Inquiry-based professional development: What does it take to support teachers in learning about inquiry and nature of science?

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European Science Education Research Association
Lyon, France, September 5-9, 2011

1865 THE UNIVERSITY OF MAINE

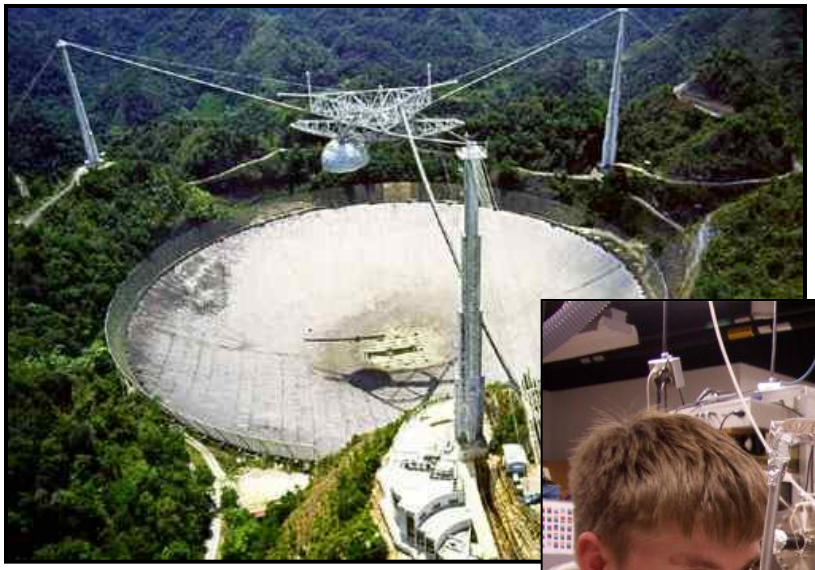
CORNELL UNIVERSITY FOUNDED A.D. 1865

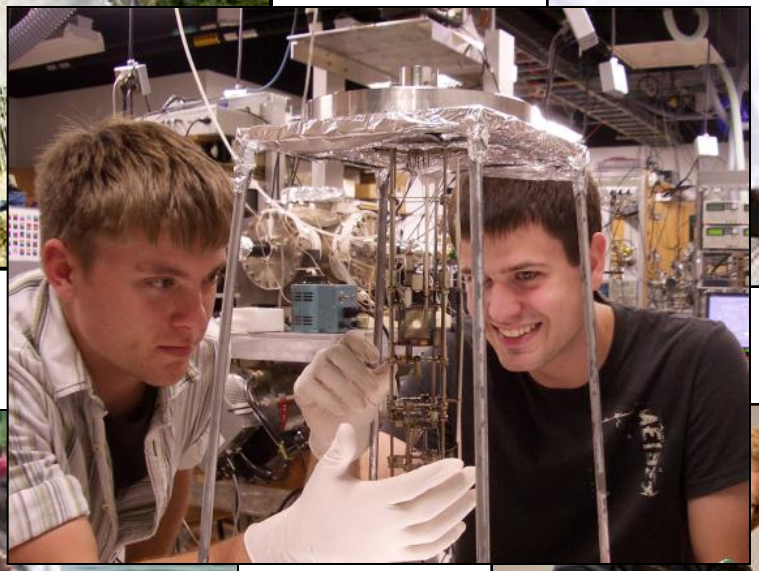
- Standards place inquiry as a central teaching strategy (NRC, 1996, 2000)

Inquiry-Based Instruction

- Models scientific inquiry, using data as evidence to answer scientific questions (Schwab, 1962; Crawford, 2000)

- Provides a context to teach about the nature of scientific knowledge (Schwartz et al. 2004)



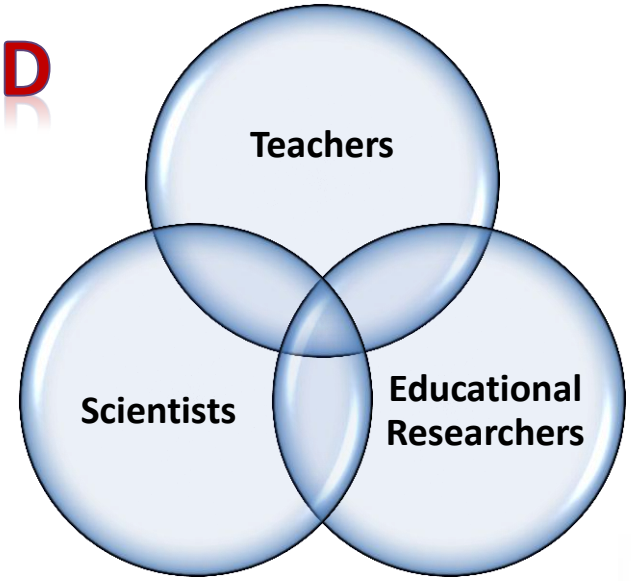


- Even some of the best teachers struggle to teach science as inquiry or about NOS (Capps et al., 2011)

- Teachers need support!

Context

EXPERIENCED TEACHERS



PALEONTOLOGICAL RESEARCH INSTITUTION

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Professional Development

Innovative Curriculum Materials

Classroom Population Study:

A background lesson to the Fossil Finders Investigation

Fossil Finders Pilot Curriculum, Cornell University—Summer 2010

Lesson Description

This lesson engages students in an exploration of population data. Students will learn about making observations and inferences based on their own measurements and compiled classroom data. In this lesson, students will be introduced to statistical concepts, graphing data, and analyzing and comparing compiled data.

Time Estimate: 50 minute class period

Lesson Goals: Students will…

- Measure height in centimeters and record it in a data table
- Form a human histogram

Innovative Curriculum Materials

Classroom Population Study:

What do Geologists do?

A background lesson to the Fossil Finders Investigation

Fossil Finders Pilot Curriculum, Cornell University—Summer 2010

Lesson Description

This lesson engages students in an exploration that parallels what geologists do. In the activity, students will make observations about the accumulation of paper in a recycling bin and use this information to make inferences about the past. Students will see that by obtaining more information, they can begin to get a clearer picture of what may have occurred in the past. In this lesson students will learn about the principles of superposition and relative-age dating.

Innovative Curriculum Materials

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What is a Fossil & What does it tell us?

A background lesson to the Fossil Finders Investigation

Fossil Finders Pilot Curriculum, Cornell University—Summer 2010

Authentic Scientific Investigation

Website and Database

View Reports

Relative Abundance of Organisms Within a Sample

A report detailing the abundance of organisims cataloged within a single fossil sample.

Select sample...

Distribution of Organism Sizes Within a Sample

A report detailing the occurance of size of a specific organisim within a single sample.

Select sample...

Select organism...

Select fragmentation level...

Relative Abundance of Organisms Across Horizons

A report detailing the relative abundance of organisims as found in the horizons of a specific locale.

Select locale...

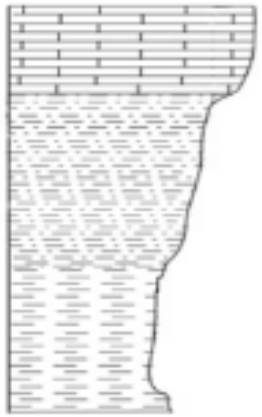
Select organism...

Organism Size Against Relative Abundance Within a Locale

A report plotting the relative abundance of a specific organism against it's size as found throughout a single locale.

Select locale...

Select organism...



Comprehensive Report for a Locale

A report detailing various vital statistics on fossils found throughout a single locale. Information detailed by horizon

Select locale...

Guiding Frameworks

- Teaching science as inquiry (NRC, 1996, 2000)
  - Essential Features/Abilities to Do
  - Teacher/Student Initiated

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- Teaching science as inquiry (NRC, 1996, 2000)
  - Essential Features/Abilities to Do
  - Teacher/Student Initiated
- Nature of Science (NOS) (Lederman et al., 2002)
- Teacher reflection (Dewey, 1933; Loughran, 2002; Schön, 1983)

Research Questions

1) What was the impact of the PD on teachers' subject matter knowledge?

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2) What was the impact of the PD on teachers' views of inquiry and NOS?

Participants

Participants

+ a group of comparison teachers

Participants

Years Teaching	College Science Courses	Science PD Programs
12.3	10.6	3.0

Q1: Impact on teacher knowledge

Developed a 24-item assessment:

- Conceptions of earth science
- Conceptions of evolution

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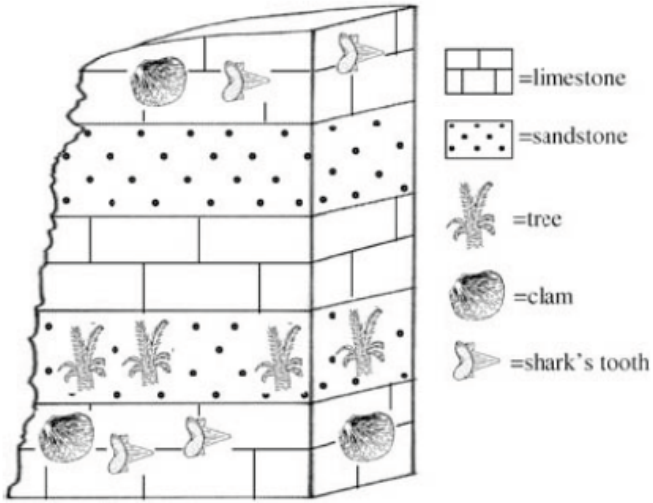
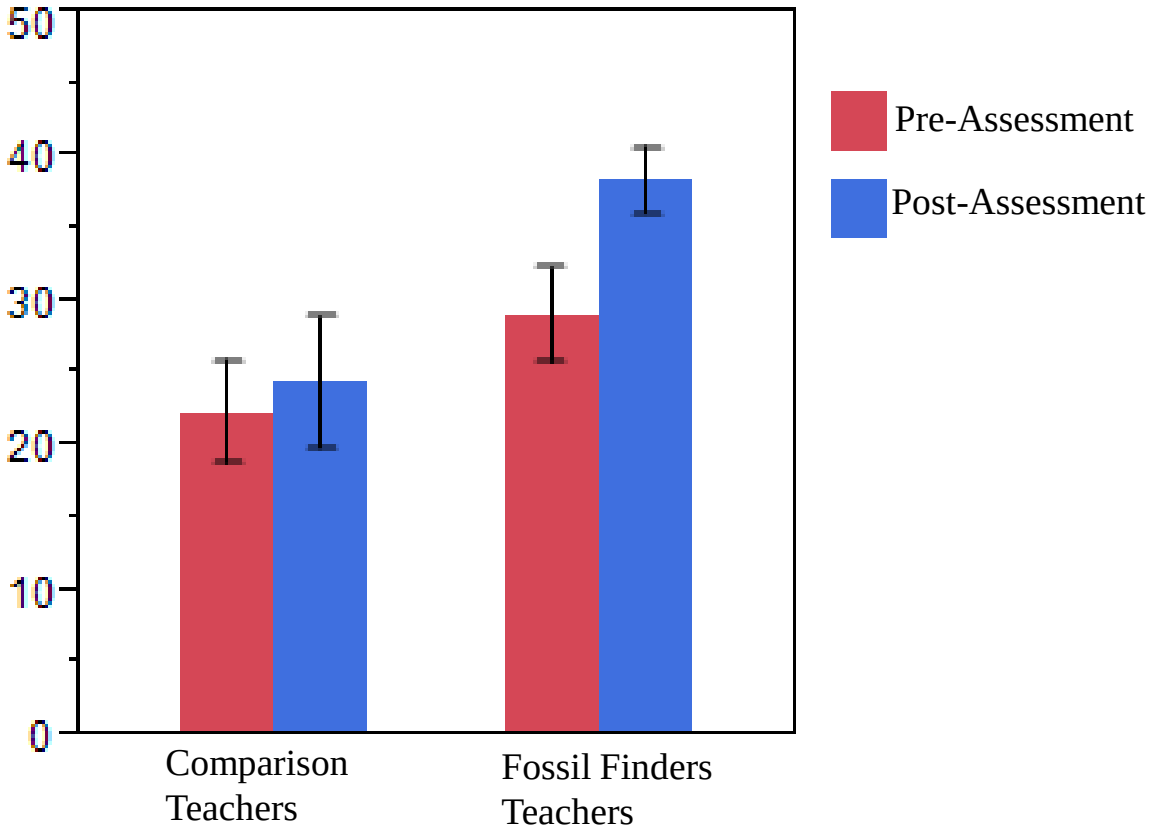
22. The illustration below represents a series of rock layers from a specific geologic work site.



Based on this illustration, please describe what might have occurred through time at this site in order for these rock layers to have formed and for these fossils to have been preserved.

ANCOVA: change = pre score + treatment

Q1: Findings



relative change of the treatment and comparison groups were significantly different statistically ($t = -2.94$, $p<0.01$)

Q1: Findings

- Greatest change on items related to geological concepts (e.g. principle of superposition)

- Greater changes for teachers who entered the program with limited subject matter knowledge

Q2: Impact on teacher views

Developed a 17-item assessment

- Conceptions of Inquiry (NRC, 2000)
- Views of NOS (Lederman et al., 2002)

Q2: Impact on teacher views

Developed a 17-item assessment

- Conceptions of Inquiry (NRC, 2000)
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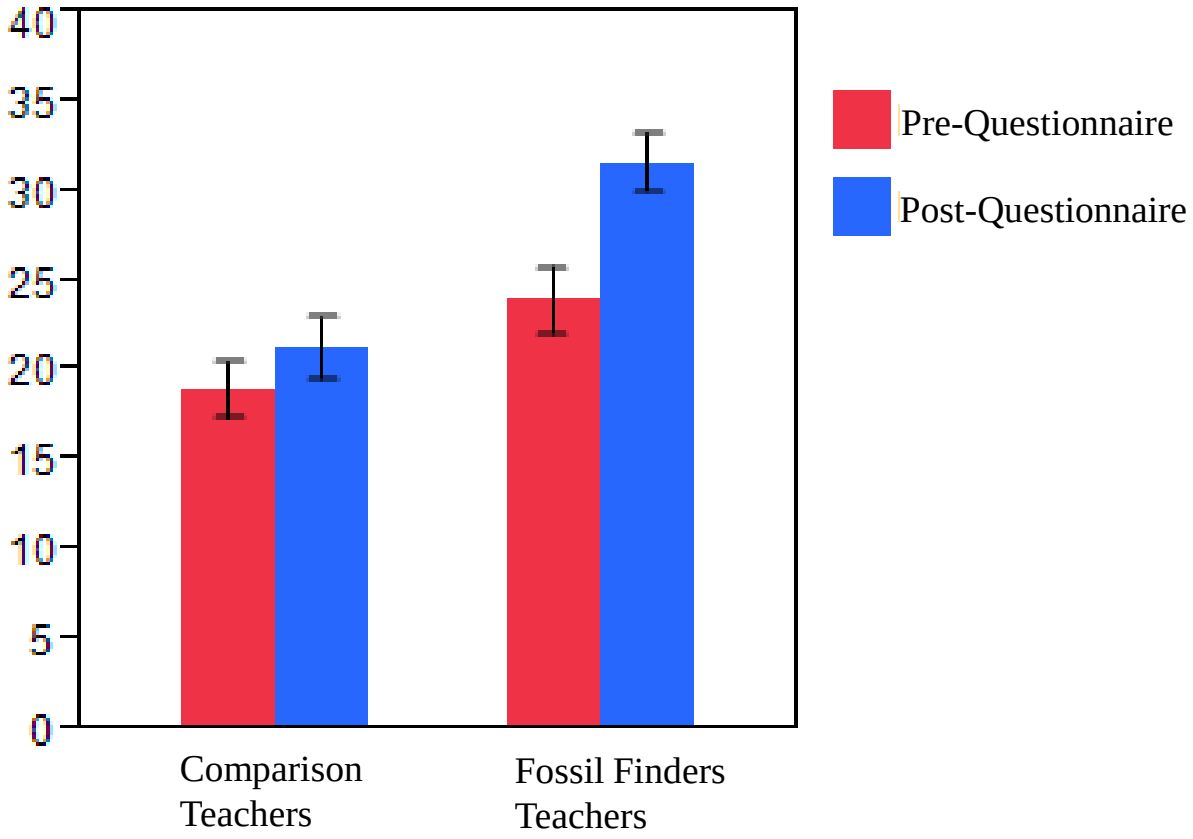
	Question	0 Uninformed/Naive	1 Emerging	2 More Informed	3 Robust Understanding
1.	What, in your opinion, is science? What makes science (or a scientific discipline such as physics, biology, etc.) different from other disciplines of inquiry (e.g., religion, philosophy)? *(VNOS-Form C, Question 1)*	Scientific is the collection of facts, proven through experimentation, objective, absolute; other disciplines rely on opinion, intuition, are subjective, just observations.	Science depends on observations or data, but offers no explanation or examples or contains some misconceptions.	Science depends on observations and data but does offer an explanation or example and has no major misconceptions.	Science is an approach to answering questions and uses evidence to develop explanations.
2.	What is an experiment? Give an example. *(VNOS- Form C, Question 2)*	Does not know what an experiment is or has serious misconceptions (for example, "anything is an experiment" or "dropping a ball and watching it fall" is an experiment). A way to answer a question.	An experiment is a test of an hypothesis or an experiment is a way to collect data. No example or faulty example provided, includes misconceptions.	A way to test an hypothesis and gather data, may mention the use of variables and controls. No major misconceptions.	An experiment is a controlled way to test an hypothesis against data/evidence. It involves manipulating the objects/variable of interest while keeping all other factors the same. Few, if any misconceptions.
3.	Does the development of scientific knowledge require	Yes it	Sometimes but should also	here are	The methods used in a scientific investigation

Q2: Findings



relative change of the treatment and comparison groups were significantly different statistically ($t = -4.46$, $p<0.001$)

Q2: Examples of Change

*"Students will learn to **chase their curiosity** in the classroom in the hopes they will continue to do so outside the classroom."*
(Participant teacher, pre-views questionnaire, 8-1-09)

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(Participant teacher, pre-views questionnaire, 8-1-09)

*"Students are actively seeking to **answer a scientific question** in class. They will work to answer this question by **recording data** and **analyzing their results**. Finally, the students will **communicate their findings** in some way to the class."*
(Participant teacher post-views questionnaire, 9-7-09)

Q2: Examples of Change

*"I think a **law is a glorified theory**. Laws, like Newton's Laws, are theories that have stood the test of time and of new data."*
(Participant teacher, pre-views questionnaire, 7-22-09)

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*"I think a **law is a glorified theory**. Laws, like Newton's Laws, are theories that have stood the test of time and of new data."*
(Participant teacher, pre-views questionnaire, 7-22-09)

*"A scientific **law defines** what will happen **while a theory explains** why it happens. The law of gravity tells us how an object will behave when dropped but doesn't get into the reasons why it behaves that way. The "why" is left to theories."*
(Participant teacher, post-views questionnaire, 8-21-09)

- Greater changes for those who entered the program with moderate views of inquiry and NOS (is there some threshold??)

- Pre: Most participant and comparison teachers felt confident in their ability to teach science as inquiry, but their conceptions of inquiry did not align with ideas put forth by the *NSES*

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- Post: Many FF teachers lost confidence, but gained in their understanding of inquiry
  - Over confidence might act as a barrier to change

Reflective Comments

6 teachers linked new knowledge to their classroom practice:

1. Reflection on former teaching (5/19)
2. Intent to change teaching (4/19)

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6 teachers linked new knowledge to practice:

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These teachers demonstrated greater change in their views of inquiry and NOS (μ=11.2 vs. μ=7.4)

Reflection on Former Teaching

"We did the readings and we talked about inquiry, and I realized in many ways I was close and I was doing some things that were similar to inquiry, but not full on inquiry." (Participant teacher, post-interview, 9-28-09)

Intent to Change

"I have been using hands-on activities since I began teaching. Revising my activities to become inquiry activities will take a little bit of time and thought, but it will be time and thought well spent." (Participant teacher, post-views questionnaire, 9-7-09)

Conclusions

- Participant teachers made significant changes in subject matter knowledge

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- Participant teachers made significant changes in inquiry and NOS.
- Active reflection on one's views and teaching practice may help to solidify new knowledge and assist in anchoring this knowledge in one's teaching practice

Implications

- Need for rigorous and long-term PD to support teachers in articulating views and changing their practice

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- Developing innovative ways to support teacher reflection

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Paper will be posted at: www.fossilfinders.org

This research was funded by the National Science Foundation DRK12 award # 0733223. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of The National Science Foundation.