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USC NCTA Summer 2018
Lesson Plan: Determining Earthquake History

Introduction

This lesson was largely inspired by what was viewed in Kunming and Taipei City regarding Earth's history and evidence of Earth's history. What I saw when I was there was a lot of connection to Physics (my main content area) and so i wanted to explore a lesson that would touch on Physics as well as the incoming Earth Science standards that will be introduced to Physics the coming year.

Lesson Sequence

Grade	Content Areas Being Integrated
11th, Physics	Determining Earthquake History

	Physics and Earth Science Disciplines
Key Content Standards	*HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.* *HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.*

Learning Objective	*Students will be able to understand how earthquake information is collected as well as how it can be traced back by using remnants including the Kunming Stone Forest.*
Prior Knowledge	*Students know the basic principles of frequency, wavelength and the speed of waves in unspecified examples - like sound and light. Students understand the wave equation as the relationship between the three concepts. Students have also learned the basics to waves - including the two major types, longitudinal waves and transverse waves. Longitudinal waves exist in contexts where the wave moves parallel to the direction that they are oriented in like springs or sound. Transverse waves exist in contexts where waves move perpendicular to the direction that they are oriented in like light.*
Differentiation	*All vocabulary will be posted to the side for students to refer to throughout the learning segment. Organizers will be differentiated to reduced cognitive demand of online reading and research. Discussion structures will allow students to test and build ideas before sharing them to the whole class.*
Concepts	*Frequency, wavelength, speed of waves, amplitude, period, resonance, seismic waves, longitudinal waves, transverse waves,*

Lesson (1 of 3): Analyzing Earthquake Evidence (40 Minutes)

Lesson / Activity Description

Immediate Prior Knowledge	**Teacher has set norms and culture for participation and class structure.**	**Students have immediate prior knowledge about waves and their characteristics - amplitude, frequency, period, velocity, and wavelength.**
Sequence	**Teacher does:**	**Students do:**
Engage	Teacher prompts students to take out their notebook and answer, “What evidence do you think there is that an earthquake will occur soon?” Teacher provides the warm up on the front projector screen and gives students a few minutes to have the questions copied and answered.	Students take out their notebooks and answer the warm up question.
Review / Recap	Teacher reviews concepts discussed during the previous session. Teacher contextualizes that this week will be spent on a specific type of longitudinal wave - the seismic wave. Like all waves: seismic waves transfer energy, have a velocity, and have the characteristics of all waves (an amplitude, wavelength, period and frequency). These waves, however, are pulses rather than periodic waves (they occur under specific conditions). Teacher also prefaces that this information is pertinent to californias in particular, who are constantly at risk due to underground rock movement.	Students recall their knowledge of frequency, wavelength, velocity, amplitude and period as well as their relationship in different contexts that we have discussed so far.
Explore	Teacher transitions back to Warm Up and invites students to share responses in pairs and to share ideas in a structured class discussion. Teacher explains that in middle school, earthquakes were taught in the context of rock movement and underground convection. In physics, we will be learning about earthquakes as they pertain to waves and physics. Teacher provides slips of different earthquake warning signs and tasks students to place them in the right order. Teacher reviews different steps for the class	Students share responses in pairs and then bring ideas to the rest of the class. Students will need to read through the different warning signs of an earthquake and attempt to model the flow of movement as an earthquake occurs. Students review their groups steps and follow

	and demonstrates photographs of different pieces of equipment for students to see. Teacher then tasks students to think of ways that earthquakes before digital technology was developed.	along the different pieces of technology we use for earthquake detection in present day. Students also begin to think about how earthquake records can be understood before the time of modern technology.
Exit Ticket	Teacher tasks students to think of a way that we can understand earthquake activity before digital instruments were developed and write their responses on an exit ticket.	Students answer the prompt on an exit ticket.

Supplemental Materials

Earthquake Signs

Massive land masses move at convergent and transverse plate boundaries, which produce a “sling-shot” effect	A p-wave is experienced which travels the fastest among the waves emitted from the epicenter.	A s-wave is experienced which travels slowest among the waves emitted from the epicenter.
Scientists use seismographs at different locations to detect the epicenter of the earthquake	Three seismographs tend to be used in particular in order to triangulate the epicenter.	Depending on the distance from the epicenter and the surface above the epicenter, warnings are sent out to prepare for potential destruction.

Lesson (2 of 3): Resonance (90 Minutes)

Lesson / Activity Description		
Sequence	**Teacher does:**	**Students do:**
Engage	Teacher prompts students to take out their notebook and answer, "How might some areas be unaffected by an Earthquake?" Teacher provides the warm up on the front projector screen and gives students a few minutes to have the questions copied and answered. Teacher provides different photographs of buildings that have been affected by an earthquake and others that remain standing. In some cases, the windows are destroyed at one floor, yet they are unaffected on the floor above and below. Some freeway parts are destroyed, yet others remain flat and safe to drive on. Teacher invites students to share responses in pairs and to share ideas in a structured class discussion.	Students take out their notebooks and answer the warm up question. Students share responses in pairs and then bring ideas to the rest of the class.
Explore	Teacher plays a video that demonstrates the breaking of windows as an earthquake occurs as well as how the building moves. ***San Francisco Earthquake - 1989*** *https://www.youtube.com/watch?v=Z7eABGpOHv8* A demonstration with a textbook and paper slips is done. Teacher prompts students to consider how different properties of the wave produce irregularities in how the buildings / paper slips move. Teacher gives students time to work in pair to discuss which property of wave (amplitude, frequency, period, velocity, etc.) produces changes in the waves movement. After class discussion, teacher informs students that this is known as the resonant frequency and provides the definition.	Students identify that the building moves in certain ways as the wave travels through it. Students are able to see that depending on the frequency of the wave. Students each receive a copy of the demonstration provided and working with their tables, students engage with the demonstration to try and understand which wave property affects building movement. Students copy down the definition of the resonant frequency.
Explain	Teacher provides demonstration of wine glass and a wave module. By raising the wave module to the resonant frequency of the wine glass, the wine glass will shatter - but will be	Students model what will happen before, during and after the wine glass reaches its resonant frequency and note these changes on the left side of their interactive notebook.

	unaffected at the other frequencies. This is largely a way that we can detect the strength of earthquakes prior to the development of earthquake technology. There aren't remnants of glass around, but there is the stone forest in Kunming, China. Teacher provides pictures of the stone forest and tasks students to write down what they see.	Below their glass model, students take down observations of what they see across the pictures. Observations can include the shape of the rocks, the presence of some rocks above others - but most importantly, a band that exists across a certain height above the ground that denotes the resonant frequency of the earthquake that occured in Kunming in 1833.
Evaluate	Teacher passes out the laboratory assignment, which will be to use pictures and measurements of the banding in the rock formation to determine the true magnitude of the earthquake. Teacher reviews the the directions for the laboratory assignments as well as the math involved with quantifying amounts. The laboratory assignment will task students to complete a graph as well as determine a magnitude by the end of the assignment.	Students review laboratory assignment and use dimensional analysis, estimates, graphing skills, and wave equations in order to determine the magnitude of the earthquake.

Lesson 2 Photo: Kunming Banding

Lesson 3: Engineering to Survive Earthquakes (90 Minutes)

Lesson / Activity Description

Sequence	Teacher does:	Students do:
Engage	Teacher prompts students to take out their notebook and answer, “What solutions can be engineered to survive earthquakes?” Teacher provides the warm up on the front projector screen and gives students a few minutes to have the questions copied and answered. Teacher provides different photographs of buildings that are engineered for earthquake survival. Teacher invites students to share responses in pairs and to share ideas in a structured class discussion.	Students take out their notebooks and answer the warm up question. Students share responses in pairs and then bring ideas to the rest of the class.
Explore	Teacher shows video on movement safety features that exist in buildings including The Citicorp Center, The Petronas Twin Towers, and the Yokohama Landmark Tower. In addition to the examples are schematics on the Wind Dampener in Taipei 101 - a massive counterweight held by four steel ropes and beams that minimizes the amount of movement. Teacher tasks students to take note on each building - particularly where the dampener is located, and how high the buildings are.	Students are tasked with researching each of the buildings and taking note of where the dampeners are based on the average wind speed of the location.
Evaluate	The next task will have students create a dampener out of brass weights and a structure out of popsicle sticks. Students will need to determine where to put the dampener as well as how much dampener to put based on the height of the structure. This data will be graphed in order to inform relationships between seismic waves and wave properties.	Students will need to construct different sized structures out of popsicle sticks and place a brass weight dampener with the appropriate mass in order to effectively survive the earthquake simulated by shaking the table.

Lesson 3 Photo: Taiwan 101 Wind Dampener