Using the STEBI-B to Determine the Impacts of a Standards-Driven Course on Pre-service Students' Sense of Personal and Teaching Efficacy in Science Education

Pamela G. Christol, Northeastern State University
April Dean Adams, Northeastern State University

Abstract

This paper addresses the impacts that a Standards-driven course has on pre-service teachers' sense of personal science teaching self-efficacy and teaching efficacy beliefs related to outcome expectancy in the area of science education. Quantitative data were gathered from the Science Teaching Efficacy Beliefs Instrument Form B (STEBI-B), consisting of two subscales: a Personal Science Teaching Efficacy (PSTE) Belief Scale and the Science Teaching Outcome Expectancy (STOE) Scale. The fifty-five subjects involved in this pretest, posttest one group research design study are pre-service elementary, early childhood and special education teachers from Northeastern State University enrolled in the course, *Science in the Elementary School*, during the spring semester of 2005. Results suggest that the course teaching strategies may be responsible for the improvement in personal science teaching self-efficacy, and that modifications to the course are necessary in order to facilitate positive changes in outcome expectancy beliefs by pre-service educators.

Introduction

Over the past several decades, the quality and amount of instruction in science education in elementary schools has been of concern (Tilgner, 1990; Gee, 1996). Stefanich and Kelsey (1989) found that, in elementary schools, less time is spent on science instruction than on any other subject. An earlier study found that 90% of teachers relied on textbooks 90% of the time in elementary science instruction (Stake & Easley, 1978). Later studies found that, in grades 1-6 in self-contained elementary classes, an average of only about half an hour per day was spent on science instruction, compared to almost an hour per day on mathematics instruction, and approximately 70 minutes on reading/language arts instruction (Weiss, Matti, & Smith, 1994). Furthermore, science instruction has been found to be comprised primarily of textbook readings, memorizing, repeating and confirming scientific facts and listening to lectures (Yager & Lutz, 1994).

There are many goals in elementary science teacher education, which include instilling confidence in pre-service teachers' ability to teach science successfully. Teachers who lack confidence, based on a healthy science teaching self-efficacy, are less likely to teach science (Ramey-Gassert & Shroyer, 1992). Many studies have used self-efficacy to investigate factors impacting pre-service teachers' belief system and their sense of confidence as it relates to their ability to be successful teachers (Tschannen-Moran, Hoy, & Hoy, 1998). The relationship among teacher performance, teacher self-efficacy and student achievement has been identified through research (Ashton, 1984). Low self-efficacy towards teaching elementary sciences may result in avoidance of teaching science and a reduced quality of science instruction by those teaching science (Riggs, 1988). Solutions may be provided through researching self-efficacy and related science teaching behaviors (Riggs, 1991).

According to Bandura (1986), efficacy differs from other types of self-appraisal, including self-concept and self-esteem. The most central and pervasive mechanism of personal agency controlling human motivation, affect, and action is self-efficacy. Through cognitive, motivational, and affective mediating processes, the principles of self-efficacy operate on behavior (Bandura, 1989). As the level of induced self-efficacy increases, the higher the performance accomplishments (Bandura, 1982; Ashton, 1984). Based on Bandura's work on self-efficacy, Enochs and Riggs (1990) devised the Science Teaching Efficacy Belief Instrument (STEBI-B) to measure science teaching self-efficacy and outcome expectancy in pre-service elementary teachers.

Since its development in 1990, the STEBI-B has been used in studies to measure science teaching self-efficacy. This instrument resulted from Bandura's (1977) self-efficacy theory, which suggests that behavior can be predicted by considering two factors. The first theory posits

that if an action is believed to have a favorable result, people will be motivated to perform that action. This is known as outcome expectation. The second, self-efficacy expectation is the belief that the action can be performed successfully. By analyzing these two factors, it is thought that behavior can be predicted. The two scales that make up the STEBI-B are the Personal Science Teaching Efficacy (PSTE) Belief Scale and the Science Teaching Outcome Expectancy (STOE) Scale. These were designed to be used with pre-service elementary school teachers as an accurate predictor of science teaching behavior.

Science Content Course

The course that is described in this study is a science requirement for all elementary education, early childhood education, and special education majors at Northeastern State University (NSU). NSU is a regional university in Oklahoma with approximately 9500 students on three campuses. The original campus in Tahlequah serves primarily students from rural northeastern Oklahoma. The campuses in Muskogee and Broken Arrow serve students from urban areas in Northeastern Oklahoma. NSU is a comprehensive, primarily undergraduate university that focuses on teacher preparation. The College of Education is the largest college at NSU and teacher preparation is an important mission of the university. Methods courses for specific content areas are taught in the content area college, not the College of Education. This practice facilitates the hiring of science education and mathematics education faculty by the College Science and Health Professions.

Entitled, *Science in the Elementary School*, the course is a general science content course that teaches science through inquiry and that attempts to help students integrate knowledge of science, learning, pedagogy and students. The course utilizes integrated hands-on inquiry, discussion, demonstration, and lecture format in which students and instructor are able to move

seamlessly from one instructional format to another as needed. Whenever feasible, concepts are taught through guided inquiry using hands-on materials. Discussions and interactions with groups and individual students are used to draw attention to important aspects of the inquiry. Short lectures provide explanations that are not directly available through hands-on inquiry and demonstrate important concepts. Students are given time to explore for themselves before class discussion and explanations. The course also attempts to help students integrate knowledge concerning science, learning, pedagogy, and students by providing contexts in which integration may occur and providing tasks that require integration of knowledge bases.

Although the primary focus of the course is the development of fundamental science content, the course also helps students integrate other knowledge bases that are important to teaching. After completing the course, the student will be able to **a**pply fundamental science concepts to everyday situations, demonstrate the appropriate use of science process skills and the nature of science by designing an age appropriate science instructional unit for the elementary classroom. They will also be able to identify effective teacher characteristics and become aware of effective teaching strategies for science instruction.

In particular, the course attempts to address the following professional development standards from the National Science Education Standards (NSES) (NRC, 1996):

> Professional Development Standard A: Professional development for teachers of science requires learning essential science content through the perspectives and methods of inquiry. (p. 59)
>
> Professional Development Standard B: Professional development for teachers of science requires integrating knowledge of science, learning, pedagogy, and students; it also requires applying that knowledge to science teaching. (p. 62)

The instructor of this reformed course holds a B.S. in Physics, an M.S. in Biology, and an Ed.D. in Curriculum and Instruction, Science Education. The students involved in this study are pre-service teachers from Northeastern State University enrolled in the course, *Science in the Elementary School*.

Purpose

Research indicates that elementary teacher preparation programs lack adequate science content and scientific literacy preparation (Fort, 1993; NRC, 1996: Tobias, 1992 & 1990). The National Science Education Standards (NSES) (National Research Council, 1995) recommend changes in the way teacher preparation programs prepare elementary teachers. However, little impact has been made in teacher preparation programs on the beliefs and practices of pre-service teachers (Raizen & Michelsohn, 1994). This paper addresses how the changes implemented in the described course affect pre-service teachers' sense of personal and teaching efficacy.

Methods

This study involves 55 students during the spring semester of 2005 enrolled in the course, *Science in the Elementary School*. The demographic information of the total number of students enrolled in the course is summarized in Table 1.

Table 1

Demographic Information

Demographic	Percentage
Gender	
Men	9.6%
Women	91.4%

Class	
Juniors	15.5%
Seniors	84.5%
Major:	
Elementary Education	63.8%
Early Childhood	20.7%
Special Education	10.3%
Undeclared	3.4%
Other	1.7%

N=58 (Demographics of Entire Class)

Procedure

Fifty-five students were given the STEBI-B (Enochs & Riggs, 1990), pretest on the first day and 51 students were given the STEBI-B posttest on the last day of the semester. The STEBI-B is composed of two subscales, Personal Science Teaching Efficacy (PSTE) and Science Teaching Outcomes Expectancy (STOE) and consists of 23 Likert items, each with five response categories – strongly agree, agree, uncertain, disagree, and strongly disagree. Scores on the PSTE may range from 13 to 65, and STOE scores may range from 10 to 50. The STEBI-B reliability analysis has an alpha coefficient of 0.90 for the PSTE subscale and an alpha coefficient of 0.76 for the STOE subscale.

Results and Discussion

An independent, two-tailed t-test was applied to the STEBI-B PSTE subscale scores and to the STEBI-B STOE subscale scores separately to determine if there was a significant

difference between the means of the pretests and the posttests. There was a significant difference between the pretest and posttest means on the STEBI-B for the PSTE subscale (Pretest mean = 46.76, n =55, SD = 6.07, Posttest mean = 49.92, n =51, SD = 6.06, $t = 2.70$, $p < 0.01$.) There was no significant difference between the pretest and posttest means on the STOE subscale (Pretest mean score = 35.11, n = 55, SD = 0.571 n = 51, the posttest mean score = 35.98, SD = 0.515.) A comparison of the pretest and posttest means indicated that significant improvement was found in self-efficacy, but no significant change was found in outcome expectancy. Only personal science teaching efficacy changed in the pre-service students after taking the Standards-driven course, *Science in the Elementary School*. These results are summarized in Table 2.

Table 2

Means and *t*-Test Results for PSTE and STOE Pretests and Posttests

	Mean	S.D.	Std. Error Mean	*t*-Statistic	Significance
PSTE					
Pretest*	46.76	6.07	0.819	2.70	$p < 0.01$
Posttest**	49.92	6.06	0.848		
STOE					
Pretest*	35.11	4.23	0.571	1.13	Not
Posttest**	35.98	3.68	0.515		Significant

* N = 55
**N = 51

Conclusions and Implications

Addressing the NSES Professional Development Standards A and B, the course teaches concepts primarily through guided inquiry using hands on materials. It also strives to help students integrate knowledge concerning science, learning, pedagogy, and students by providing contexts in which integration may occur and providing tasks that require integration of knowledge bases. Improvement in personal self-efficacy by the NSU pre-service students as evidenced by the results of the STEBI-B Personal Science Teaching Efficacy (PSTE) subscale suggest that the course teaching strategies may be responsible for these changes. Results also indicate that modifications to the course are necessary in order to facilitate positive changes in outcome expectancy beliefs by pre-service teachers.

Suggestions for future studies include determining whether these gains in personal teaching self-efficacy are carried into the classroom after pre-service teachers begin their teaching careers. The data obtained from this study were drawn from a single institution and an individual instructor, therefore generalizing results from this study to other academic institutions is limited. Suggestions include replicating this study with students from other institutions and from courses taught by other instructors at the same institution.

This material is based upon work supported by the National Science Foundation under grant number ESI-0455573. Any opinions, findings, and conclusions or recommendations expressed in these materials are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

References

Ashton, P. (1984). Teacher efficacy: A motivational paradigm for effective teacher education. *Journal of Teacher Education, 35*(5), 28-32.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*, 191-215.

Bandura, A. (1981). Self-referent thought: A developmental analysis of self-efficacy. In J. H. Flacell & L. Ross (Eds.), *Social cognitive development frontiers and possible futures*. (pp. 200-239). Cambridge University Press.

Bandura, A. (1982). Self-efficacy mechanism in human agency. *American Psychologist,* 37*(2),* 122-147.

Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory, Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A. (1989). Human agency in social cognitive theory. *American Psychologist,* 44 (9), 1175-1184.

Bleicher, R.E. (2001, March). *Building science teaching confidence in pre-service Elementary teachers*. Paper presented at the annual meeting of the National Association of Research in Science Teaching Association, St. Louis, MO.

Bleicher, R.E. (2002, April). *Increasing confidence in pre-service elementary teachers.* Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA.

Bleicher, R.E., & Lundgren, J. (2002). Building confidence in pre-service elementary Teachers. In P. Rubba, .W. DiBiase, & B. Crawford (Eds.), *Proceedings of the*

2002 Annual International Conference of the Association for the Education of Teachers in Science. (pp1549-1562). ERIC Document Reproduction Service No. ED 465 602.

Enochs, l., & Riggs, I. (1990). Further development of an elementary science Teaching efficacy beliefs instrument. *School Science and Mathematics,* 10, 194-202.

Fort, D. (1993). Science shy, science savvy, science smart. *Phi Delta Kappan,* 74, 674-683.

Gee, C.J. (1996). *Pre-service elementary teachers: Their science content knowledge, pedagogical knowledge, and pedagogical content knowledge.* Paper presented at the National Association for Research in Science Teaching, St. Louis, Missouri.

Ginns, I.S., & Foster, W.J., (1983). Pre-service elementary teacher attitudes to science and science teaching. *Science Education, 67*(2), 277-282.

Jarrett, O.S. (1999). Science interest and confidence among pre-service elementary teachers. *Journal of Elementary Science Education, 11*(1), 49-59.

National Research Council. (1996). *National science education standards.* Washington, D.C: National Academy.

National Science Teachers Association (1992). *The content core.* Washington, DC: National Science Teachers Association.

Raizen, S.A., & Michelsohn, AM. (Eds.). (1994). The future of science in elementary schools: Educating prospective teachers. San Francisco: Jossey-Bass.

Ramey-Gassert, L., & Shroyer, M.G. (1992). Enhancing science teaching self-efficacy

in pre-service elementary teachers. *Journal of Elementary Science Education,* 4, 26-34.

Riggs, I. (1988). The development of an elementary teacher's science efficacy belief instrument. Unpublished manuscript, Kansas State University, Manhattan, Kansas.

Riggs, I.M. (1991, April 3-7). *Gender differences in elementary science teacher self-efficacy.* Paper presented at the American Educational Research Association, Chicago, IL.

Riggs, I.M., & Enochs, L.G. (1990). Toward the development of an elementary teacher's science teaching efficacy belief instrument. *Science Education,* 74(6), 625-637.

Settlage, J. (2000). Understanding the learning cycle: Influence on abilities to embrace the approach by pre-service elementary school teachers. *Science Education,* 84, 43-50.

Stake, R.E., & Easley, J.A. (1978). *Case studies in science education.* Urbana, IL: Center for instructional research and curriculum evaluation and committee on Culture and cognition, University of Illinois at Urbana-Champagne, Vols. 1 and 2.

Stefanich, G.P., & Kelsey, K.W. (1989). Improving science attitudes of pre-service teachers. *Science Education,* 73, 187-194.

Stevens, C., & Wenner, G. (1996). Elementary pre-service teacher's knowledge and beliefs regarding science and mathematics. *School Science and Mathematics,* 96, 2-9.

Tilgner, P.J. (1990). Avoiding science in the elementary school. *Science Education, 74*

(4), 421-431.

Tobias, S. (1990). *They're not dumb, they're different: Stalking the second tier*. Tucson, AZ: Research Corporation.

Tobias, Sheila. (1992). *Revitalizing undergraduate science: why some things work and why most don't.* Tucson, AZ: Research Corporation.

Tschannen-Moran, M., Hoy, A., & Hoy, W. (1998). Teacher efficacy: Its meaning and Measure. *Review of Educational Research,* 68(2), 202-248.

Weiss, I.R. (1997). Comparing teacher views and classroom practice to national standards. *National Institute for Science Education Brief, 1*(3), 1-11.

Weiss, I.R., Matti, M.C., & Smith, P.S. (1994). *Report of the 1993 national survey of science and mathematics education.* Chapel Hill, NC: Horizon Research.

Yager, R., & Lutz, M. (1994). Integrated science: The importance of "how" verses "what." *School Science and Mathematics,* 94, 338-346.