EXPLORING PLATE TECTONICS WITH MODELS AND AN ONLINE CURRICULUM

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In this presentation, the following questions will be addressed:

1. Why create online curriculum materials and models for students?
2. What supports are in place for online curriculum to support student learning of science?
3. What supports are in place to aide teachers in use of the online curriculum?
Plate tectonics demands an understanding of complex, invisible, dynamic processes.

Experiments, as traditionally perceived of in K-12 classrooms, are impossible.

The processes that shape the Earth take place out of sight, over unimaginably long times. This temporal scale challenges K-12 students understanding of the processes.

The processes of plate tectonics take places a part of an integral system, which challenges the spatial skills of students.

To truly understand plate tectonics, you need to consider system level processes occurring over a vast spatial scale and extensive periods of time.

(Resnick, Atit, & Shipley, 2012)
Learning Progressions around the big idea of Plate Tectonics show what ideas K-12 students express, at varying levels of normative explanations.

The ideas expressed in this diagram at the left showcase three progress variables (Plate Motion, Mechanism of Plate Motion, and Plate System) and the empirically generated and tested levels at which students explanations may be expressed.

This learning progression served as a jumping off point for the GEODE curriculum and its focus on system understanding. The way plate tectonics is currently taught in secondary schools, students don't develop a system-level understanding.

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Geosciences, and plate tectonics in particular, needs to join the other sciences as an investigatory (lab) science—it needs to be about developing an understanding of the world via exploration of data, observations, and models. However, geoscience, because of its temporal and spatial scales, does not explore scientific questions in the same way as more traditional classroom sciences.

The Challenges in Geoscience

Geosciences, and plate tectonics in particular, needs to join the other sciences as an investigatory (lab) science—it needs to be about developing an understanding of the world via exploration of data, observations, and models. However, geoscience, because of its temporal and spatial scales, does not explore scientific questions in the same way as more traditional classroom sciences.
The Next Generation Science Standards (NGSS)

The NGSS provide states, districts, schools, and teachers with a framework for teaching science. At the Middle School level, students are expected to use historical data to explain plate motion. However, what this data looks like and the sources from which it comes are undefined.
The GEODE Model

The GEODE curriculum is grounded in not only the NGSS but also in Ambitious Science Teaching (Windschitl, Thompson, & Braaten, 2018) where a unit of investigation is driven by a phenomenon and students collect evidence to support an explanation of the phenomenon. Student talk, not often a part of online curricula is high encouraged in the model, and supported with tips in the teacher edition.
The GEODE driving phenomenon:
What will Earth look like in 500 million years?

In this module, you will consider the question: what will Earth look like in 500 million years? You will use data from Earth and models of a fictional planet to explore plate tectonics.

Estimated Time to Complete This Module: 345 minutes

1. Earth’s moving surface
2. Interpreting Earth’s clues
3. What happens with a lot of moving plates?
4. What drives plate motion?
5. What will Earth look like in the future?
Recipe for a GEODE case study

- Analyze Topography
- Identify data patterns
- Hypothesize from data
- Model tectonic plate motion
- Explain mechanisms involved in real-world data and landforms
Seismic Explorer uses publicly available data from the USGS in an online data visualization tool which integrates earthquake, volcano and plate motion data sets. Students can select which data to view, and look for patterns in the data.

Seismic Explorer can also help students visualize data representing underneath the Earth’s surface through cross sections like the one at the right which focuses a section of the Andes Mountains. Students can see that there are increasingly deeper earthquakes moving east, and that volcanoes are above earthquakes at specific depths.
The GEODE Tools

Tectonic Explorer is an interactive dynamic plate tectonic model of an Earth-like planet which allows students to manipulate the density of plates, number of plates, and direction of forces. Students can also create cross sections to see not only the surface level changes as the plates interact but also the subsurface changes, such as rifts and subduction.
Alongside the student version of the curriculum, teachers have access to their own specialized version of the curriculum where they can get theory and background about the curriculum, pedagogical supports, exemplar answers and reasoning for acceptable answers in multiple choice questions.
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Questions?
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GEODE

Transforming geoscience education with interactive models for exploring plate tectonics.