Analogous Reasoning and Conceptual Model Development of Complex Earth Systems

Bruce E. Herbert[1], Karen McNeal[2], Nathan Gardiner[1], and Jayme Foster[1]

[1]Geology & Geophysics, Texas A&M University

[2]Geosciences, Mississippi State University

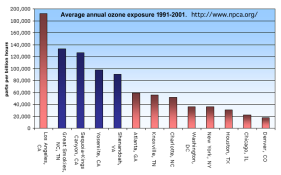
Synopsis

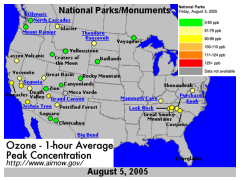
Understanding near-surface earth systems is central to the development of solutions to important environmental issues arising from the growth of human populations and economic activities (Herbert, 2006). There is a need for new models of science education and training that focuses on developing expertise in problem-orientated science.

There are three fundamental cognitive challenges in understanding complex earth systems:

- Conceptualization of the Earth as a complex system
- Causal reasoning about complex Earth systems
- Application of conceptual and scientific models of earth systems to support problem solving

Great Smoky National Park has the highest ozone levels in the US





cumulative exposure index

http://www.asl-associates.com/restofstory.htm

- 90 percent of the black cherry trees and tall milkweed plants show leaf symptoms of ozone injury
- 28 species show similar signs when exposed to levels of ozone during controlled studies
- Sensitive tulip poplars show reduced growth

Adaptive environmental management is iterative and explicitly incorporates learning and conceptual model development.

Research Question

Students, like all people, organize knowledge and reason about environmental issues through manipulation of conceptual models. We are interested in the potential role of analogous reasoning concerning surficial earth systems using large geospatial datasets to scaffold student development of richer, more accurate models of earth systems.

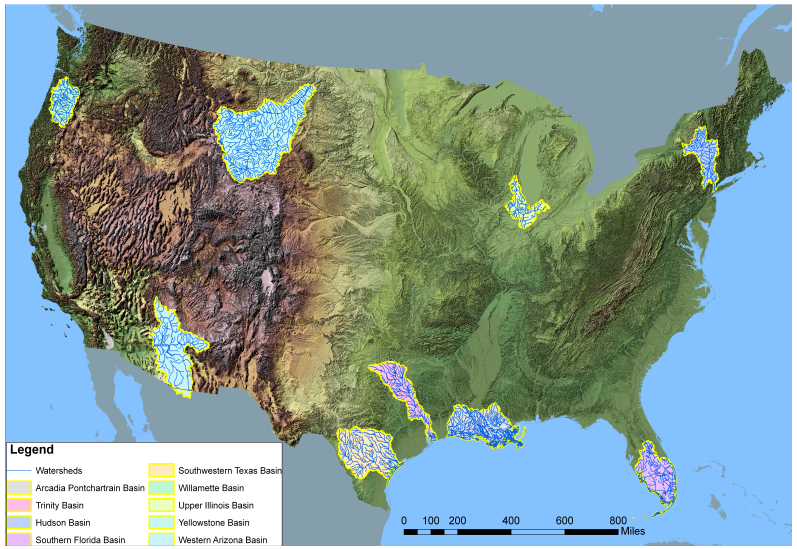
Authentic Tasks in the Classroom

Classroom Context: Upper division, majors course in environmental geology. Students are a mix of geology and environmental science students.

"*In this lab, you are to act as if you are an environmental consultant bidding and completing a project report for the federal government.*

We will assume that the data on the server or USGS web sites is the data you have collected during your study. In this project, you are to write a proposal and a research report on a question of your choice concerning water quality in the South Platte River."

Large Geospatial Datasets to Support Student Analogous Reasoning



Analogous Reasoning

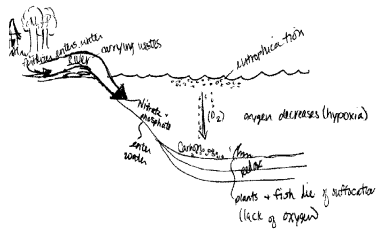
Analogical reasoning is a method of processing information that compares the similarities between new and understood concepts, and then uses those similarities to gain understanding of the new concept. Use of analogy is a form of inductive reasoning because it projects what is likely to be true, rather than deductively proving something as fact.

The use of analogical reasoning can be divided into four steps:

- **Generating the analogy**: A well understood case is compared to a less familiar or target case
- **Understanding the analogous case**: An understanding of the relationships between attributes in the familiar case is sought
- **Determine validity of analogy**: Similarities and relationships between the familiar case and the target case are evaluated
- **Apply findings**: Attributes from the familiar case are transferred to the target case

Research

Evaluate student (undergraduates and teachers) use of analogous reasoning to support conceptual model development. Datasets include representations and student think alouds (Mixed methods, Creswell, Plano & Clark, 2007)



Student Expressed Conceptual Model

Preparing Future Faculty Through Teaching as Research Projects

TAMU-CIRTL College Alignment for Collaboration is a discipline-based, teaching workshop at TAMU for graduate students-post-doc-faculty teams that explores teaching as research; assessment of learning, and the design of educational (*teaching as research*, TAR) projects.

The **Center for the Integration of Research, Teaching, and Learning** seeks to support a learning community of six, diverse research universities, including Texas A&M, mutually engaged in teaching-as-research activities to prepare future faculty in teaching and learning for all students.

References

Sell, K., Herbert, B.E., Stussey, C.L., and Schielack, J., 2006, Use of physical models and information technology to address undergraduate student mental model development of complex environmental systems: J. Geol. Ed. 54: 396-407.

Herbert, B.E., 2006, Student understanding of complex Earth systems, in C.A. Manduca, and Mogk, D.W., eds., Special Paper 413: Earth and Mind: How Geologists Think and Learn about the Earth: Boulder, CO, Geological Society of America, p. 95-104.

Acknowledgement
CIRTL is funded through the Division of Undergraduate Education of the National Science Foundation (CIRTL; http://cirtl.net/; Award 0717768, 2008-2011).