



Understanding Middle and High School Students' Ideas: Teaching Earth Science Concepts in Meaningful Ways

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Presentation Goal

The Earth Space Science Partnership (ESSP) has conducted interviews with middle grade and high school students throughout the state of Pennsylvania about their ideas on mountains, earthquakes, and volcanoes.

The goal of this presentation is to present findings from the ESSP work with the intent to inform teachers of what thoughts middle grade and high school students have about these concepts so that we can begin a conversation around meaningful ways of teaching them.

Interviews

- Pilot
- 1st Round
 - Bald Eagle, Bellefonte, Philadelphia, Reading, and State College School Districts
- Student Demographics (rural and urban)

Number of Students	Grade Level
2	2 nd grade
21	6 th grade
7	9 th grade
13	11 th grade
6	12 th grade

Interview Protocol- Volcanoes

- What do you know about volcanoes?
- Draw a picture of a volcano.
- Where do you find volcanoes? Can volcanoes happen anywhere throughout the world or only in certain places?
- How do volcanoes form or where do they come from?
- Is there anything else you know about volcanoes?

Interview Protocol- Earthquakes

- What do you know about earthquakes?
- Where do earthquakes happen? Do they happen in all places throughout the world or only in certain places?
- How do earthquakes happen?
- Is there anything else you know about earthquakes?

Interview Protocol- Mountains

- What do you know about mountains?
- Where do you find mountains? Can mountains happen anywhere throughout the world or only in certain places?
- How are mountains formed or where do they come from?
- Is there anything else you know about mountains?



So, where are we going with this?

Upward Bound Math Science Context

- Supplemental math and science academic program
- Summer residential program with a science research component
- Students are:
 - Low-income
 - First-generation college
 - Grades 9-12
- Students from Harrisburg, Philadelphia, Reading, and Pittsburgh



So...What did you find ?

UBMS 9th Grade Interviews

What we uncovered?

- 9PLT_UBMS_Student 43

- Volcanoes

“...sometimes there are volcanoes underwater.”

“Like umm I forget what it’s called. It’s called like the ring of fire. It makes a big circle around the US- no not the US the world and like in certain spots like a chain of them [volcanoes]... It’s like all over seas and comes around... Not in Antarctica. Well, under the sea is cold and they form there. I guess yeah they can be where it’s warm or cold.”

- Earthquakes

“Depends on what plates it’s on. Like some plates don’t move. Like on [the] East coast we barely have earthquakes... Like we felt the aftershock of an earthquake... I guess all the plates at one time moved.”

- Mountains

“ I guess you find them everywhere. They’re overseas. They’re here. There’s like two chains of them over here...There’s like a lot of mountains in one spot. I guess you can say they connect. You’ve got the Rockies on the west coast and the Appalachian on this side. *In response to are they [mountains] bound to specific places.* I guess so.”

UBMS 9th Grade Interviews

What we uncovered?

- 11PLT_UBMS_Student 44

- Volcanoes

“They’re in Hawaii.”

“Hawaii...in that part. Umm, that part. It may have been over near that part. It might have been China or Korea or something. Like over near that area. ”

“Umm just those couple of places that I know.” *In response to whether they could be other places that the student may not know.* “yeah, they could be there too”

“ I may talking about earthquakes, but I think tectonic plates under the earth cause something to form.”

- Earthquakes

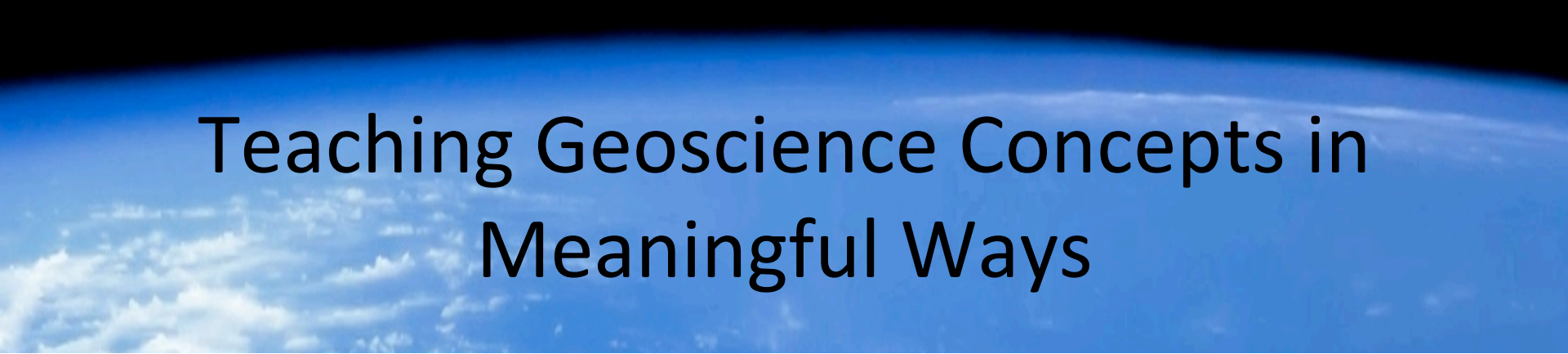
“they are more popular in California”

“ A lot in California like on the west side, the west coast and ummm over in China”
In response to why “Aren’t there tectonic plates directly under California? *In response to if this is the same with China* “Yeah, I think so. Cause aren’t they like kinda relatively close. Not to close, but aren’t they like on the same side of the globe”

UBMS 9th Grade Interviews

What we uncovered?

- 9PLT_UBMS_Student 49
 - Earthquakes
 - “They could. They could happen anywhere. But I never heard of a earthquake happening in like Philly. Not until recently. It’s possible it can happen anywhere just not... in a lot of areas. Probably depending on where it’s at. ”



Teaching Geoscience Concepts in Meaningful Ways

UBMS Advanced Geoscience Course Context

- 6 students
- 11th and 12th grade level
- 3 female, 3 male students
- From Harrisburg and Philadelphia
- 5 African American students 1 Latino student

UBMS Advanced Geoscience Course

- Non-traditional approach to teaching earthquakes, volcanoes, and plate tectonics
- Focus on constructing explanations in science –
Claims, Evidence, Reasoning Framework
- Focus on using a data rich exercise in constructing
knowledge – Discovering Plate Boundaries

Claims, Evidence, Reasoning Framework

- Claims, Evidence, Reasoning Framework
 - Students were presented with a lesson on the *Claims, Evidence, Reasoning Framework*.
 - Students were then instructed to apply the CER framework to their sense-making of the data presented on the various maps during the Discovering Plate Boundaries activity.
 - Students were then asked to present Claims, Evidence, and Reasoning in classroom discussions and on written assessments.

Discovering Plate Boundaries Activity

- Students worked in pairs to make sense of maps
 - Group A – seismology map
 - Group B – volcanology map
 - Group C – geochronology map
- Each group was also given a map showing Earth's tectonic plate boundaries
- Students were given directions to “describe patterns” and relate their respective map (seismology, volcanology, or geochronology) to the map of plate boundaries.

Sawyer, D., Henning, A., Shipp, S., & Dunbar, R. (2005). A data rich exercise for discovering plate boundary processes. *Journal of Geoscience Education*, 53(1): 65–74.

Volcanology Map

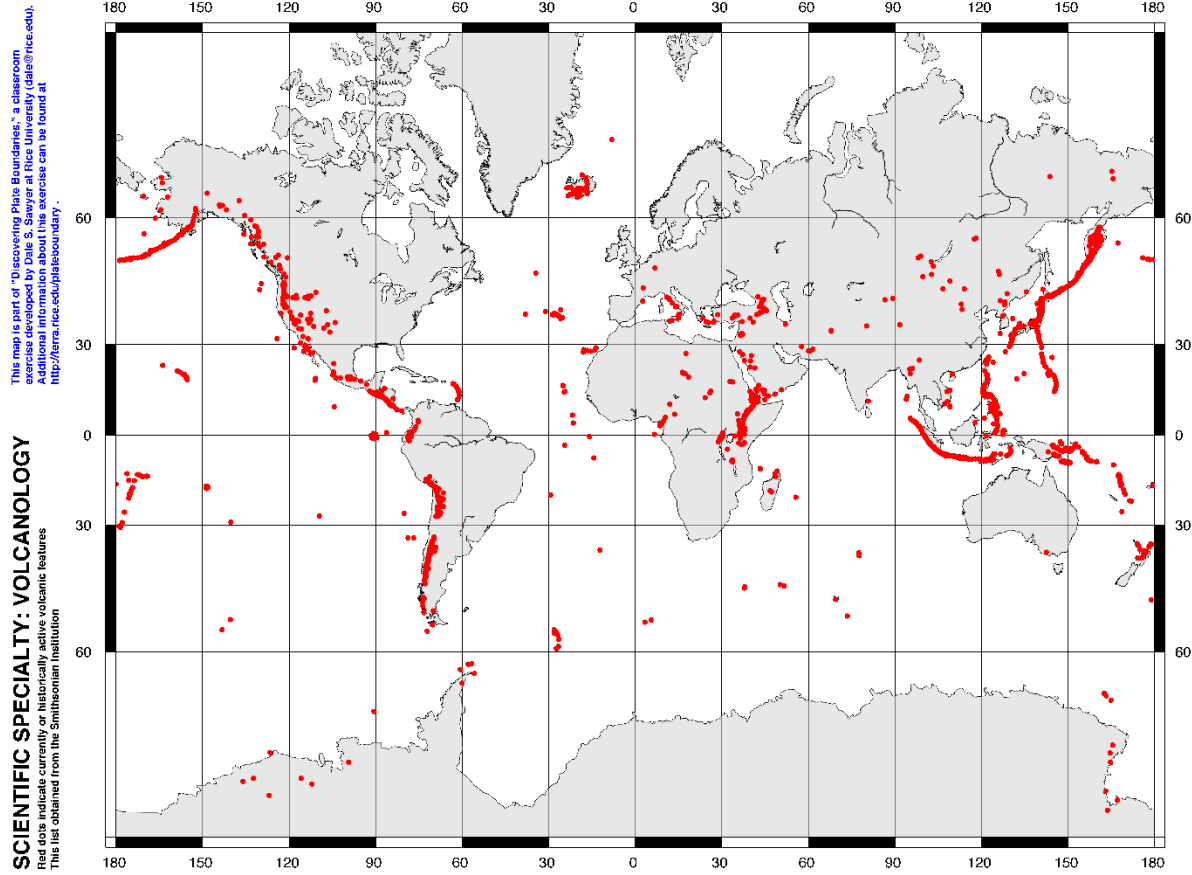
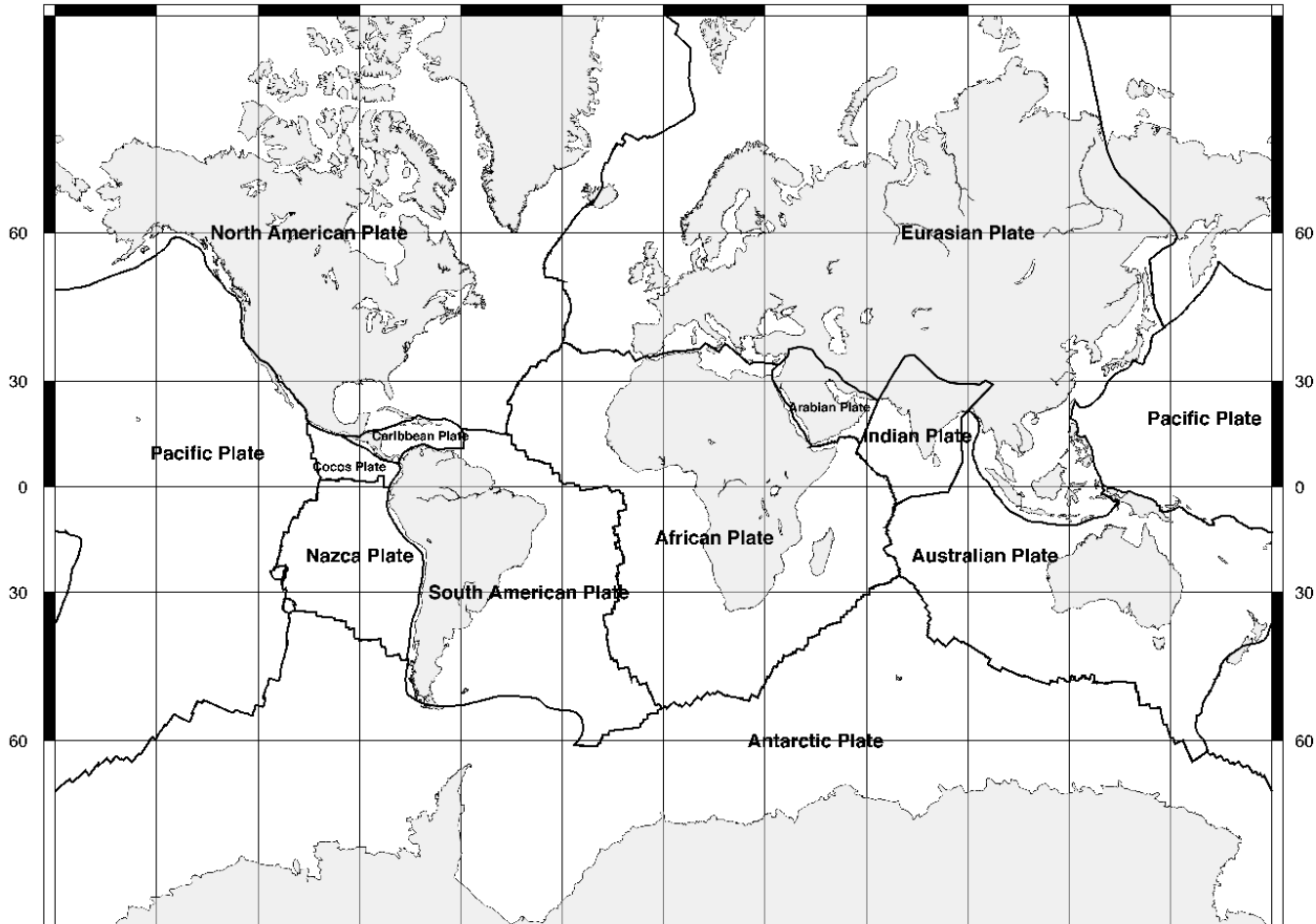


Plate Boundary Map

This map is part of "Discovering Plate Boundaries," a classroom exercise developed by Dale S. Sawyer at Rice University (dale@rice.edu). Additional information about this exercise can be found at <http://terra.rice.edu/plateboundary/>.

E BOUNDARY MAP
from Dietmar Mueller, Univ. of Sydney



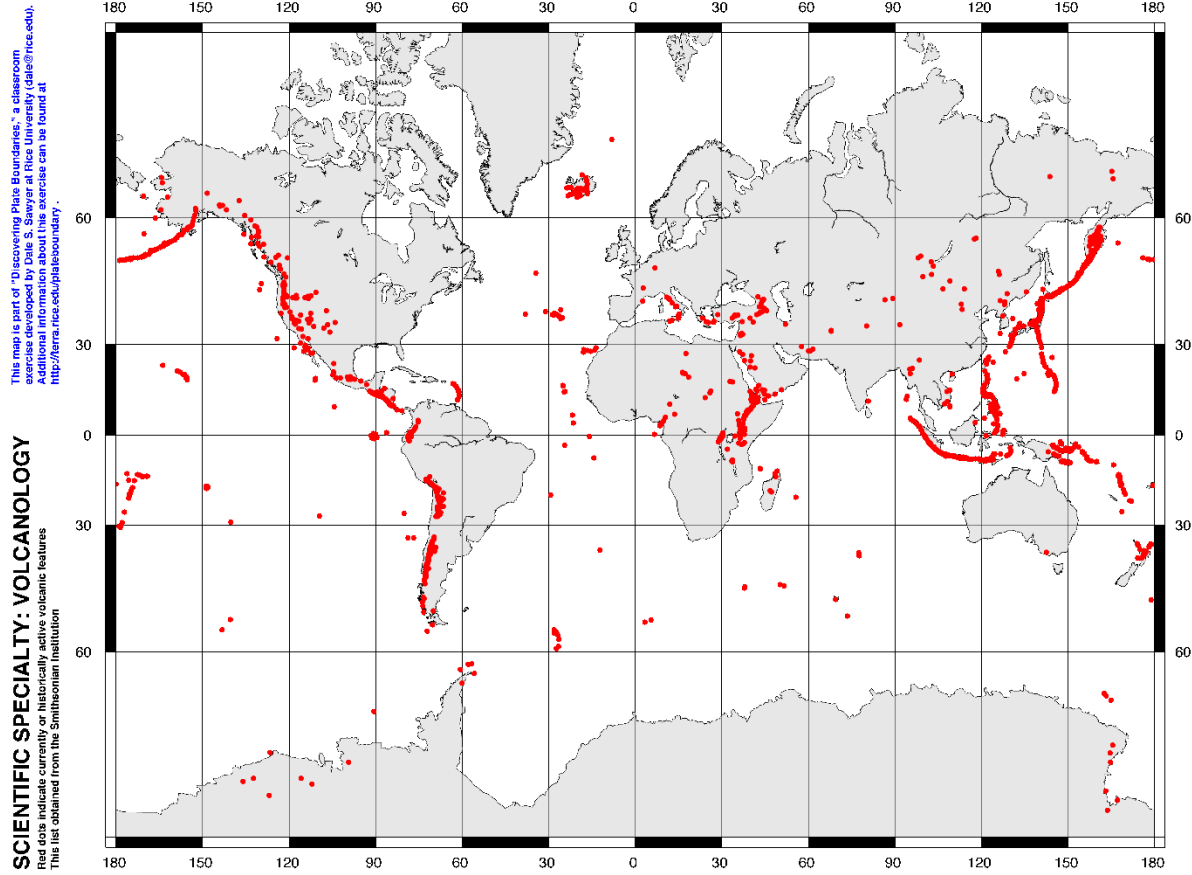
Discovering Plate Boundaries Activity

- Students then formed two groups (3 students in each) with one student presenting on each of the three maps (seismology, volcanology, and geochronology). Students were to describe their interpretations of their map, to their group members, as it relates to Earth's plate boundaries.
- All students came together during whole class discussion to make sense of all data from each of the maps.

Student Claims and Evidence

- Student One
 - Claim - All plate boundaries are not the same
 - Evidence - Some plates have little volcanic activity
 - Claim - Volcanoes do not occur only in hot ecosystems
 - Evidence - There are a few volcanoes in Antarctica

Volcanology Map



Student Claims and Evidence

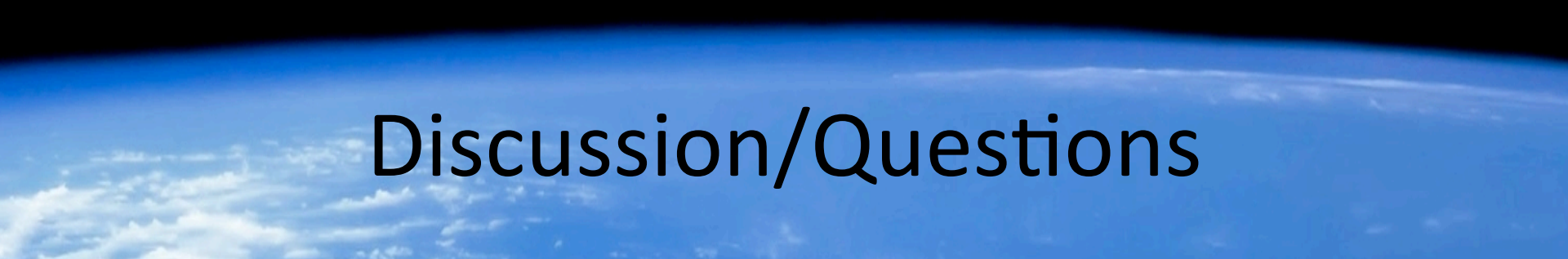
- Student Two
 - Claim - All plate boundaries are not the same
 - Evidence - There are different patterns along plate boundaries

Student Pre-Test and Post-Test Results

Student	Pre-Test	Post-Test
One	17%	67%
Two	42%	92%
Three	33%	92%
Four	25%	100%
Five	21%	58%
Six	50%	92%
Class Average	33%	83.5%

Results

- Students were able to construct their own knowledge claims and support this through evidence based on data rich exercise
- Better academic performance on post-test scores than pre-test scores
- Students addressed their own alternative conceptions based on their work with the data presented in the maps (volcanoes do not occur only in hot places)



Discussion/Questions

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