Advanced Manufacturing & Prototyping Integrated to Unlock Potential

Earth Science Data Visualization (6DVS)

"*Shake and Break*"

Earthquake Challenge

Module Description	Students engage as earth scientists to help a company decide where to build its new cell manufacturing plant in northern California. Students map 10-year earthquake data to see if the sites have significant activity. Then, they map 40-year data to see a surprising change in the data set within their assigned region and across the larger region their classmates are mapping. Students learn the importance of looking at data over a long time and across a wide geographic area. They create visualizations of these data to make a recommendation to the company about the selected site. The module covers basic concepts of seismology, plate tectonics, earth's structure, seeding further exploration of GPS standards later in the year. *Module features Dr. Andrew Newman's work in GT's Earth & Atmospheric Sciences on earthquake forecasting through land deformation mapping.*	
Related Georgia Performance Standards	***S6E5.*** *Obtain, evaluate, and communicate information to show how Earth's surface is formed.* *a. Ask questions to compare and contrast the Earth's crust, mantle, inner and outer core, including temperature, density, thickness, and composition.*	
Module Timeline	**50-minute class periods:** 4 days Day 1: Section 1,2 Day 2: Section 2,3 Day 3: Section 3,4 Day 4: Section 4,5	**90-minute blocks:** 2 days Day 1: Sections 1,2,3 Day 2: Section 3,4,5
Documents Included in the Download	**<u>Student Materials Folder</u>** • Student Edition *(recommended to be printed double sided)* • Student Worksheet Packet *(recommended to be printed single sided)* • Map Grids *(recommended to be printed single sided in high resolution)* **<u>Teacher Materials Folder</u>** • Materials List • Annotated Teacher's Edition • Teacher Preparation Guide • Videos	

5E Stage	Student Activities How will students engage actively in the three dimensions throughout the lesson?	Teacher Activities How will the teacher facilitate and monitor student learning throughout the lesson?
Engage How does the lesson capture student interest, activate prior knowledge, and connect to a complex question, global issue, or real world problem?	• Students are introduced to the challenge (helping BuzzTech determine the best location in California for building a cellphone/tablet manufacturing plant) *(1.1,1.2)*	• Guide students through text to check for understanding • Discuss the concept of tradeoffs and the pros/cons that the different sites offer that will have to be considered alongside the earthquake data
Explore How does the lesson allow students to develop a common base of experiences by actively investigating the phenomenon or problem?	• Students are given a section map and earthquake data to plot on it. They will use different colored stickers to pinpoint locations & represent the magnitude of the earthquakes for a 10-year period. *(2.1,2.2)* • Students analyze their section maps and discuss whether or not it would be a good option for the manufacturing plant *(2.2)*	• Divide students into groups of 3, assign sections and explain how to plot points using the grid • Provide students with the 10-year data and stickers for plotting • After the activity, lead a class discussion about whether the section would be a good place to build the plant (or not)
Explain How does the lesson allow students to develop, share, critique, and revise their own explanations before connecting those to accepted scientific explanations and terminology?	• Students learn earthquake basics (structure of earth, how they are detected/measured). *(3.1,3.2,3.3)* • Students watch videos of how the magnitude of earthquakes affects the amount of damage inflicted *(3.3)*	• Facilitate reading and discussion on the basics of earthquakes, detecting and measuring them and how the strength of the earthquake impacts the amount of damage caused
Elaborate How does the lesson allow students to extend their conceptual understanding of the three dimensions through opportunities to apply knowledge, skills, and abilities in new experiences?	• Students use different colored stickers to pinpoint locations & represent the magnitude of the earthquakes for a 40-year period. *(4.1)* • Students analyze their section maps and discuss whether or not it would be a good option for the manufacturing plant *(4.2)* • Students combine the 9 sections together to create a larger map. They analyze the spatial and temporal data to look for patterns and consider locations for moving the plant. *(4.3,4.4)* • Students learn about earthquake research and forecasting at GT *(4.5)*	• Provide students with the 40-year data and stickers for plotting • After the activity, lead a discussion about whether the section would be a good place to build the plant (or not) • Facilitate a discussion on the importance of visualizing data in different ways (chart vs. map), how more information can be learned from different visuals, why 10 years' worth of data wasn't enough. (temporal) • Facilitate a discussion about spatial data and how viewing the combined map gives students a new idea of earthquake patterns
Evaluate How does the lesson—through both formative assessments embedded throughout the lesson and a summative assessment that might coincide with the elaborate phase—make visible students' thinking and their ability to use practices with core ideas and crosscutting concepts to make sense of phenomena and/or to design solutions?	**Formative:** Ongoing questioning and discussion *(all sections)* Section Maps (*2.2, 4.1)* **Summative:** Letter to BuzzTech Sheet *(5)* Students will write a letter to BuzzTech with their decision of what would be the best location to build the new plant. Letter is scaffolded for students but remind them to include details of the factors making the site a good location	

	1.1	1.2	1.3	2.1	2.2	3.1	3.2	3.3	4.1	4.2	4.3	4.4	4.5	5
Engage	—	—	—											
Explore				—	—									
Explain						—	—	—						
Elaborate									—	—	—	—	—	
Evaluate					—				—					—

Section 1 – The Earthquake Challenge *(30 minutes)*

The focus of Section 1 is to provide students with a background of the Earthquake Challenge. Students are introduced to the BuzzTech company, which manufactures cell phone and tablets and is looking to open a manufacturing plant near San Francisco, California. BuzzTech has chosen three possible sites to relocate their plant to California and each site has certain advantages and disadvantages. Students will review a chart with these pros and cons and also view maps (relief and high map) of these three locations. In addition to this table and the maps, students are introduced to the idea that earthquakes might also be a factor in planning where to position the manufacturing plant. Students are given a brief explanation of the cause of an earthquake and what happens to structures on the earth's surface when an earthquake occurs (they shake and move, and maybe even collapse). If the location of BuzzTech's new plant was damaged by an earthquake, they could lose a lot of money and risk their employees being injured. Students are then introduced to the challenge- they must review the three locations and decide which location is best for BuzzTech to build their plant –considering factors such as earthquakes, transportation, and workforce.

Preparation

Materials	Student Pages
• N/A	• N/A

Prep the Day Before:

- Review the section and challenge.
- Review Maps/ Prepare to display maps from student text using overhead projector.

Planning

GPS	S6E5. *Obtain, evaluate, and communicate information to show how Earth's surface is formed.*
NGSS	Practice: Analyzing and Interpreting Data: *Analyze and Interpret data to provide evidence for phenomena.* Disciplinary Core Idea: ***ESS2.A:*** *Earth's Materials and Systems* *The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future.* ***ESS2.B:*** *Plate Tectonics and Large-Scale System Interactions* *Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided and spread apart.* Crosscutting Concept: *Scale Proportion and Quantity* *Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.*

Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
• Earthquake • Seismic Waves • Relief maps	• How does the movement of lithospheric plates cause major events on earth's surface? • Why do earthquakes occur? • Are natural disasters random or evenly dispersed?	• Discussion Questions: **Participation**

Section 2 – Investigate the Earthquake Data *(25 minutes)*

Students understand that it is important for BuzzTech to determine the frequency and severity of earthquakes that occur in the areas surrounding the proposed sites for the manufacturing plant. ***In Part 1****, the class will examine historical earthquake data from the United States Geological Survey that will allow them to determine the location, the Richter Scale reading, and the date of the earthquake in each of the proposed areas over a 10-year time period. Working in teams, students will plot locations, magnitude and date of earthquakes in their section. Students will use different colored stickers to represent the magnitude of the earthquake. These stickers will allow students to create a visual of the types of earthquakes that occur in their section.*

Preparation

Materials	Student Pages
• Section Maps (9 –total for each of the 9 groups) • Green, Yellow, Red Sticker Dots (1 set for each group) • Copy of 10-year earthquake data for each section (9 per class)	• N/A
Prep the Day Before: Prepare appropriate data sets for each group (Section Map and Section Data)	

Planning

GPS	S6E5. *Obtain, evaluate, and communicate information to show how Earth's surface is formed.*
NGSS	Practice: Analyzing and Interpreting Data: *Analyze and Interpret data to provide evidence for phenomena.* Disciplinary Core Idea: ***ESS2.A:*** *Earth's Materials and Systems* *The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future.* ***ESS2.B:*** *Plate Tectonics and Large-Scale System Interactions* *Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided and spread apart.* Crosscutting Concept: *Scale Proportion and Quantity* *Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.*

Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
• Earthquake • Richter Scale • Plotting Points/Grid System • Data	• How does the movement of lithospheric plates cause major events on earth's surface?	Discussion Questions: **Participation** Section Maps: **Formative**

Section 3 – Add to Your Understanding *(30 minutes)*

In order for students to understand the context of their challenge and how to assist BuzzTech determine their location for their plant, they need to understand background information on the structure of the surface of the earth and how earthquakes affect life in Northern California. This section introduces to the basics of the structure of the earth through videos, diagrams, and pictures showing the layers of the earth. Students will learn that the earth's outer layer (the crust) is broken up into a series of plates that fit together like a puzzle. It is the movement of these plates and the energy released when these plates grind against one another that causes earthquakes. Students will then be introduced on how earthquakes are detected (through a seismograph) and how earthquakes are measured (through the Richter Scale). They will watch a video a video that compares earthquakes of different measurements (different values on the Richter scale) to see the difference of damage caused by a small earthquake vs. damage caused by a large earthquake. After watching the video, the class will participate in a discussion reflecting on the video and how their increased knowledge about earthquakes will help them determine how to evaluate where BuzzTech should build their manufacturing plant.

Preparation

Materials	Student Pages
• Videos (Earth's Surface; Earthquake Samples)	• N/A
Prep the Day Before: Review Class Discussion Questions and possible answers. Review science of earthquakes for additional background knowledge: http://earthquake.usgs.gov/learn/kids/eqscience.php	

Planning

GPS	**S6E5.** *Obtain, evaluate, and communicate information to show how Earth's surface is formed.* *a. Ask questions to compare and contrast the Earth's crust, mantle, inner and outer core, including temperature, density, thickness, and composition.*
NGSS	**Practice:** Analyzing and Interpreting Data: *Analyze and Interpret data to provide evidence for phenomena.* **Disciplinary Core Idea:** ***ESS2.A:*** *Earth's Materials and Systems* *The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future.* ***ESS2.B:*** *Plate Tectonics and Large-Scale System Interactions* *Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided and spread apart.* **Crosscutting Concept**: *Scale Proportion and Quantity* *Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.*

Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
• Layers of the Earth: Crust, Mantle, Inner Core, Outer Core • Plates (tectonic) • Earthquake • Seismograph • Richter Scale	• How does the movement of lithospheric plates cause major events on earth's surface? • Why do earthquakes occur?	• Discussion Questions: **Participation**

Section 4 – Visualizing Data *(55 minutes)*

Students will follow the same procedure as before to plot data and map earthquakes from a 40-year time period, observing the difference in patterns with additional data. Students will read text that will explain to them why in science it is important to look at temporal data (data that changes its pattern over time) and examine data over long periods of time to reveal patterns and make evidence-based decisions. They will also learn the value of using visual representations of data to communicate information. Students will then reassemble their sections on a board in the front of the classroom. They will be asked to compare the patterns they see across the map in nine sections with the patterns they viewed in their own section. This is viewing the data spatially and will give students the ability to see the patterns of earthquakes over a wider area. Viewing the earthquake data both temporally and spatially will allow students to make a better-informed recommendation to BuzzTech.

Preparation

Materials	Student Pages
• Section Maps (9 –total for each of the 9 groups) • Green, Yellow, Red Sticker Dots (1 set for each group) • Copy of 40-year earthquake data for each section (9 per class) • Science Fair Board for posting Section Maps • Tape	• N/A
Prep the Day Before: Prepare to have a place in your classroom to display the nine section maps taped together. Review section and think of different examples of temporal and spatial data. **Temporal Data:** Climate, Glacier recession, tree growth **Spatial Data:** GPS, Deforestation, Oceans Rising, Erosion	

Planning

GPS	**S6E5.** *Obtain, evaluate, and communicate information to show how Earth's surface is formed.*
NGSS	**Practice:** **Analyzing and Interpreting Data:** *Analyze and Interpret data to provide evidence for phenomena.* **Disciplinary Core Idea:** ***ESS2.A:*** *Earth's Materials and Systems* *The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future.* ***ESS2.B:*** *Plate Tectonics and Large-Scale System Interactions* *Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided and spread apart.* **Crosscutting Concept**: *Scale Proportion and Quantity* *Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.*

Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
• Data Visualization • Temporal Data • Spatial Data • Earthquake • Richter Scale • Plotting Points/Grid System • Data	• How can we communicate scientific data to the public? • How does the movement of lithospheric plates cause major events on earth's surface?	• Section Maps: **Formative** • Class Discussion Question: **Participation**

Section 5 – Answer the Earthquake Challenge *(40 minutes)*

Students will have the opportunity to answer the earthquake challenge through applying their knowledge of the temporal and spatial earthquake data in the proposed locations for the BuzzTech plant. They will review the details about other factors and the pros/cons of each location in addition to the earthquake data. Students will work in groups to use this information to make a presentation of their site decision or individual students will write a letter explaining their site decision. Students will need to use the data visualizations to support their decision.

Preparation

Materials	Student Pages
• N/A	• Letter to Buzztech
Prep the Day Before: Decide the appropriate assessment for the module and prepare instructions/rubrics for students completing presentation or letter	

Planning

GPS	***S6E5.*** *Obtain, evaluate, and communicate information to show how Earth's surface is formed.*
NGSS	<u>Standards:</u> <u>Practice:</u> **Analyzing and Interpreting Data:** *Analyze and Interpret data to provide evidence for phenomena.* **Constructing Explanations and Designing Solutions:** *Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe nature operate as they did in the past and will continue to do so in the future.* <u>Disciplinary Core Idea:</u> ***ESS2.A:*** *Earth's Materials and Systems* *The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future.* ***ESS2.B:*** *Plate Tectonics and Large-Scale System Interactions* *Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided and spread apart.* <u>Crosscutting Concept</u>: *Scale Proportion and Quantity* *Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.*

Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
• Data Visualization • Temporal/Spatial Data • Earthquakes	• How can we communicate scientific data to the public? • How does the movement of lithospheric plates cause major events on earth's surface?	• Letter to Buzztech: **Summative**