live Dangerously?				
	Exceeds Expectations	Meets Expectations	Below Expectations	Needs to Redo
Goal and audience	The goal statement provides a clear, strong statement for the author's position and is written for the spouse as the audience.	The goal statement provides a clear statement for the author's position and is written for the spouse as the audience.	The goal statement is present but does not make the author's position clear; audience is unclear.	Goal statement is not present and the audience is not clear. Must be redone and resubmitted.
Evidence to support argument	Includes 3 or more reasons (facts, statistics, examples, real-life experiences) that support the argument.	Includes 2 or more reasons (facts, statistics, examples, real-life experiences) that support the argument.	Includes 1 or more reasons (facts, statistics, examples, real-life experiences) that support the argument.	Does not include reasons that support the argument; must be redone and resubmitted.
Letter format	Complies with all the proper conventions of writing.	Makes 3-5 errors in conventions of writing.	Makes 5-8 errors in conventions of writing.	Many errors in conventions of writing. Must be redone and resubmitted.

