LESSON SEED FOR INTEGRATING CONTENT STANDARDS IN A HIGH SCHOOL STEM-CENTRIC LEARNING EXPERIENCE

Teacher	Content Standards	Potential Activities	Real-World Connection
 **Attributes of a STEM-centric minded high school teacher**: • Collaborate with educators in other disciplines to develop integrated lessons. • Facilitate student engagement and questioning – this includes asking questions that promote higher order thinking and guiding students through the problem solving process. • Involve students in the real-world application of content. • Provide opportunities for students to design and conduct investigations to address the real-world connection. • Facilitate learning experiences that allow for the intentional and purposeful integration and application of content. • Provide support to students in their use of technology for exploration of the real-world connection. • Conduct ongoing assessments of students' performance, both formally and informally, to guide instruction and raise the quality of teaching.	**Mathematics** **G.CO.2** Represent transformations in the plane using, *e.g.*, transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (*e.g.*, translation versus horizontal stretch). Essential Skills and Knowledge: • Ability to see parallels between function transformations (F.BF.3) and geometric transformations. • Knowledge that rigid transformations preserve the size and shape of a figure. **G.CO.5** Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, *e.g.*, graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another. Essential Skills and Knowledge: • Ability to interpret and perform a given sequence of transformations and draw the result. • Ability to accurately use geometric vocabulary to describe the sequence of transformations that will carry a given figure onto another.	**Mathematics** Crustal plates are in extremely slow but constant flux – position and shape change by only millimeters per year; but change is constant as the plates are moved by convection currents within the Earth's mantle, material is subducted along boundaries where plates collide, and new material is created along boundaries where plates are moving apart. Although the above is true, in the short term (centuries to millennia), one can think of the crustal plates as rigid geometric figures (irregularly shaped polygons) moving around on the surface of a liquid (the molten mantle of the earth). With this in mind, students can use data on speed and direction of movement (rotation and translation) to project plate locations and draw the transformed plates on a coordinate grid overlaid on a map of tectonic plates and make predictions about the result of the movement of crustal plates through time.	**Earthquake in Maryland on August 23, 2011**: A 5.8 earthquake struck the D.C. area and beyond, shaking buildings, shattering windows and causing major traffic delays in the region. **Read more:** http://www.wjla.com/articles/2011/08/earthquake-felt-in-washington-d-c-area-65531.html#ixzz32yVZGFGh **Earthquake Resources:** Resources on earthquakes are provided in a separate document titled, "Earthquake Resources." This document gives the URLs for web sites featuring data, articles, animations, simulations, and other resources may be useful in this lesson seed. **Essential Questions**: • How does the viscosity of the mantle change; and what are the effects of viscosity on the movement of the crustal plates? • How will the Earth's surface continue to change? Explain how it is possible to predict those changes. • Explain how the incidence and location of earthquakes and volcanic eruptions support the Theory of Plate Tectonics. • Explain the effectiveness of the role of government in assisting people in the aftermath of a natural disaster. **Culminating Activity**: • Have students design and perform an experiment that demonstrates the effect of heat on the viscosity of a liquid (*e.g.*, at higher temperatures, the viscosity of a liquid is lower; at lower temperatures, the viscosity is higher – a fact that relates to the convection currents in the earth's mantle that are responsible for the movement of the crustal plates). Attached is an article about how to make a homemade viscometer (http://thevirtuosi.blogspot.com/2012/07/a-homemade-viscometer-i.html) and a sample lab experiment on the effect of heat on the viscosity of fluids (http://www.usc.edu/CSSF/History/2004/Projects/J1511.pdf).
	Science **ESS2.B: Plate Tectonics and Large-Scale System Interactions** • The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle, providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection. (HS-ESS2-3) • Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust. *(ESS2.B Grade 8 GBE)* (HS-ESS2-1)	**Science** Emphasize with students that the movement of the crustal plates is the result of heat generated in the core of the earth (and the radioactive decay processes responsible that produce the heat). Have students research Pangaea to illustrate and visualize changes in the earth's surface. Students can research and use data to project changes in the position of crustal plates in the future as well as in the past. Teachers should also emphasize the Science and Engineering Practices and Cross-Cutting Concepts referenced below: **Science and Engineering Practices** • Developing and Using Models • Planning and Carrying Out Investigations • Analyzing and Interpreting Data • Engaging in Argument from Evidence	

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NOTE: Feel free to use other content standards <u>as appropriate</u> that have a <u>natural fit</u> – for example, Visual Arts.

<u>STEM Standards of Practice</u> (SOPs)

1. Learn and Apply Rigorous Science, Technology, Engineering, and Mathematics Content
2. Integrate Science, Technology, Engineering, and Mathematics Content
3. Interpret and Communicate STEM Information
4. Engage in Inquiry
5. Engage in Logical Reasoning
6. Collaborate as a STEM Team
7. Apply Technology Appropriately

Please be sure to incorporate the SOPs appropriate to the STEM learning experience you are creating. You may or may not be able to incorporate all seven STEM SOPs into every aspect of a lesson. However, in a STEM unit, which is typically longer and more global in scope, the expectation is that all seven STEM Standards of Practice will be addressed.

<u>English Language Arts</u>

RST 9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

RI7 Analyze various accounts of a subject told in different mediums (*e.g.*, a person's life story in both print and multimedia), determining which details are emphasized in each account. (SC, 9-10)

WHST.9-10.1 Write arguments focused on discipline-specific content.

L1 Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners, building on others' ideas and expressing their own clearly and persuasively.

<u>Social Studies</u>

D2.Civ.5.9-12. Evaluate citizens' and institutions' effectiveness in addressing social and political problems at the local, state, tribal, national, and/or international level.

D2.Civ.11.9-12. Evaluate multiple procedures for making governmental decisions at the local, state, national, and international levels in terms of the civic purposes achieved.

<u>Cross-Cutting Concepts</u>

- Cause and Effect
- Energy and Matter
- Structure and Function
- Stability and Change

<u>English Language Arts</u>

Students can read informational text and examine various types of data, photographs, maps, and other types of digital and non-print text to develop arguments that cite specific and relevant evidence to support:

- The Theory of Plate Tectonics
- Predictions about geologic events in the future and extrapolations about events that have occurred in the past

Students can read several non-fiction personal accounts (perhaps from a Red Cross representative, someone from FEMA, or another credible witness) about a major earthquake (or related event such as a volcanic eruption or tsunami) and watch a video or digital representations of the same event and look for the central ideas and how the author develops and defines them. Additionally, they could read an article about the role of government in assisting people after a natural disaster. Student s should write an argument that addresses the relationship between the personal needs of the survivors and the effectiveness of the government actions.

Students can also participate in a range of collaborative discussions on this and related topics.

<u>Social Studies</u>

Students can research and examine the roles of government in supporting and assisting people in the aftermath of a natural disaster, such as an earthquake, volcanic eruption, or tsunami.

- Using data on the speed and direction of the movement of crustal plates, have students explain the relationship among the movement of the crustal plates, the underlying force(s) behind the movement, and the eventual position and disposition of that plates in the future (perhaps100 years, 500 years, 1,000 years, 10,000 years, etc.).
- Students can 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. Emphasis could be on how the appearance of land features (such as mountains, valleys, and plateaus) and sea-floor features (such as trenches, ridges, and seamounts) are a result of both constructive forces and destructive mechanisms

AND/OR

Students could develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection. Emphasis could be on both a one-dimensional model of Earth, with radial layers determined by density, and a three-dimensional model, which is controlled by mantle convection and the resulting plate tectonics.

- Students can examine a recent earthquake (such as the Tohoku, Japan earthquake and tsunami in 2011) or other natural disaster (Hurricane Katrina in New Orleans in 2005) and debate and/or write to justify the government's involvement and response, looking at both the negative and positive aspects of the response.

NOTE: Make sure that you facilitate the students' understanding of the relationships between these activities and the standards being referenced.

<u>Career Connections</u>: Seismologist; Architect; Geoscientist; Surveyor; City Planner; Cartographer; Historian; Volcanologist; Environmental Geophysicist; Geologist; Geodynamicist; Geodesist; Geophysical Modeler; and others that are appropriate

<u>Engineering Design Process</u>

Teachers should take students through the engineering design process. Use a model that is most appropriate for your needs (*e.g.*, the ITEEA engineering design model which can be found on *msde.blackboard.com*. Look on the left menu under "Professional Learning Resources – "2013 Educator Effectiveness Academy Resources" – "Engineering").