Spring 5-2011

Science Teaching Efficacy Beliefs of 5th and 8th Grade Science Teachers

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The University of Southern Mississippi

SCIENCE TEACHING EFFICACY BELIEFS OF 5^{TH} AND 8^{TH} GRADE SCIENCE TEACHERS

by

Susan Melony Hanson

A Dissertation
Submitted to the Graduate School
of The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

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ABSTRACT

SCIENCE TEACHING EFFICACY BELIEFS OF 5^{TH} AND 8^{TH} GRADE SCIENCE TEACHERS

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The purpose of this study was to determine which, if any, variables had a significant relationship to personal science teaching efficacy beliefs and outcome expectancies. The independent variables tested were number of undergraduate science methods courses taken, level of teacher education, number of years as a classroom teacher, number of years as a science teacher, teacher beliefs regarding instructional strategies in science, and teacher beliefs regarding student engagement in the science classroom. Through surveys completed by 5^{th} and 8^{th} grade science teachers, the researcher analyzed data via multiple regressions to determine significance. Results of the data analysis showed the greatest significance was between personal science teaching efficacy beliefs and number of years as a classroom teacher, and teacher beliefs regarding instructional strategies in science and outcome expectancy and student engagement in the science classroom. Implications for current practice include a need for improved teacher education programs for pre-service science teachers, collaboration between universities and public school districts, improved methods for teacher retention in the science classroom, and the use of hands-on and minds-on instruction in the science classroom.

DEDICATION

This dissertation is dedicated to my father, the late Carnie Ray Harvey. My father set my feet on the path for this goal, but did not live to see his dream fulfilled. I would not have achieved this goal without the values my father instilled in me from a very young age. Through his commitment to hard work and his emphasis of the importance of an education, my father served as the ultimate role model for me. I love you and miss you Daddy Boy.

ACKNOWLEDGMENTS

I would like to take this opportunity to thank those who have stood beside me and helped me through this journey. I would first like to thank my committee members; Dr. Rose Jones, Dr. J.T. Johnson, Dr. Marybeth Evans, Dr. Hani Morgan, Dr. Stacy Reeves, and Dr. Barbara Stanford. A special thanks to Dr. Rose Jones for her tireless efforts and willingness to talk, even when it was very late in the evening. You have been a special mentor and friend through this entire journey. I would next like to thank my husband, Rod, for the endless nights of frozen pizzas and peanut butter and jelly sandwiches he consumed because I was in class or working on this study. I could not have reached this goal without your ceaseless support and willingness to sacrifice. I love you with all my heart. I would also like to thank my mother, Linda Harvey, for her unconditional love, strength, and support of my decision to pursue my Ph.D. She has been my inspiration and biggest cheerleader whenever I doubted myself. To my sister, Melinda Sharpton, words cannot express what you mean to me. Thank you for always being there for me. I would finally like to say to my nephew, Ryan, and my nieces, Raye-Anna, Rylee, Allie, Mollie, and Carlie, that the most important gift you can give yourself is the gift of a good education. Strive to be the best and aim for the stars - with hard work and perseverance you can accomplish anything. Nana loves you all.

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CHAPTER I

PROBLEM

Introduction

In 1989, the American Association for the Advancement of Science's Project 2061 published *Science for All Americans*. The purpose of the publication was to identify educational practices that would serve to make the next generations of students literate in science. The authors of the publication noted that students in the United States rank near the bottom in science when compared to international studies of science education performance. The performance of seventeen-year-olds at this time was still lower than performance levels in 1969; a statistic also mentioned in *A Nation at Risk* (1983). The results of these studies spurred a reform movement in science education. Wixson, Dutro, and Athan (2003) stated "This modern reform movement has been characterized by efforts to create new policy instruments, to elicit, encourage, or demand changes in teaching and learning, and reduce the tangles of regulation, bureaucracy, proliferating policy, and incoherent governance that would impede reform" (p. 70).

Reform in Science Education

Southerland et al. (2007) noted the science reformation movement was led by the American Association for the Advancement of Science (AAAS), the National Science Teachers Association (NSTA), and the National Research Council (NRC). The collaboration of these groups resulted in "visions for science learners, standards for content, teaching and assessment; and descriptions of systemic changes needed to enact these standards" (Southerland et al., 2007, p. 47). The AAAS provided a definition of scientific literacy which was published in *Science for All Americans* (1989). The NSTA and NRC published the *National Science Education Standards* (1996) which set forth the standards for science teaching, professional development, assessment, content, programs, and systems. The following points detail the beliefs of the groups for science reform:

1. The goal of science education is to prepare people to lead personally fulfilling and responsible lives.
2. Democratic equality in science can be achieved by ensuring that students become scientifically literate.
3. Acquiring scientific literacy is no longer thought to be the goal for a select segment of the student population.
4. Inquiry is central to science education reform.
5. Students bring knowledge with them into the classroom and build from this knowledge to construct new scientific understandings.
6. The changes called for will be a slow, laborious process that will require a long-term, sustained effort. (Southerland et al., 2007, p. 48)

Researchers have also noted a conflict in communication between educators and policy makers with regard to science education reform. Because No Child Left Behind (NCLB), which is currently being reauthorized as the Elementary and Secondary Education Act (ESEA), mandates that science test scores are now a part of adequate yearly progress (AYP), it is imperative that improvements to science education are put into place (United States Department of Education, 2010). A clear line of communication between educators and policymakers must be present to ensure all aspects of science education reform are met. Southerland et al. (2007) suggested the idea of first-order/second-order change for the lead in reformation. The researchers defined first-order change as small changes to existing practices “e.g., changes in texts, number of students in a classroom, length of day, equipment” (p. 46). On the other hand, second-order change is “meant to alter the fundamental patterns of schooling; these changes are much more radical and transformative because they challenge the structures and rules that constitute traditional schooling practices… science education reforms…represent an attempt to enact second-order change” (p. 46).

The Framework for Science Education Reform

Constructivism

Gunel (2008) stated “Constructivism as a learning theory, therefore, emphasizes the role of the learner’s existing conceptual structure in making sense of the new learning experience” (p. 220). Constructivism is based on differing theories and practices; however, two basic beliefs underlie the premise: learners actively construct knowledge rather than learning information through transmission and educators must change curricula, classroom exchanges, and classroom dynamics (Gunel, 2008). Many theorists including Jean Piaget, Lev Vygotsky, Jerome Bruner, and John Dewey, can be credited with different theories regarding constructivism. However, the fundamental premises of these theories involve the construction of knowledge by children through thinking and interaction (Green & Gredler, 2002). Other researchers have further suggested that the effective teaching and learning of science should involve cooperative groups working together in a learning community (Liang & Gabel, 2005).

Standards-Based Instruction

The 1983 publication of *A Nation at Risk* made the public aware of the need for improvements in education in the United States, more specifically, science education with standards and inquiry-based instruction. Standards-based instruction involves not only standards for content, but standards for performance and opportunities to learn as well. Proponents of standards-based instruction argue there are three integral components needed for the implementation of standards-based instruction. Wixson et al. (2003) stated these components as:

> (a) establishing challenging academic standards for what all students should know and be able to do; (b) aligning policies—such as testing, teacher certification, and professional development—and accountability programs to the standards; and (c) restructuring the governance system to delegate overtly to schools and districts the responsibility for developing specific instructional approaches that meet the standards for which the state holds them accountable. (p. 71)

Thompson (2009) noted that advocates for science education reform support the use of standards-based instruction because research shows it improves teacher practices, student learning, and the quality of science instruction.

Swanson and Stevenson (2002) noted although reform movements have garnered national attention and support, the ultimate decision to move to standards-based instruction ultimately fell to the individual states, the majority of which have embraced the transition to standards-based instruction. Ultimately, four cornerstones emerged in response to changes in curricula throughout the states. These cornerstones were (a) content standards which detailed superior academic materials students must learn, (b) performance standards which detailed student mastery of required content, (c) aligned assessments which would test students statewide to measure performance in certain content areas, and (d) professional standards which set forth certification requirements to ensure teachers are skilled in teaching methods and subject knowledge (Swanson & Stevenson, 2002). Researchers have also noted the establishment of standards in school systems could enhance equal opportunities for all students (O'Day & Smith, 1993; Pajak, 2001).

Inquiry-Based Instruction

Colburn (1998) stated "Ideally, in an inquiry-based classroom authentic investigation is common…investigation may be stimulated by a problem posed by the teacher…or by students' natural curiosity" (p. 16). Keys and Bryan (2001) suggested that the *National Science Education Standards* promoted inquiry as the central tenant for science teaching. Students must have the abilities to engage in and understand scientific inquiry. The ability to engage in scientific inquiry includes (a) identifying and posing questions, (b) designing and conducting investigations, (c) analyzing data and evidence, (d) using models and explanations, and (e) communicating findings. The ability to understand scientific inquiry includes knowing the processes used by scientists and knowledge of scientific concepts (Keys & Bryan, 2001).

Keys and Bryan (2001) further noted Nespor's (1978) frameworks for teacher beliefs which stated "they are episodic (based on story), affective (value laden), and are built on existential presumptions (making abstract attributes such as ability real entities). These elements of a belief system may significantly affect how teachers implement inquiry-based instruction" (p. 635). Von Secker (2002) noted the *Standards* advocate a shift from teacher-centered lessons which use textbooks and lectures to:

> inquiry-oriented approaches that (a) engage student interest in science, (b) provide opportunities for students to use appropriate laboratory techniques to collect evidence, (c) require students to solve problems using logic and evidence, (d) encourage students to conduct further study to develop more elaborate explanations, and (e) emphasize the importance of writing scientific explanations on the basis of evidence. (p. 151)

Teacher Self-Efficacy and Science Teaching Efficacy

Bandura (1977) defined self efficacy as "the conviction that one can successfully execute the behavior required to produce the outcomes" (p. 193). Bandura's theory was founded on the belief that psychological actions in any form shaped and strengthened self-efficacy. Two sub-scales of self-efficacy are personal expectations and outcome expectations. Outcome expectancies are the beliefs people hold that certain behaviors will result in certain outcomes;

whereas, personal expectations are the beliefs people hold that they can successfully engage in the necessary behaviors to produce desired outcomes. Efficacy expectations are based on information from four areas: (a) performance accomplishments, (b) vicarious experiences, (c) verbal persuasion, and (d) physiological states. Each of these areas has varying modes of generation (Bandura, 1977). Riggs and Enochs (1989) stated “though science is required of all students in elementary school … elementary teachers do not usually teach science as a high priority … in a way that enhances student achievement” (p.3). The researchers also suggested that many teachers do not teach science in an effective manner because of low levels of self-efficacy and more specifically, science teaching efficacy. The ability to determine teacher efficacy regarding science teaching could contribute to the changes needed for improvements in science achievement (Riggs & Enochs, 1989).

Reform in Mississippi

The Mississippi Department of Education reformed the frameworks for science education in the state with the goal of raising test scores and to no longer be ranked last nationwide. The new framework implemented in 2010 set forth new goals for science education in Mississippi. These goals included (a) engaging in the national promotion of science, (b) the improvement of science education in Mississippi through research-based development of science standards and, (c) improved guidance and direction for planning instruction. Mississippi educational leaders determined research-based foundations for this change in the science framework. The new standards set forth were aligned to the 2009 National Assessment of Educational Progress (NAEP) science framework and National Science Standards and also included Depth of Knowledge (DOK) levels for each objective in every grade. The new framework was more challenging than the previous one because each grade and course contained (a) an inquiry strand, (b) science process skill, (c) critical thinking and problem solving skills, (d) allowed for conceptual development, and (e) vertically aligned objectives to allow scaffolding and spiraling of the framework (Mississippi Department of Education Office of Student Assessment, 2010).

Statement of the Problem

Recent research has determined that there is a significant deficit in science education in the United States. In September of 2008 the Mississippi Department of Education released the goals for the 2010 Mississippi Science framework. The goals included; (a) embracing the promotion of science, (b) implementing steps to improve science education, (c) implementing research-based science standards, and (d) improving planning and instruction. These changes came as a result of the 2005 NAEP report. According to the 2005 NAEP statistics report, fourth and eighth grade students in Mississippi rank the lowest of all states in science assessment. It is for these reasons that improvement in science education must take place in classrooms throughout Mississippi (Mississippi Department of Education Office of Student Assessment, 2010).

Researchers have determined that self-efficacy in science teaching can have an impact on science achievement. Personal expectations and outcome expectations are two measures of science teaching efficacy. The expectation measures are based on information from four areas which have varying modes of generation (Bandura 1977). Riggs and Enochs (1989) further noted that low levels of self-efficacy result in ineffective instruction in the science classroom. Determining science teaching efficacy, more specifically personal science teaching efficacy and science teaching outcome expectancy, could lead to positive results in student science achievement.

Research Questions and Hypotheses

The purpose of this study was to determine if relationships exist between personal science teaching efficacy and science teaching outcome expectancy and the identifying variables (a) number of undergraduate science methods courses, (b) level of teacher education, (c) number of years as a classroom teacher, and (d) number of years as a science teacher. The study was also an attempt to determine if relationships exist between personal science teaching efficacy and science teaching outcome expectancy and the variables of (a) self-efficacy beliefs about student engagement and (b) self-efficacy beliefs about instruction. From these research questions the following specific hypotheses emerged that were explored in this study:

H_1: The number of undergraduate science methods courses, level of teacher education, number of years as a classroom teacher, and number of years as a science teacher had a significant relationship to science teaching outcome expectancy.

H_2: The number of undergraduate science methods courses, level of teacher education, number of years as a classroom teacher, and number of years as a science teacher had a significant relationship to personal science teaching efficacy.

H_3: Self-efficacy beliefs about student engagement and instruction were significantly related to personal science teaching efficacy.

H_4: Self-efficacy beliefs about student engagement and instruction were significantly related to science teaching outcome expectancy.

Definition of Terms

For this study the following terms are relevant to the topic being studied. Definitions for each of the terms are listed below.

- Constructivism - knowledge that a learner did not gather solely from teachers; instead the learner's knowledge was constructed by the individual learner
- Inquiry-based instruction - inquiry-based practices are the best method for science instruction because teachers do not rely strictly on traditional instructional strategies such as, textbooks and lectures. Inquiry-based instruction provides ample opportunities for students to engage in thinking and questioning of concepts.
- Level of teacher education - undergraduate bachelor's degree or graduate degrees which include (a) master's degree, (b) master's degree through the alternative route, (c) specialist's degree, and (d) doctoral degree.

- Number of undergraduate science methods courses taken - those courses which are related to teaching science. This did not include courses that would be found as requirements in degrees for science and technology or prerequisite courses normally taken in the first two years of an undergraduate program. Examples of these courses would be, but are not limited to, biology, anatomy and physiology, physical science, and environmental biology.
- Number of years as a classroom teacher - the total number of years the participant has taught in a public or private school.
- Number of years as a science teacher - the total number of years the participant has taught science in a public or private school. This definition also includes the teaching of science only or in conjunction with other subjects.
- Personal science teaching efficacy - the confidence the science teacher has in his or her ability to successfully teach science.
- Science education reform – the movement to improve science education in the United States.
- Scientific literacy - the knowledge and understanding of scientific concepts in conjunction with the ability of students to ask and answer questions stemming from curiosity about daily occurrences, the ability of students to read and understand scientific articles, and the ability of students to identify scientific issues related to political decisions on both a local and national level. Issues related to political decisions include environmental

laws and anti-terrorism laws regarding defense against nuclear and biological warfare.

- Science teaching outcome expectancy - the belief of the science teacher those students in his/her science classroom will be influenced by effective teaching.
- Self-efficacy beliefs about student engagement - the beliefs teachers hold regarding engaging students in science lessons and activities.
- Self-efficacy beliefs about instruction - the beliefs teachers hold regarding his or her ability to design and implement successful science lessons.
- Standards-based instruction - standards-based instruction involves common teaching goals for teachers, a consistent and logical guide for instruction, and an equal opportunity for students of all languages, ethnicities, socioeconomic status, and level of learning to become scientifically literate.

Delimitations

The study was delimited in the following ways:

1. Only science teachers in five counties were used as participants.
2. Only fifth and eighth grade science teachers were asked to participate.
3. This study did not measure the subject knowledge of the participating science teachers.
4. This study did not measure student perceptions of science and the science classroom.

5. This study did not measure teacher curriculum planning or alignment for science.

Assumptions

There are assumptions that underlie the study. These assumptions were:

1. The participants answered all questions honestly.
2. All participants have some expertise in science teaching.

Justification

The first purpose for conducting this study was the result of data analysis for fifth and eighth grade Mississippi Science Test (MST) scores. The mean scores for the 2008-2009 school year were 556.6 for fifth grade and 854.00 for eighth grade (Mississippi Department of Education Office of Student Assessment, 2010). This places fifth and eighth grade means in the basic range. These statistics are of concern because science test scores are a part of adequate yearly progress (AYP). If states are not performing at the proficient or advanced level in science AYP will be adversely affected. This could result in non-compliance with the requirements of NCLB and the current proposed reauthorization of NCLB known as the Elementary and Secondary Education Act (ESEA).

A second purpose for conducting this study was the researcher's personal beliefs regarding the importance of science in schools. Many students are choosing fields of study other than science due to many contributing factors. Singh, Granville, and Dika (2002) stated:

> The middle school years, Grades 5 through 8, are a critical period for American students regarding achievement in mathematics and science. Achievement in these subjects in middle school determines high school curricular choices and enrollment in higher level mathematics and science courses. These curricular opportunities and choices further influence access to postsecondary and occupational opportunities. (p. 323)

The researchers further suggested because of the sequential nature of these courses, success in the middle grades was essential to enrollment in advanced courses in later grades (Singh et al., 2002).

With this information in hand, research was conducted to determine what factors could be influencing test scores. From this research it was determined that one of the emerging fields of study regarding science education was science teaching efficacy. After a thorough review of the literature the researcher came to the conclusion that further studies of subject specific efficacy beliefs, science in particular, was warranted. Results of this study offer several potential benefits which include: (a) improvement in MSST scores for both fifth and eighth grade students, (b) improvement in personal teacher beliefs that science can be taught successfully, (c) improvement in professional development for in-service teachers, (d) improvement in preparation of pre-service teachers for teaching science in elementary and secondary classrooms, (e) improvement in science curricula for Mississippi school districts, and (f) improvement in national rankings for Mississippi science test scores. The results of this research will meld into the current literature because researchers are now focusing on more subject specific efficacy beliefs of teachers. This study will also be pertinent to the literature because it addresses components that are essential to the current science education reform movement.

CHAPTER II

REVIEW OF LITERATURE

Introduction

This study examined the relationship of science teaching efficacy beliefs and teacher efficacy beliefs about student engagement in science and instructional practices in science. This chapter will address the history of science education in the United States, the theoretical framework for this study, the need for reform in science education which will include student engagement in science and instructional practices in science, teacher self-efficacy, and the requirements mandated by the Mississippi State Department of Education and the United Stated Department of Education for science. The review of literature for the theoretical framework will address constructivism and the major theorists associated with the theory. With regard to reformation of science education, this review will address the need for scientific literacy through standards-based and inquiry-based instruction, the need for improved staff development for in-service teachers, the need for improved teacher education programs to prepare pre-service teachers, and how students should be engaged in the science classroom.

The History of Science Education in the United States

In 1989, the American Association for the Advancement of Science's Project 2061 published *Science for All Americans*. The purpose of the publication was to identify educational practices that would serve to make the next generations of students literate in science. The authors of the publication noted that students in the United States rank near the bottom in science when compared to international studies of science education performance. The performance of seventeen-year-olds at this time was still lower than performance levels in 1969; a statistic also mentioned in *A Nation at Risk* (1983). In September of 2008 the Mississippi Department of Education released its goals for the 2010 Mississippi Science framework. The goals included, (a) embracing the promotion of science, (b) implementing steps to improve science education, (c) implementing research-based science standards, and (d) improving planning and instruction. These changes come as a result of the 2005 NAEP report. According to the 2005 NAEP statistics, fourth and eighth grade students in Mississippi rank the lowest of all states in science assessment (Mississippi Department of Education Office of Student Assessment, 2010). It is for these reasons that improvement in science education must take place in classrooms across the United States.

Mintzes and Wandersee (2005) stated “the history of science education in the United States is characterized by large-scale, recurring, and at times disruptive and detrimental shifts in curricular emphases and instructional practices at the elementary and secondary school levels” (p. 29). The authors further stated “Typically these shifts reflect a response to some real or imagined threat posed by domestic or international circumstances in the political, social, economic, or military areas” (p. 29). Although science teachers have not taken on the entire burdens of these shifts, they have endured more disorder due to the role science has played in national defense.

The push for improvements in science education can be dated back to the launch of Sputnik. Rigdon (2007) noted the October 4, 1957 launch of Sputnik led to a time of firm influences of the scientific community on politicians. Beginning in 1957, Dwight D. Eisenhower actively sought advice from top scientists until the end of his presidency. As a result of the newly dubbed “race to space,” came the formation and/or improvement of agencies to improve science and mathematics education in the United States. Of these agencies were most notably The National Science Foundation (NSF) and The National Aeronautics and Space Administration (NASA). As a response to the launch of Sputnik, Congress tripled the portion of funding education for the NSF’s appropriated budget. On July 29, 1958, Congress passed the National Aeronautics and Space Act which led to the official beginning on October 1, 1958 of NASA (Rigdon, 2007).

For fifteen years improvement to science and mathematics education was of vital importance in the United States. However, the fervor to put the United States on top in the field of science waned and once again the subject of science was literally forgotten (Bybee, 2007). Some researchers would argue that a new Sputnik-event would solve the problem. Bybee noted there would never be another Sputnik, however; an era of significant reforms in science, technology, engineering, and mathematics was needed to ensure the United States had scientifically literate individuals. Bybee further noted reforms should include the development of new instructional materials for science and technology, certification of science teachers should be aligned with national standards, and keeping the public aware of what school science reform is and why it is beneficial to students (Bybee, 2007).

Other researchers would argue a Sputnik-event has already occurred. The 1983 publication of *A Nation at Risk* made the dilemma of science education in the United States public knowledge. The preeminence of the United States in science had been overtaken by other countries, and there had been a consistent decline in science achievement scores since 1969. Researchers determined that students in the United States were scientifically illiterate, and a commitment to life-long learning must be present to solve problems in science education. It was concluded from the research findings that educational declines in the United States were a result of inadequacies in content, expectations, time, and teaching. The researchers recommended a strengthening of graduation requirements, more rigorous and measurable standards in schools, and improved teacher preparation programs with all of the recommendations being specifically related to science education (*A Nation at Risk,* 1983).

In 2008 the National Center for Education Statistics, Institute of Education Sciences released *The Condition of Education 2008*. Indicator nineteen was the international comparison of science literacy based on the 2007 Program for International Student Assessment's (PISA) findings. The report was in regard to science literacy of 15-year-olds. The researchers determined that the average science literacy score in the United States was 489 which fell below the international average of 500. When specific science sub-skills were examined, it was determined that students in the United States were deficient in explaining phenomena scientifically and in using science evidence. The key element identified as being imperative to science education reform was what students should know and be able to do in science. Educators have articulated a need for a new view of science achievement. To support this idea, a balanced approach which considers alternatives and changes in science is needed. The problem in achieving this balance is finding a viable way to combine traditional and alternative perspectives of science (National Center for Education Statistics, 2008).

Theoretical Basis for Reform

Mintzes and Wandersee (2005) suggested that reform of science education should include reformations of the current curriculum and classroom practices of teachers. The researchers further noted that science teachers needed to understand the desired reforms, become acquainted with reform leaders, and evaluate the necessary changes with regard to the impact on student learning and achievement in science. The failure of teachers to embrace the proposed changes can lead to control of standards and teaching practices in the science classroom that would be delegated by people other than educators.

Constructivism

The reform movement for science education was led by the theory of constructivism (Erdogan & Campbell, 2008). Constructivism can be defined as knowledge that a learner did not gather strictly from teachers, instead the learner's knowledge was constructed by the individual learner (Matthews, 2003; Peters, 2006). Gunel (2008) stated “Constructivism as a learning theory, therefore, emphasizes the role of the learner's existing conceptual structure in making sense of the new learning experience" (p. 220). The implications for science education were ground-breaking due to social constructivist doctrines (Slezak, 2001; Peters, 2006). In *Science for All Americans* (1989), the authors did not explicitly define constructivism; however, the authors stated "People have to construct their own meaning regardless of how clearly teachers or books tell them things. Concepts are learned best when they are encountered in a variety of contexts and expressed in a variety of ways" (Chapter 13, para. 4). When students learn in this manner it is assured that information becomes imbedded in their knowledge. Powell and Kalina (2009) noted that for students to be able to construct knowledge, the teacher must know each student's current stage of knowledge.

Colburn (1998) stated "From a constructivist viewpoint, science teaching involves helping students understand how and why some knowledge explains and predicts more accurately than other (prior) knowledge (or beliefs) by providing experiences and opportunities that encourage students to construct accurate knowledge" (p. 11). Colburn further stated "Because no student is void of knowledge … learning science involves replacing some ideas with others … students must be makers of knowledge" (p. 11). In order for science teachers to apply constructivist principles they must help students change their thinking. Science teachers must make students discontented with misconceptions, a belief related to Piaget's equilibration theory. This dissatisfaction with concepts was not the only element of reformation needed to move toward a constructivist view of science teaching. The researcher noted a shift to inquiry-based teaching was imperative (Colburn, 1998).

Constructivist Theorists

John Dewey. Dewey can be considered one of the most influential theorists of educational practices. Although a student of philosophy, Dewey and his wife worked collaboratively to develop the best methods for education. Dewey was a progressive educator who shared the beliefs of Vygotsky, Montessori, and Piaget (Mooney, 2000). Mooney stated these beliefs as "education should be child centered; education must be both active and interactive; and education must involve the social world of the child and the community" (p.4). Dewey's beliefs regarding how children learn best are as follows:

1. Children learn best when they interact with other people, working both alone and cooperatively with peers and adults.
2. Children's interests form the basis for curriculum planning.
3. Education is a part of life. As long as people are alive, they are learning, and that education should address what the person needs to know at the time, not prepare them for the future. He further believed that curriculum should grow out of the real home, work, and other life situations.
4. Teachers must be sensitive to the values and needs of families. These should be reflected in and deepened by what happens at school.

5. Teachers do not teach just subject matter, but also how to live in society. Dewey also felt that teachers did not just teach individual children, but also shape society. (Mooney, 2000, p. 5)

Dewey further believed that when students were interested in what was being presented and could relate the concepts to real life, learning was enjoyable (Mooney, 2000). Howes (2008) noted the use of Dewey's educative experiences enabled teachers to better understand the concepts of real-world and hands-on learning in the science classroom. Dewey further believed that teachers should be confident when planning lessons and the curriculum used in the classroom should be based on the teacher's knowledge of the students and their abilities (Mooney, 2000).

Jerome Bruner. Educated as a psychologist, Jerome Bruner became a proponent of education in the 1950s. Bruner authored the highly successful book *The Process of Education: A Landmark in Educational Theory.* In the book, Bruner noted the belief that children had the ability to understand basic science concepts at an early age. Bruner argued that science curriculum should be designed as a scaffold to cultivate these early abilities (Bruner, 1977). Bruner can clearly be noted as a proponent of constructivism and science education as evidenced by this statement:

> we have reached a level of public education in America where a considerable portion of our population has become interested in a question … "What shall we teach and to what end?" The new spirit perhaps reflects the profound scientific revolution of our times as well.

> The trend is accentuated by what is almost certain to be a long-range crisis in national security, a crisis whose resolution will depend upon a well-educated citizenry. (p. 1)

Bruner further stated “massive general transfer can be achieved by appropriate learning, even to the degree that learning properly under optimum conditions leads one to “learn how to learn” (p. 6).

Jean Piaget. The concept of cognitive constructivism was developed by Jean Piaget. Although he had not planned on working with children, Piaget was a major contributor to the field of education (Mooney, 2000). Piaget’s (1953) focal point for constructivism involved the individual child and how that child constructed knowledge. Working with children at the Alfred Binet Laboratory School, Piaget began to question the thought process of children while observing similarities at certain ages of wrong answers given by the children. The subsequent work completed by Piaget gave a profound view of how children create knowledge (Mooney, 2000).

Piaget believed that humans could not immediately understand knowledge given to them. Instead they had to use the information given and construct their own knowledge. Piaget further believed children constructed schemas through the process of assimilation and accommodation. This process occurred during four different developmental stages, sensorimotor (ages zero to two), preoperational (ages two to seven), concrete operational (ages seven to 11), and formal operational (ages 11 to adulthood). The learning abilities of children in each stage were based on logical development. The idea of assimilation and accommodation were what Piaget believed helped children determine equilibration which occurred with the transition of one stage to the next. Until children can assimilate and accommodate new information Piaget stated they were in a state of disequilibrium. Piaget held the belief that teachers must understand the stages of development to know if students were able to grasp concepts logically. Only when students were clear on the attainment of concepts logically could effective learning occur (Piaget, 1953; Powell & Kalina, 2009).

Lev Vygotsky. Vygotsky began his career as a secondary literature teacher. Through classroom experiences, Vygotsky became interested in cognitive and language development and their relationship to learning. By studying the work of Sigmund Freud, Jean Piaget, and Maria Montessori, Vygotsky determined some children needed more assistance with learning than others (Mooney, 2000). Mooney (2000) stated:

> Vygotsky has changed the way educators think about children's interactions with others. His work showed that social and cognitive development work together and build on each other. Although Vygotsky shared Piaget's views that children's knowledge was constructed from personal experience, he thought that personal and social experience cannot be separated. (p. 82)

Social constructivism can be beneficial to students because there are high levels of collaboration and social interaction involved. The concept of social constructivism was developed by Lev Vygotsky. Vygotsky held the belief that social integration was a vital part of learning. The theory of social constructivism was based on Vygotsky's ideas regarding the social interactions of students in the classroom setting combined with each individual student's processes of critical thinking. Social constructivism included the language aspects of Vygotsky's theory of development (Powell & Kalina, 2009). One of Vygotsky's main learning theories was the zone of proximal development (ZPD) which he defined as" the place at which a child's empirically rich but disorganized spontaneous concepts meet the sytematicity and logic of adult reasoning. As a result of such a meeting, the weaknesses of spontaneous reasoning are compensated by the strengths of scientific logic" (Vygotsky, 1986, p. xxxv). Scaffolding and cooperative learning were also recognized as integral parts of social constructivism. Researchers have stated that scaffolding supported the ZPD and enabled students to progress to the next level of learning. In addition to scaffolding, Vygotsky believed that social interaction in conjunction with cultural influences affected students and their ability to learn (Vygotsky, 1986; Powell & Kalina, 2009).

Reformed Science Teaching and Learning

Society has evolved to the point that people must have the ability to solve complex problems and an understanding of science and technology. The need for these skills was a result of two major changes in society; global issues that are technological in nature and modern economies that have become saturated in technology. Because of these changes, reform in science education is a necessity. Research has shown students are not gaining science literacy in their classes (Wieman, 2006). In order for a reformation in science education to occur, all reform must be based on scientific teaching. This form of teaching involves active learning strategies that engage students in the process of science. Scientific teaching strategies have been tested and proven reliable for reaching all students. Researchers stress that the foundation for learning these strategies must be addressed in teacher education programs (Handelsman et al., 2004).

Scientific Literacy

The publication of Science for All Americans led the way for science education reform that was based on scientific teaching. Scientific teaching should include strategies in which the student would be actively involved in the science process, and these strategies should be proven through research (Handelsman et al., 2004). Because there is a national goal for all students to be scientifically literate, The National Research Council set forth the National Science Education Standards in 1996. These standards were formed to ensure American students had the resources and instructional strategies necessary to achieve the national goal of scientific literacy. Scientific literacy was defined in the *Standards* as “the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity” (p. 22). Scientific literacy includes the ability of students to ask and answer questions stemming from curiosity about daily occurrences, the ability of students to read and understand scientific articles, the ability of students to identify scientific issues related to political decisions on both a local and national level. Southerland et al. (2007) stated,

> The science education research community will not, and should not, reverse its focus on scientific literacy for all to more efficient performance on standardized tests. Scientific literacy entails construing effective science teaching as a practice that results in students' construction of applicable, meaningful, and useful knowledge. (p. 46)

The *Standards* (1996) included (a) standards for science teaching, (b) professional development for science teachers, (c) assessments in science, (d) science content, (e) science education programs, and (f) science education systems. Each of the standards was designed to emphasize excellence and equity and the need to understand that science is more than a process. The council stated "Inquiry is central to science learning … importance of inquiry does not imply that all teachers should pursue a single approach to teaching science … teachers need to use many different strategies to develop the understandings and abilities described in the *Standards*" (p. 2). Roth (2007) further noted that scientific literacy was collective and emergent and should not be hybridized into classrooms where no scientific communication or literacy could exist. Liang and Gabel (2005) stated "Whereas the vision of science education described in the Standards requires changes throughout the entire education system, the success of the reform in science education will eventually depend on teachers" (p. 1143).

Instructional Practices/Standards-Based Instruction

The foundation for inquiry-based learning was standards-based instruction. Researchers have determined that standards-based instruction was effective for science teaching. In a study conducted by Thompson in 2009, evidence was found that models such as the P3 Model (Preparation, Practice, and Performance) were reliable for helping schools that were experiencing difficulties with reforming science education and curricula.

The reform movement for standards-based education began in the 1990s. This movement advocated high standards for all students and was grounded in three principles which were (a) students should be engaged in challenging subject matter, (b) students should develop critical thinking skills, and (c) students should be able apply abstract knowledge to solve real-world problems. Although reform movements have garnered national attention and support, the ultimate decision to move to standards-based instruction ultimately fell to the individual states, the majority of which have embraced the transition to standards-based instruction. Ultimately, four cornerstones emerged in response to changes in curricula throughout the states. These cornerstones were (a) content standards which detailed superior academic materials students must learn, (b) performance standards which detailed student mastery of required content, (c) aligned assessments which would test students statewide to measure performance in certain content areas, and (d) professional standards which set forth certification requirements to ensure teachers are skilled in teaching methods and subject knowledge (Swanson & Stevenson, 2002).

There has been widespread agreement regarding the use of standards to improve the academic performance of students. The supporters of standards-based instruction purport many positive aspects of this form of instruction. Some of these positive aspects include,(a) common teaching goals for teachers, (b) a consistent and logical guide for instruction, and (c) an equal opportunity for students of all languages, ethnicities, socioeconomic status, and level of learning to become scientifically literate (Ogawa, Sandholtz, Martinez-Flores, & Scribner, 2003).

Instructional Practices/Inquiry-Based Instruction

In order for teachers to be effective teachers of science they must not only establish a collaborative environment within the classroom, but with colleagues as well. This can only be achieved if teachers possess knowledge of theory and practices related to science learning and teaching. Key to this knowledge is the concept of inquiry-based classrooms (National Science Education Standards, 1996).

Researchers have determined that inquiry-based practices were the best method for science instruction because students were given the chance to enhance higher order thinking skills while concurrently learning scientific concepts (Heppner, Kouttab, & Croasdale, 2006). Inquiry-based classrooms do not use traditional instructional strategies such as, textbooks and lectures. Instead of this more teacher-centered approach, Von Secker (2002) stated

> inquiry-oriented approaches … engage student interest in science, provide opportunities for students to use appropriate laboratory techniques …, solve problems using logic and evidence, encourage students to conduct further study to develop more elaborate explanations, and emphasize the importance of writing scientific explanations on the basis of evidence. (p.151)

Gunel (2008) stated that teachers who used traditional approaches presented science "as an accumulation of facts, theories, and rules that students have to memorize and practice" (p. 209). The results of these teaching methods were a decline in understanding science concepts, popularity of science, and the choice of science subjects as a specialization (Gunel, 2008; Millar, Osborne, & Nott, 1998). In order to create inquiry-based classrooms teachers must be proficient in questioning. This includes teacher knowledge of students' backgrounds and proper implementation and understanding of questioning techniques (Gunel, 2008).

Although many strategies for inquiry-based instruction are recommended for science teaching, teachers must create teaching practices that keep students engaged. These teaching practices will not be the same for all teachers. Each individual teacher must formulate the strategies appropriate to the factors pertinent to their classrooms. These factors include (a) teacher knowledge, (b) age of students, (c) knowledge level of students, and (d) student language proficiency (Keys & Bryan, 2001).

Improvements in Staff Development for In-Service Teachers

The *National Science Standards* (1996) advocates professional development for science teachers that is equivalent to that of teachers of other subjects. It is stated in the *Standards,* "Becoming an effective science teacher is a continuous process that stretches from preservice experiences in undergraduate years to the end of a professional career" (p. 55). To ensure reform changes take place, professional development for science teachers must involve active engagement in learning that increases teacher knowledge, understanding, and ability in science education. Four standards are suggested for science teaching professional development which include professional development that (a) teaches science through inquiry, (b) integrates knowledge and pedagogy, (c) builds understanding for lifelong learning, and (d) is coherent and integrated (National Science Standards, 1996).

Davis, Petish, and Smithey (2006) researched five areas science teachers were expected to understand. These areas included “(1) the content and disciplines of science, (2) learners, (3) instruction, (4) learning environments, and (5) professionalism” (p. 607). The authors defined professionalism as the teacher becoming a reflective practitioner seeking opportunities for professional growth. These opportunities included understanding the science classroom in relation to the larger community, being involved in planning and developing science programs in their school, and seeking opportunities for relevant professional development. Professional development can aid science teachers to understand content and instruction. These professional development opportunities should be science-specific (Davis et al., 2006). Yager (2005) noted the *Standards* set forth fourteen features deemed vital for the growth and development of in-service teachers. The standards were written in the format of more emphasis as opposed to less emphasis in professional development. These included less emphasis on courses and workshops and more emphasis on a variety of professional development activities and less emphasis on individual learning and more emphasis on collegial and collaborative learning.

Improvements to Teacher Preparation Programs for Pre-Service Teachers

Mulholland and Wallace (2001) stated "Many experiences are shaped during preservice field experience. Unfortunately, preservice teachers are rarely exposed to good role models during field placement because many practicing teachers have difficulty with science and avoid teaching it" (p. 243). Minger and Simpson (2006) suggested that favorable beliefs about science teaching should be fostered during pre-service education programs. Many pre-service teachers have negative attitudes about science that they bring with them into their teacher education program. Traditional courses reinforce insecurities in science and do not promote positive attitudes toward science teaching (Briscoe, Peters, & O'Brien, 1993; Stevens & Wenner, 1996; Watters & Ginns, 2000; Minger & Simpson, 2006). Further research in England and Wales has determined that few pre-service teachers studied science past the age of sixteen; therefore leading to a lack of confidence in science and science teaching. Liang and Gabel (2005) stated "only 4% of grade K-5 teachers … in elementary schools had undergraduate or graduate majors in science or science education … fewer than three in ten reported feeling well prepared to teach sciences … compared with 77% for reading/language arts" (p. 1144). Liang et al. (2005) suggested this information shows the urgency for the promotion of learning to teach science in teacher education programs. Teacher education programs must develop subject and pedagogical knowledge in science while at the same time improve confidence in teaching science. Teacher preparation courses should identify weaknesses and offer support in those science teaching areas in which pre-service teachers are deficient (Heywood, 2007).

Saka (2009) also suggested that pre-service teacher education programs were not preparing students to teach science. The researcher conducted a study which was an attempt to design an approach for pre-service teachers that involved cooperative learning and discussion to improve science achievement and to improve science teaching skills of pre-service teachers. Saka found that these strategies were effective in improving pre-service teachers' self-efficacy and student science achievement.

Davis et al. (2006) discussed the importance of positive experiences for pre-service science teachers. Substantial programs can promote improved comprehension of science instruction. The researchers suggested "multiple cycles of planning, teaching, and reflection, over the course of a year" (p. 634). Pre-service teachers involved in science methods courses elicited better understanding of science and improved attitudes in regard to teaching science, students in their science classrooms, the science classroom learning environment, and self-efficacy.

In a study conducted in 2004, Bleicher stated "people are motivated to perform an action if they believe the action will have a favorable result and they are confident that they can perform that action successfully." (p. 384) A high sense of self-efficacy is important for all teachers; however, it is of utmost importance for pre-service and novice teachers. Teachers new to the classroom may be less likely to teach science, and teach it well, if they are not confident in the concepts they are required to present to their students. Bleicher also noted that early identification of low self-efficacy in teaching science was vital to teacher education programs (Bleicher, 2004).

Tekkaya, Cakiroglu, and Ozkan (2004) used the Science Concepts Test and Science Teaching Efficacy Belief Instrument to examine Turkish pre-service science teachers' knowledge of science concepts and their self-confidence in teaching science. The researchers found that the pre-service teachers were confident in their ability to teach science; however, their knowledge of science concepts was generally low. Moseley, Reinke, and Bookout (2002) conducted a study to determine what effect, if any, involvement in a three day program on outdoor environmental education had on pre-service teachers' self-efficacy for teaching environmental science. From the study the researchers found that although self-efficacy was high before and during the program, it dropped after a period of time once the program had been completed. Cakiroglu, Cakiroglu, and Boone (2005) conducted a study that compared pre-service teachers' in Turkey and the United States science teaching self-efficacy beliefs. The study found differences in Turkish and American pre-service teachers' beliefs. The American participants were found to have stronger science efficacy beliefs than the Turkish participants. Palmer (2006) attempted to determine the changes in pre-service teachers' self-efficacy beliefs over a period of time as a result of participation in a science methods course. Results showed that positive changes occurred due to participation in the course. In 2001, Finson conducted a study to determine if pre-service teachers who held less stereotypical perceptions of science teaching could develop higher levels of self-efficacy. The results of the study noted that pre-service teachers could develop higher levels of self-efficacy but only if preconceived stereotypes were eliminated.

Student Engagement in the Science Classroom

The *National Science Education Standards* (1996) set forth the desired attributes for student involvement in the science classroom. It was stated "Learning science is something students do, not something that is done to them" (p. 20). Teachers are encouraged to teach science actively so that students are involved in inquiry-based activities and interacting with their teacher and peers. A shift to active science learning means less presentation of information by the teacher and more interaction with students. Hands-on activities are not the only aspect of active learning. Students must have minds-on experiences as well. This concept involves teaching students how to think critically and question concepts about science.

The concept of student engagement in the science classroom is evident in this statement from *Science for All Americans*:

> In learning science, students need time for exploring, for making observations, for taking wrong turns, for testing ideas, for doing things over again; time for building things, calibrating instruments, collecting things, constructing physical and mathematical models for testing ideas; time for learning whatever mathematics, technology, and science they may need to deal with the questions at hand; time for asking around, reading, and arguing; time for wrestling with unfamiliar and counterintuitive

> ideas and for coming to see the advantage in thinking in a different way. Moreover, any topic in science, mathematics, or technology that is taught only in a single lesson or unit is unlikely to leave a trace by the end of schooling. To take hold and mature, concepts must not just be presented to students from time to time but must be offered to them periodically in different contexts and at increasing levels of sophistication. (Chapter 13, para. 33)

Researchers have found that motivated students were more engaged in the learning process. Motivation has been found to be directly correlated to academic engagement and achievement. When students are motivated and actively involved in the learning process positive cognitive outcomes are likely (Banks, McQuater, & Hubbard, 1978; DeCharms, 1984; Dweck, 1986; Ryan, Connell & Deci, 1985; Singh, Granville, & Dika, 2002). Singh et al. (2002) defined academic engagement "as active involvement, commitment, and attention as opposed to apathy and lack of interest" (p. 324). The researchers further stated "Motivation and academic engagement may have a reciprocal relationship. Motivation affects engagement in academic tasks and engagement further enhances interest and motivation. Both motivation and academic engagement further learning" (p. 324).

Teacher Self-Efficacy

Riggs and Enochs (1989) stated "though science is required of all students in elementary school … elementary teachers do not usually teach science as a high priority … in a way that enhances student achievement" (p. 3).

Researchers have shown that ineffective teaching practices are a result of low levels of teacher self-efficacy. Monteiro, Carrillo, and Aguaded (2010) stated,

> beliefs cannot be mapped directly onto practice, but they can provide an understanding of an individual's performance … if, in a specific context there is a good comprehension of the beliefs, goals and knowledge underlying a teacher's decisions and actions, then a coherent and detailed explanation of what the teacher did and why can be achieved. (p. 1269)

Bandura (1977) defined self- efficacy as "the conviction that one can successfully execute the behavior required to produce the outcomes" (p. 193). Bandura's theory was founded on the belief that psychological actions in any form shaped and strengthened self-efficacy. Self-efficacy can be categorized into two sub-scales, personal expectations and outcome expectancies. These two sub-scales both influence the confidence teachers have in the classroom. When people are able to establish positive self-efficacy beliefs, they will be able to generalize to other instances that in which the individual viewed themselves as inadequate. Cognitive processing is also vital to beliefs regarding self-efficacy. "The impact of information on efficacy expectations will depend on how it is cognitively appraised" (Bandura, 1977, p. 200).

Yilmaz (2009) noted that self-efficacy was an important concept of the social cognitive theory. Teachers with a high sense of self-efficacy add to a more competent and efficient educational system than teachers with a low sense of self-efficacy. A teacher's sense of self-efficacy can positively or negatively affect the students they teach. A high sense of self-efficacy can lead to positive student motivation and attitudes. Teacher self-efficacy can also affect classroom management which can lead to highly academic and productive activities, not a class period spent managing discipline problems (Yilmaz).

Nunn and Jantz (2009) noted that teacher efficacy can be affected by several factors that in turn have an impact on effectively providing an environment for students that is conducive to success. Research has shown an overwhelming support for the idea that teacher self-efficacy can empower students and provide beneficial educational outcomes. Teachers that have a high sense of self-efficacy can elevate the cognitive performance of students. Nunn and Jantz (2009) further stated “as teacher efficacy increases, the perception of responsibility for and capacity to affect outcomes also increases, thus reinforcing the strength and direction of teacher-student interactions” (p. 600). Riggs and Enochs (1989) noted Bandura’s belief that,

> people high on both outcome expectancy and self-efficacy would act in an assured, decided manner. Low outcome expectancy paired with high self-efficacy might cause individuals to temporarily intensify their efforts, but will eventually lead to frustration. Persons low on both variables would give up more readily if the desired outcomes were not reached immediately. (p. 5)

Science Teaching Efficacy

Saka (2009) noted that pre-service teachers that were not prepared for teaching science nor were the programs sufficient to improve self-confidence in teaching science. Riggs and Enochs (1989) stated “Teacher self-efficacy studies have also tended to focus on the investigation of teacher efficacy beliefs in general rather than specific subject areas. For elementary teachers in particular, a subject specific instrument would be more informative" (p. 6). The researchers determined the need for subject specific efficacy because efficacy beliefs were found to be reliant on particular situations. This belief led the researchers to question if general levels of self-efficacy precisely reflected teacher beliefs about their ability to teach subject areas, and more specifically, science. Riggs and Enochs further suggested that the ability to determine teacher efficacy regarding science teaching could contribute to the changes needed for improvements in science achievement.

Researchers have suggested that teacher attitude and confidence in science were important factors in the level of science education received by their students. Teaching science can have a tremendous impact on teacher confidence and self-efficacy. This impact can eventually determine whether or not the individual continues to teach science. Research has shown that students learn more when teachers have a high level of self-efficacy. Teachers with low levels of self-efficacy exhibited negative characteristics such as (a) little to no commitment to their profession, (b) performing in a custodial manner in the classroom, and (c) spending less time on academics than other teachers. Teachers have been shown to spend less time teaching subjects in which their self-efficacy is low; this includes the subject of science. Research has proven that science is one subject in which low levels of self-efficacy negatively impact student achievement (Mulholland & Wallace, 2001). Davis et al. (2006) noted that in order for teachers to become successful science teachers, they must become confident and envision themselves as effective contributors in the classroom. The researchers also suggested that teachers with higher levels of self-efficacy (a) involved their students actively in the learning process, (b) thought the students could learn more through cooperative learning and hands-on experiences, and (c) became more fully developed and competent science teachers. In contrast, the researchers stated that teachers with low levels of self-efficacy (a) tended to lay blame on other people for their failures, (b) engaged students in science activities that were fun, rather than educational and which promoted cooperative learning, and (c) focused more on student behavior than student learning.

Mississippi State Framework for Science

During the 2006-2007 school year, the state of Mississippi implemented the first Mississippi Science Test (MST) for fifth and eighth grade students. The test was a criterion-referenced assessment which ensured that Mississippi was in full compliance with requirements set forth in No Child Left Behind (NCLB). The assessments were developed to be aligned with the Mississippi Curriculum Science Framework for 2001, and a committee of Mississippi's teachers selected and approved the items that appeared on the tests. Beginning in 2010, Mississippi implemented a new framework for science accountability. This framework was based on research and was intended to improve the scores on the MST and raise Mississippi's rating with the National Assessment of Educational Progress (NAEP). According to NAEP statistics, Mississippi fourth and eighth grade students' science scores were the lowest in the United States. With this information in hand, the Mississippi Department of Education reformed the frameworks for science education in the state with the goal in mind of raising test scores and to no longer be ranked last nationwide. The new framework implemented in 2010 set forth new goals for science education in Mississippi. These goals included engaging in the national promotion of science and the improvement of science education in Mississippi through research-based development of science standards and improved guidance and direction for planning instruction. Mississippi educational leaders determined research-based foundations for this change in the science framework. The new standards set forth were aligned to the 2009 NAEP science framework and National Science Standards and also included Depth of Knowledge (DOK) levels for each objective in every grade. The new framework was more challenging than the previous one because each grade and course contained (a) an inquiry strand, (b) a science process skill, (c) critical thinking and problem solving skills, (d) allowed for conceptual development, and (e) vertically aligned objectives to allow scaffolding and spiraling of the framework (Mississippi Department of Education Office of Student Assessment, 2010).

Summary

This review of literature has given a basis for the purpose of this study. Detailed within the review was the theoretical basis for the study which included constructivism and the leading constructivist theorists. The importance of constructivist teaching was reflected through the literature supporting constructivist teaching for science education and the leading theorists. A thorough examination of the history of science education in the United States was given as well. This portion of the review reflected the importance of scientifically literate students. The review of literature furthered the importance of science by providing a solid inspection of the push for science education reform in the United States. This reform includes a shift to standards-based and inquiry-based instructional practices, student engagement in science, professional development for in-service teachers, and the need for improved pre-service teacher education programs. The literature review further detailed research pertinent to teacher self-efficacy and more specifically, science teaching efficacy and the related two sub-scales; personal science teaching efficacy and science teaching outcome expectancy. The final section of the review detailed the requirements of the Mississippi State Department of Education regarding science education in Mississippi.

CHAPTER III

METHODOLOGY

Overview

Prior to 1960, science education as academia was found only in the United States (Fensham, 2004). After 1960, science education academia including research has seen a dramatic increase. Fensham stated,

> In a number of countries … there are now thousands of published studies, and the total is increasing by several hundred each year … I believe that today's large body of researchers now recognize each other as a community of colleagues engaged in a common enterprise. (p. 3)

The purpose of this study was to determine if relationships exist between personal science teaching efficacy and science teaching outcome expectancy and the identifying variables (a) number of undergraduate science methods courses, (b) level of teacher education, (c) number of years as a classroom teacher, and (d) number of years as a science teacher. The study also determined if relationships exist between personal science teaching efficacy and science teaching outcome expectancy and the variables of (a) self-efficacy beliefs about student engagement and (b) self-efficacy beliefs about instruction. The study was based on the theories of constructivism founded by Piaget, Vygotsky, Dewey, and Bruner. The beliefs of these theorists include the teaching and learning of science in a hands-on, inquiry-based, and social/collaborative environment. Another basis for the study came from requirements set forth by the *National Science Standards* (1996) which were developed in response to reports that students in the United States were scientifically illiterate. This chapter will provide a detailed description of the research design, research questions and hypotheses, participants, instrumentation, procedures, limitations, and data analysis that were involved with the study.

Research Design

This study was a correlational study. There were four independent variables used which included: (a) number of undergraduate science methods courses taken, (b) level of teacher education, (c) number of years as a classroom teacher, and (d) number of years as a science teacher. These variables were treated as nominal or ordinal variables. Two other independent variables were used which included: (a) self-efficacy beliefs about student engagement and (b) self-efficacy beliefs about instruction. These independent variables were measured quantitatively with a Likert-type scale. In the study there were two dependent variables. The two dependent variables used were personal science teaching efficacy and science teaching outcome expectancy.

Operational Definitions

1. Number of undergraduate science methods courses taken was defined as those courses which related to teaching science. This did not include courses that would be found as requirements in degrees for science and technology or prerequisite courses normally taken in the first two years of an undergraduate program. Examples of these courses would be, but are not limited to, biology, anatomy and physiology, physical science, and environmental biology.

2. Level of teacher education was defined as undergraduate bachelor's degree or graduate degrees which include (a) master's degree, (b) master's degree through the alternative route, (c) specialist's degree, and (d) doctoral degree.
3. The number of years as a classroom teacher was defined as the total number of years the participant has taught in a public or private school.
4. The number of years as a science teacher was defined as the total number of years the participant has taught science in a public or private school. This definition also included the teaching of science only or in conjunction with other subjects.
5. Self-efficacy beliefs about student engagement were defined as the beliefs teachers hold regarding engaging students in science lessons and activities.
6. Self-efficacy beliefs about instruction were defined as the beliefs teachers hold regarding their ability to design and implement successful science lessons.
7. Personal science teaching efficacy was defined as the confidence the science teacher has in his/her ability to successfully teach science.
8. Science teaching outcome expectancy was defined as the belief of the science teacher that students in his/her science classroom will be influenced by effective teaching.

Research Questions and Hypotheses

The purpose of this correlational study was to determine if relationships exist between personal science teaching efficacy and science teaching outcome expectancy and the identifying variables (a) number of undergraduate science methods courses, (b) level of teacher education, (c) number of years as a classroom teacher, and (d) number of years as a science teacher. The researcher also determined if relationships exist between personal science teaching efficacy and science teaching outcome expectancy and the variables of (a) self-efficacy beliefs about student engagement and (b) self-efficacy beliefs about instruction. From these research questions the following specific hypotheses emerged that were explored in this study:

H_1: The number of undergraduate science methods courses, level of teacher education, number of years as a classroom teacher, and number of years as a science teacher had a significant relationship to personal science teaching expectancy.

H_2: The number of undergraduate science methods courses, level of teacher education, number of years as a classroom teacher, and number of years as a science teacher had a significant relationship to science teaching outcome expectancy.

H_3: Self-efficacy beliefs about student engagement and instruction were significantly related to personal science teaching efficacy.

H_4: Self-efficacy beliefs about student engagement and instruction were significantly related to science teaching outcome expectancy.

Participants

The participants for this study were chosen through purposive sampling and included fifth and eighth grade science teachers in ten school districts. The fifth and eighth grade teachers at the schools in these districts represent a population of approximately 140 teachers. According to a table of recommended samples sizes the desired sample for this study will be 108 subjects (Krejcie & Morgan, 1970; Patten, 2009). A smaller sample size will be sufficient for this study due to a small amount of variability within the population. Patten (2009) stated "If there is very little variability (i.e., the population is homogeneous), researchers can obtain accurate results from a small sample" (p.57). All of the members of the proposed population represent a homogeneous group in which all members are teachers of science. The only variabilities that must be noted are the differences in grade levels taught and teaching at different schools.

Participants were solicited during face-to-face meetings in which the instruments were explained. Potential subjects were given letters of informed consent stating they may refuse to participate or withdraw from the study at any time without any penalty.

Instrumentation

Three self-report instruments were used for data collection.

Demographic Data Sheet

The demographic data sheet for this study was developed by the researcher. Data included were the number of undergraduate science methods courses taken, level of teacher education, number of years as a classroom teacher, and number of years as a science teacher. A copy of the demographic data sheet can be found in this study as Appendix A.

Science Teaching Efficacy Belief Instrument (STEBI)

The STEBI (Riggs & Enochs, 1989) is an instrument designed to test science teaching efficacy beliefs in order to predict science teaching behavior. The instrument measures the beliefs through two sub-scales; personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE).

The theoretical basis for the STEBI comes from Bandura's work with phobics and self-efficacy. It was Bandura's belief that life experiences led to the development of action and outcome expectancies, and that specific beliefs concerning coping abilities were developed through self-efficacy (Bandura, 1977). From research regarding self-efficacy, Riggs and Enochs (1989) determined that self-efficacy studies tended to focus on efficacy beliefs in general. A subject specific instrument in science would give teachers more information to ensure student success. The researchers stated "A specific measure of science teaching efficacy beliefs should be a more accurate predictor of science teaching behavior and thus more beneficial to the change process necessary to improve students' science achievement" (p. 7).

Criterion and content validity were determined through the use of a panel of judges that were deemed experts in the construct being measured. The researchers stated "Each judge was responsible for clarifying the dimension of each item, rate each scale, and rate the total instrument's items and their representativeness, thus contributing to the instrument's content validity" (p. 8).

Items were eliminated if inconsistently classified by three of the five judges (Riggs & Enochs, 1989).

Reliability for the STEBI was determined through both a pilot and major study. The pilot study was conducted with seventy-one practicing elementary teachers who were enrolled in graduate courses at a mid-western university. The purpose of the pilot study was to refine the item pool through item analysis. Major flaws were found in the sub-scale of science teaching outcome expectancy. As a result, a factor analysis was completed on each sub-scale before selecting further items. The factor analysis showed further flaws in the outcome expectancy scale. The researchers ultimately decided to select items on the basis of factor loading to avoid causing the item-total correlations from being meaningless. Reliability analysis resulted in a Cronbach's alpha of 0.92 for the PSTE sub-scale and 0.74 for the STOE sub-scale (Riggs & Enochs, 1989). In this study reliability analysis resulted in a Cronbach's alpha of .90 for the PSTE sub-scale and .78 for the STOE sub-scale.

The major study included a sample of 331 practicing elementary teachers who were located in both rural and urban areas. No specific geographic location for the participants was given. The researchers conducted a one-tailed t-test to determine if there were significant differences between the rural and urban samples, of which none were noted. A factor analysis was conducted to determine the number of significant factors, with an additional factor analysis completed to eliminate items that were cross loaded or loaded into the wrong factor. Final data analysis of the major study produced a preliminary Cronbach's alpha of 0.91 for the sub-scale PSTE. Item-total correlations were 0.53 or higher for all but two of the items. The researchers deleted these items which produced a final Cronbach's alpha of 0.92 for PSTE. The preliminary Cronbach's alpha for STOE was 0.76. Item-total correlations were 0.34 or higher for all but two of the items. The researchers deleted these items which produced a final Cronbach's alpha of 0.77 for STOE. Pearson r correlations were run for all criteria and the researchers found all criteria were significantly correlated in a positive direction (Riggs & Enochs, 1989).

The researchers discussed the possible reasons for the lower alpha score for STOE. Past research had shown this as a difficult construct to measure. It was noted "The lower alpha of the STOE scale seems consistent with past research efforts in which this construct was most difficult to define and measure" (Riggs & Enochs, 1989, p.14). Further explanations for the lower score included limited science background knowledge of the teachers and students and low student motivation. Ultimately the researchers concluded that test results proved the validity and reliability of the STEBI (Riggs & Enochs, 1989). A copy of the author's permission for use letter can be found in this study as Appendix B.

Scoring Instructions for STEBI

Questions on the instrument are scored as follows: *Strongly Agree* = 5; *Agree* = 4; *Uncertain* = 3; *Disagree* = 2; and *Strongly Disagree* = 1. The following questions were reverse scored to ensure consistent values between positively and negatively worded questions: questions 3, 6, 8, 10, 13, 17, 19, 20, 21, 22, 24, and 25. The following questions measure personal science teaching efficacy belief: questions 2, 3, 5, 6, 8, 12, 17, 18, 19, 21, 22, 23, and 24. The following questions measure outcome expectancy: questions 1, 4, 7, 9, 10, 11, 13, 14, 15, 16, 20, and 25 (Riggs & Enochs 1989).

Teachers' Sense of Efficacy Scale (TSES)

The TSES (Tschannen-Moran & Hoy, 2001) is an instrument that was developed to measure teachers' sense of self-efficacy in the classroom. The instrument measures self-efficacy beliefs through three sub-scales, (a) efficacy in student engagement, (b) efficacy in instructional practices, and (c) efficacy in classroom management. For the purposes of this study only the sub-scales of efficacy in student engagement and efficacy in instructional practices were used. The researcher also received permission from the author to use this instrument specifically with science teachers to determine the variables in relation to the science classroom. A copy of the permission letters from the author to use the instrument and use it specifically for science teachers can be found in this instrument as Appendix C.

The theoretical basis for this instrument was Bandura's theories regarding self-efficacy. Tschannen-Moran and Hoy (2001) stated "A teacher's efficacy belief is a judgment of his or her capabilities to bring about desired outcomes of student engagement and learning, even among those students who may be difficult or unmotivated" (p. 783). Teachers' sense of self-efficacy can be related to student achievement, teacher behavior in the classroom, and teacher retention. When teachers have a greater sense of self-efficacy they are more likely to invest more effort in teaching, have greater levels of planning and organization, be less critical of students, and recover more quickly and efficiently from setbacks. The researchers noted the difficulties that had been faced when trying to develop a measurement instrument for teacher self-efficacy. Many of the existing instruments lack proper validity and reliability, have confusion regarding the meaning of the factors, and lack an appropriate level of specificity. For these reasons, the researchers determined there was a need for a new instrument to measure teacher self-efficacy that did not have the problems found in other instruments (Tschannen-Moran & Hoy, 2001).

To begin the development of the new instrument the researchers first studied several instruments to determine the deficiencies in each. The researchers then worked with eight graduate students at The Ohio State University to develop the instrument. Participants determined that using a Likert-type scale related to Bandura's scale was best; however, the participants expanded Bandura's original list of teacher capabilities. Each member of the group selected items from Bandura's scale and created eight to 10 new items, all of which represented important elements of teaching. The entire pool of questions were discussed and it was determined that 27 of Bandura's 30 item scale would be retained. Nineteen items created by the group were retained as well for a total of 52 items on the instrument to be piloted. A nine-point Likert-type scale was created as well (Tschannen-Moran & Hoy, 2001).

Tschannen-Moran and Hoy (2001) piloted the new instrument in three separate studies. The final instrument consisted of two forms a long form and a short form. The long form contained 24 items and the short form contained 12 items. For the purpose of this study the long form was utilized. Final data analysis for the instrument revealed a Cronbach's alpha of 0.94 for the total long form instrument. The sub-scale efficacy of student engagement had a Cronbach's alpha of 0.87 and the sub-scale of efficacy of instructional practices had a Cronbach's alpha of 0.91 both of which prove reliability of this instrument and its sub-scales (Tschannen-Moran & Hoy, 2001). In this study reliability analysis resulted in a Cronbach's alpha of .83 for student engagement and .86 for instructional strategies.

The sub-scale scores were determined by computing unweighted means of the items loading on each factor. Construct validity was determined for both the long and short forms. The researchers assessed the validity by correlating the new instrument to other existing measures of teacher efficacy. Total scores of the TSES were positively related to Rand measure items and the personal teaching efficacy factor and general teacher efficacy factor of the Gibson and Dembo measure. The Rand measure is an instrument consisting of two items to measure teacher self-efficacy. The instrument measures teacher efficacy in relation to factors beyond the influence of the teacher. Because the instrument was so short other researchers attempted to design more in-depth instruments. However, the Rand measure was the foundation for other instruments, including the TSES. The Gibson and Dembo instrument was created to measure teacher efficacy as well. This instrument was created on the basis of the Rand measure and Bandura's self-efficacy instrument. This instrument measures two sub-scales, personal teaching efficacy and general teaching efficacy. The strongest correlations were between the TSES and personal teaching efficacy of the other scales. The lower correlations were between the TSES and general teacher efficacy. The researchers noted "this scale is the least successful in capturing the essence of efficacy" (Tschannen-Moran & Hoy, 2001, p. 801). From their findings the researchers deemed the TSES a valid and reliable instrument for measuring teacher self-efficacy with regard to student engagement, instructional practices, and classroom management.

Scoring Instructions for TSES

The long form of the TSES was used for this study with the following sub-scale measurements: efficacy in student engagement – questions 1, 2, 4, 6, 9, 12, 14, and 22; efficacy in instructional strategies – questions 7, 10, 11, 17, 18, 20, 23, and 24; efficacy in classroom management – questions 3, 5, 8, 13, 15, 16, 19, and 21. None of the questions required reverse scoring (Tschannen-Moran & Hoy, 2001).

Procedures

The following steps were utilized for data collection for this study:

1. The researcher obtained permission to conduct the study from the superintendents from ten school districts. A sample copy of the letter sent to each superintendent and sample permission forms to be signed by the superintendents can be found in this study as Appendices D and E.
2. Upon obtaining permission from the district superintendents the study was submitted to the Internal Review Board (IRB) at the University of

Southern Mississippi for approval. No research was conducted until approval from the IRB was received. A copy of the IRB approval can be found in this study as Appendix F.

3. Upon obtaining IRB approval, the principals of each school in the districts were contacted for permission to conduct the study with the fifth and eighth grade science teachers in the school and to designate a convenient meeting time to address the teachers.
4. The researcher met with the fifth and eighth grade science teachers at the time agreed upon and asked for voluntary participation in this study. The researcher explained how to complete the questionnaires and asked if any clarification was needed for any sections. The questionnaires were in the following order: (a) demographic data, (b) STEBI, and (c) TSES, but the teachers were not required to complete them in that order. Those teachers agreeing to participate were given an informed consent letter along with the questionnaires. A copy of the informed consent letter can be found in this study as Appendix G.
5. At the end of two weeks, the researcher returned to each school to collect the completed questionnaires. The teachers had placed the questionnaires in a manila envelope provided by the researcher, sealed them, and placed them in an agreed upon location at the school. Any teachers not turning the questionnaire in were asked if they need an additional copy or additional time to complete it. The researcher did give additional time to complete the questionnaire and

additional copies that were needed.

Limitations

As with any research study there are limitations that exist that will restrict the generalizability of the findings. Within this proposed study there were several possible limitations that must be addressed. The first limitation was the use of purposive sampling. The sample was limited to only fifth and eighth grade science teachers; therefore, the results could not be generalized to the entire population of science teachers. A second limitation was the use of school districts located in five Mississippi counties. This limitation did not allow for generalizability to the other districts found in the state of Mississippi. A third limitation was the fact the study was only being conducted with teachers in Mississippi, thus limiting generalizability to all fifth and eighth grade science teachers in the United States. The final limitation that must be addressed was the short duration period of the study. The proposed timelines were followed which allowed for a two- week turn around between distributing the questionnaires and collection for data analysis.

Data Analysis

The SPSS statistical program was used for all data analysis for the study. When the researcher collected all questionnaires, the data was entered and descriptive statistics were run for each variable to determine means, standard deviations, and frequencies. Categorical variables were re-coded and all variables were centered before proceeding with additional statistical tests. Each statistical test conducted was a one-tailed test with alpha set at .05. The researcher set alpha at this point to avoid making a Type I error in the study. Items that were to be reverse scored according to the scoring guidelines were corrected as well. Listed below are the hypotheses for this study and a description of the statistical tests that were conducted for each.

Hypotheses One and Two

H_1: The number of undergraduate science methods courses, level of teacher education, number of years as a classroom teacher, and number of years as a science teacher had a significant relationship to personal science teaching efficacy.

H_2: The number of undergraduate science methods courses, level of teacher education, number of years as a classroom teacher, and number of years as a science teacher had a significant relationship to science teaching outcome expectancy.

For each of these hypotheses the researcher performed a multiple regression. As a part of the multiple regressions for each hypothesis the researcher ensured there were no violations of the three assumptions of linearity, homoscedasticity, and normality of residuals.

Hypotheses Three and Four

H_3: Self-efficacy beliefs about student engagement and instruction were significantly related to personal science teaching efficacy.

H_4: Self-efficacy beliefs about student engagement and instruction were significantly related to science teaching outcome expectancy.

For each of these hypotheses the researcher conducted Pearson r correlations to determine if a relationship exists between the listed variables. Tests to ensure the assumptions of linearity, homoscedasticity, and normality of residuals have not been violated were run as well.

Summary

According to the 2005 NAEP statistics, fourth and eighth grade students in Mississippi rank the lowest of all states in science assessment. It is for these reasons that improvement in science education must take place in classrooms across the United States (Mississippi Department of Education Office of Student Assessment, 2010). This above listed reason is the basis for the researcher's desire to conduct this study.

This chapter has detailed the methods that were used to conduct this study. Within this chapter the researcher has given detailed descriptions for the following aspects of the study: (a) an overview with a literature basis for conducting the study, (b) the research design which included operational definitions, (c) the research questions and hypotheses, (d) participants for the study and how they will be chosen, (e) the instruments that will be used in the study which included validity and reliability of each instrument, (f) the procedures that will be employed to conduct the study, (g) the limitations of the study, and (h) how data collected will be analyzed. The chapters that follow will provide discussions of the results and the findings of the study.

CHAPTER IV

RESULTS

Overview

The purpose of this study was to determine if relationships exist between personal science teaching efficacy and science teaching outcome expectancy and the identifying variables (a) number of undergraduate science methods courses, (b) level of teacher education, (c) number of years as a classroom teacher, and (d) number of years as a science teacher. The study was also designed to determine if relationships exist between personal science teaching efficacy and science teaching outcome expectancy and the variables of (a) self-efficacy beliefs about student engagement and (b) self-efficacy beliefs about science instruction. The study was based on the theories of constructivism as well as the requirements set forth by the *National Science Standards* (1996), The United States Department of Education, and the Mississippi State Department of Education.

The researcher obtained IRB approval to conduct the study; as well as approval from the superintendent's in ten school districts. Surveys were distributed to 102 fifth grade science teachers and 38 eighth grade science teachers in these districts. Participants were given two weeks to complete the surveys, with additional copies of the survey and additional time for completion given if needed. The participants were also given letters of informed consent at the time the surveys were distributed. A total of 85 surveys were returned by the fifth grade science teachers and a total of 32 surveys were returned by the eighth grade science teachers. In total 117 surveys were returned, giving the researcher a return rate of 83.6%. Once all surveys had been returned, the researcher entered the data into the SPSS statistical program.

This chapter will provide a detailed description of the data analysis procedures and results that were involved with the study.

Descriptives

Descriptive statistical tests were run for the sub-scales (a) personal science teaching efficacy, (b) outcome expectancy, (c) self-efficacy beliefs about student engagement in science, and (d) self-efficacy beliefs about instruction in science. Test results showed N = 117 for each of the sub-scales. Means and standard deviations for each of the sub-scales were also calculated. Table 1 illustrates these results.

Table 1

Descriptives (N = 117)

Measure	M	SD
Personal efficacy scale	51.77	8.55
Outcome expectancy scale	41.24	6.48
Student engagement	7.01	.97
Instructional strategies	7.50	.85

Note. The items for the scales of personal efficacy and outcome expectancy were scored on a five point Likert-type scale. Minimum = 26, maximum = 65 for personal efficacy; minimum = 21, maximum = 58 for outcome expectancy. The items for the scales of student engagement and instructional strategies were scored on a nine point Likert-type scale. Minimum = 4.88, maximum = 9.00 for student engagement; minimum = 5.13, maximum = 9.00 for instructional strategies.

Frequencies for each independent variable were run as well. Frequencies for undergraduate science methods courses resulted in validity for zero to seven courses. Table 2 illustrates these results.

Table 2

Frequency Table for Undergraduate Methods Courses

No. of courses	Frequency	%	M	SD
0	27	23.1		
1	47	40.2		
2	15	12.8		
3	12	10.3		
4	6	5.1		
5	2	1.7		
6	6	5.1		
7	2	1.7		
Cumulative	117	100	1.68	1.72

Note. Minimum = 0 courses; maximum = 7 courses

Frequencies for the variable level of education are listed in Table 3. Means and standard deviations for this variable were not calculated. Table 3 illustrates these results.

Table 3

Frequency for Teacher Level of Education

Level	Frequency	%
Bachelors	77	65.8
Masters	38	32.5
Specialist	2	1.7
Cumulative	117	100

Frequencies for the variable number of years as a classroom teacher ranged from one-half years to 37 years, and the mean and standard deviation were computed as well. Table 4 illustrates these results.

Table 4

Frequencies for Number of Years as a Classroom Teacher

Years	Frequency	Percent	M	SD
.5	3	2.6		
1.0	4	3.4		
1.5	1	.9		
2.0	9	7.7		
3.0	6	5.1		
4.0	8	6.8		
4.5	2	1.7		
5.0	8	6.8		
6.0	1	.9		

Table 4 (continued).

Years	Frequency	Percent	M	SD
6.5	1	.9		
7.0	8	6.8		
7.5	2	1.7		
8.0	9	7.7		
9.0	3	2.6		
10.0	5	4.3		
11.0	5	4.3		
11.5	1	.9		
12.0	3	2.6		
13.0	5	4.3		
14.0	5	4.3		
15.0	3	2.6		
16.0	2	1.7		
18.0	1	.9		
19.0	4	3.4		
20.0	2	1.7		
21.0	3	2.6		
22.0	2	1.7		
23.0	1	.9		
25.0	2	1.7		
28.0	2	1.7		

Table 4 (continued).

Years	Frequency	Percent	M	SD
30.0	1	.9		
31.0	3	2.6		
32.0	1	.9		
37.0	1	.9		
Cumulative	117	100	10.53	8.27

Note. Minimum =. 5 years; maximum = 37 years

Frequencies for the variable number of years as a science teacher were run and resulted in a range of one-half years to thirty-seven years of experience. The mean and standard deviation were calculated for this variable as well. Table 5 illustrates these results.

Table 5

Frequencies for Number of Years as a Science Teacher

Years	Frequency	Percent	M	SD
.5	6	5.1		
1.0	10	8.5		
1.5	1	.9		
2.0	7	6.0		
3.0	9	.9		
4.0	11	9.4		
4.5	1	.9		

Table 5 (continued).

Years	Frequency	Percent	M	SD
5.0	9	7.7		
6.0	4	3.4		
6.5	2	1.7		
7.0	8	6.8		
7.5	1	.9		
8.0	7	6.0		
9.0	6	5.1		
10.0	4	3.4		
10.5	1	.9		
11.0	4	3.4		
12.0	2	1.7		
13.0	3	2.6		
14.0	4	3.4		
15.0	2	1.7		
18.0	2	1.7		
19.0	2	1.7		
19.5	1	.9		
20.0	3	2.6		
21.0	1	.9		
24.0	1	.9		

Table 5 (continued).

Years	Frequency	Percent	M	SD
26.0	1	.9		
28.0	1	.9		
30.0	1	.9		
31.0	1	.9		
37.0	1	.9		
Cumulative	117	100	8.15	7.23

Note. Minimum = .5 years; maximum = 37 years

Ancillary Findings

Although not included as variables in the study, frequencies were calculated for the grade level taught by each participant, number of days per week each participant taught science, number of minutes per class period participants had to teach science, and the grade level in which science as a part of the daily curriculum begins. Table 6 illustrates these findings.

Table 6

Frequencies for Participant Grade Level Taught

Grade Level	Frequency	Percent
Fifth	85	72.6
Eighth	32	27.4
Cumulative	117	

Table 7 illustrates the number of days per week that the participants taught science.

Table 7

Frequencies for Number of Days per Week Science is Taught

Days per Week	Frequency	Percent
2	2	1.7
3	1	.9
4	8	6.8
5	106	90.6
Cumulative	117	

Table 8 illustrates the number of minutes per class that the participants taught science.

Table 8

Frequencies for Number of Minutes per Science Class Period

Minutes	Frequency	Percent	M	SD
20	6	5.1		
25	3	2.6		
30	18	15.4		
35	1	.9		
40	10	8.5		
43	1	.9		

Table 8 (continued).

Minutes	Frequency	Percent	M	SD
45	14	12.0		
50	21	17.9		
53	3	2.6		
55	10	8.5		
60	26	22.2		
70	1	.9		
90	3	2.6		
Cumulative	117		47.03	14.12

Each participant reported the grade level in which science begins as a part of the daily curriculum. Table 9 illustrates these findings.

Table 9

Frequencies for Grade Level in Which Science Begins

Grade Level	Frequency	Percent
Kindergarten	22	18.8
1	10	8.5
2	4	3.4
3	22	18.8
4	18	15.4
5	37	31.6
6	3	2.6

Table 9 (continued).

Grade Level	Frequency	Percent
7	1	.9
Cumulative	117	

In summary, descriptive tests were run for all demographic variables and sub-scales. Frequencies, means, and standard deviations were calculated for each variable and sub-scale as well. The researcher also reported frequencies for the grade level taught by participants, the number of days per week the participants taught science, the number of minutes per class period the participant taught science, and the grade level in which science begins as a part of the daily curriculum in his or her district.

Statistical

Each statistical test conducted was a multiple regression with alpha set at .05. Items that were to be reverse scored according to the scoring guidelines were corrected as well.

Hypotheses One and Two

H_1: The number of undergraduate science methods courses, level of teacher education, number of years as a classroom teacher, and number of years as a science teacher had a significant relationship to personal science teaching efficacy.

The researcher failed to reject this hypothesis. Test results showed a significant relationship between personal science teaching efficacy and the variables of undergraduate science methods courses, level of teacher education, number of years as a classroom teacher, and number of years as a science teacher. The overall statistics were $F(5, 111) = 3.328$, $p = .008$, $R^2 = .130$. This explains the model was significant because p was less than .05. The model explained 13.0% of the variability in the dependent variable. The independent variable bachelor's degree was absorbed in the constant with the constant being 47.53. The interpretations of the unstandardized coefficient b were as follows:

1. Teachers with a master's degree resulted in a 2.47 increase in personal science teaching efficacy beliefs, controlling for all other variables.
2. Teachers with a specialist's degree resulted in a 1.88 decrease in personal science teaching efficacy beliefs, controlling for all other variables.
3. Undergraduate methods courses resulted in a .75 increase in personal science teaching efficacy beliefs, controlling for all other variables.
4. Number of years as a classroom teacher resulted in a .15 decrease in personal science teaching efficacy beliefs, controlling for all other variables.
5. Number of years as a science teacher resulted in a .47 increase in personal science teaching efficacy beliefs, controlling for all other variables.

The variable with the greatest significance to personal science teaching efficacy beliefs was number of years as a science teacher due to the results of a .39 Beta and a significance of .02. Table 10 illustrates these findings.

Table 10

Multiple Regression for Hypothesis 1

Standardized Coefficients Model	Beta	t	Sig
(Constant)		32.97	.00
Masters	.13	1.49	.13
Specialist	-.02	-.32	.74
Undergraduate methods	.15	1.68	.09
Classroom teacher	-.15	-.87	.38
Science teacher	.39	2.33	.02

H_2: The number of undergraduate science methods courses, level of teacher education, number of years as a classroom teacher, and number of years as a science teacher had a significant relationship to science teaching outcome expectancy.

The results of the multiple regression caused the researcher to reject this hypothesis. The overall statistics were $F (5, 111) = 2.26$, $p = .053$, $R^2 = .092$. The model explained only 9.2% of the variability in the dependent variable. The hypothesis was rejected because p was greater than .05.

Hypotheses Three and Four

H_3: Self-efficacy beliefs about student engagement and instruction were significantly related to personal science teaching efficacy.

The researcher failed to reject this hypothesis. The overall statistics were F (2, 114) = 13.678, $p < .001$, $R^2 = .194$. The model explained 19.4% of the variability in the dependent variable. The interpretations of the unstandardized coefficient b were as follows:

1. Beliefs regarding student engagement in science resulted in a 2.09 decrease in personal science teaching efficacy beliefs, controlling for all other variables.
2. Beliefs regarding instructional strategies in science resulted in a 5.26 increase in personal science teaching efficacy beliefs, controlling for all other variables.

The variable with the greatest significance to personal science teaching efficacy was beliefs regarding instructional strategies in science with a .52 Beta and a significance of .00. Table 11 illustrates the results of this test.

Table 11

Multiple Regression and Pearson r Correlation for Hypothesis 3

Model	Standardized Coefficients Beta	t	Sig
(Constant)		4.05	.00
Student engagement	-.23	-2.35	.02

Table 11 (continued).

Standardized Coefficients Model	Beta	t	Sig
Instructional strategies	.52	5.18	.00

H_4: Self-efficacy beliefs about student engagement and instruction were significantly related to science teaching outcome expectancy.

The researcher failed to reject this hypothesis. The overall statistics were $F(2, 114) = 25.041$, $p < .001$, $R^2 = .305$. The model explained 30.5% of the variability in the dependent variable. The interpretations of the unstandardized coefficient b were as follows:

1. Beliefs regarding student engagement in science resulted in a 4.21 increase in science teaching outcome expectancy, controlling for all other variables.
2. Beliefs regarding instructional strategies in science resulted in a 1.42 decrease in science teaching outcome expectancy, controlling for all other variables.

The variable with the greatest significance to science teaching outcome expectancy was beliefs about student engagement in science due to a Beta of .63 and significance of .00. Table 12 illustrates the results of this test.

Table 12

Multiple Regression and Pearson r Correlation for Hypothesis 4

Model	Standardized Coefficients Beta	t	Sig
(Constant)		4.79	.00
Student engagement	.63	6.73	.00
Instructional Strategies	-.18	-1.99	.04

Summary

This chapter has detailed the descriptive and statistical tests run for this study. Descriptive statistics were run for the sub-scales (a) personal science teaching efficacy, (b) outcome expectancy, (c) self-efficacy beliefs about student engagement in science, and (d) self-efficacy beliefs about instruction in science. Means and standard deviations for each sub-scale were calculated as well. Frequencies, means, and standard deviations were calculated for the independent variables (a) number of undergraduate methods courses, (b) teacher level of education, (c) number of years as a classroom teacher, and (d) number of years as a science teacher. Multiple regressions with alpha set at .05 were run for the following hypotheses:

H_1: The number of undergraduate science methods courses, level of teacher education, number of years as a classroom teacher, and number of years as a science teacher had a significant relationship to personal science teaching efficacy.

H_2: The number of undergraduate science methods courses, level of teacher education, number of years as a classroom teacher, and number of years as a science teacher had a significant relationship to science teaching outcome expectancy.

H_3: Self-efficacy beliefs about student engagement and instruction were significantly related to personal science teaching efficacy.

H_4: Self-efficacy beliefs about student engagement and instruction were significantly related to science teaching outcome expectancy.

The researcher failed to reject hypotheses 1, 3, and 4, and rejected hypothesis 2.

Although not included as variables in the study, frequencies were calculated for the grade level taught by each participant, number of days per week each participant taught science, number of minutes per class period participants had to teach science, and the grade level in which science as a part of the daily curriculum begins.

This chapter has served to detail the statistical tests run for this study. Further detailed discussion of these results will follow in the next chapter of this study.

CHAPTER V

DISCUSSION

Summary of Study

With the October 4, 1957 launch of the Russian satellite Sputnik, came the proverbial race to space. At this time President John F. Kennedy set a goal; by the end of the decade to have an American travel to the moon and return safely. The goal of the President and the launch of Sputnik enabled supporters of reform in science and mathematics education to see their long awaited efforts for reform come to the forefront (Bybee, 2007). Bybee (2007) stated “Sputnik has come to symbolize – an era of significant reform of science, technology, engineering, and mathematics (STEM) education” (p. 1). With the reauthorization of NCLB to ESEA comes a blueprint for improvements in STEM education. The proposed reform stresses the need to improve literacy in STEM education with standards that will foster college and career readiness (U.S. Department of Education, 2010).

One important area in science education is teacher self-efficacy. Bandura (1997) defined self-efficacy as “beliefs in one’s capabilities to organize and execute the courses of action required to produce given attainments” (p. 3). Bandura (1997) further noted “Unless people believe they can produce desired effects by their actions, they have little incentive to act” (p. 3). The theory of self-efficacy was one of the underlying reasons the researcher endeavored to conduct this study. With the decline of science test scores in Mississippi, the researcher was determined to find out if any relationships existed between science teaching efficacy and different factors in the classroom.

The researcher first obtained IRB permission and permission from the superintendents of ten school districts to conduct this study. Upon receiving IRB approval, the researcher contacted the principals at the schools in each district to meet with the fifth and eighth grade science teachers. At each meeting the researcher asked for voluntary participants to complete the surveys which included a demographic survey, STEBI, and TSES. The researcher also explained that the TSES survey should be answered in relation to science teaching beliefs and instruction. The participants were also given letters of informed consent at this time. After two weeks the researcher returned to collect the completed surveys. It was at this time the researcher also gave additional copies and time to complete the surveys requested by some participants. A total of 117 surveys were returned of the original 140 distributed. This resulted in a return rate of 83.6%. Once all surveys had been collected, the researcher entered all data into SPSS and statistical programs were completed. The next section of this chapter will give a detailed discussion of these findings.

Conclusions and Discussions

The researcher first conducted descriptive statistical tests for the sub-scales (a) personal science teaching efficacy, (b) outcome expectancy, (c) self-efficacy beliefs about student engagement in science, and (d) self-efficacy beliefs about instruction in science; as well as the independent variables (a) number of undergraduate science methods courses taken, (b) teacher level of education, (c) number of years as a classroom teacher, and (d) number of years as a science teacher. Frequencies, means, and standard deviations were calculated for each of the sub-scales and independent variables.

The demographic data survey also included questions regarding (a) grade level currently teaching, (b) number of days per week the participant taught science, (c) number of minutes per class period allotted for science instruction, and (d) the grade level in which science becomes a part of the daily curriculum in the participant's school district. Frequencies were calculated for each of these responses; however, this data was not included in the final multiple regressions completed by the researcher. Of the 117 participants, 85 were fifth grade science teachers and 32 were eighth grade science teachers. The number of days per week the participants taught science ranged from two days per week to five days per week with 90.6% of the respondents teaching science five days per week. The number of minutes per class period for science instruction ranged from 20 minutes to 90 minutes with a majority of 22.2% of the respondents having class periods of 60 minutes. The grade in which science begins as a part of the daily curriculum ranged from Kindergarten to seventh grade with a majority of 31.6% of the respondents noting that science becomes a part of the daily curriculum in fifth grade.

The researcher ran multiple regressions with alpha set at .05 for the following hypotheses:

H_1: The number of undergraduate science methods courses, level of teacher education, number of years as a classroom teacher, and number of years as a science teacher had a significant relationship to personal science teaching efficacy.

H_2: The number of undergraduate science methods courses, level of teacher education, number of years as a classroom teacher, and number of years as a science teacher had a significant relationship to science teaching outcome expectancy.

H_3: Self-efficacy beliefs about student engagement and instruction were significantly related to personal science teaching efficacy.

H_4: Self-efficacy beliefs about student engagement and instruction were significantly related to science teaching outcome expectancy.

Hypothesis One and Two

The researcher failed to reject hypothesis one and rejected hypothesis two. Overall statistics for hypothesis one showed a significant relationship between personal science teaching efficacy and each of the independent variables (a) number of undergraduate science methods courses, (b) level of teacher education, (c) number of years as a classroom teacher, and (d) number of years as a science teacher. The variable bachelor's degree was absorbed in the constant. Interpretations of the unstandardized coefficient b showed the variables of teachers with a master's degree, number of undergraduate methods courses, and number of years as a science teacher each resulted in increases in personal science teaching efficacy beliefs. The number of years as a science teacher was shown to be the most significant variable with a significance of .021. Interpretations of the unstandardized coefficient b showed the variables of teachers with a specialist's degree and number of years as a classroom teacher each resulted in decreases in personal science teaching efficacy belief.

These results support the existing literature regarding preparation of pre-service science teachers who will become qualified science teachers in the classroom and the importance of science teaching efficacy.

The ESEA Blueprint for Reform (2010) purports to strengthen teacher preparation programs and professional development for STEM teachers. The ESEA (2010) will "ensure that more prospective teachers, including STEM teachers, have access to high-quality preparation programs … funding for districts to implement professional development that is relevant to student, teacher, and school needs … including developing content knowledge in STEM fields" (p. 3). Minger and Simpson (2006) noted,

> the importance of cultivating student and teacher attitudes remains vital to the basic framework of science curricula and pedagogy … preservice teacher education programs may be the best time for students to gain experiences that develop favorable beliefs about the nature of science teaching. (p. 49)

Teacher preparation programs for pre-service science teachers must ensure the candidates are aware of what is expected in the science classroom. Davis, Petish, and Smithey (2006) argue the standards set forth by the Interstate New Teacher Assessment and Support Consortium (INTASC) and NSES form the basis for what is expected of pre-service and new science teachers. By adhering to these standards pre-service teacher programs can provide a map for what new science teachers are expected to know and to do in the science classroom. Research results showed that most pre-service science teachers did not have sufficient knowledge of science content. The researchers found this to be most prevalent at the elementary teaching level (Davis, Petish, & Smithey). Among several recommended changes in programs for pre-service elementary science teachers is an emphasis to improve pre-service teacher attitudes regarding science and science teaching (Cox & Carpenter, 1989; Minger & Simpson, 2006). Research has shown that the beliefs held by pre-service teachers can have an impact on what is learned (Richardson, 1996; Minger & Simpson, 2006). Liang and Gabel (2005) also note,

> the inadequacy of the preparation of science teachers in the United States has remained an issue for past decades … only 4% of K-5 teachers assigned to teach science in elementary schools had undergraduate or graduate majors in science or science education … fewer than 10% of these felt very well qualified to teach life sciences. (pp. 1144-1145)

Finson (2001) stated "When teachers have a low self-efficacy, their teaching tends to be characterized by authoritative, teacher-centered roles with a less clear understanding of the various developmental levels of their students" (p. 31). Finson further noted that science teachers with weak content knowledge backgrounds had lower personal efficacy (Rubeck & Enochs, 1991; Finson, 2001). Wheatley (2002) argued that some aspects of low self-efficacy in science teachers are essential for educational reform; most significantly reform of teacher learning. Tschannen-Moran and Hoy (2001) defined teacher efficacy as "a judgment of his or her capabilities to bring about desired outcomes of student engagement and learning … sense of efficacy has been related to student outcomes such as achievement" (p. 783). Teacher efficacy also has an effect on teacher behavior in the classroom related to goals, aspirations, and effort put forth. A strong sense of efficacy leads to higher levels of planning, organization, persistence, and patience (Tschannen-Moran & Hoy, 2001).

Riggs and Enochs (1989) noted that much attention has been placed on teacher attitudes regarding science, but not teacher beliefs. "Teacher belief systems, however, have been neglected as a possible contributor to behavior patterns of elementary teachers with regard to science" (p. 3). In order to better understand teacher behavior teacher beliefs must be examined as well as teacher attitudes (Riggs & Enochs).

Hypotheses Three and Four

The researcher failed to reject both hypothesis three and four. Overall statistics for hypothesis three showed a significant relationship between personal science teaching efficacy and the variables student engagement in science and instructional strategies in science. The variable with the greatest significance was instructional strategies in science which had a significance of .00. Interpretations of the unstandardized coefficient b showed an increase in personal science teaching efficacy in regard to beliefs regarding instructional strategies in science and a decrease in personal science teaching efficacy with regard to beliefs about student engagement in science. Overall statistics for hypothesis four showed a significant relationship between science teaching outcome expectancy and the variables student engagement in science and instructional strategies in science. The variable with the greatest significance was beliefs about student engagement in science which had a significance of .00. Interpretations of the unstandardized coefficient b showed an increase in science teaching outcome expectancy with regard to beliefs about student engagement in science and a decrease in science teaching outcome expectancy with regard to beliefs about instructional strategies in science.

These findings complement the existing literature regarding the need for improved science instructional strategies which foster student engagement in the science classroom, primarily through constructivist methods of which inquiry-based teaching is a tenet.

The theories of Piaget, Vygotsky, Dewey, and Bruner are most notable regarding the theory of constructivism. Mooney (2000) noted “these are the major contributors to the body of knowledge upon which our best practices … are based” (p. xvi). Kamii and Ewing (1996) suggested,

> There are three main reasons for basing teaching on Piaget’s constructivism: (1) it is a scientific theory that explains the nature of human knowledge, (2) it is the only theory in existence that explains children’s construction of knowledge from birth to adolescence, and (3) it informs educators of how Piaget’s distinction among the three kinds of knowledge changes the way we should teach many subjects. (p. 260)

The researchers further noted that although education should not be solely based on scientific knowledge, teaching should be based on this knowledge since science does not revert back to archaic theories (Kamii & Ewing). Jaramillo (1996) noted Vygotsky's sociocultural theory contributed to constructivism as evidenced by the connection of his theoretical framework to the tenets of constructivist curricula and pedagogy. Jaramillo (1996) stated,

> Conceptual parallels between Vygotsky's theory and constructivism were evident in the following components: networking, socially negotiated meaning making, experimentalism, collectivism, adults and more competent peers as learning facilitators, the social and historical dimensions of learning, problem solving, and active learning participation. (p. 133)

Tobin, Briscoe, and Holman (as cited in Erdogan & Campbell, 2008) defined constructivism as "the construction of knowledge by individuals as sensory data are given meaning in terms of prior knowledge. Learning is an interpretive process, involving construction of individuals and social collaborations" (p. 1891). Constructivist methods have been the basis for reform in science education. Through constructivist methods students are able to formulate learning via social interactions and the testing of ideas in context through application of understandings (Tobin, Briscoe, & Holman, 1990; Erdogan & Campbell, 2008). The shift to a constructivist framework requires teachers to teach in ways that are dissimilar to how they were personally taught (Gieryn, 1999; Erdogan & Campbell, 2008). Keys and Bryan (2001) stated,

> From a cognitive constructivist perspective, knowledge is not independent of the knower; knowledge is understanding physical and abstract objects

> in our experience. For children, knowledge about science will be an individual construction through participation in the social and physical environment of the classroom. (p. 633)

As noted in the *Standards* (1996), inquiry is fundamental for learning in the science classroom. Olson and Loucks-Horsley (2000) suggested that inquiry can take many forms; however, "It encompasses not only an ability to engage in inquiry but an understanding of inquiry and of how inquiry results in scientific knowledge" (p. 13). One of the foundations for reforms regarding inquiry came from John Dewey's belief that science was more than an accumulation of information. Dewey argued that more emphasis needed to be placed on science as a way of thinking along with a method to be learned (Dewey, 1910; Olson & Loucks-Horsley, 2000). In 1999, the National Research Council published six general findings regarding inquiry in science. These findings were:

1. Understanding science is more than knowing facts.
2. Students build new knowledge and understanding on what they already know.
3. Students formulate new knowledge by modifying and refining their current concepts and by adding new concepts to what they already know.
4. Learning is mediated by the social environment in which learners interact with others.
5. Effective learning requires that students take control of their own learning.

6. The ability to apply knowledge to novel situations, that is, transfer of learning, is affected by the degree to which students learn with understanding. (Bransford, Brown, & Cocking, 1999; Olson & Loucks-Horsley, 2000, pp. 116-119)

Other researchers have suggested that science instruction must be designed so that students are engaged in both hands-on and minds-on activities (van Driel, Beijaard, & Verloop, 2001; Gunel, 2008).

Limitations

As with any research study, limitations existed that restricted the generalizability of the findings. Within this study there were several possible limitations that must be addressed. The first limitation was the use of purposive sampling. The sample was limited to only fifth and eighth grade science teachers; therefore, the results could not be generalized to the entire population of science teachers. A second limitation was the use of school districts located in five Mississippi counties. This limitation does not allow for generalizability to the other districts found in the state of Mississippi. A third limitation was the fact the study was only being conducted with teachers in Mississippi, thus limiting generalizability to all fifth and eighth grade science teachers in the United States. The final limitation that must be addressed was the short duration period of the study. The proposed timelines were followed which allowed for a two week turn around between distributing the questionnaires and collecting them for data analysis.

Recommendations for Policy and Practice

The results of the analysis provide substantiation for recommendations for current policy and practice. The knowledge obtained from the study clearly shows a need for diligence in (a) the preparation of pre-service science teachers, (b) the need for retention of qualified science teachers, and (c) the implementation of instructional strategies in the classroom which foster student engagement.

Preparation of Pre-Service Science Teachers

Results of the statistical tests for this study showed a mean of 1.68 for the number of undergraduate methods courses taken by the participants. This result gives clear evidence that pre-service teachers are not being prepared to enter the classroom and teach science effectively; therefore, impacting science teaching efficacy beliefs. With reform efforts in science at a zenith, programs need to be enacted that will give pre-service teachers the opportunity to focus on science specific methods courses. University program leaders must ensure that all pre-service teachers are prepared to enter the classroom. Pre-service teachers should be given the opportunity to have true concentrations in a content subject that consist of more than one methods course. University program leaders need to reevaluate current teacher education programs to ensure pre-service teachers, both elementary and secondary, are prepared to teach science at any grade level. It would even be prudent to require that secondary science teachers have a minor in an area of science in order to receive a teaching license.

At the same time, it is the responsibility of administrators in elementary and secondary schools to ensure new teachers are provided with ample support to increase confidence in science teaching efficacy. Mentor programs are in place in most schools, but these programs need to focus as much attention on supporting science teaching as is given to teaching language arts and mathematics. Administrators, especially those in elementary schools, need to stress the importance of science in the lower grades. According to the ancillary findings in this study, the average grade in which science begins as a part of the daily curriculum was fifth grade. With the importance of the Mississippi State Science Test due to AYP requirements, it is obvious that more emphasis on science education in K-4 is needed.

The best solution to this problem would be if university program leaders, administrators, and teachers, both pre-service and in-service, could foster better collaborative efforts. Clear lines of communication between universities and elementary and secondary schools would give a better picture of what pre-service teachers needed to be better prepared in the science classroom. Using the standards from INTASC and the NSES and input from administrators and teachers, a solid foundation could be provided for pre-service science teachers.

Retention of Qualified Science Teachers

Because number of years as a science teacher had the most significant impact on personal science teaching efficacy, it is imperative that science teachers feel confident in their teaching abilities so they remain in the science classroom. Having confident science teachers will lead to longer terms of retention and a superior quality of instruction, thus benefiting the students in the science classroom.

The ultimate responsibility for this should be given to administrators in elementary and secondary schools. Administrators, just like classroom teachers, need to be held accountable for the deficiencies in science education, especially in K-4 classrooms. When schedules are made for the school year, ample time must be given for the teaching of science. It is quite possible that lower elementary teachers feel frustrated because they are given so little time to teach science. Science teachers in upper elementary grades may possibly feel the same way. These feelings of frustration could lead to burn out and a sense of apathy in the science classroom, thus resulting in lower beliefs in science teaching efficacy. Tschannen-Moran and Hoy (2001) stated “teachers’ efficacy beliefs also relate to their behavior in the classroom. Efficacy affects the effort they invest in teaching, the goals they set, and their level of aspiration” (p. 783).

The possible results of lower science teaching efficacy could also be shorter tenure time in the science classroom. If teachers do not feel confident in the teaching of science, it is only normal to presuppose they will not remain in the science classroom for an extended period of time. It is vital that schools retain qualified science teachers because the consistency, reliability, and expertise of these well qualified science teachers in the classroom will in due course result in student success.

Science Instructional Strategies Which Foster Student Engagement

Statistical results for this study showed that instructional strategies in science had the most significant relationship to personal science teaching efficacy and student engagement in science had the most significant relationship to outcome expectancy. The researcher chose to address these two results together due to the belief that the two are interrelated. Instructional strategies in science should foster active student engagement. The *Standards* (1996) clearly state the need for all students to achieve scientific literacy. This goal can be reached by giving all students the chance to learn science. Specific principles guided the creation of the *Standards*. These principles included the thought that science learning is an active process; science is something students do through active process. Active process is defined as "physical and mental activity. Hands-on activities are not enough – students must also have "minds-on" experiences" (p. 20). Teachers and administrators should work collaboratively using the *Standards* and the guidelines set forth by the Mississippi State Department of Education to ensure that quality lessons are being presented in the science classroom. Through collaborative efforts, curricula and assessments could truly be aligned with the standards for effective science instruction.

Science instruction should also occur on a daily basis at all grade levels. Administrators in K-4 should ensure that students in these grades are taught the basic principles of science in an interesting and engaging manner. These grade levels set the foundation for success of failure in upper grade level science classes. Without a firm foundation, students in upper grades will continue to struggle in science. Science instruction should be a combination of methods that compliment the desired goals and objectives. Science education reform proponents support a constructivist method of teaching science. Teaching in a constructivist manner allows students to construct their own meaning from information that is presented. Instructional strategies in science should encompass the spectrum from the use of the textbook as a guide and teacher lecture to critical thinking activities in which students are physically and mentally engaged in the learning process. The ultimate goal of the science teacher should be to engage students in actively learning science while fostering an appreciation and respect for the subject. An atmosphere like this in the science classroom would be conducive to encouraging students to choose a field of science in which to study or work in future years.

Recommendations for Future Research

In education, research must be ongoing to ensure teaching practices do not become stagnant. From the results of this study and from the literature reviewed, several recommendations for future research can be identified.

1. Because a more solid foundation in science education is needed in lower grades, the researcher would recommend this study be replicated with the use of teachers in grades K-4 as the participants. Special attention should be paid to how confident these teachers feel in their content knowledge of science and how much time is spent daily teaching science.

2. Because administrators have the ultimate responsibility of ensuring best practices are being followed in the classroom, the researcher would recommend a study be conducted to determine collaboration methods used by administrators with science teachers. This study should also focus on administrator knowledge of science standards and current trends in science education.
3. Because Mississippi mandates a yearly science test in fifth and eighth grades, the researcher would recommend a study be conducted to determine which factors such as; race, gender, socioeconomic status, and critical needs school districts, has the most impact on yearly test scores.
4. Because data analysis in this study showed a significant relationship between personal science teaching efficacy and instructional strategies and a significant relationship between outcome expectancy and student engagement, this study could be replicated as a qualitative study in which interview, artifacts, and surveys could be used to obtain more specific information regarding current practices in science classrooms. This study should cover a range of grade levels.
5. Because of the increase in science-related occupations, the researcher would recommend a study be conducted to determine student attitudes and beliefs regarding science. The results of such a study could be used to develop programs which would enhance the science

curriculum for those students who express a desire to study science in a post-secondary setting.

Conclusion

The motivation of the researcher to conduct this study was not only the low science test scores in Mississippi, but a personal desire to see more effective methods of science being used in the classroom. The basis for this study came from a qualitative project conducted by the researcher in which it became apparent through classroom observations that many teachers did not exhibit strength in their knowledge of science. A heavy reliance on the textbook for class instruction with no use of activities which engaged the students, prompted the researcher to conduct a literature review. This review of the literature ultimately resulted in the decision to study science teaching efficacy beliefs.

In this study, the researcher attempted to determine if significant relationships exist between different independent variables and the dependent variables personal science teaching efficacy and outcome expectancy. From the results obtained through data analysis of the STEBI and TSES, the researcher determined that the number of years as a science teacher and beliefs regarding instructional strategies in science had the most significant relationship to personal science teaching efficacy. The researcher further determined through data analysis of the STEBI and TSES that student engagement in the science classroom had the most significant relationship to outcome expectancy.

It is the hope of the researcher that this study will prompt future research into science teaching efficacy beliefs and the need for improved science education in not only Mississippi classrooms, but across the United States as well.

APPENDIX A

DEMOGRAPHIC DATA SHEET

Please provide an answer to each question.

1. Please indicate the number of undergraduate science methods courses you took. These are courses that were specifically designed for teaching science. This will not include courses that would be found as requirements in degrees for science and technology or prerequisite courses normally taken in the first two years of an undergraduate program. Examples of these courses would be, but are not limited to, biology, anatomy and physiology, physical science, and environmental biology.

____

2. Please indicate your current level of education. Do not include any degrees that you are in the process of completing.

____

3. Please indicate the total number of years you have been a classroom teacher.

____

4. Please indicate the total number of years you have been a science teacher. Please include all years, even if you taught science in conjunction with other subjects.

____

5. Please indicate the grade level you currently teach.

____

6. Please indicate the number of days per week you teach science.

____

7. Please indicate the total number of minutes you engage in science instruction during the science class period.

____

8. In your school district, at what grade level is science content initiated as a part of the daily curriculum?

____

APPENDIX B

PERMISSION LETTER TO USE STEBI

OSU
Oregon State
UNIVERSITY

Science and Mathematics Education
Oregon State University, 239 Weniger Hall, Corvallis, Oregon 97331-6508
T 541-737-1305 | **F** 541-737-1817 | www.oregonstate.edu/dept/sci_mth_education | enochsl@onid.orst.edu

June 1, 2010

Susan M Hanson
PO Box 3
Hurley, MS 39555

Dear Susan,

I am writing concerning the use of the Science Teaching Efficacy Belief Instrument (STEBI) in your Doctoral dissertation. It is a pleasure to give you permission to use the STEBI. I look forward to reading your manuscript. If you have questions regarding the use of this instrument, please don't hesitate to call me (541-737-1305).

Sincerely,

Larry G Enochs
Professor
Science and Mathematics Education
237 Weniger Hall
Oregon State University
Corvallis, OR 97331
541-737-1305
http://smed.science.oregonstate.edu/node/42

APPENDIX C

PERMISSION TO USE TSES

ANITA WOOLFOLK HOY, PH.D.

PROFESSOR
PSYCHOLOGICAL STUDIES IN EDUCATION

Dear Susan,

You have my permission to use the *Teachers' Sense of Efficacy Scale* in your research. A copy of both the long and short forms of the instrument as well as scoring instructions can be found at:

Best wishes in your work,

Anita Woolfolk Hoy

Anita Woolfolk Hoy, Ph.D.
Professor

COLLEGE OF EDUCATION
29 WEST WOODRUFF AVENUE
COLUMBUS, OHIO 43210-1177

PHONE 614-292-3774
FAX 614-292-7900
HOY.17@OSU.EDU

APPENDIX D

DISTRICT SUPERINTENDENTS' LETTER FOR PERMISSION TO CONDUCT STUDY

Susan Melony Hanson, M.Ed.
6803 Cumberland Trail
Moss Point, MS 39562
May 18, 2010

(Insert address for district here)
Dear (Insert superintendent's name here),

My name is Susan Melony Hanson and I am a doctoral student at The University of Southern Mississippi. I am beginning my dissertation and would like permission to conduct my study in the schools in your district. My dissertation topic is science teaching self-efficacy and my targeted population is 5th and 8th grade science teachers. Your teachers would be asked to complete a short survey that should take no longer than twenty minutes to complete. Each teacher would have two weeks to complete the survey and return it to a designated box in the teacher workroom/lounge at their school. The teachers will be informed that they are not required to participate in the study and can withdraw from the study at anytime with no penalty. Due to deadline commitments I am required to get district approval before the proposal of my dissertation in July. Please be aware that the actual study will not take place until the first weeks of the 2010-2011 school year.

Through research required for my doctoral classes, I became very interested in the scores for our 5th and 8th grade science students. Through data analysis I determined the mean average for 5th graders was basic. It was from this research that I decided to choose this topic for my dissertation. I will use the Science Teaching Efficacy Belief Instrument to determine the level of confidence our science teachers have, and what factors such as; undergraduate science methods courses, years teaching, and level of education, have on science teaching self-efficacy.

All participants, school names, and results will remain anonymous. Participant numbers and letters representing all schools will be used to ensure this anonymity. The only persons that will have access to these results will be me and the members of my dissertation committee. These members include: Dr. Rose Jones, chairman, Dr. J.T. Johnson, statistician, Dr. Hani Morgan, Dr. Stacy Reeves, Dr. Barbara Stanford, and Dr. Mary Beth Evans.

This project will be reviewed by the Human Subjects Protection Review Committee, which ensures that research projects involving human subjects follow federal regulations, before the study is conducted. Any questions or concerns about rights as a research subject should be directed to the chair of the Institutional Review Board, The University of Southern Mississippi, 118 College Drive #5147, Hattiesburg, MS 39406-0001, (601-266-6820).

If you have any further questions or would like to meet with me in person, please feel free to contact me at 228-990-1058 or susan.hanson@eagles.usm.edu. If you are willing to allow your teachers to participate in this study please sign the attached form and return it to me in the self-addressed stamped envelope provided. Upon receiving your approval, as a courtesy I will contact the principals at each of the schools to obtain their permission as well.

Sincerely,

Susan Melony Hanson, M.Ed.

APPENDIX E

SUPERINTENDENTS' PERMISSION FORM TO CONDUCT STUDY

(Insert school address here)

Permission to Conduct Dissertation Study
Susan Melony Hanson, M.Ed.

I, ____________(Superintendent's Name)_____________________, give Susan Melony Hanson permission to conduct her dissertation survey- Science Teaching Efficacy Belief – with the 5^{th} and 8^{th} grade science teachers in my district. I understand the study will not be conducted until approval has been granted from the Institutional Review Board at The University of Southern Mississippi, and that the teachers are in no way obligated to participate in the study. I further understand that teachers may withdraw from participation in the study at anytime with no fear of penalty.

____
Signature

____
Date

APPENDIX F

IRB APPROVAL

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

Institutional Review Board

118 College Drive #5147
Hattiesburg, MS 39406-0001
Tel: 601.266.6820
Fax: 601.266.5509
www.usm.edu/irb

HUMAN SUBJECTS PROTECTION REVIEW COMMITTEE
NOTICE OF COMMITTEE ACTION

The project has been reviewed by The University of Southern Mississippi Human Subjects Protection Review Committee in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services (45 CFR Part 46), and university guidelines to ensure adherence to the following criteria:

- The risks to subjects are minimized.
- The risks to subjects are reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered regarding risks to subjects must be reported immediately, but not later than 10 days following the event. This should be reported to the IRB Office via the "Adverse Effect Report Form".
- If approved, the maximum period of approval is limited to twelve months. Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: **10072604**
PROJECT TITLE: **Science Teaching Efficacy Beliefs of 5th and 8th Grade Science Teachers**
PROPOSED PROJECT DATES: **08/01/2010 to 08/01/2011**
PROJECT TYPE: **Dissertation**
PRINCIPAL INVESTIGATORS: **Susan Melony Hanson**
COLLEGE/DIVISION: **College of Education & Psychology**
DEPARTMENT: **Curriculum, Instruction, & Special Education**
FUNDING AGENCY: **N/A**
HSPRC COMMITTEE ACTION: **Exempt Approval**
PERIOD OF APPROVAL: **11/16/2010 to 11/15/2011**

Lawrence A. Hosman
Lawrence A. Hosman, Ph.D.
HSPRC Chair

11-18-2010
Date

APPENDIX G

TEACHER INFORMED CONSENT LETTER

November 29, 2010

Dear Teacher,

My name is Melony Hanson and I am a doctoral student at The University of Southern Mississippi. I am conducting my dissertation study regarding science teaching efficacy and science teaching beliefs of 5th and 8th grade science teachers. The attached questionnaires will help me to measure these attitudes and should take you approximately twenty minutes to complete. Once you have completed the questionnaire please place it in the manila envelope I have provided, seal it, and then return it to the designated box in the teacher's lounge. As a former teacher I am well aware of the demands on your time and would greatly appreciate your participation.

Participation in this study is completely voluntary and you may decline to participate or discontinue participation at any time. All information and data collected during this study will be completely anonymous, and any identifying information inadvertently obtained will remain confidential. Upon completion of the study all information, data, and questionnaires will be destroyed.

Your participation in this study will help me to better understand how science teaching efficacy and science teaching beliefs are possibly related. It is hoped the results of this study will aid in developing more effective curriculum planning and alignment through teacher collaboration, thus having a positive effect on the state science test scores. I will be presenting the results of my findings to my dissertation committee; however, neither you nor your school will be identified in the results.

By completing the attached questionnaire you are granting permission for this confidential data to be used for the purposes described above.

This project has been reviewed by the Human Subjects Protection Review Committee, which ensures that research projects involving human subjects follow federal regulations. Any questions or concerns about rights as a research subject should be directed to the chair of the Institutional Review Board, The University of Southern Mississippi, 118 College Drive #5147, Hattiesburg, MS 39406-0001, (601) 266-6820.

If you should have any questions are concerns please feel free to contact me at 228-990-1058 or susan.hanson@usm.edu. Thank you so much for your participation in this study.

Sincerely,

Susan Melony Hanson
Susan Melony Hanson

REFERENCES

American Association for the Advancement of Science. (1989). *Project 2061: Science for all Americans*. New York: Oxford University Press.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*(2), 191-215. Retrieved from http://www.apa.org/pubs/journals

Bandura, A. (1997). *Self-efficacy: The exercise of control.* New York: W.H. Freeman and Company.

Banks, C., McQuater, G., & Hubbard, J. (1978). Toward a reconceptualization in the socio-cognitive bases of achievement orientations in blacks. *Review of Educational Research, 28*(3), 381-397. Retrieved from http://www.sagepub.com/journals

Bleicher, R. (2004). Revisiting the STEBI-B: Measuring self-efficacy in preservice elementary teachers. *School Science and Mathematics, 104*(8), 383-391. Retrieved from http://www.sagepub.com/journals

Bransford, J., Brown, A., & Cocking, R. (1999). *How people learn: Brain, mind, experience, and school.* Washington, DC: National Academies Press.

Briscoe, C., Peters, J., & O'Brien, G. (1993). An elementary science program emphasizing teachers' pedagogical content knowledge within a constructivist epistemological rubric. In. P. Rubba, L. Campbell, & T. Dana (Eds.), *Excellence in educating teachers of science* (pp. 1-20). Columbus: ERIC Clearinghouse for Science, Mathematics, and Environmental Education.

Bruner, J. (1977). *The process of education: A landmark in education.* Cambridge: Harvard University Press.

Bybee, R. (2007). Do we need another Sputnik? *American Biology Teacher,* 454-457. Retrieved from http://www.nabt.org/publications

Cakiroglu, J., Cakiroglu, E., & Boone, W. (2005). Pre-service teacher self-efficacy beliefs regarding science teaching: A comparison of pre-service teachers in Turkey and the USA. *Science Educator, 14*(1), 31-40. Retrieved from http://www.nsela.org

Colburn, A. (1998). *Constructivism and science teaching.* Indiana: Phi Delta Kappa Educational Foundation.

Cox, C. & Carpenter, J. (1989). Improving attitudes toward teaching science and reducing science anxiety through increasing confidence in science ability in in-service elementary school teachers. *Journal of Elementary Science Education, 1(2),*14-35. Retrieved from http://www.theaste.org/publications

Davis, E., Petish, D., & Smithey, J. (2006). Challenges new science teachers face. *Review of Educational Research, 76*(4), 607-651. Retrieved from http://www.sagepub.com/journals

DeCharms, R. (1984). Motivation enhancement in educational settings. In R. E. Ames & C. Ames (Eds.) *Research on motivation in education: Volume I, Student Motivation* (pp. 275-310). Orlando: Academic Press.

Dewey, J. (1910). *How we think.* Lexington, MA: D.C. Heath.

Dweck, C. (1986). Motivational processes affecting learning. *American Psychologist, Al*(10), 1040-1048. Retrieved from http://www.apa.org/publications

Erdogan, I. & Campbell, T. (2008). Teacher questioning and interaction patterns in classrooms facilitated with differing levels of constructivist teaching practices. *International Journal of Science Education, 30*(14), 1891-1914. doi: 10.1080/09500690701587028

Fensham, P. (2004). *Defining an identity: The evolution of science education as a field of research.* Boston: Kluwer Academic.

Finson, K. (2001). Investigating preservice elementary teachers' self-efficacy relative to self-image as a science teacher. *Journal of Elementary Science Education, 13*(1), 31-42. Retrieved from http://www.theaste.org/publications

Gibson, S. & Dembo, M. (1984). Teacher efficacy: A construct validation. *Journal of Educational Psychology, 76*(4), 569-582. Retrieved from http://www.apa.org/publications

Gieryn, T. (1999). *Cultural boundaries of science: Credibility on the line.* Chicago: University of Chicago Press.

Green, S. & Gredler, M. (2002). A review and analysis of constructivism for school-based practice. *School Psychology Review, 31*(1), 53-70. Retrieved from http://www.nasponline.org/publications

Gunel, M. (2008). Critical elements for the science teacher to adopt a student-centered approach: The case of a teacher in transition. *Teachers and*

Teaching: Theory and Practice, 14(3), 209-224. doi: 10.1080/13540600802006095

Handelsman, J., Ebert-May, D., Beichner, R., Bruns, P., Chang, A., DeHaan, R., … Gentile & Wood, W. (2004). Scientific teaching. *Science, 304*(5670), 521-522. Retrieved from http://www.sciencemag.org

Heppner, F., Kouttab, K., & Croasdale, W. (2006). Inquiry: Does it favor the prepared mind? *American Biology Teacher,* 390-392. Retrieved from http://www.nabt.org/publications

Heywood, D. (2007). Problematizing science subject matter knowledge as a legitimate enterprise in primary teacher education. *Cambridge Journal of Education, 37* (4), 519-542. doi: 10.1080/03057640701705856

Howes, E. (2008). Educative experiences and early childhood science education: A Deweyan perspective on learning to observe. *Teaching and Teacher Education, 24,* 536-549. doi: 10.106/j.tate.2007.03.006

Jaramillo, J. (1996). Vygotsky's sociocultural theory and contributions to the development of constructivist curricula. *Education, 117(2),* 133-140. Retrieved from http://www.projectinnovation.biz/index.html

Kamii, C. & Ewing, J. (1996). Basing teaching on Piaget's constructivism. *Childhood Education, 72(5),* 260-264. Retrieved from http://www.udel.edu/bateman/acei

Keys, C. & Bryan, L. (2001). Co-constructing inquiry-based science with teachers: Essential research for lasting reform. *Journal of Research in*

Science Teaching, 38(6), 631-645. Retrieved from http://www.narst.org/publications

Krejcie, R. & Morgan. D. (1970). Determining sample size for research activities. *Educational and Psychological Measurement, 30,* 607-610. Retrieved from http://www.epm.sagepub.com

Liang, L. & Gabel, D. (2005). Effectiveness of a constructivist approach to science instruction for prospective elementary teachers. *International Journal of Science Education, 27*(10), 1143-1162. doi: 10.1080/09500690500069442

Matthews, M. (2003). “Teaching Science.” In Randall Curren (Ed.), *A companion to the philosophy of education* (342-353). Oxford: Blackwell.

Millar, R., Osborne, J., & Nott, M. (1998). Science education for the future. *School Science Review, 80*(291), 19-24. Retrieved from http://www.ase.org.uk/journals

Minger, M. & Simpson, P. (2006). The impact of a standards-based science course for preservice elementary teachers on teacher attitudes toward science teaching. *Journal of Elementary Science Education, 18*(2), 49-60. Retrieved from http://www.theaste.org/publications

Mintzes, J. & Wandersee, J. (2005). *Teaching science for understanding: A human constructivist view.* Orlando: Academic Press.

Mississippi State Department of Education Office of Student Assessment. (2010). *Mississippi Curriculum Test 2, Second Edition.* Retrieved from http://www.mde.k12.ms.us

Monteiro, R., Carrillo, J., & Aguaded, S. (2010). Teacher scripts in science teaching. *Teaching and Teacher Education, 26,* 1269-1279. doi: 10.1016/j.tate.2010.01.004

Mooney, C. (2000). *Theories of childhood: An introduction to Dewey, Montessori, Erikson, Piaget, & Vygotsky.* St. Paul: Redleaf Press.

Moseley, C., Reinke, K., & Bookout, V. (2002). The effect of teaching outdoor environmental education on preservice teachers' attitudes toward self-efficacy and outcome expectancy. *The Journal of Environmental Education, 34*(1), 9-15. Retrieved from http://www.neeea.org/nejee.html

Mulholland, J. & Wallace, J. (2001). Teacher induction and elementary science teaching: Enhancing self-efficacy. *Teaching and Teacher Education, 17,* 243-261. Retrieved from http://www.elsevier.com

National Academy of Sciences (1996). *National science education standards.* Washington, DC: National Academy Press.

Nespor, J. (1978). The role of beliefs in the practice of teaching. *Journal of Curriculum Studies, 19,* 317-328. doi: 10.1080/002.20270601032025

Nunn, G. & Jantz, P. (2009). Factors within response to intervention implementation training associated with teacher efficacy beliefs. *Education, 129*(4), 599-607. Retrieved from http://www.projectinnovation.biz/index.html

O'Day, J. & Smith, M. (1993). Systemic reform and educational opportunity. In S. H. Fuhrman (Ed.), *Designing coherent education policy: Improving the system* (pp. 250-312). San Francisco: Jossey-Bass.

Ogawa, R., Sandholtz, J., Martinez-Flores, M., & Scribner, S. (2003). The substantive and symbolic consequences of a district's standards-based curriculum. *American Educational Research Journal, 40*(1), 147-176. Retrieved from http://www.aera.net/publications

Olson, S. & Loucks-Horsley, S. (2000). *Inquiry and the national science education standards: A guide for teaching and learning.* Washington, DC: National Academies Press.

Pajak, E. (2001). Clinical supervision in a standards-based environment: Opportunities and challenges. *Journal of Teacher Education, 52,* 233-243. doi: 10.1177/0022487101052003006

Palmer, D. (2006). Durability of changes in self-efficacy of preservice primary teachers. *International Journal of Science Education, 28*(6), 655-671. doi: 10.1080/09500690701587028

Patten, M. (2009). *Understanding research methods: An overview of the essentials* (7th ed.). Glendale, CA: Pyrczak.

Peters, M. (2006). Special issue- Philosophy of science education. *Educational Philosophy and Theory, 38*(5), 579-584. Retrieved from http://www.wiley.com/bw/journal

Piaget, J. (1953). *The origins of intelligence in children.* New York: International Universities Press.

Planty, M., Hussar, W., Snyder, T., Provasnik, S., Kena, G., Dinkes, R., … & Kemp, J. (2008). *The condition of education 2008* (NCES 008-031).

National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education, Washington, DC.

Powell, K. & Kalina, C. (2009). Cognitive and social constructivism: Developing tools for an effective classroom. *Education, 130*(2), 241-250. Retrieved from http://www.projectinnovation.biz/index.html

Richardson, V. (1996). The role of attitudes and beliefs in learning to teach. In J. Sikula (Ed.), *Handbook of research on teacher education* (pp. 102-119). New York: Macmillan.

Rigdon, J. (2007). Eisenhower, scientists, and Sputnik. *Physics Today, 60*(6), 47-52. Retrieved from http://www.physicstoday.org

Riggs, I. & Enochs, L. (1989, April). *Toward the development of an elementary teacher's science teaching efficacy belief instrument.* Paper presented at the Annual Meeting of the National Association for Research in Science Teaching, San Francisco, CA. Document retrieved from www.eric.ed.gov/PDFS/ED308068.pdf.

Roth, W. (2007). Toward a dialectical notion and praxis of scientific literacy. *Journal of Curriculum Studies, 39*(4), 377-398. doi: 10.1080/002.20270601032025

Rubeck, M. & Enochs, L. (1991, April). *A path analytical model of variables that influence science and chemistry teaching self-efficacy and outcome expectancy in middle school science teachers.* Paper presented at the annual meeting of the National Association for Research in Science Teaching, Anaheim, CA.

Ryan, R., Connell, J., & Deci, E. (1985). A motivational analysis of self-determination and self-regulation in education. In C. Ames & R. Ames (Eds.), *Research on motivation in education. The classroom milieu* (Vol. 2, pp. 13-51). London: Academic Press.

Saka, A. (2009). Hitting two birds with one stone: Assessment of an effective approach in science teaching and improving professional skills of student teachers. *Procedia Social and Behavioral Sciences, 1,* 1533-1544. Retrieved from http://www.sciencedirect.com/science/journal

Singh, K., Granville, M., & Dika, S. (2002). Mathematics and science achievement: Effects of motivation, interest, and academic engagement. *The Journal of Educational Research, 95*(6), 323-332. Retrieved from http://www.taylorandfrancisgroup.com

Slezak, P. (2001). "A critique of radical social constructivism." In Phillips (Ed.), Education yearbook of the national society for the study of education. Part I, *Constructivism in education: Opinions and second opinions on controversial issues,* Chicago: University of Chicago Press.

Southerland, S., Smith, L., Sowell, S., & Kittleson, J. (2007). Chapter 2 resisting unlearning: Understanding science education's response to the United States' national accountability movement. *Review of Research in Education, 31,* 45-77. doi: 10.3102/0091732X07300046045

Stevens, C. & Wenner, G. (1996). Elementary preservice teachers' knowledge and beliefs regarding science and mathematics. *School Science and Mathematics, 96,* 2-9. Retrieved from http://www.ssma.org

Swanson, C., & Stevenson, D. (2002). Standards-based reform in practice: Evidence on state policy and classroom instruction from state assessments. *Educational Evaluation and Policy Analysis, 24*(1), 1-27.

Tekkaya, C., Cakiroglu, J., & Ozkan, O. (2004). Turkish pre-service science teachers' understanding of science and their confidence in teaching it. *Journal of Education for Teaching, 30*(1), 57-66. Retrieved from http://www.tandf.co.uk/journals

Tobin, K., Briscoe, C., & Holman, J. (1990). Overcoming constraints to effective elementary science teaching. *Science Education, 74,* 409-420. Retrieved from http://www.onlinelibrary.wiley.com

Tschannen-Moran, M. & Hoy, A. (2001). Teacher efficacy: Capturing an elusive construct. *Teaching and Teacher Education, 17,* 783-805. Retrieved from http://www.elsevier.com

Thompson, C. (2009). Preparation, practice, and performance: An empirical examination of the impact of standards-based instruction on secondary students' math and science achievement. *Research in Education, 81*, 53-62. Retrieved from http://www.manchesteruniversitypress.co.uk/journals

Traianou, A. (2006). Teachers' adequacy of subject knowledge in primary science: Assessing constructivist approaches from a sociocultural perspective. *International Journal of Science Education, 28*(8), 827-842. doi: 10.1080/09500690500404409

United States. (1983). A *nation at risk: The imperative for educational reform: A report to the nation and Secretary of Education, United States Department* *of Education.* Washington, DC: National Commission on Excellence in Education.

United States Department of Education. (2010). *ESEA reauthorization: A blueprint for reform*. Retrieved from http://www2.ed.gov/policy

Van Driel, J., Beijaard, D., & Verloop, N. (2001). Professional development and reform in science education: The role of teachers' practical knowledge. *Journal of Research in Science Teaching, 38(2),* 137-158. Retrieved from http://www.onlinelibrary.wiley.com

Von Secker, C. (2002). Effects of inquiry-based teacher practices on science excellence and equity. *The Journal of Educational Research, 95*(3), 151-160. Retrieved from http://www.taylorandfrancisgroup.com

Vygotsky, L. (1986). *Thought and language*. Cambridge: MIT Press.

Watters, J. & Ginns, I. (2000). Developing motivation to teach elementary science: Effect of collaborative and authentic learning practice in preservice education. *Journal of Science Teacher Education, 11,* 301-321. Retrieved from http://www.thaste.org/publications

Wheatley, K. (2002). The potential benefits of teacher efficacy doubts for educational reform. *Teaching and Teacher Education, 18,* 5-22. Retrieved from http://www.elsevier.com

Wieman, C. (2006). Science education for the 21st century: A scientific approach to science education. *AIP Conference Proceedings, 869*(1), 19-26. doi: 10.1063/1.2400629

Wixson, K., Dutro, E., & Athan, R. (2003). Chapter 3: The challenge of developing content standards. *Review of Research in Education, 27,* 69-107. doi: 10.3102/0091732X027001069

Yager, R. (2005). Achieving the staff development model advocated in the national standards. *Science Educator, 14*(1), 16-24. Retrieved from http://www.nsela.org

Yilmaz, A. (2009). Self-efficacy perception of prospective social studies teachers in relation to history teaching. *Education, 129*(3), 506-520. Retrieved from http://www.projectinnovation.biz/index.html