Plate Tectonics Unit

Grade 6

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5 weeks

Essential understandings	1. The Earth is made up of layers: crust, mantle, outer core and inner core 2. The tectonic plates(crust) are constantly moving 3. Convection currents drive the movement of the plates and seismic activity 4. The source of heat driving convection currents is radioactivity deep within the Earth's mantle 5. Sea floor spreading shows the history and rate of plate tectonics. 6. There are four types of plate boundaries: transform, divergent, convergent and plate boundary zones 7. The Earth's magnetic field contributes to plate tectonics and how scientist study the rate of movement of plates(the study of magnetic striping on the ocean floors)	
NGSS standards	**MS-ESS2-3 Earth's Systems** Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.	Day 3 -Pangaea, how scientists used fossils and the shapes of the continents to determine plate tectonics and continental drift
		Day 8-The Earth's magnetic field shifting is evident in sea floor spreading samples
		Day 9- Seafloor spreading shows the rate of movement of tectonic plates
	MS-ESS2-2 Earth's Systems Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.	Day 4 –Plate boundaries types have changed the surface of the Earth(valleys, mountains, trenches....)
		Day 9- Seafloor spreading shows the rate of movement of tectonic plates
		Day 10-Earthquakes and tsunamis have drastically changed the surface of the Earth
		Day 11-Volcanos have drastically changed the surface of the Earth and vegetation
		Day 2-Layers of the Earth- the students need to understand the Earth has layers in order to understand the cycling of Earth's materials

	MS-ESS2-1 Earth's Systems Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.	Day 5-Convection currents drive the cycling of materials through the Earth
		Day 6-types of wave effect the cycling of Earth's materials
		Day 7-Wave speed- the speed of waves is impacted by the different materials of the Earth
		Day 10-Earthquakes and tsunamis are a result of the energy flow of the cycling of Earth's materials
		Day 11-Volcanos are a result of the energy flow of the cycling of Earth's materials
	MS-ESS1-4 Earth's Place in the Universe Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.	Day 4 Plate boundaries show how plates have moved over time
		Day 8 the Earth's magnetic field shifting is shown in rock strata and plate boundary points
		Day 9 seafloor spreading shows how plates have moved over time
Math standards	CCSS.MATH.CONTENT.6.SP.B.5 Summarize numerical data sets in relation to their context, such as by: CCSS.MATH.CONTENT.6.SP.B.5.A Reporting the number of observations. CCSS.MATH.CONTENT.6.SP.B.5.B Describing the nature of the attribute under investigation, including how it was measured and its units of measurement. CCSS.MATH.CONTENT.6.SP.B.5.C Giving quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered. CCSS.MATH.CONTENT.6.SP.B.5.D Relating the choice of measures of center and variability to the shape of the data distribution and the context in which the data were gathered.	
ELA standards	CCSS.ELA-LITERACY.RI.6.1 Cite textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text. CCSS.ELA-LITERACY.RI.6.7 Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue. CCSS.ELA-LITERACY.RI.6.8	

	Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not.	
SS standards	CCSS.ELA-LITERACY.RH.6-8.1 Cite specific textual evidence to support analysis of primary and secondary sources. CCSS.ELA-LITERACY.RH.6-8.2 Determine the central ideas or information of a primary or secondary source; provide an accurate summary of the source distinct from prior knowledge or opinions.	
Writing standards	CCSS.ELA-LITERACY.W.6.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. CCSS.ELA-LITERACY.W.6.2.A Introduce a topic; organize ideas, concepts, and information, using strategies such as definition, classification, comparison/contrast, and cause/effect; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension. CCSS.ELA-LITERACY.W.6.2.B Develop the topic with relevant facts, definitions, concrete details, quotations, or other information and examples. CCSS.ELA-LITERACY.W.6.2.C Use appropriate transitions to clarify the relationships among ideas and concepts. CCSS.ELA-LITERACY.W.6.2.D Use precise language and domain-specific vocabulary to inform about or explain the topic. CCSS.ELA-LITERACY.W.6.2.F Provide a concluding statement or section that follows from the information or explanation presented.	
Speaking & Listening standards	CCSS.ELA-LITERACY.SL.6.2 Interpret information presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how it contributes to a topic, text, or issue under study. CCSS.ELA-LITERACY.SL.6.5 Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information.	
Immersion Outline	Day 1	Mean, median, mode and range
	Day 2	Layers of the Earth
	Day 3	Pangaea
	Day 4	Types of plate boundaries
	Day 5	Convection currents
	Day 6	Compressional and shear waves
	Day 7	Speed of waves
	Day 8	The Earth's magnetic field
	Day 9	Seafloor spreading
	Day 10	Earthquakes and tsunamis
	Day 11	Volcanoes
Investigation Outline	Throughout the course of the Immersion, students will be continuously adding questions to a chart called "investigable questions". The students will pick three investigable questions. They will from there narrow down their three investigable questions to one. This will be the question that they will spend the rest of the time investigating.	
	Possible Questions	• How do architects (city builders) design homes to withstand earthquakes?

		• What would happen if the Yellowstone caldera erupted in our lifetime? • Why are the plate boundaries where they are? • Why can't scientist predict earthquakes? • How do city builders prepare or plan for a tsunami? • How do volcanoes become extinct or dormant? • How active is the ring of fire? • Which Earth material do waves travel the fastest? • Can we force the magnetic field to switch polarity?
Inquiry & Coalesce Outline	Day 12	Students will narrow down questions to 1
	Day 13	Students will plan jobs and research plan
	Day 14	Research
	Day 15	Research
	Day 16	Research
	Day 17	Research
	Day 18	Research
	Day 19	Research
	Day 20	Research/Prepare
Going Public Outline	Day 21	Prepare
	Day 22	Prepare
	Day 23	Prepare
	Day 24	Presentations to class
	Day 25	Presentations to other classes
Unit Notes	Throughout the course of the Immersion, students will be continuously adding questions to a chart called "investigable questions".	
Immersion Plan	The immersion lessons are to teach the students the essential understandings through labs/activities. Each lab/activity aligns to the NGSS for the unit. Some labs/activities may align to more than one. The major understanding is that the crust of the Earth is constructed of moving tectonic plates. Each lab/activity helps the students to understand the makeup of the Earth, why and how plates move and the implications that plate tectonics has on the inhabitants of Earth. The effects of plate tectonics created and separated Pangaea(day 3) , sea floor spreading(day 9), formations of the earth(day 4), tsunamis, earthquakes(day 10) and volcanoes(day 11). The causes of plate tectonics are the layers of the Earth(day 2), convection currents(day 5), wave speed(day 7), wave type(day 6), plate boundaries(day 4), and the Earth's magnetic field(day 8). Other contents incorporated in this unit are: **Math**-mean, median, mode and range -In science, we look and collect data. In order to analyze the data we sometimes need to interpret it. The best way to do that is by identifying the mean, median mode and range of the data. **ELA**- At multiple times during this unit, the students will have to read data or informational articles. Scientist obtain their knowledge and understanding by reading data and informational articles written by their peer scientists. During the investigation stage of the project, the students will be conducting intensive amounts of research. The research will require reading and analyzing articles, interviews, videos, pictures and data.	

	SS-Plate tectonics directly correlates with the 5 themes of geography: movement, regions, human-environment interactions, location and place. *Movement*-impacts how people/animals have/do move across the Earth. *Regions*-regions of the world were formed by plate tectonics, mountains, valleys, oceans, rivers and plains. *Human-environment interaction*-The movement of tectonic plates directly impacts humans. Plate tectonics can level towns and kill many people. Plate tectonics can impact economies. *Location*- different locations are affected by plate tectonics in different ways. Some locations have higher activity associated with plate tectonics(plate boundary areas) and some do not. *Place*:-different places are identified by certain characteristics, such as religion, race, nations	
Immersion details	**Day 1** **Mean, median, mode and range**	
	Rationale	The students need to be able to analyze and find the average of their data. Finding the average(mean), is not something the students have learned in math yet, but is something that as scientists they need to know
	Materials	• Lab sheet • Number cards • Clipboard • Pencil
	What	**The students will learn mean, median, mode and range(max & min) using science data** Mean, Median, Mode and Range(max & min) Mean-the average of a set of numbers Median-the middle number of a set of numbers Mode-the number that occurs the most Range-the difference between the max(largest number) and the min(the smallest number)
	How	In teams, students will be given bags of numbers. They will find the mean, median, mode and range(max & min) of these numbers. The teams will argue which(mean, median, mode and range is the best to use to represent their data.
	Day 2 **The Layers of the Earth**	
	Rationale	The Earth is made up of four different layers, the inner core(magnetic), outer core, mantle(where magma comes from) and the crust(the tectonic plates). All three layers below the crust impact the movement of tectonic plates.
	Materials	• Poster paper • markers • Glue • Scissors • Construction paper • Clipboards • Pencil • Lab sheet • Binder • Informational articles on the different core layers

	What	The students will learn about the layers of the Earth: inner core, outer core, mantle and crust.
	How	In home groups, students will number themselves 1, 2, 3 or 4. Students will then divide up into their new number groups. Each group will be assigned a layer of the Earth to become an expert on. <u>New Groups</u> 1: inner core 2: outer core 3: mantle 4: crust *Experts will have to answer these key questions about their layer:* a. What is the composition of the layer? b. What is the density and thickness of the layer? c. What makes the layer unique? d. How did scientists determine the information about this layer? e. What will be the limitations of your model? Students will then return to their home groups and construct their models.
	Day 3 Pangaea	
	Rationale	Continental drift is a theory that explains how the continents have moved over billions of years. This theory was constructed by Alfred Wegner. Pangaea is the name of the supercontinent(when all the continents were connected). We know Pangaea existed because the continents fit together like puzzle pieces, and along the borders of where the continents were once connected, the fossils and vegetation are the same.
	Materials	• Pangaea map • Construction paper • Glue • Scissors • Informational article on theory of continental drift(Pangaea)
	What	Students will learn about how Pangaea and the Theory of Continental drift lead to the discovery of plate tectonics.
	How	The students will receive a paper of that contains the continents. The continents will have fossils on them. The students will cut out the pieces of the continents are use the fossils as a way to piece the continents together. Once, completed, the continents will be connects into the supercontinent of Pangaea.
	Day 4 Types of Plate Boundaries	
	Rationale	There are three main types of plate boundaries.

		Convergent-two plates collide together (how mountains are made). Divergent-two plates move apart (ocean trenches, valleys). Transform-two plates slide up and down next to each other (San Andreas fault).
	Materials	• Cardboard pieces • Shaving cream • Clean-up supplies • Clipboards • Pencil • Lab sheet • Binder • Informational article on examples of plate boundaries (i.e. Mt. Everest, Marina Trench, etc...)
	What	The students will learn about the 3 major types of plate boundaries: divergent, convergent and transform.
	How	Students will receive cardboard pieces with arrows. The arrows tell the students which way to push the cardboard, while it is on top of a layer of shaving cream. The students will diagram their results. The students will then look at actual pictures of real-life geological formations from plate boundaries that match their different diagrams. As a class, we will properly label their diagrams, as well as the real-life pictures of geological formations created by shifting plate boundaries. **The students will also learn a great song to help them learn about the different boundaries and how they move. **
	Day 5 Convection Currents	
	Rationale	Convection currents are created within the mantle from radioactivity in the core of the Earth. Convection currents heat unevenly, which make the tectonic plates move differently in different parts of the world.
	Materials	• Mini bread tin • Corn syrup • Candle • Matches • Card stock • Lab sheet • Clipboards • Pencil • Timers • Poster paper • Post-it notes • Markers
	What	The students will learn about convection currents that drive tectonic activity.
	How	The students will perform a lab determine how bottom-up heating effects things(tectonic plates) that are on the surface. 1. The students will have a fire proof container that is elevated with bricks. 2. They will fill the ¼ of the way with magma(corn syrup). 3. The students will place tectonic plates(pieces of thick

		paper) on the top of the magma(corn syrup). 4. The students will diagram the placement of the tectonic plates(thick paper) 5. The students(possibly teachers) will then light a candle underneath the fire proof container. 6. The students will make observations about the movement of the tectonic plates(thick paper) at 30 second intervals for ten minutes. 7. The teachers will extinguish and remove the heat source. 8. The students will continue to diagram the tectonic plates(thick paper) at 30 second intervals for two minutes. 9. The students will draw the final placements of the tectonic plates(thick paper) 10. The students will summarize their data and produce a theory about heat and the movement of tectonic plates. 11. The students will display their theories around the room for other groups to comment on with post-its notes. 12. Class discussion about the theories. Hopefully there will be debate, similarities and differences.
	Day 6 Wave Types	
	Rationale	There are two types of waves that travel in the mantle and crust. Each type of wave has a different effect on the crust of the Earth. Shear waves move side to side and compressional waves move up and down.
	Materials	• Meter sticks • Painters tape • Slinkys • Lab sheet • Clip boards • Timers • Pencil • Space
	What	The students will learn about waves--compressional and shear.
	How	*Part A-Shear Waves* 1. Students will assemble in teams 2. Each group will be given a slinky 3. Groups will stretch their slinky out in a straight line with a 6 foot differential between the holders of the slinky 4. The student at one end will move their slinky to the right 1 foot and back to the center in a quick motion one time, while the student at the opposite end keeps their end of the slinky in the same position. The students will do ten trials of this, and record each trial in a data table. The students will record the time it takes the wave to travel from one end to the other. Each group will determine whether they start the time when the slinky first moves or when it comes back to the starting point. 5. The students will find the mean, median, mode and range(max & min) of their data table. *Part B-Compressional Waves* 1. Students will assemble in teams 2. Each group will be given a slinky 3. Groups will stretch their slinky out in a straight line with a 6 foot differential between the holders of the slinky 4. The student at one end will move their slinky up 6

		inches and back to the center in a quick motion one time, while the student at the opposite end keeps their end of the slinky in the same position. The students will do ten trials of this, and record each trial in a data table. The students will record the time it takes the wave to travel from one end to the other. Each group will determine whether they start the time when the slinky first moves or when it comes back to the starting point. 5. The students will find the mean, median, mode and range(max & min) of their data table. ***Parts A & B Conclusion:*** 1. The students will use their data tables to construct a conclusion about which type of wave is the quickest. They will support their conclusion with their data. The students will also draw a theory on which type of wave they think will cause the most damage. ***Part C-Independent Student Design*** 1. Students will assemble in teams 2. Each group will be given a slinky 3. Groups will determine the 1) type of wave they are going to use & 2) the variables they are going to test(4 variables). The students will also need to identify the control(s) of their experiment. 4. The students will then create a data table to use to record the result of their experiment. 5. The students will find the mean, median, mode and range(max & min) of their data table. 6. Students will construct a theory about their experiments and it's results. 7. The students will take all the parts of their experiment and construct a digital presentation. The students will share their process and findings with their peers.
	Day 7 Wave Speed	
	Rationale	Waves travel at different speeds in the mantle and crust based on the type, thickness or temperature of the material the waves are traveling through
	Materials	• room temperature water • 1000mL beaker • wave bin • flashlight • timer • marker • ruler • lab sheet • clip board • pencil • rocks • dirt • sand • bricks • ice • hot water • cold water • thermometers
	What	The students will learn about wave speed and how different variables can impact wave speed.
	How	*Part A-Baseline Wave Speed Tests*

		1. Students will assemble in their teams 2. Students will gather their materials and read over the lab 3. Students will using a ruler make 2 1 cm diameter dots in a straight line that are 15 cm apart on the bottom of the water table 4. Students will pour 1000 mL of water into their water tables 5. Students will measure the mass of their seismic activity(rock) 6. Students will shine a flashlight on one of the dots 7. Students will drop seismic activity(a rock) onto the other dot and start the timer 8. The students will stop the timer when the first wave(ripple) reaches the second dot that is being illuminated by the flashlight 9. The students will complete 10 trials of this and record results in their data tables 10. Students will determine the mean, median, mode and range(max & min) for their data table 11. Students will make a theory about seismic activity and wave speed *Part B-Student Designed Wave Speed Tests* 1. Students will assemble in their teams 2. Students will determine what variables they are going to test and what will be their constants 3. Students will make a data table for their experiment 4. Students will gather their materials 5. Students will complete their experiment 6. The students will complete 10 trials of this and record results in their data tables 7. Students will determine the mean, median, mode and range(max & min) for their data table 8. Students will draw conclusions about wave speed from their experiment, and the previous experiment 9. Students will present their experiment and findings to the class
	Day 8 The Magnetic Field of the Earth	
	Rationale	The Earth has a magnetic field that can affect plate tectonics. The magnetic field can also change polarities.
	Materials	• projector • elmo • computer • video • lab sheet • informational article on the Earth's magnetic field
	What	The students will learn about the Earth's magnetic field.
	How	The students will watch a video about the magnetic field of the Earth. Neil deGrasse Tyson can explain this much better than I ever could.
	Day 9 Seafloor Spreading	
	Rationale	The seafloor is spreading due to plate tectonics. The evidence found in sea floor spreading shows the rate of movement of tectonic plates. Scientist can also identify

		when the magnetic fields of the Earth switched polarity.
	Materials	• images of seafloor spreading • chart paper • post-its • markers
	What	The students will learn about seafloor spreading.
	How	Gallery walk round 1: The students will examine different samples of the sea floor. They will write their observations on the chart paper with the image. The students will discuss their findings. Students will read an informational article about seafloor spreading. Gallery walk round 2: Students will examine different samples of the seafloor. They will again write down their observations, but this time with the knowledge of seafloor spreading from the article. The students will discuss what they observed about seafloor spreading in the pictures as a whole class.
	Day 10 Earthquakes & Tsunamis	
	Rationale	(All of the activities and content leading up to this are the causes of earthquakes and tsunamis. This topic was intentionally left last, so that the students will be able to see the connection) Earthquakes are movement of the tectonic plates that we can feel. The can be at a variety of strengths, to not being felt at all, to devastating destruction. Tsunamis are caused when earthquakes occur in a body of water of the coast of a continent.
	Materials	• videos • diagrams • informational articles • data tables of earthquake points in the US • map
	What	The students will learn about earthquakes and tsunamis.
	How	Students will watch a replication of the 2004 tsunami. How it was created, how it traveled and the destruction it caused. Students will look at a map and identify earthquake points on the ring of fire. Students will read a news article from the 1906 San Francisco earthquake.
	Day 11 Volcanoes	
	Rationale	There are three types of volcanoes, composite, cinder cone and shield. Each type of volcano has a different effect on the Earth. (All of the activities and content leading up to this are the causes of and types of volcanoes. This topic was intentionally left last, so that the students will be able to see the connection)
	Materials	• Elmo

		• Projector • Construction paper • Markers • Lined paper • Pencil • Informational articles on volcano types
	What	The students will learn about volcanoes.
	How	1. Students will read about the different types of volcanoes. Students will make a graphic organizer of the different types of volcanoes, their build, causes and types of eruptions. 2. Students will watch a video about the Yellowstone caldera. 3. Students will write an assessment of what will happen to the people of the USA when the Yellowstone caldera erupts.
Inquiry Details	Materials	• Chromebooks • Fault line maps • Ring of Fire maps • Plate boundary maps • USGS earthquake monitoring website • USGS volcanic activity monitoring website • USGS tsunami monitoring website • Wave tanks • Timers • Geological material (sand, dirt, rocks, etc) • Rulers • Slinkys • Tape • News articles of earthquakes, volcanic eruptions and tsunamis • Soil samples from before and after volcanic eruptions • Whatever the students will need to complete their investigations
	Student Groupings	Students will be group based on their topic/investigative question selection.
Inquiry & Coalesce Details	• In the teams the students will create an action plan on how they will research and investigate their investigable question. • The students will spend 1 class period deciding their investigable question. • The students will spend 1 day creating their coalescence and inquiry plan with their teams. • The students will spend 6 days researching their investigable questions.	
	Materials	• Chromebooks • Articles • Binders • Pencils • Graphic organizers
	Day 12	Students will narrow down their investigable questions to one.
	Day 13	Teams will create an action plan for research and going public plan.

	Day 14	Research
	Day 15	Research
	Day 16	Research
	Day 17	Research
	Day 18	Research
	Day 19	Research
	Day 20	Research/Prepare presentation
Going Public Details	Presentation options	• Magazine Article • Interview • Podcast • Powerpoint • Prezi • News report
	Presentation essential components	• Data table • Graph • Investigable question • Their discoveries • Implications for humans • Implications for the environment(ecosystems) • 5 themes of geography must be represented
	Day 21	Prepare presentation
	Day 22	Prepare presentation
	Day 23	Prepare presentation
	Day 24	Practice Presentation
	Day 25	Present
Assessments	Assessment # 1	1. Explain Pangaea and continental drift 2. Diagram and label the layers of the Earth
	Assessment #2	1. Identify, by labeling, plate boundaries 2. Students will be able to explain how convection currents impact plate tectonics 3. Students will explain the two types of waves
	Assessment #3	1. Students will explain how materials(density) can impact wave speed 2. Students will explain how the earth's magnetic field impact plate tectonics 3. Students will explain seafloor spreading
	Assessment #4	1. Students will explain in writing what causes either a volcanic eruption, an earthquake or a tsunami. 2. Students will explain in writing how the natural disaster they chose impacts humans.
	Self-assessment	• The students will use a self-assessment rubric to assess their work in class each day they are in the inquiry and coalescence part of the unit. • The students will also self-assess after the present their going public piece.
	Peer assessment	• The students will assess their peers 3 times during the inquiry coalescence piece of the unit using a peer assessment rubric • The students will assess their peers after they present their going public piece using a peer assessment rubric

	Final assessment	• The students will be assessed using a rubric on their going public project • The students will have the expectations of the essential components of their project right after they pick their investigable question • The students will have the rubric for their final presentation after they pick their investigable question
Diverse & EL learners		• All IEPs and 504s accommodations and modifications will be met. • In addition, the students will receive additional support by having reading articles read aloud, or watching a video on the information presented in a reading article. • Students will receive small group or individual support when needed by teachers(gened or sped) and/or paraprofessionals. • Students will receive, if needed, modified data tables. • Students will be allowed to use a calculator if needed. • Students will receive texts/articles or videos in their native language if needed.

****Unit plans subject to change without notice****