Environmental Science Institute
The University of Texas at Austin

Citizen Science: Man vs. Machine is Providing Rapid Earthquake Information
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This file contains suggestions for how to incorporate the material from this CDROM into curriculum using the Texas Essential Knowledge and Skills for Science and Math.

§112.3. Science, All Grades.

(b) Knowledge and skills.

(2) Scientific processes. The student uses scientific methods during field and laboratory investigations. The student is expected to:

(A) plan and implement descriptive and simple experimental investigations including asking well-defined questions, formulating testable hypotheses, and selecting and using equipment and technology;

(B) collect information by observing and measuring;

(C) analyze and interpret information to construct reasonable explanations from direct and indirect evidence;

(D) communicate valid conclusions; and

(E) construct simple graphs, tables, maps, and charts using tools including computers to organize, examine, and evaluate information.

SLIDE 4,13: Hand students different graphs of earthquake hazards from around the world and ask them to analyze which areas of the world have a higher threat from earthquakes and why this could be. Answers could be in the form of an essay, a worksheet, or a class presentation in groups.

(3) Scientific processes. The student uses critical thinking and scientific problem solving to make informed decisions. The student is expected to:

(A) analyze, review, and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information;

(B) draw inferences based on data related to promotional materials for products and services;

(C) represent the natural world using models and identify their limitations;

(D) evaluate the impact of research on scientific thought, society, and the environment; and

(F) connect Grade X science concepts with the history of science and contributions of scientists.

SLIDE 4: Have students learn about the history of seismology and different seismometers that have been constructed over hundreds of years, include the formation of the Richter scale and how engineers today are constructing earthquake-resistant buildings.

Elementary School Science

§112.5. Science, Grade 3.

(6) Science concepts. The student knows that forces cause change. The student is expected to:

(A) measure and record changes in the position and direction of the motion of an object to which a force such as a push or pull has been applied; and

(B) identify that the surface of the Earth can be changed by forces such as earthquakes and glaciers.

SLIDE 4,7-9,13,26: Tell students why earthquakes happen (it's a result of friction between two rocks that releases energy in the form of waves which in turn move the Earth); explain different faults where earthquakes can occur (normal, reverse, transverse) and how the Earth's features can change due to earthquakes (mudslides, cracks in the Earth's surface, etc.). Tell students the difference between magnitude (determined by fault slip) and intensity (damage done) and scales used for these (Richter and Modified Mercalli)

Middle School Science

§112.22. Science, Grade 6.

(b) Knowledge and skills.

(6) Science concepts. The student knows that there is a relationship between force and motion. The student is expected to:

(A) identify and describe the changes in position, direction of motion, and speed of an object when acted upon by force;

(B) demonstrate that changes in motion can be measured and graphically represented; and

(C) identify forces that shape features of the Earth including uplifting, movement of water, and volcanic activity.

SLIDE 4: Tell students why earthquakes happen (it's a result of friction between two rocks that releases energy in the form of waves which in turn move the Earth); explain different faults where earthquakes can occur (normal, reverse, transverse) and how the Earth's features can change due to earthquakes (mudslides, cracks in the Earth's surface, etc.)

(5) Science concepts. The student knows that the equilibrium of a system may change. The student is expected to:

(A) describe how systems may reach equilibrium such as when a volcano erupts; and

(B) observe and describe the role of ecological succession in maintaining an equilibrium in an ecosystem.

SLIDE 4: Explain how when an earthquake occurs it is the Earth's way of establishing equilibrium by releasing built up energy, similar to when a volcano erupts.

(8) Science concepts. The student knows that complex interactions occur between matter and energy. The student is expected to:

(A) illustrate examples of potential and kinetic energy in everyday life such as objects at rest, movement of geologic faults, and falling water; and

(B) identify that radiant energy from the sun is transferred into chemical energy through the process of photosynthesis.

SLIDE 4,7-9: Explain how when an earthquake occurs it is the Earth's way of establishing equilibrium by releasing built up energy, similar to when a volcano erupts.

§112.23. Science, Grade 7.

(b) Knowledge and skills.

(8) Science concepts. The student knows that complex interactions occur between matter and energy. The student is expected to:

(A) illustrate examples of potential and kinetic energy in everyday life such as objects at rest, movement of geologic faults, and falling water; and

(B) identify that radiant energy from the Sun is transferred into chemical energy through the process of photosynthesis.

SLIDE 4,7-9,13: Tell students why earthquakes happen (it's a result of friction between two rocks that releases energy in the form of waves which in turn move the Earth); explain different faults where earthquakes can occur (normal, reverse, transverse) and how the Earth's features can change due to earthquakes (mudslides, cracks in the Earth's surface, etc.)

High School Science

§112.49. Geology, Meteorology, and Oceanography.

(c) Knowledge and skills.

(3) Scientific processes. The student uses critical thinking and scientific problem solving to make informed decisions. The student is expected to:

(A) analyze, review, and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information;

(B) draw inferences based on data related to promotional materials for products and services;

(C) evaluate the impact of research on scientific thought, society, and the environment;

(D) describe the connections between geology, meteorology, oceanography, and future careers; and

(E) research and describe the history of geology, meteorology, oceanography, and contributions of scientists.

SLIDE 7-9, 21,26,31,36,71: Explain to students how earthquakes occur as a result of faulting and the difference between the magnitude (determined by fault slip) and intensity (how much damage there was) and the scales used to measure these (Richter and Modified Mercalli). Also discuss the history of seismology and how new technology is helping geophysicists better understand the Earth's interior. A geophysicist could be a guest speaker for a class period and describe his/her work. Students can research the different seismic instruments that are available today and how they have changed from the first seismometers, and what is being done to predict earthquakes (if even possible). Students can do research projects on many topics in seismology including if *DYFI?* (determined by people's input over the internet) is as accurate as *ShakeMap* (determined from seismometers/machines).

(6) Science concepts. The student knows the processes of plate tectonics. The student is expected to:

(A) research and describe the historical development of the theories of plate tectonics including continental drift and sea-floor spreading;

(B) analyze the processes that power the movement of the Earth's continental and oceanic plates and identify the effects of this movement including faulting, folding, earthquakes, and volcanic activity; and

(C) analyze methods of tracking continental and oceanic plate movement.

SLIDE 7-9,26: Explain to students how earthquakes occur as a result of faulting and the difference between the magnitude (determined by fault slip) and intensity (how much damage there was). Also the effects of depth on earthquake intensity (a deep earthquake is less intense than a shallow earthquake of the same magnitude) is another to discuss with students.

(5) Science concepts. The student knows the effects of waves on everyday life. The student is expected to:

(A) demonstrate wave types and their characteristics through a variety of activities such as modeling with ropes and coils, activating tuning forks, and interpreting data on seismic waves;

(B) demonstrate wave interactions including interference, polarization, reflection, refraction, and resonance within various materials;

(C) identify uses of electromagnetic waves in various technological applications such as fiber optics, optical scanners, and microwaves; and

(D) demonstrate the application of acoustic principles such as in echolocation, musical instruments, noise pollution, and sonograms.

SLIDE 7: Tell students about the different waves involved in earthquakes (e.g., P, S, Love, Rayleigh) and how geophysicists use these waves to tell them about the interior of the Earth. Refracted waves and reflected waves can be used to find salt domes, oil, and natural gas. Students could be given three seismograms from three different locations, which show the same earthquake, and can find the epicenter by plotting these seismograms on a map.

§112.47. Physics.

(c) Knowledge and skills.

(8) Science concepts. The student knows the characteristics and behavior of waves. The student is expected to:

(A) examine and describe a variety of waves propagated in various types of media and describe wave characteristics such as velocity, frequency, amplitude, and behaviors such as reflection, refraction, and interference;

(B) identify the characteristics and behaviors of sound and electromagnetic waves; and

(C) interpret the role of wave characteristics and behaviors found in medicinal and industrial applications.

SLIDE 7: Tell students about the different waves involved in earthquakes (e.g., P, S, Love, Rayleigh) and how geophysicists use these waves to tell them about the interior of the Earth. Refracted waves and reflected waves can be used to find salt domes, oil, and natural gas. Students could be given three seismograms from three different locations, which show the same earthquake, and can find the epicenter by plotting these seismograms on a map.

Elementary School Math

§111.12. Mathematics, Kindergarten.

(b) Knowledge and skills.

(12) Probability and statistics. The student constructs and uses graphs of real objects or pictures to answer questions. The student is expected to:

(A) construct graphs using real objects or pictures in order to answer questions; and

(B) use information from a graph of real objects or pictures in order to answer questions.

SLIDE 4,13,23,57: Ask the students to read a hazard map and to predict the probability of an earthquake occurring in certain areas.

§111.13. Mathematics, Grade 1.

(b) Knowledge and skills.

(10) Probability and statistics. The student uses information from organized data. The student is expected to:

(A) draw conclusions and answer questions using information organized in real-object graphs, picture graphs, and bar-type graphs; and

(B) identify events as certain or impossible such as drawing a red crayon from a bag of green crayons.

SLIDE 4,13,23,57: Ask the students to read a hazard map and ask them to predict the probability of an earthquake occurring in certain areas.

§111.14. Mathematics, Grade 2.

(b) Knowledge and skills.

(11) Probability and statistics. The student organizes data to make it useful for interpreting information. The student is expected to:

(A) construct picture graphs and bar-type graphs;

(B) draw conclusions and answer questions based on picture graphs and bar-type graphs; and

(C) use data to describe events as more likely or less likely such as drawing a certain color crayon from a bag of seven red crayons and three green crayons.

SLIDE 4,13,23,57: Ask the students to read a hazard map and to predict the probability of an earthquake occurring in certain areas.

§111.15. Mathematics, Grade 3.

(b) Knowledge and skills.

(14) Probability and statistics. The student solves problems by collecting, organizing, displaying, and interpreting sets of data. The student is expected to:

(A) collect, organize, record, and display data in pictographs and bar graphs where each picture or cell might represent more than one piece of data;

(B) interpret information from pictographs and bar graphs; and

(C) use data to describe events as more likely, less likely, or equally likely.

SLIDE 4,13,23,57: Ask the students to read a hazard map and to predict the probability of an earthquake occurring in certain areas.

§111.17. Mathematics, Grade 5.

(b) Knowledge and skills.

(12) Probability and statistics. The student describes and predicts the results of a probability experiment. The student is expected to:

(A) use fractions to describe the results of an experiment; and

(B) use experimental results to make predictions.

SLIDE 4,13,23,57: Ask the students to read a hazard map and to predict the probability of an earthquake occurring in certain areas.

(13) Probability and statistics. The student solves problems by collecting, organizing, displaying, and interpreting sets of data. The student is expected to:

(A) use tables of related number pairs to make line graphs;

(B) describe characteristics of data presented in tables and graphs including the shape and spread of the data and the middle number; and

(C) graph a given set of data using an appropriate graphical representation such as a picture or line.

SLIDE 4,13,23,57: Ask the students to read a hazard map and to predict the probability of an earthquake occurring in certain areas.

Middle School Math

§111.22. Mathematics, Grade 6.

(b) Knowledge and skills.

(10) Probability and statistics. The student uses statistical representations to analyze data. The student is expected to:

(A) draw and compare different graphical representations of the same data;

(B) use median, mode, and range to describe data;

(C) sketch circle graphs to display data; and

(D) solve problems by collecting, organizing, displaying, and interpreting data.

SLIDE 4,13,23,57: Give students the number and locations of earthquake occurrences for 10 years in the United States and have students construct an earthquake hazard map from which they could make predictions on when, where, and what magnitude an earthquake might be in a certain state or area.

§111.23. Mathematics, Grade 7.

(b) Knowledge and skills.

(11) Probability and statistics. The student understands that the way a set of data is displayed influences its interpretation. The student is expected to:

(A) select and use an appropriate representation for presenting collected data and justify the selection; and

(B) make inferences and convincing arguments based on an analysis of given or collected data.

SLIDE 4,13,23,57: Give students the number and locations of earthquake occurrences for 10 years in the United States and have students construct an earthquake hazard map from which they could make predictions on when, where, and what magnitude an earthquake might be in a certain state or area.

§111.24. Mathematics, Grade 8.

(b) Knowledge and skills.

(11) Probability and statistics. The student applies concepts of theoretical and experimental probability to make predictions. The student is expected to:

(A) find the probabilities of compound events (dependent and independent);

(B) use theoretical probabilities and experimental results to make predictions and decisions; and

(C) select and use different models to simulate an event.

SLIDE 4,13,23,57: Give students the number and locations of earthquake occurrences for 10 years in the United States and have students construct an earthquake hazard map from which they could make predictions on when, where, and what magnitude an earthquake might be in a certain state or area.

(12) Probability and statistics. The student uses statistical procedures to describe data. The student is expected to:

(A) select the appropriate measure of central tendency to describe a set of data for a particular purpose;

(B) draw conclusions and make predictions by analyzing trends in scatter plots; and

(C) construct circle graphs, bar graphs, and histograms, with and without technology.

SLIDE 4,13,23,57: Give students the number and locations of earthquake occurrences for 10 years in the United States and have students construct an earthquake hazard map from which they could make predictions on when, where, and what magnitude an earthquake might be in a certain state or area.

High School Math

§111.36. Mathematical Models with Applications (One-Half to One Credit).

(c) Knowledge and skills.

(4) The student uses probability models to describe everyday situations involving chance. The student is expected to:

(A) compare theoretical and empirical probability; and

(B) use experiments to determine the reasonableness of a theoretical model such as binomial, geometric, etc.

SLIDE 4,13,23,57: Give students the number and locations of earthquake occurrences for 10 years in the United States and have students construct an earthquake hazard map from which they could make predictions on when, where, and what magnitude an earthquake might be in a certain state or area.