Developing A Hypothetical Learning Progression for Plate Tectonics

PENNSTATE 1855

Upper Anchor

Volcanoes, earthquakes and mountains are the surface manifestations of large-scale movement of both solid and near-solid earth materials. Such movements can be explained as a natural consequence of the initial formation of the planet, its subsequent differentiation into chemically distinct units (crust, mantle, core), and the continual transfer of heat from the interior of the planet to the surface.

Conceptual Interviews

Total number of students interviewed = 89

Middle Grades = 59

High School = 27

University = 3

Students with the new protocol = 40

Students with pre/post = 23 (46 interviews)

Volcanoes Mechanism

5B	Mantle has sequestered heat from formation, conductive heat from the core and radioactive decay Core has sequestered heat from earth's formation and convection is the primary way heat moves from the interior toward the surface.
5A	Mantle has sequestered heat from formation, conductive heat from the core and radioactive decay Core has sequestered heat from earth's formation. [Hawaii exception]
4B	The interior of the earth is heated from multiple sources - initial formation energy and radioactive decay and convection is the primary way heat moves from the interior toward the surface.
4A	The interior of the earth is heated from multiple sources - initial formation energy and radioactive decay.
3B	The interior of the earth is the source of the heat and hot material moves from the interior of the earth to the surface
3A	The interior of the earth is the source of the heat energy (heat rises)
2	The heat sources for volcanoes are internal vs. external to earth (earth energy system).
1	Heat is part of the mechanism for volcanoes and the heat in volcanoes comes from someplace other than the volcano
0	Other / Supernatural explanation / Missing or unclear mechanism

Connections to:

Scientific Practices

What initial models (or analogs) do students use to describe plate tectonic or volcanic phenomena? [e.g. broken plates, ships floating on lava, pipes into the core]

What are the key conceptual understandings needed to move between models? How are these linked to correspondences and non-correspondences between analogs and phenomena?

Cross Cutting Concepts

Scale focus changes from events to boundaries (location) to plates to plate tectonic systems (processes).

Time moves from events to patterns of events to patterns of events over time.

How do you deal with the contextual nature of the application of science concepts [e.g. density or convection]?

Plate Tectonics

7	Students understand that "it must be the case" that all plate interactions are interdependent (e.g. if the North American Plate is getting bigger, then the Pacific Plate must be getting smaller)
6	Students understand that material is recycled and mass is conserved. Students indicate that boundaries and the phenomena that occur there are a RESULT of plate dynamics, not the cause.
5	Students describe the continuous process of movement of individual plates that leads to intermittent events at boundaries, driven by new material is being formed and old material being destroyed. Students indicate that plates are bounded on all their sides by other plates.
4	Students describe the continuous process of movement of a gapless system of individual plates that leads to intermittent events at boundaries.
3	Students include a description of a boundary where two plates diverge. Students see tectonic plates as acting independent of one another, indicating there may be 'space' between plates. They continue to use other terms without description or understanding of associated process.
2	Not simply boundary focused, but identify that there are plates. Students focus on subduction as a process at boundaries where one plate goes under another. Terms are mentioned, but there is no description or understanding of process; e.g. Pangea, Mid-Ocean Ridge, Asthenosphere
1	Geographic association of a phenomenon with plate boundaries (e.g. rubbing leads to earthquakes, volcanoes happen at plate boundaries)
0	Supernatural decision; random; associated with water; associated with regional climate

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