Enhancing Prospective Teachers’ Science Teaching Efficacy Beliefs Through Scaffolded, Student-Directed Inquiry

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Abstract

This study examined the impact of a recently revised science course that engaged preservice teachers in a scaffolded, student-directed inquiry unit on local streams. Upon the completion of the inquiry project, the teacher candidates in the stream study classes demonstrated significantly greater improvement in the personal science teaching efficacy (PSTE) beliefs than their peers did in the non-stream study classes. Furthermore, the paper reported how the prospective elementary teachers perceived their understandings of science and the instructional strategies related to the stream study unit. Implications and recommendations for future studies are also discussed.

According to the most recent science education reform documents, improving students’ understanding of science and scientific inquiry is critical for developing a scientifically literate society (American Association for the Advancement of Science [AAAS], 1993; National Research Council [NRC], 1996, 2000). Learning and teaching science as inquiry requires not only grasping scientific information, but also developing fundamental understandings and abilities to conduct scientific inquiry (NRC, 1996, 2000). In this article, we will investigate the effects of a recently revised science course that engaged the prospective teachers in a scaffolded, student-directed inquiry unit on local streams by examining whether the teacher candidates’ personal science teaching efficacy (PSTE) beliefs were changed and how the prospective teachers perceived their understandings of science and the instructional strategies associated with the stream study unit.

Background for the Study

Learning and Teaching Science as Inquiry

Scientific inquiry generally refers to the diverse ways in which scientists study the natural world. The publication Inquiry and the National Science Education Standards (NRC, 2000) identified the following five essential features of classroom inquiry: (1) learners are engaged by scientifically oriented questions; (2) learners give priority to evidence in responding to questions; (3) learners formulate explanations from evidence to address scientifically oriented questions; (4) learners evaluate their explanations in light of alternative explanations, particularly those reflecting scientific understanding; and (5) learners communicate and justify their proposed explanations.
To further distinguish among various forms of classroom inquiry, science education researchers have also developed an inquiry continuum that classifies classroom inquiry into different levels from structured inquiry to open inquiry. Whereas the traditional confirmatory laboratory experiences, or cookbook labs, usually provide students with step-by-step procedures to verify known principles, in structured inquiry, the teacher presents a question, lab equipment, and procedures for students to complete the inquiry. Subsequently, students need to make conclusions based on their findings or results. At the second level of the inquiry continuum, known as guided inquiry, the teacher provides a question and lab equipment, while the students design the procedure, analyze data, and make conclusions. In student-directed inquiry, the third level, the teacher presents a topic and lets students develop their own questions and design their own investigations. The highest level of the inquiry continuum is referred to as open inquiry or student research inquiry. At this level, students select topics and investigate their own questions (e.g., Bonnstetter, 1998).

To date, various studies have reported the positive effects that inquiry-oriented science learning and teaching have on preservice teachers’ understanding of the nature of science, attitudes and beliefs about science learning and teaching, and their classroom teaching performance (e.g., Adamson et al., 2003; Haefner & Zembal-Saul, 2004; Haim, 2003; McGinnis, Kramer, Shama, Graeber, Parker, & Watanabe, 2002; Richardson & Liang, 2008; Slater, Safko, & Carpenter, 1999). However, the difficulties and limitations of inquiry teaching have also been reported (e.g., Dreyfus, Jungwirth, & Eliovitch, 1990; Riggs & Kimbrough, 2002). Studies suggest that successful inquiry teaching requires significant intellectual commitment on the part of the learners as well as deep cognitive engagement in the subject. Because of this, simply having learners conduct inquiry activities and/or scientific experiments is not sufficient in developing a fundamental understanding of science and scientific inquiry.

The more recent research on learning and teaching has pointed to the importance of scaffolded inquiry (i.e., providing scaffolds or written instructional supports during student inquiry) and promoting learners’ meta-cognitive awareness (i.e., deliberate, conscious control of cognitive activity) in developing lifelong learners (Krajcik, Blumenfeld, Marx, & Soloway, 2000; NRC, 1999, 2005). It has been reported that students who enrolled in inquiry-based science classes with metacognitive facilitation or a reflective assessment component outperformed their counterparts in similar classes without metacognitive facilitation. Furthermore, adding this metacognitive or reflective assessment process to science curriculum was particularly beneficial for conventional lower-achieving learners (e.g., Liang & Gabel, 2005; White & Frederiksen, 2000).

**Prospective Elementary Teachers’ Beliefs About Learning and Teaching Science**

The connection between beliefs, learning, and teaching performance can be captured by the psychological construct of self-efficacy (Bandura, 1977). According to an exhaustive review of the literature on self-efficacy, the evidence across studies has consistently shown that an individual’s perceived self-efficacy contributes significantly to the level of his or her motivation and performance accomplishments (Bandura, 1977, 1997). In his theory of social learning, Bandura (1977) outlined two components of self-efficacy: (1) personal efficacy and (2) outcome expectancy. Personal efficacy refers to the conviction that an individual