How Can the History and Philosophy of Science Contribute to Contemporary U.S. Science Teaching

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Organized by the School of Education and the Center for Philosophy and History of Science at Boston University.

How Can the History and Philosophy of Science Contribute to Contemporary Science Teaching?

HPS in K-12 Professional Development

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College *of* Education

Mathematics and Science Education

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Moon Journals by Preservice teachers

State of science teaching and learning in classrooms in the U.S.

- Most teachers use traditional approaches
- Most teachers do not understand the nature of science
- Students do not understand what science is, and what science is not
- Many teachers do not use an inquiry-based approach; or know how to articulate it

(Deboer, 2004; Krajcik, Mamlok, Hug, & 2000, Capps & Crawford, 2011).

Our assumptions about teachers and students

- (Students) cannot comprehend scientific practices, nor fully appreciate the nature of scientific knowledge itself, without directly experiencing those practices for themselves

A Framework for K-12 Science Education: *Practices, Crosscutting Concepts, and Core Ideas* **Committee on a Conceptual Framework for New K-12 Science Education Standards (2012)**

An Effective Professional Development Model for Inquiry and NOS Focused on Authentic Science Practices in the Classroom

FOSSIL FINDERS

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PALEONTOLOGICAL RESEARCH INSTITUTION

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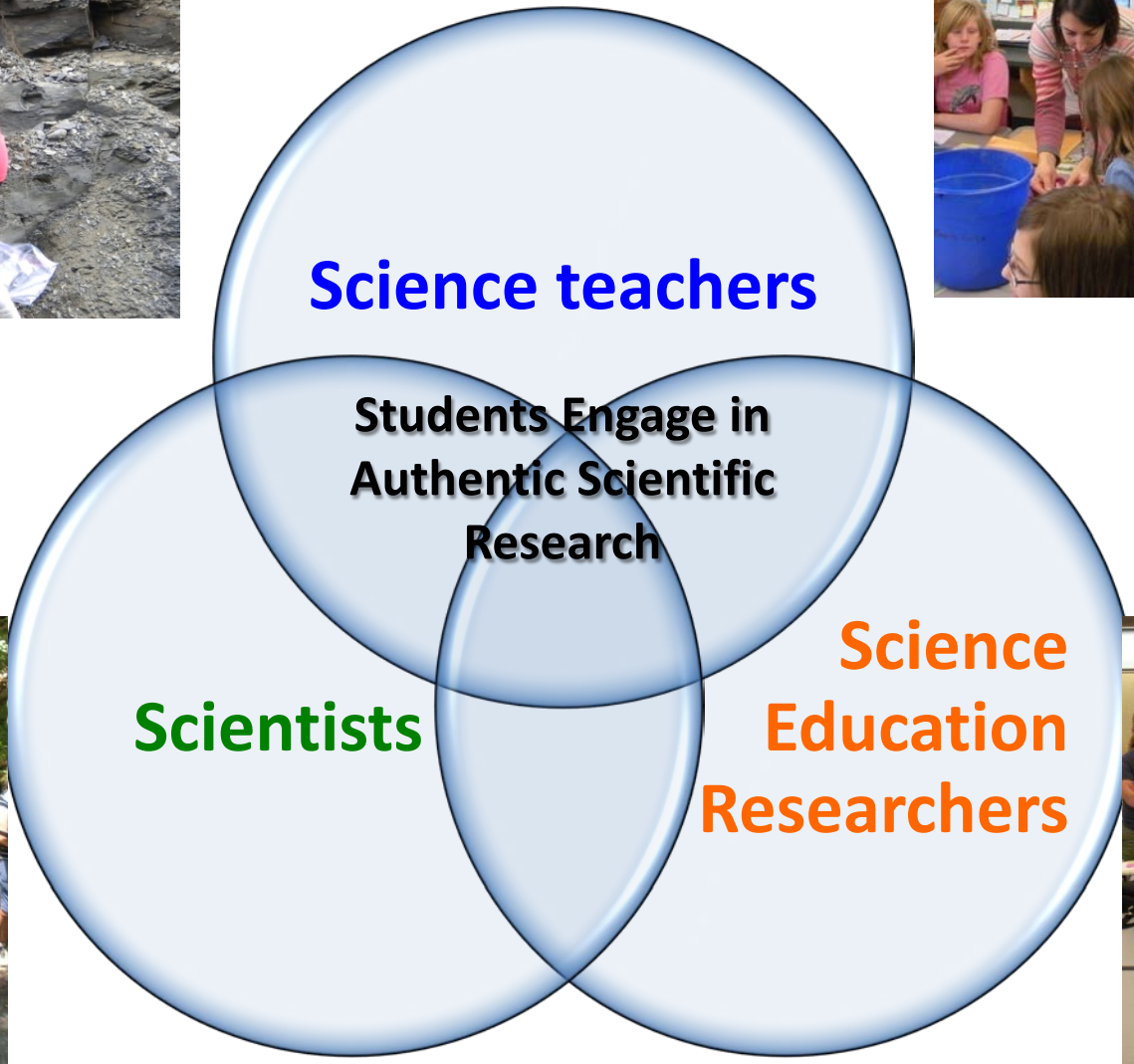
Our Community of Learners Framework



Theoretical Underpinnings of Our Work

Authentic Collaborative Inquiry PD

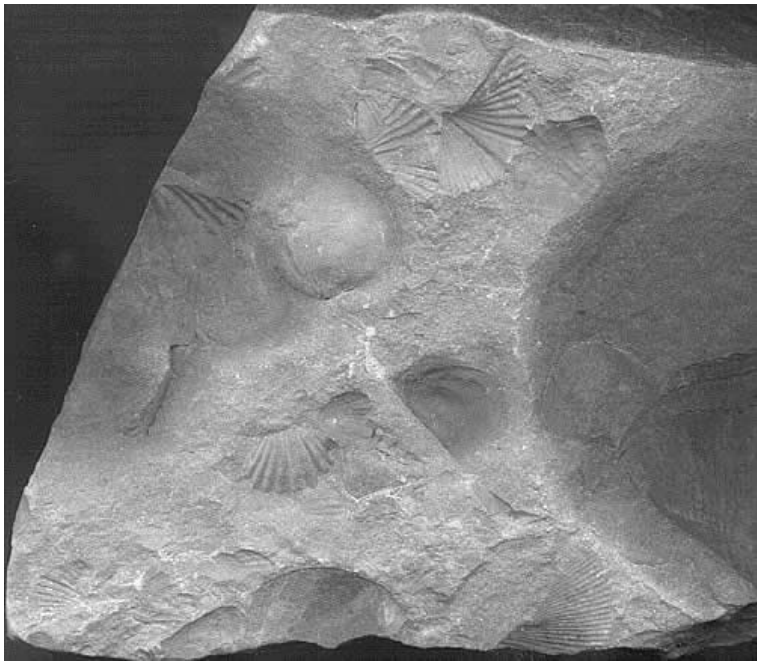
- Social-constructivist perspectives of Learning
  - (Driver 1989; Driver et al. 1994, Vygotsky 1978)
- Learning is situated; importance of authentic activities in classrooms
  - (Brown, Collins, & Duguid, 1989).
- Scientific Practices
  - (Dewey, 1938)
- Construct of authenticity
  - (Chinn and Malholtra, 2002; Braund and Reiss, 2006; Dewey, 1938; Hodson, 1998; Roth, 1995, Rosebery et al., 1989)
- Explicit attention to Nature of Science
  - (Lederman, 2004)
- Community of practice
  - (Lave & Wenger, 1991).

Nature of the Fossil Finders curriculum

- we use an authentic context to situate the teaching of Inquiry and NOS (i.e. observations and inferences; creativity; tentativeness; subjectivity; multiple methods)

Underlying framework

- Context
- Authenticity



Fossil Finders

...involves teachers and large numbers (~4000 in the testing phase) of students engaged in paleontological research, with scientists, that uses an online database

FOSSIL FINDERS

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The authentic Investigation

How has sea life responded to changes in the environment during the Devonian Period in central NY?

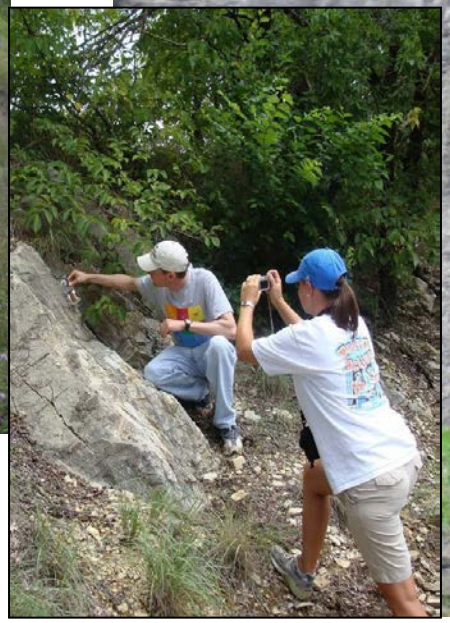
Phase 1 immerses teachers in learning about the science Principles and the scientific Practices connected with what their students will also experience.

Phase One of the Model

Teachers Immersed in Inquiry-- as a learner and reflect on NOS

Then engage their students

Phase 2 involves teachers in conducting their own scientific investigations related to the project and the main student investigation, and reflecting on how their work resembles that of a scientist



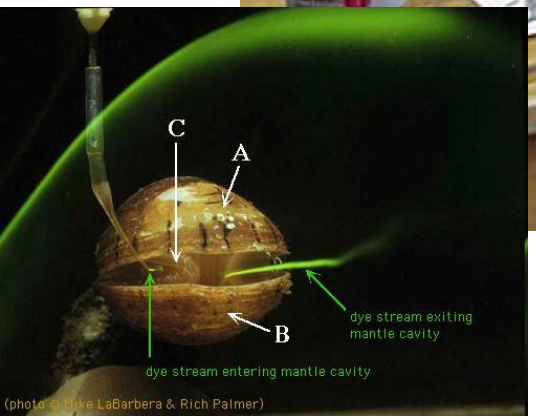
Learner-initiated scientifically oriented question

Phase Two of the Model

Teachers Engage in own inquiry-ask own questions reflect on NOS

Teachers ask own questions in teams, engage in the messiness of science– revising methods, asking new questions, and reflecting, on what is science?

Finding and identifying brachiopods!




1
2
3
4
5
6
7

FOSSIL FINDERS

Class Name: _____

Sample Number: _____

Subsample Number: _____

Rock Type (Shale/Limestone): _____

Data Collected by: _____

Organism Type: Brachiopod

Length (A) Width (B) Coloration (1-5) Fragmentation (1-5)

1 2 3

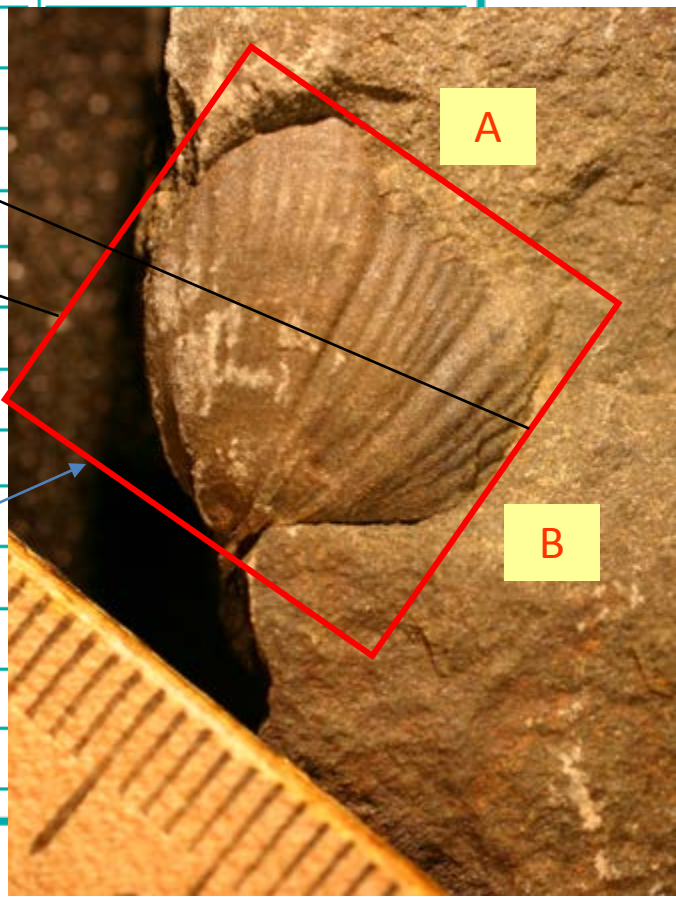
students collect information on

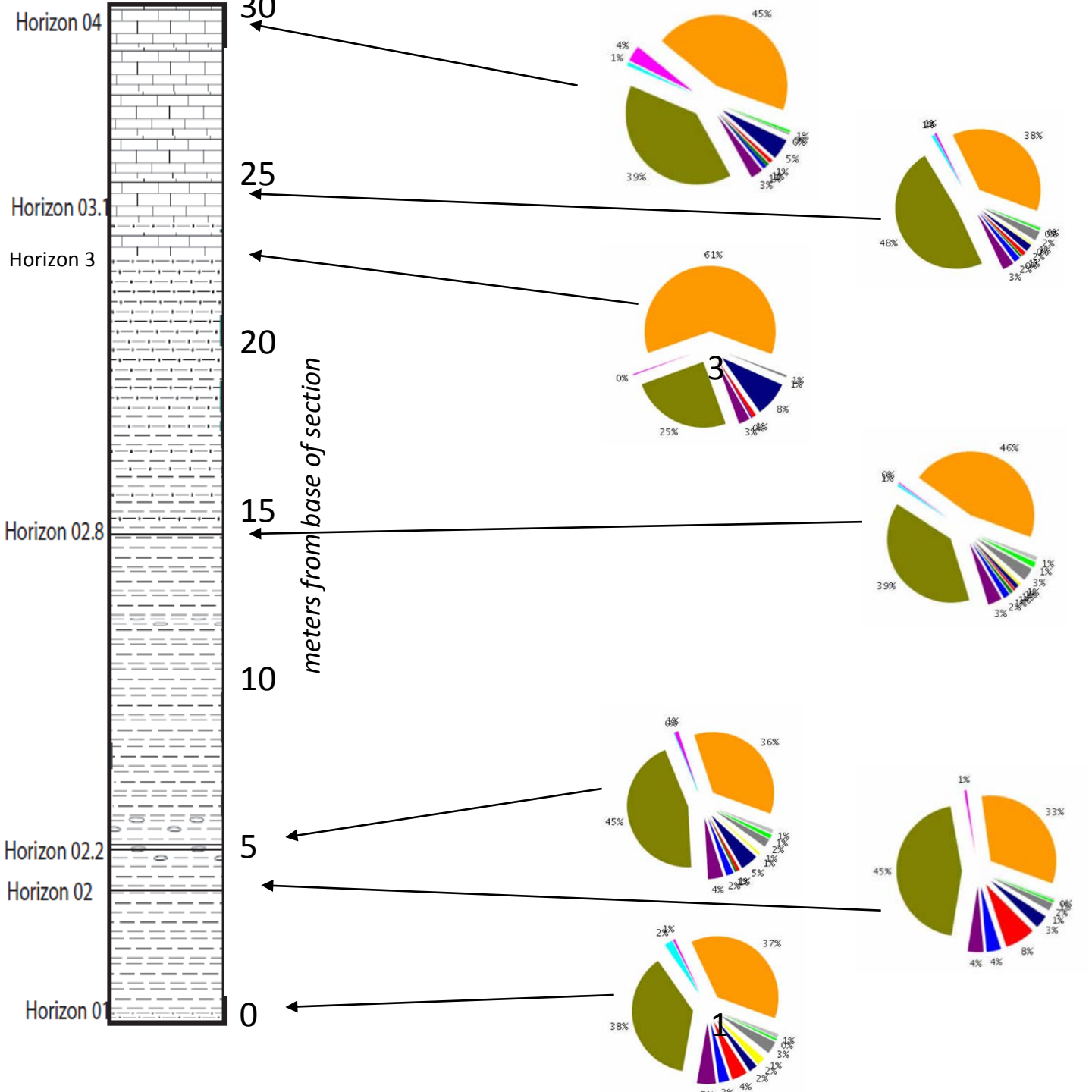
-- major taxon (brachiopods, bivalves, trilobites, etc.),

-- size in two dimensions

-- fragmentation & rock color (grayscale)

Measurements now made using calipers



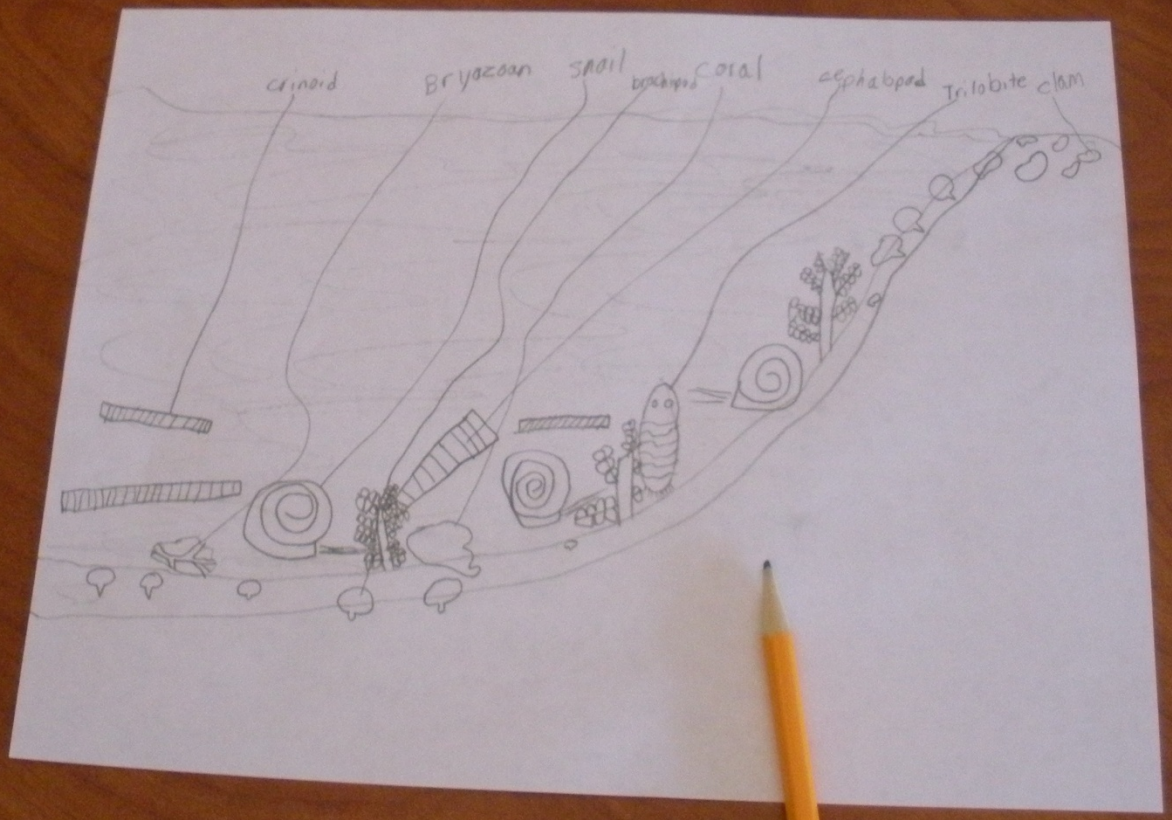


Students using the database compile series of plots to search visually for temporal trends

..Making inferences….the sea bottom looked sort of looked like this….

Smithsonian Natural History Museum Silurian Diorama

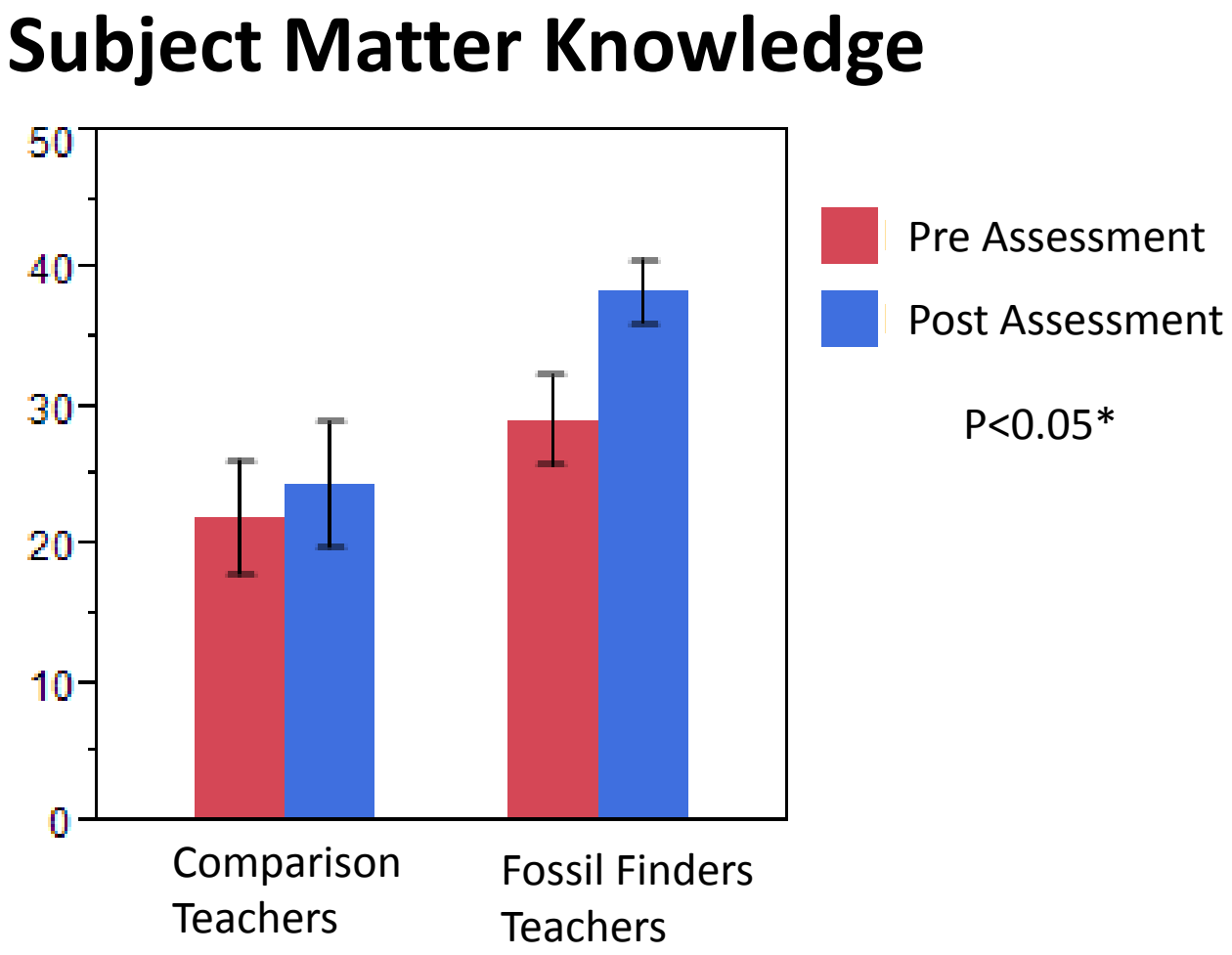
Data Interpretation : 5th Grade



We gather data across 4 areas—

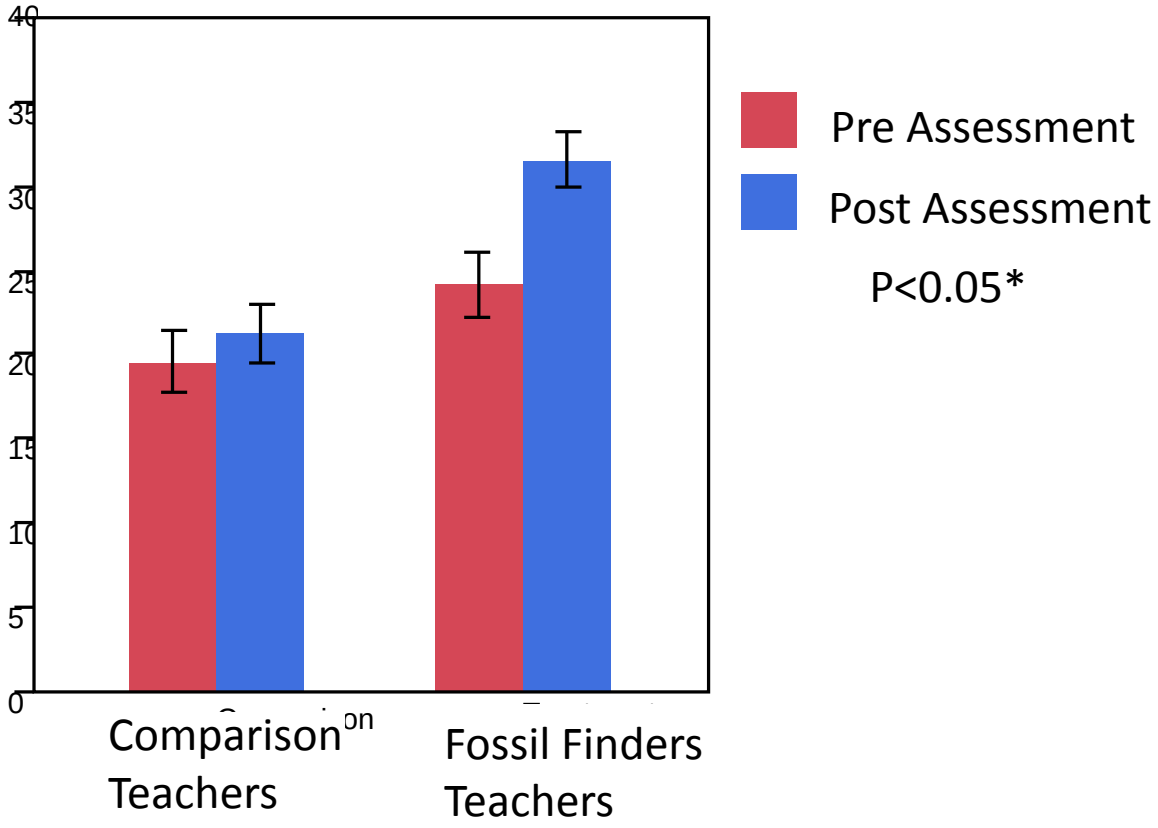
- Teacher views of NOS, inquiry, subject matter knowledge
- Teachers' intentions to act on their new view
- Actual classroom practice- what do teachers do in their classrooms?
- What do students do and learn?

Evidence of teachers' learning



Evidence of teachers' learning

Views of Inquiry & Nature of Science



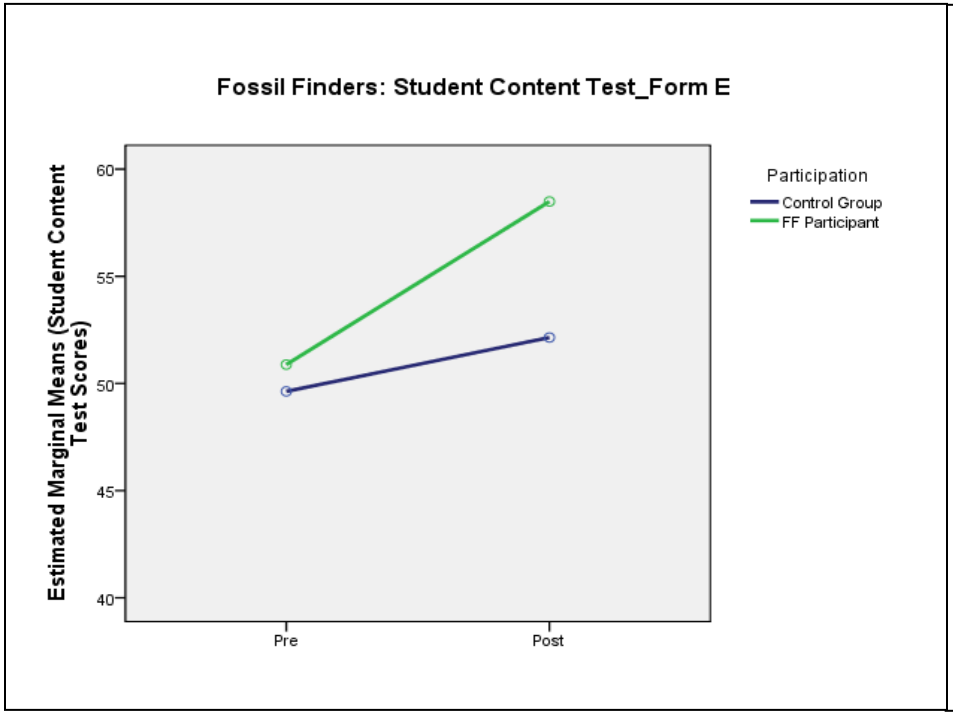
Evidence of Change in **Classroom Teaching Practices**

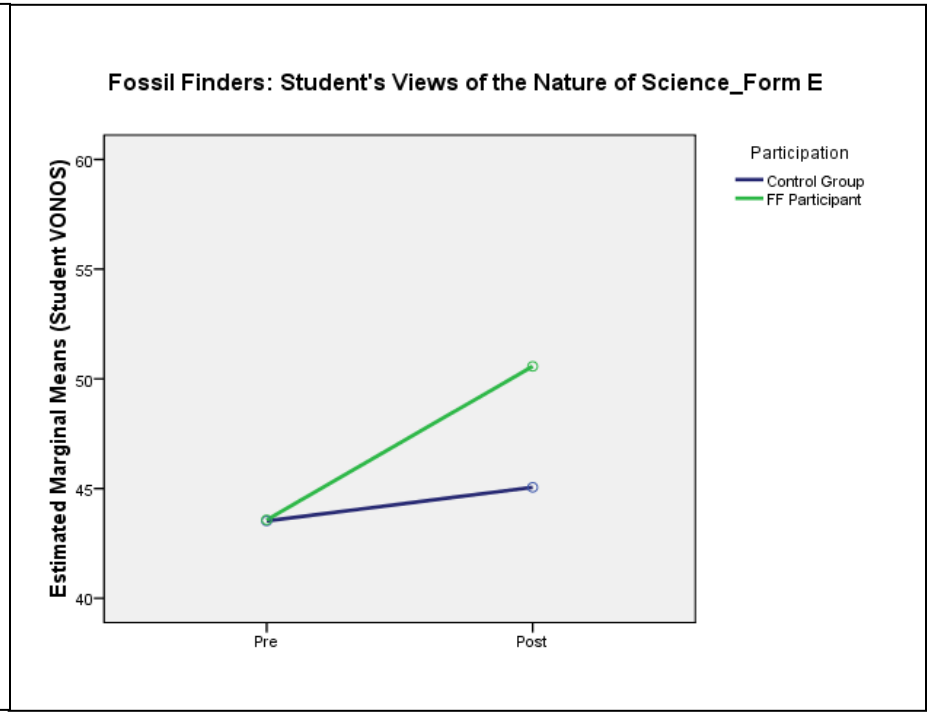
- More explicit use of NOS in classroom teaching
- Teachers increased use of data as evidence to answer scientifically-oriented questions both inside and outside of the Fossil Finders curriculum

(Capps & Crawford, 2012)

Evidence of

Student Learning





What did students learn about NOS?

Analysis of elementary student responses:

more informed understandings of the creative, cultural, and tentative aspects of science.

Guiding framework for *Fossil Finders* Curriculum and Instruction

- **Authentic investigation**
- Inquiry provides a **context** to teach **about nature of science (NOS)**
- Inquiry-based curriculum draws on lessons that highlight inquiry and NOS
- Make explicit aspects of NOS- science as a way of knowing-
- Students use logic and evidence

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Full paper posted at www.fossilfinders. org

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Database: http://data.fossilfinders.org/