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PRE-SERVICE SCIENCE TEACHERS' EPISTEMOLOGIES IN THE PHYSICAL SCIENCES[1]

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Abstract

Students' epistemologies play a crucial role in helping them construct knowledge. In addition, studying epistemological beliefs is important because they influence students' motivation and affect students' selection of learning strategies (Schommer, Crouse, & Rhodes, 1992; Hofer & Pintrich, 1997). The purpose of this study is to investigate primary pre-service science teachers' epistemologies, their views about the nature of knowledge and learning in the physical sciences. Epistemological Beliefs Assessment for Physical Science (EBAPS) (White et al., 1999) survey was used to collect data. EBAPS attempts to focus on epistemology to the extent possible, and also attempts to probe tacit, contextualized epistemological knowledge that may affect students' science learning. In that case, it is important to attend pre-service science teachers' epistemologies because it may assist us to explain the differences in their learning with research-based curricula, construct more effective curricula, and become better science instructors (Lising & Elby, 2005). The EBAPS survey was administered to primary pre-service science teachers at Bahrain Teachers College (BTC). Most of the pre-service science teachers have a great deal of difficult learning physical sciences and they behave like non-expert like.

Keywords: *Epistemology; epistemological beliefs; physical science.*

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INTRODUCTION

Students' epistemological beliefs have received rapidly increasing attention from educational researchers and teachers since the pioneering work of William Perry Jr. in 1968. The increased focus on the topic stems from research findings indicating that these beliefs are related with students' learning. Epistemological beliefs can be defined as an individual's beliefs about the nature of knowledge and the process of knowing. It refers to beliefs on "how knowledge is constructed and evaluated and how knowing occurs" (May & Etkina, 2002, p. 1249).

Students' epistemologies play a crucial role in helping them construct knowledge. In addition, studying epistemological beliefs is important because they influence students' motivation and affect students' selection of learning strategies (Schommer, Crouse, & Rhodes, 1992; Hofer & Pintrich, 1997). Particularly, students' naive beliefs affect students' aptitude to integrate their understanding of science concepts. Most students maintain beliefs that knowledge consists of fragmented facts, formulas, and equations written by authority, that are not related to their everyday experiences (May & Etkina, 2002). Therefore, students would like to see the connections to their real life. Students have difficulties understanding the nature of science. Many students even in higher education consider science as a collection of facts (Songer & Linn, 1991; Abd-El-Khalic, Bell, & Lederman, 1998; Lederman, 2007; Khishfe, 2008). The proposed study responds to probing Teacher Candidates' views about knowledge and learning so that we can assist them construct knowledge.

PURPOSE OF THE STUDY

The purpose of this study was to investigate primary pre-service science teachers' epistemologies, their views about the nature of knowledge and learning in the physical sciences.

Within the scope, the following research question was addressed:

What were the epistemological stances of primary pre-service science teachers' taking physical science courses?

MEDHODOLOGY

The research design was guided significantly by the literature survey, Epistemological Beliefs Assessment for Physical Science (EBAPS) and based on quantitative methodology. The survey has three different item types: Likert-scale agree/disagree items, multiple choice items, and debate items. EBAPS items relate directly to science and science learning, focusing on physical science. That way, whether or not epistemological beliefs depend on discipline, the assessment probes epistemological beliefs regarding physics and chemistry. In addition, students' weekly reflections were used.

The study involved second year BEd pre-service science teachers who were in Cycle 1 (Lower Primary level; N=11(out of 13) (1 section)) and Cycle 2 (Upper Primary level; N=34 (out of 38)(2 sections)) with specialization in Math & Science. Pre-service science teachers in Cycle 1 and 2 were required to take Physical Sciences course which the study took place into. Students in Physical Science (physics & chemistry) course in Cycle 1 did not have any high school science course.

Active-learning strategies to teach the course were employed in all sections. Those included: Interactive lectures (with ppp), Cooperative group problem-solving (tutorials), Hands-on and minds-on activities (lab activities), Demonstrations and computer simulations.

DATA COLLECTION

Epistemological Beliefs Assessment for Physical Science (EBAPS) was used. (30 questions) which includes likert-scale agree/disagree items, multiple choice items, debate items.

Each week students reflected on what and how they learned by writing weekly reports. Students were asked to answer four open-ended questions:

1) What did you learn in the interactive lecture and small group work or lab this week?

2) How did you learn it?

3) What questions remained unclear?

4) If you were the professor, what questions would you ask to determine if your students understood the material?

DATA ANALYSIS

EBAPS

Dimensions

1) Structure of Scientific Knowledge
- Coherent vs. Pieces (2, 8, 10, 15, 17, 19, 20, 23, 24, 28)

2) Nature of Knowing and Learning
- Propagated from authority vs. Self constructed (1, 7, 11, 12, 13, 18, 26, 30)

3) Real-Life Applicability
- Applicable vs. Non-applicable to the real world (3, 14, 19, 27)

4) Evolving Knowledge
- Knowledge changes with time (6, 28, 29)

5) Source of Ability to Learn
- Innate(inherent) vs. Acquired (5, 9, 16, 22, 25)

Results

As seen in Figure 1, Below 3 indicates Non-expert like and Above 3 indicates Expert-like.

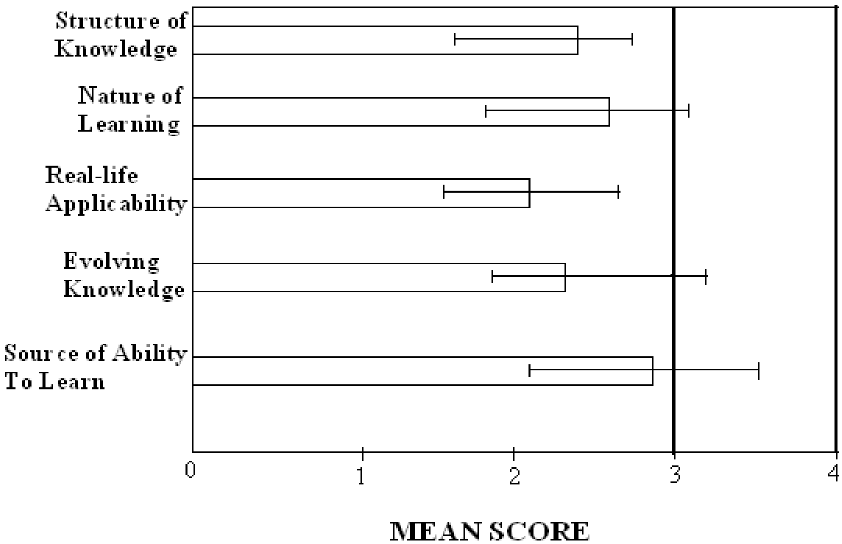

Figure 1: EBAPS results

Table 1: Pre-service science teachers' epistemological beliefs

Based on the data obtained from the EBAPS survey, Pre-service science teachers' epistemological beliefs in the physical sciences
1. Non-expert like (EBAPS score below 3) in all dimensions 2. Knowledge is in pieces 3. Learning from authority 4. Knowledge doesn't change with time (also related to Nature of Science (NOS)

Weekly Reflections

Pre-service science teachers wrote their reflections weekly and four questions were asked. Their answers were analyzed using the following categories and codes.

1. What they say they learned

Four codes in this category

- **Formula:** equations or other mathematical statement, or the implication that they think formulas are important, without elaboration on their meaning.
- **Vocabulary:** definitions or other physics/chemistry language conventions
- **Concept:** qualitative descriptions and concepts, ideas, relationships.
- **Skill:** Lab activity design skills, measurements skills, problem-solving skills.

2. How they say they learned

- **Observed phenomenon**: observe a physical phenomenon, demonstration, or experiment.
- **Learned concept from observation**: learned a concept simply by observing a phenomenon, demonstration or experiment.
- **Reasoned/derived in class (lecture, tutorial, lab):** followed the reasoning process by using prior knowledge and experience, experiment that conducted in the class.
- **Learned by doing:** learned a concept, skill or process by practicing it.
- **Authority:** told or convinced by instructor.

Pre-service science teachers' epistemological preferences

Pre-service science teachers focused on authority and practice (hands-on and minds-on activities).

CONCLUSION and DISCUSSION

Most of the pre-service science teachers have a great deal of difficult learning physical sciences and different students reflect in a different way on the construction of knowledge in the same teaching environment. Therefore, student epistemologies have an important role for learning physical science concepts.

The results of this study can be used to enhance student content learning by encouraging appropriate epistemologies (May & Etkina, 2002). Students may have knowledge that they do not use in general because they think what they believe about physical sciences. If the instruction were to attend to their beliefs, students might bring their knowledge to accept.

In addition, I see this work as contributing to teachers' understanding of students and learning which is an aspect of pedagogical content knowledge (PCK). Awareness of students' beliefs might help with decisions in the classroom and provide important insights for instructional design and organization.

Research on epistemological beliefs lacked in the Middles East Countries. The results of this study will generate novel insights that may affect or alter how researchers and practitioners in education perceive students' understanding and learning. The results of this would generate significant repercussions in pedagogy, teaching practice and curriculum development.

IMPLICATIONS FOR INSTRUCTION

The results imply that student epistemologies matter. Instructors might be able to enhance student content learning by encouraging appropriate epistemologies.

FUTURE DIRECTIONS

- How do these epistemological beliefs change after they complete a physical science course? (pre-post design)
- Examine correlations between EBAPS scores and course performance

- Do students with more sophisticated epistemological beliefs perform better in the course?

- Investigate connections between epistemological beliefs and views about the nature of science

  - Do students with more sophisticated epistemological beliefs also have more sophisticated views about the nature of science?

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