

Future Elementary Teachers' Epistemological Beliefs & Views About Nature of Science Before & After a 'Reformed' Conceptual Physics Course

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Research Questions

What are future elementary teacher's...

- epistemic beliefs about the physical sciences?
 - How do these epistemic beliefs change after they complete a 'reformed' physical science course?
- views about the nature of science?
 - How do these views change after they complete a 'reformed' physical science course?

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Research Participants

- Elementary Education Majors
 - N = 108
 - 95% Women
- Enrolled in a Conceptual Physics Course
 - Almost no students have High School Physics

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Course Pedagogy

Learning Cycle¹

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graph TD
    EXPLORATION --> CONCEPT_INTRODUCTION[CONCEPT INTRODUCTION]
    CONCEPT_INTRODUCTION --> APPLICATION
    APPLICATION --> EXPLORATION
  
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EXPLORATION

- Monday-Wednesday
- Stations in Activity Center
- Hands-on with guiding questions on worksheet.

CONCEPT INTRODUCTION

- Lecture on Wednesday.
- Address Exploration
- Use peer instruction
- Introduce concepts

APPLICATION

- Wednesday-Friday
- Hands-on experiment stations in Activity Center
- Apply concepts learned in class on Wednesday.

¹ Karplus & Renner (1974)

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Data Sources

Pre-Post Comparisons of scores on...

- Epistemic Beliefs in Physical Sciences (EBAPS)²
 - A 30 question multiple choice questionnaire
- Views about Nature of Science (VNOS)³
 - A seven-question open-ended questionnaire

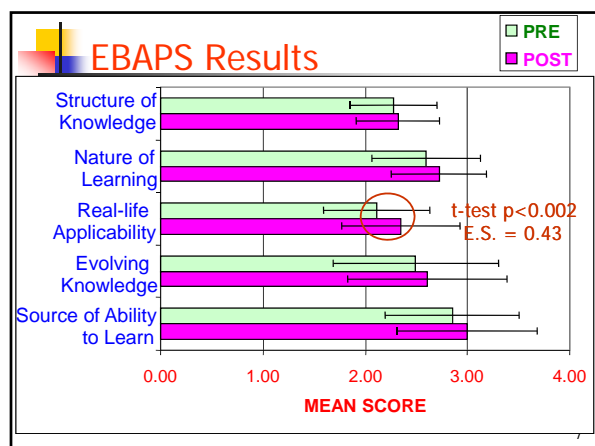
² Elby & Hammer (2002) ³ Lederman & Abd-El-Khalick (2002) ⁵

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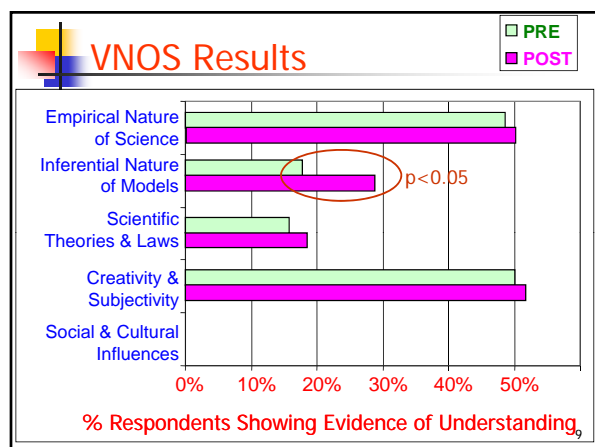
EBAPS Dimensions

- Structure of Knowledge
 - Coherent vs. Pieces
- Nature of Learning
 - Propagated from authority vs. Self constructed
- Real-Life Applicability
 - Applicable vs. Non-applicable to the real world
- Evolving Knowledge
 - Knowledge changes with time
- Source of Ability to Learn
 - Innate vs. Acquired

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- ### VNOS Dimensions
- **Empirical Nature of Scientific Knowledge**
 - Observations are used in making scientific claims.
 - **Inference & Theoretical Entities in Science**
 - Scientific models are inferential in nature.
 - **Nature of Scientific Theories & Laws**
 - Theories provide a framework for examining evidence.
 - Laws may change.
 - **Creativity & Subjectivity in Science**
 - Creativity permeates science, no single scientific process.
 - Science is a mixture of objective & subjective components.
 - **Social & Cultural Influences**
 - Science is a culture in itself and is influenced by society.



- ### Conclusions
- Future elementary teachers'...
- Epistemic beliefs (as measured by EBAPS) **do not change** significantly after this course.
 - Only change in "Real-Life Applicability" dimension
 - Views of Nature of Science (as measured by VNOS) **do not change** significantly after this course.
 - Only change in "Inferential Nature of Models" dimension

- ### Limitations of Study
- Inherent limitations in the instruments
- **EBAPS:**²
 - Teasing Epistemology vs. Expectations
 - Teasing Beliefs vs. Goals
 - Inferring students' sophistication
 - Inviting stock responses from students
 - **VNOS:**³
 - Validity of interpreting open-ended responses
 - Inter-rater reliability (low ~70%)
- ² Elby & Hammer (2002) ³ Lederman & Abd-El-Khalick (2002)¹¹

- ### Implications
- A single reformed science course, even one that uses research-based pedagogy, may not significantly alter students' views or epistemic beliefs about science.
- These issues may need to be explicitly addressed over the longer term in a students' educational experience.