Promoting Spatial Thinking with Web-based Geospatial Technologies

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DR K-12 Award 1118677

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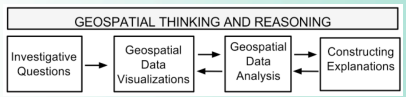
Research Questions

1. To what extent does learning Earth science with Web GIS mapping and analysis tools improve urban middle-level learners' geospatial thinking and reasoning and understandings of tectonics concepts and processes?

2. What variations in curriculum enactment occur when middle-level teachers implement Web GIS learning activities?

Geospatial Learning Design Model



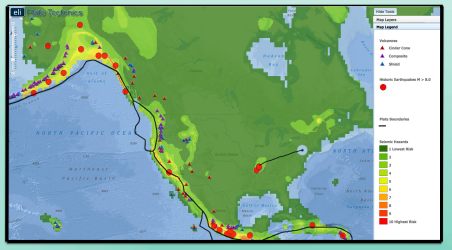
1. Elicit prior understandings of lesson concepts.
2. Present authentic task.
3. Model task.
4. Provide worked example.
5. Ask learners to perform task.
6. Scaffold task.
7. Ask learners additional questions to elaborate task.
8. Review activity concepts.

Key Features

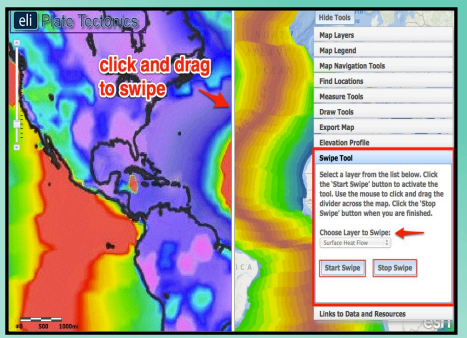
- Curriculum enhancement activities with javascript Web GIS to be platform independent (i.e. tablets, laptops, cellphones)
- Interface design for middle school learners
- Inquiry-based, geospatial learning investigations
- Visualizations and tool features designed to enable geospatial thinking
- Content and pedagogical supports for teachers

Research Methods

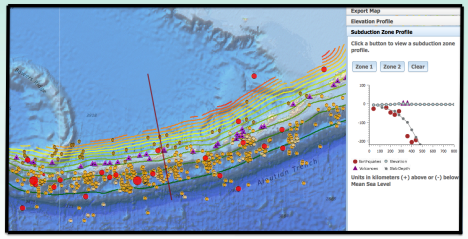
- Tectonics content knowledge measure
- Geospatial thinking and reasoning measure as applied to tectonics concepts
- Curriculum enactment measures
- Classroom observations
- Post-implementation survey
- Focus groups

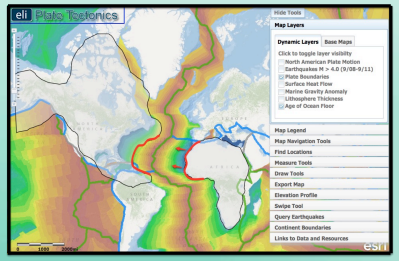


Investigation 1: Geohazards and Me: What geologic hazards exist near me? Which plate boundary is closest to me?
Analyzing relationships between locations, seismic hazards, plate boundaries, earthquakes, and volcanoes.

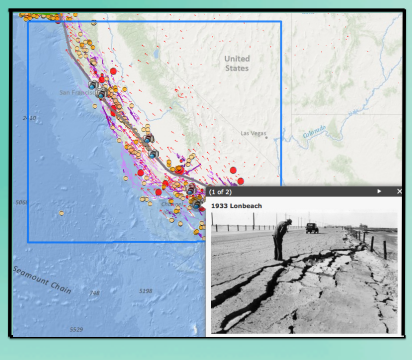


Investigation 3: How does thermal energy move around the Earth?
Investigating how surface hear flow (loss) is distributed around the Earth and its relationship to plate boundaries.





Investigation 4: What happens when plates diverge?
Investigating how tectonic strains are accommodated at the plate boundary.



Investigation 5: What happens when plates move sideways past each other?
Investigating a continental transform boundary, the San Andreas Fault zone, and the seismic hazards associated with living in this area using earthquake data and historical photographs.

Investigation 6: What happens when plates collide?
Analyzing a subduction zone profile in the Aleutian Trench to understand geospatial relationships among slab depth, earthquake foci, and volcanoes at a convergent boundary.

Results

Table 1

Tectonics Achievement for Pretest and Posttest and Paired-Sample T Tests (N = 1025)

	Pretest Mean (SD)	Posttest Mean (SD)	t	Effect Size
Entire Assessment	17.57 (5.67)	24.79 (6.03)	49.45***	1.23
GTR Subscale	9.61 (3.73)	13.71 (3.84)	39.50***	1.08
Tectonics Content Subscale	7.96 (2.57)	11.09 (2.65)	40.12***	1.20

Notes. *** $p < .001$, 2-tailed. Effect size was calculated as Cohen's d by dividing the difference between posttest and pretest mean scores by the pooled SD.

- Mixed ANOVA for the GTR subscale from pretest to posttest between academic tracks found:
  (1) a significant gain over time (ignoring or regardless of tracks), $p < .001$, $\eta^2_{partial} = .56$, with the posttest means higher than the pretest means for all levels of academic track
  (2) a significant difference between tracks (ignoring or regardless of test time), $p < .001$, $\eta^2_{partial} = .34$; the upper level academic track had the highest mean, followed by the middle-level track, and last with the low-level track

Curriculum Enactment

- Teachers enacted all eight key elements of the Web GIS investigations for more than half (60.6%) of the thirty-three observed investigations
  - Last key element, *review activity concepts*, was omitted for eight observed investigations due to time constraint issues
- Pedagogical implementation was mostly consistent for each teacher for each ability track level they taught
- There was little variability among the teachers with regards to adherence to the key elements of the Web GIS investigations during the curriculum enactment.
- For the majority of observed lessons, instruction was highly structured with much explicit modeling using a projected image.

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