EXAMINING THE RELATIONSHIP BETWEEN ELEMENTARY TEACHERS' SCIENCE SELF-EFFICACY AND SCIENCE CONTENT KNOWLEDGE

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TABLE OF CONTENTS

LIST OF FIGURES

ABSTRACT

EXAMINING THE RELATIONSHIP BETWEEN ELEMENTARY TEACHERS' SCIENCE SELF-EFFICACY AND SCIENCE CONTENT KNOWLEDGE

Mary Jo Wimsatt

Science, Technology, Engineering, and Math (STEM) education is currently commanding an ever-greater share of our national dialogue about education. Very few STEM initiatives focus on studies involving in-service teachers; most education research involves preservice teacher candidates. This researcher used a 54 question survey to examine in-service elementary teachers' science content knowledge and self-efficacy constructs. The instrument combines Enochs and Riggs' (1990) Science Teaching Efficacy Beliefs Instrument (STEBI) with the researcher's content knowledge instrument created from a northwest Florida school district's science textbook series. The researcher's instrument was created to access participants' science content knowledge so the results can be compared to science self-efficacy results from the STEBI. The results of this study show there is a statistically significant relationship between the teachers' science self-efficacy and science content knowledge. The researcher concluded that in order to increase in-service teachers' science self-efficacy, district and school personnel need to increase opportunities for teachers to improve their science content knowledge.

CHAPTER I

INTRODUCTION

As prevalent as Science, Technology, Engineering, and Math (STEM) initiatives are today, those initiatives overlook a fundamental problem. In general, the workforce pipeline of elementary school teachers fails to ensure that the teachers who inform children's early academic trajectories have the appropriate knowledge of and disposition toward science-intensive subjects and science itself. Prospective teachers can typically obtain a license to teach elementary school without taking a rigorous college-level STEM class such as calculus, statistics, or chemistry, and without demonstrating a solid grasp of mathematics knowledge, scientific knowledge, or the nature of scientific inquiry (Epstein & Miller, 2011). This lack of required courses is a recipe for ensuring that students may not have successful early experiences with math and science or for generating the curiosity and confidence in these topics that students need to pursue careers in STEM fields.

To improve STEM learning, the selection, preparation, and licensure of elementary school teachers must be strengthened (National Center for Education Statistics [NCES], 2009). Higher standards for selection into teacher preparation programs are needed. Standards that include demonstrated proficiency in math and science at a level far higher than current levels of teacher candidates have been advocated in the past (National Research Council [NRC], 1996). Elementary grade teacher preparation programs must include more rigorous math and science courses in both content and pedagogy, and teacher candidates must perform in these courses at the high levels that are expected of students (National Council on Teacher Quality [NCTQ], 2010). Furthermore, states must strengthen their licensure requirements so that teachers cannot obtain a license without passing the math and science sections of the exams (NCES, 2009).

Finally, alternative certification program administrators should continue to recruit candidates who were STEM majors in college or are STEM professionals, and licensure requirements should be streamlined in order to get these candidates into classrooms as soon as they are ready (National Science Teachers Association [NSTA], 2005). These steps represent a dramatic departure from current policy, but action is needed now in order to improve the prospects for future global competitiveness. Strengthening elementary school teachers in math and science is the first critical step in the right direction (NCTQ, 2010).

Background

Teacher education programs are under intense scrutiny as graduates appear to be inadequately prepared to teach science (Epstein & Miller, 2011). The NRC (1996) asserts that preparation of preservice elementary science teachers is inadequate both in content and pragmatic delivery of instruction. Olson and Appleton (2006) indicate that elementary science teaching practices do not promote meaningful science learning. The notion of inadequate preparations of elementary science teachers is not only affecting teacher preparation programs. The quality and frequency of science teaching and learning occurring at the elementary level as a whole, as in post-graduation for teacher candidates, continues to be questioned and analyzed (Dembo & Gibson, 1985; Driver & Oldham, 1986; Fulp, 2002; Tilgner, 1990). Ginns and Watters (1999) purport those teacher candidates' beliefs about their ability and inadequacy to teach science may manifest itself in the implementation of poorly designed, ineffective student science learning experiences that utilize meaningless and excessive use of effort and time. In an attempt to curb the sentiment that science teacher preparation is separated and disjointed in terms of science knowledge and pedagogical knowledge (Cochran, King, & DeRuiter, 1991), teacher education programs are seeking ways to reform and therefore better prepare teacher candidates before they arrive in science methods courses. Tobias (1994) advocates for improvements in pedagogy and curriculum in undergraduate science content courses to meet this goal.

Many teacher candidates, especially those in the elementary stream, advance through their teacher education programs with negative attitudes towards science as a result of their high school science experiences (Mulholland, Dorman, & Odgers, 2004; Young & Kellogg, 1993). Effective methods courses that blend pedagogical knowledge with science knowledge can increase a teacher candidate's level of confidence in his or her ability to teach science (Appleton, 1995; Cantrell, Young, & Moore, 2003; Palmer, 2006). For example, the capstone science course to a Bachelor of Science with specialty in elementary education at the University of North Dakota is called T&L 470 Science in the Elementary School. This course is the science methods course for preservice elementary teacher candidates. The aforementioned increase in confidence that teacher candidates experience may be explained by an increase of self-efficacy (NCTQ, 2010).

The psychosocial construct of self-efficacy can be used to capture the relationship of an individual's beliefs to pedagogy (Bandura, 1977a). Bandura (1997) suggests that individuals are motivated to act if the action is thought to elicit a favorable result, which he called *outcome expectation*. Further, Bandura refers to self-efficacy as an individual's confidence that he or she can successfully perform an action with a favorable result (Bleicher, 2004). Bandura (1986) distinguishes between self-efficacy and outcome expectations in that they "are differentiated because individuals can believe that a particular course of action will produce certain outcomes, but they do not act on that outcome belief because they question whether they can actually execute the necessary activities" (p. 392).

Theoretical Framework

A teacher's sense of self-efficacy has been consistently recognized as an important attribute of effective teaching and has been positively correlated to student outcomes (Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998). This study has two theoretical frameworks that interact with each other to provide insight into the research questions. These frameworks are (a) self-efficacy and (b) content knowledge. Understanding the framework of these constructs will provide a clearer foundation for the purpose of this study.

Self-efficacy. Bandura (1986) describes self-efficacy as "beliefs in one's capabilities to organize and execute the courses of action required to manage prospective situations" (p.389). Self-efficacy is context-specific such that it evaluates the capability to perform a specific task (Plourde, 2002). Schunk (1991) suggests that self-efficacy is "an individual's judgment of his or her capabilities to perform given actions" (p. 207). Thus, professional development or further education that impacts teachers' understanding of their teaching content can affect the teachers' perceived ability level and therefore, self-efficacy.

The focus of Bandura's social cognitive construct of self-efficacy has been related to teaching and teacher preparation in many studies (Ashton & Webb, 1986; Bleicher & Lindgren, 2005; Brand & Wilkins, 2007; Enochs & Riggs, 1990; Finson, Riggs, & Jesunathadas, 1999; Gibson & Dembo, 1984; Guskey, 1988; Woolfolk & Hoy, 1990). Lockman (2006), Wingfield, Galper, Denton and Seefeldt (1999) indicate that teachers who maintain high self-efficacy in the form of high expectations for themselves and their students yield students that obtain high achievement.

There are two major aspects of self-efficacy: (a) personal efficacy and (b) outcome expectancy. Bandura (1977a, 1986) distinguishes between these two aspects by arguing that personal efficacy refers to an individual's belief that he or she can do something to yield a specific outcome, while outcome expectancy infers an individual's conception that a specific action will produce a specific outcome. With regard to teaching, personal efficacy is known as teaching efficacy in which an individual believes he or she can be an effective teacher as well as pragmatically overcome barriers to student learning (Lockman, 2006). Lockman further contends that teacher outcome expectancy refers to a teacher's belief that he or she can effectively influence student learning.

Bandura (1986, 1997) asserts that there are four sources for self-efficacy information which provide insight into the nature of teaching and teacher training. These are: (a) mastery experiences; (b) physiological and emotional arousal; (c) vicarious experiences; and (d) social persuasion. Mastery experiences, as described by Bandura (1997), are the most powerful source of efficacy information as mastery experience reflects successful past experiences that have contributed to an individual's expectation of future ability. Bandura (1996) describes physiological and emotional arousal as being associated with positive emotions that reflect confidence and self-assurance as well as the expectation of future success.

Schunk (1989) comments that individuals who relate and identify themselves with others through observable moments, or vicarious experiences, can reinforce a belief that they too have the competence to be successful in similar situations. Social persuasion occurs when an individual experiences praise in the form of an expression of another person's faith, usually from a superior or advisor, in one's ability to successfully engage in a specific task (Bandura, 1997). In terms of science education, Enochs and Riggs (1990) suggest that Bandura's notion of self-efficacy is delineated by teachers who believe in his or her ability to effectively teach science, as in personal science teaching efficacy, and further that effective science teaching can influence student learning of science, namely science teaching outcome expectancy.

Pedagogical content knowledge. Shulman (1986) embraces the idea that successful teachers have a special understanding of content knowledge and pedagogy which they draw on in teaching that content:

> [PCK includes] the most useful forms of representation of [topics], the most powerful analogies, illustrations, examples, explanations, and demonstrations - in a word, the ways of representing and formulating the subject that make it comprehensible to others. (Shulman, 1986, p. 9)

Also encapsulated in the idea of PCK is the notion that successful teachers have a special knowledge about learners which informs their teaching of particular content:

> Pedagogical content knowledge also includes an understanding of what makes the learning of specific topics easy or difficult: the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons. (Shulman, 1986, p. 9)

While Shulman's (1986) notion of PCK may seem to resolve the question of what it is that successful teachers know in order to teach in ways that achieve student understanding, the concept and its relationship to other fields of teacher knowledge is debated in the literature (Cochran, et al., 1991; Lederman, 1998). While the uncertainty of this relationship and the general "fuzziness" (Shulman, 1986, p. 12) around the concept of PCK has impacted the method that is used to explore teachers' PCK, researchers have not focused on these concerns. Rather this researcher is interested in finding ways of helping in-service teachers improve their current classroom practice. Thus, PCK is a means of thinking about and exploring the knowledge that successful teachers have about how to teach particular content topics to particular students in ways that promote understanding; the intention is to document this thinking and exploration so that it might enhance the science teaching practice of others.

Of course, whether the documentation of teachers' PCK is useful to other teachers depends to some extent on the degree to which a teacher's PCK has been internalized throughout a teacher's academic career. Van Driel, Verloop, and de Vos (1997) conclude from their investigation of the literature that research on science teachers' PCK should enable useful generalizations to be made. The position is that it is reasonable to assume that there will be similarities between teachers in Australian schools who have similar backgrounds in teaching and learning science (Van Driel & Berry, 2012).

Statement of the Problem

There is a growing call for teacher education departments to strengthen their science programs (President's Council of Advisors on Science and Technology [PCAST], 2010). Under the scrutiny of public and private assertions of inadequately preparing elementary science teachers, there is a significant push to improve the science teaching self-efficacy of the teacher candidates within the programs (Epstein & Miller, 2011). Czerniak (1998) suggests that improving a teacher candidate's self-efficacy will have positive longitudinal effects as delineated by being better classroom science teachers in the years to come. This hypothesized end will act as the catalyst to change the aforementioned negative perceptions of teacher preparedness in science.

There are studies that provide detailed recommendations on how to improve science teaching self-efficacy through treatments and interventions (Guskey, 1988; Plourde, 2002). In this study, the researcher examined the relationship between in-service elementary teachers' self-efficacy and science content knowledge. This research context reflects a series of elementary school science experiences that have affected an individual's sense of capabilities in science and therefore in the ability to teach science. These experiences originate from the learning experiences in science content classrooms. If these experiences have had negative effects on in-service elementary teachers' science teaching self-efficacy, then recommendations must be made to remedy this situation as lack of science learning experiences lower an elementary teacher's science teaching self-efficacy even before entering the classroom.

Purpose of the Study

Teacher self-efficacy is a particularly critical issue at the elementary school level. A number of studies carried out during the 1990s found that many practicing elementary teachers have low self-efficacy for teaching science, especially physical science topics (e.g., Ramey-Gassert, Shroyer, & Staver, 1996; Carré & Carter, 1990) and lower self-efficacy substantially reduced the quantity and quality of science taught (Anderson, 2002; Goodrum, Cousins, & Kinnear, 1992). Research has shown that the problem of low self-efficacy for teaching science is still a concern. Murphy, Neil, and Beggs (2007) carried out a large scale study which found that lack of teacher confidence was still the current issue of major concern in elementary science. Consequently, there is a continuing need to develop the science teaching self-efficacy of in-service elementary teachers.

The purpose of this study was to investigate how elementary teachers' perceptions of science teaching self-efficacy differ according to personal science expectancy and science teaching outcome expectancy among in-service elementary teachers. Then the researcher examined how those personalized self-efficacies relate to content knowledge. The results of self-efficacy in teachers will help evaluate what teacher education programs and professional development trainings need to focus on in order to better enable elementary teachers to teach science.

Research Question

Based on the problem statement, the research question to be answered in this quasi-experimental study is:

1. Is there a relationship between levels of elementary teachers' science self-efficacy and their science content knowledge?

Significance of the Study

The importance of this study is that teacher preparation programs are under attack as they are considered to be producing inadequate elementary science teachers (NRC, 1996). This attack may be a result of teachers feeling challenged in their understanding of science and their confidence in basic science knowledge (Ellis, 2001). If teacher education programs are designed to better prepare elementary science teachers, it stands to reason that determining more insight into how methods courses affect science teaching self-efficacy would be a prudent step in the right direction. Watters and Ginns (1995) contend that the predilection of becoming an effective elementary science teacher is influenced by a preservice elementary teacher candidates' self-efficacy. Fulp (2002) notes that upon evaluation of the 2000 *National Survey of Science and Mathematics Education: Status of Elementary School Science Teaching* that fewer than 30% of elementary teachers report feeling well prepared to teach science. It is vital that teacher education programs, in an effort to make a significant and permanent influence on the science teaching self-efficacy of in-service elementary teachers, be aware of the far reaching repercussions of the courses and experiences preservice teachers engage within the preparation program (Lockman, 2006). In understanding better the context in which science teaching self-efficacy can increase, practical and theoretical assertions can then be made to further enhance the experiences and training of future science teachers.

Definition of Terms

Directly related to the purpose of the study are the definitions of key terms. The following terms are defined to provide clarity as to their meaning in the context of this study.

Bloom's Taxonomy. Bloom's taxonomy is a method of dividing learning into three domains of behavior: cognitive, affective, and psychomotor and six cognitive processes: knowledge, comprehension, application, analysis, synthesis, and evaluation (Bloom & Krathwohl, 1956).

Content Knowledge. A deep understanding of subject matter that can help students create useful cognitive maps, relate one idea to another and addresses misconceptions (Shulman, 1986).

Necessary Experiences. Instructional training that consists of management, presentations, interactions, group work, discipline, questioning, and discovery and inquiry instruction (Glatthorn, Jones, & Bullock, 2006).

Motivation. Activation to action. Level of motivation is reflected in choice of courses of action and in the intensity and persistence of effort (Bloom, 1974).

Personal science teaching efficacy, (PSTE). A teacher's belief in his or her skills and abilities to positively impact student achievement (Swackhamer, Koellner, Basile, & Kimbrough, 2009).

Self-efficacy. "The belief in one's capabilities to organize and execute the courses of action required to manage prospective situations" (Bandura, 1994, p. 2).

Science teaching efficacy belief instrument (STEBI). An instrument constructed to measure a teacher's personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE).

STEM. Science, technology, engineering, and math.

Science teaching outcome expectancy (STOE). A teacher's belief that the educational system can work for all students, regardless of outside influences such as socio-economic status and parental influence (Swackhamer, et al., 2009).

Limitations of the Study

There are limitations to this study. Primarily, the participation was voluntary and the in-service teachers who took the instrument may have a bias towards teaching science; thus they may already have increased self-efficacy and content knowledge in science. Another limitation may be the time needed to complete the instrument. Completion of the 54 question instrument could have taken up to 40 minutes, which could have been a deterrent to busy teachers. Finally, an additional limitation may be that teachers were motivated to take the instrument for the opportunity to win a gift certificate to Target® and not take the instrument seriously.

Chapter Summary

In this chapter the researcher elaborates upon and defines the importance of STEM content in the classroom. The theoretical framework identifies the foundation of self-efficacy and pedagogical content knowledge to be the basis of the study. Also mentioned is the: (a) statement of the problem, (b) purpose of the study, (c) research questions, (d) significance of the study, and (e) limitations of the study.

CHAPTER II

REVIEW OF THE LITERATURE

The chapter provides a review of the three areas that are the foundation of the study: self-efficacy, content knowledge, and Bloom's taxonomy. The researcher defines *self-efficacy* and explores self-efficacy as a psychosocial construct and reviews its relevance in the elementary school and in teacher preparation. The researcher elaborates upon content knowledge in the areas of science and Bloom's taxonomy.

Self-Efficacy

Science teaching self-efficacy is based upon Bandura's (1997) social cognitive theory of self-efficacy; *self-efficacy* refers to one's perceived capabilities to execute actions that will produce given attainments. Science teaching self-efficacy is therefore one's perceived capability to teach science effectively and believe that such teaching will yield meaningful science learning for future students.

The following paragraphs summarize the development of the concept of self-efficacy through the work of Bandura (1977b, 1986, 1994, 1996, and 1997). Bandura (1977b) published *Self-efficacy: Toward a unifying theory of behavioral change* as a vehicle to introduce the theory that psychological procedures affect levels of self-efficacy. Bandura (1977b) suggests that expectations of personal efficacy are derived from four sources of information: (a) performance accomplishments, (b) vicarious experiences, (c) verbal persuasion, and (d) psychological states (p. 193). Bandura (1997) comments that *performance accomplishments*, or mastery experiences, refers to the level of success in past experiences that contribute to an individual's expectation of future ability in the same context. Bandura (1986) notes that vicarious experiences are how an individual can relate to and identify with someone else during observable moments. Essentially, this term refers to the idea that if someone else can be seen accomplishing a task or demonstrating a specific behavior, the person observing who can relate to the observed individual can accomplish the same tasks or demonstrate the same behaviors. Social or verbal persuasion manifests when someone of a higher ranking, or a more powerful position, expresses faith, praise, or confidence in another individual's ability to participate in a specific task successfully. The psychological states of an individual, as a result of physiological and emotional sources of arousal, provide the basis from which confidence and self-assurance are coupled with the expectation of future success (Bandura, 1996).

Bandura (1977b) argues that factors such as enactive, vicarious, exhortative, and emotive sources influence the cognitive processing of efficacy information. With these factors as parameters, Bandura developed various treatments to test his hypothesized relationship between perceived self-efficacy and behavioral changes. More specifically, Bandura introduces readers to the complex nature of self-efficacy through the perspective of sources that impact it and provocative treatments that can change it.

In publishing *Social foundations of thought and action: A social cognitive theory,* Bandura (1986) promotes the idea that humans are capable of being self-regulating, self-reflecting, proactive, and self-organizing. This idea opposes the other psychosocial perspective that suggests that humans are reactive entities led by changes and forces in the environment or driven by ulterior concealed inner impulses (Pajares, 2002). What this idea means is that humans have the ability to judge their behavior and identify how such behavior alters their environments. By acknowledging one's inherent personal factors and reflecting on them in relation to behavior, one can use this information as the basis for future judgments and subsequent behavior. This advancement in the understanding of the human agency provides the foundation from which the more subtle aspects of self-efficacy can be explored.

Bandura (1986) identifies that the theoretical center of the social cognitive theory consists of self-efficacy beliefs in suggesting, “peoples’ judgments of their capabilities to organize and execute courses of action required to attain designated types of performances” (p. 391) affect their capabilities. People who believe in their abilities to accomplish tasks and prosper through challenges are the source from which continued effort and perseverance arise. If someone believes they can succeed in a given action, it is that confidence that becomes part of the motivation necessary to act to succeed. However, an absence of such belief in the face of challenge and resistance will result in minimal incentive to persevere or alter behavior as a mechanism to find personal accomplishment. In the arena of science teaching, if one believes they have the background and knowledge to teach science effectively, they will do so in real classrooms outside of the teacher education programs. However, if one lacks that belief and is concerned or fearful about her ability to teach science in the schools, there is little incentive to do so, resulting in an ineffective science education for students.

Bandura (1986) proposes the two subcomponents that form self-efficacy namely personal efficacy and outcome expectancy. Bandura notes personal efficacy as the belief in one’s ability to behave or act in a way that will yield a specified outcome. For science teaching, this belief is the confidence that one could effectively teach science. Outcome expectancy refers to the notion that a specific outcome will arise as a result of a specific action. For science teaching, a teacher would believe that future students will effectively learn science from her teaching of science. The background of this study is framed around the perspective that not enough effective science teaching and learning occurs in the elementary system. The question of why this deficit occurs may be partially answered in considering the effects of science teaching self-efficacy during teacher education programs.

In *Self-efficacy: The exercise of control*, Bandura (1997) further describes the role of self-efficacy beliefs in the human agency: “people’s level of motivation, affective states, and actions are based more on what they believe than on what is objectively true” (p. 2). This quote highlights the power of having a strong sense of self-efficacy. This work, however, holds deeper connection to teaching as Bandura contends that people with high self-efficacy can sometimes outperform those with advanced skill sets who suffer from self-doubt. Unfortunately, even an enormous amount of self-efficacy in one’s ability can result in success when the background information, knowledge, and skills are absent. For teaching, people with a good sense and understanding of science knowledge and pedagogic knowledge can embrace their energies to design, organize, and implement effective science teaching as long as they have the self-efficacy that they can do so. Conversely, someone with greater scientific and pedagogic knowledge may not be able to teach science effectively as he or she may have doubts to her ability to do so. However, without a comfortable amount of both scientific and pedagogic knowledge, an abundance of personal self-efficacy will not be enough to teach science effectively. On this note, many researchers (Shulman, 1986) relate science teaching self-efficacy with teaching.

Tschannen-Moran, et al., (1998) examine the conceptual groundwork and tools for measuring teacher self-efficacy. The purpose of the examination was to clarify the construct as well as improve methods for measuring it. Tschannen-Moran, et al., identify two competing ideas of teacher self-efficacy, one from Rotter’s (1966) social learning theory and one from Bandura’s (1977b) social cognitive theory of self-efficacy. The relevant aspect of this article is the overarching model that Tschannen-Moran, et al., present. In this model, the authors suggest that teachers make self-efficacy decisions partially based on the results of assessing available resources and constraints in specific teaching contexts.

Schunk (1991) describes self-efficacy in providing a thorough overview of the psychosocial construct. Like Tschannen-Moran, et al., (1998), Schunk describes different perspectives of the related constructs to self-efficacy which include: (a) perceived control, (b) outcome expectations, (c) perceived value, (d) attributions, and (e) self-concept. Schunk continued the study in capturing the resultant self-efficacy as a result of the effects of personal variables such as goal setting and information processing and situation variables such as models, feedback, and rewards.

Gibson and Dembo (1984) provide explanations as to what changes in levels of Personal Science Teaching Efficacy (PSTE) and Science Teaching Outcome Expectancy (STOE) subscales mean from a pragmatic perspective. Here, Gibson and Dembo identify high scores on the PSTE subscale to mean a strong belief in one's ability to teach science in a rich and effective way while high scores on the STOE subscale denote a high expectation that the practice of one's science teaching would elicit meaningful learning in students. It is these descriptive explanations which helped focus the broad understandings of what each of the two science teaching self-efficacy components refer.

El-Deghaidy (2006) reports results of an investigation of Egyptian preservice teachers' levels of self-efficacy and self-image as science teachers. In this work, El-Deghaidy describes the four main sources Bandura (1997) identifies that impact self-efficacy: (a) mastery experiences, (b) physiological and emotional states, (c) vicarious experiences, and (d) social persuasion. Further, El-Daghaidy describes PSTE and STOE from a simplistic perspective; PSTE defines confidence in the ability to teach science, and STOE refers to the confidence that future students will positively learn from the teaching. Schunk (1989) completed a meta-analysis of peer modeling research and within it comments that people who relate to others through vicarious experiences can develop a stronger sense of efficacy so that they too can be successful in a similar situation. This pattern is a major component of peer teaching and observation during field placement and practicum. Finson, et al., (1999) sought to investigate the relationship between self-efficacy and perceptions of self as a science teacher among preservice elementary teacher candidates. The method used to collect the data was the Draw-A-Science-Teacher Teaching Checklist and the Science Teaching Efficacy Beliefs Instrument (STEBI-B).

The purpose of Bleicher and Lindgren's (2005) research was to examine the relationships between conceptual understanding and both PSTE and STOE subscales of science teaching self-efficacy developed within a constructivist-based science methods course and variables that contribute to those changes. The theoretical framework of their study was constructivist learning theory and self-efficacy. They collected data from 49 elementary preservice student teacher candidates (Bleicher & Lindgren, 2005, p. 212). The results indicate that participation in the constructivist-oriented science methods course increased perceptions of self-efficacy on both subscales and conceptual understanding. These data indicate that increasing the number of science content courses preservice elementary teacher candidates take may not be sufficient enough to increase science efficacy (Young & Kellogg, 1993). Rather, it is the learning environment within such science content courses that makes the difference.

Perceptions of Science in the Elementary School

Driver and Oldham (1986) provide insight and advocate for establishing better curriculum development in science in the light of an initiative from the United Kingdom called the Children's Learning in Science Project. In their work, Driver and Oldham describe the dynamics of a constructivist approach to learning and the effectiveness of student learning it was intended to achieve. These researchers provide a glimpse into the condition of elementary school science curriculum and how it needs to change as the concerns for student epistemology were gaining steam and as the call for better taught science lessons began to become more prevalent. Constructivist-oriented learning was the answer to these calls and part of the impetus of reform in science teacher preparation as preservice elementary teacher candidates needed to be prepared to teach along this theoretical pedagogic line. Teacher education programs have not yet fully embraced this notion and are being scrutinized for graduating ineffective and inadequate science teachers as a result (NRC, 1996).

The NRC (1996) continues to express concern about science teaching in the elementary school through an inquiry into the national science standards and offers suggestions as to how teacher education programs can find new ways to improve science teacher candidates throughout their programs of study. One way is to have collaboration between education and science departments. Tilgner (1990) acknowledges the challenges facing science education at the elementary school, the elementary science teacher curriculum, and the factors affecting students' interest in science. Tilgner sought a solution to the perceived shortcomings of science teacher preparation programs and offered a thorough list of characteristics of effective elementary science programs to learn from and help modify the then current practices in science teacher development. The author notes, however, that preservice elementary teacher candidates seemed to have inefficient and alternative understandings in science and, even more concerning, have little interest in teaching science. It is, therefore, not surprising that Dembo and Gibson (1985) write that the global condition of science teacher preparation and training was in crisis and teetering on the edge of collapse unless reform to science teacher preparation occurred swiftly as the then current standards of science education were failing the learners.

Olson and Appleton (2006) continue to share a concern about the condition of elementary science teacher preparation and practice. Olson and Appleton focus on providing solutions that meet current understandings of teaching and learning and the effectiveness of well-prepared, science-knowledge confident, and self-efficacious preservice elementary teacher candidates entering the field post-graduation as in-service teachers. While it appears that a dark cloud hangs over elementary level science teacher preparation and training programs, there is some light that provides hope in terms of reversing the mostly negative perception of the last 20 years by developing and employing exceptional science teachers at the elementary level. One method that has been shown to improve the quality of science teaching at the elementary level is for teachers to have a stronger sense of their science teaching self-efficacy (Woolfolk & Hoy, 1990).

In addition to Riggs (1988) and Enochs and Riggs (1990), Huinker and Madison (1997) provide insight into operational definitions for *self-efficacy* while investigating, among other items, the effects of methods courses on PSTE and STOE. The authors claim:

> People who see themselves as efficacious set challenges for themselves and are more likely to persist in their efforts until they succeed. People who perceive themselves as inefficacious are more likely to shy away from difficult tasks and even abandon them in the face of obstacles. (p. 108)

People with a strong sense of efficacy in their capabilities approach difficult tasks as challenges to be mastered rather than as threats to be avoided (Bandura, 1994). These individuals have developed their self-efficacy by mastering experiences and achieving goals through perseverance and overcoming obstacles. Their success can be realized through sustained effort.

Self-Efficacy in Teaching and Teacher Preparation

Researchers relate self-efficacy and teaching to teacher education and preparation (Gibson & Dembo, 1984; Tschannen-Moran, et al., 1998; Watters & Ginns, 1995). Gibson and Dembo sought to develop an instrument to measure teacher self-efficacy while providing construct validation support to the individual differences in teaching effectiveness. Further, the authors examine the relationship between observable teacher behaviors and teacher self-efficacy. As a result, Gibson and Dembo developed a 30-item scale called the Teacher Efficacy Scale. Using a factor analysis of the responses, Gibson and Dembo found two substantial factors that correspond to Bandura's two-tier factor model of self-efficacy, namely the PSTE and STOE.

Ashton and Webb (1986) wrote *Making a difference: Teachers' sense of efficacy and student achievement.* In the book, Ashton and Webb suggest that preservice elementary teacher candidates are ideal to study as teacher beliefs may be good predictors of future teaching behavior. By identifying and understanding preservice teacher self-efficacy beliefs, researchers may use these beliefs as predictors to gauge how these preservice teachers will teach once they become in-service teachers. This work is specifically aimed at science teaching.

The purpose of Guskey's (1988) research was to explore attitudes toward implementing new instructional practices. In this study of 120 teachers in a professional development program, Guskey determines that teachers who have a high sense of teaching self-efficacy are more open to new pedagogic ideas for teaching and learning. These high self-efficacy teachers are more willing to put the needs of their students first and try innovative teaching and learning strategies to maximize meaningful learning than are teachers with a low sense of teaching self-efficacy. Allinder (1994) adds commentary to exploring in-service teachers with high levels of teaching efficacy in studying direct and indirect instructional services. Allinder indicates that teachers with a strong sense of teaching self-efficacy are more likely to be enthusiastic, better planned, and more organized than are teachers with a weak sense of teaching self-efficacy.

Woolfolk and Hoy (1990) examine the structure and meaning of self-efficacy amid preservice teachers. The authors then relate the participants' efficacy to beliefs about control and motivation. The focus questions of this research were: (a) "Is the structure of efficacy for prospective teachers the same as has been found for experienced teachers?"; and (b) "Are prospective teachers' beliefs about efficacy related to their orientations toward discipline, order, control, and motivation in schools?" (p. 210). Woolfolk and Hoy (1990) found two independent aspects of efficacy: teaching efficacy and personal efficacy.

Lockman (2006) studied preservice secondary teacher candidates in an attempt to explore teacher efficacy beliefs, beliefs regarding student learning, and the perceived role of the secondary science teacher. Lockman conducted this research throughout a yearlong teacher preparation program. Results of the mixed-method study indicate that the yearlong teacher preparation program yielded increases in the levels of PSTE. Lockman also provides readers with descriptions of PSTE and STOE which are helpful in determining operational definitions for this dissertation. Lockman suggests that in-service teachers with a strong sense of self-efficacy coupled with high expectations for themselves and their students promote high achievement from the students.

Wingfield, et al., (1999) studied 33 in-service Grade 1 teachers' beliefs about: student ability; effort; sociability; participation in extracurricular endeavors; student achievement; and expectations for students' future studies. Wingfield, et al., concluded that teachers who maintained high self-efficacy thought students could achieve more than they actually could. This comment, like Lockman's (2006) implications, are reasons to continue trying to improve the levels of self-efficacy in preservice elementary teacher candidates while enrolled in teacher preparation programs. It is the positive attributes stemming from a strong sense of self-efficacy which are identified by the above research that teacher education programs seek to strengthen within their future teachers by helping to raise their levels of self-efficacy. A high sense of self-efficacy during the preservice program does not always result in positive results once the preservice teacher candidate becomes an in-service teacher.

In their longitudinal study of preservice teachers from entry into teacher education programs through teaching their own classrooms post- graduation, Woolfolk Hoy and Spero (2005) found that although there was an increase in one's sense of self-efficacy during the teacher preparation program, there was also a significant decline in that same sense of self-efficacy during the first year of teaching. Woolfolk Hoy and Spero suggest a reason for this decline in self-efficacy may be due to a lack of support received during that year. Information of this nature should help drive the structuring of the teacher preparation programs such that preservice teachers can be informed of, and prepared for, this plausible outcome and be given resources and support strategies to handle it. This support will aid beginning teachers in those challenging times during their first year and help minimize the reduction in teaching efficacy, as the results of maintaining a high level of self-efficacy are critical to success in teaching.

Brand and Wilkins (2007) sought to investigate the four sources that impact self-efficacy as suggested by Bandura (1994). Band and Wilkins explore preservice elementary teacher candidates' development into effective science teachers through enrolling and participating in a science and mathematics methods course designed for the elementary level. Brand and Wilkins researched how mastery experiences and vicarious learning contribute to the self-efficacy of teachers.

Bettering Science Content Area Knowledge

The purpose of Stotsky's (2006) work was to identify and describe the types of knowledge and skills preservice teacher candidates should have acquired in their teacher education programs. The author then argues that the wrong faculty members are held accountable for much of the core information needed to teach Grade 5 through Grade 12.

Stotsky (2006) presents three types of knowledge needed to become a teacher: (1) academic knowledge which is the subject area content knowledge in their field; (2) generic professional knowledge and skills which is pedagogic knowledge; and (3) license-specific professional knowledge and skills for teaching in the area of their licensure. The implications of this model suggest that much of the knowledge and skills needed to teach come from content area courses, not education based courses. Within this claim is the suggestion that better pedagogy in such courses would help develop stronger teachers as they would have acquired greater knowledge and skills in their subject area to be later combined with pedagogic knowledge within methods courses. The work concluded with an argument for teacher education reform being a campus wide endeavor.

Mestre (2001) provides a brief historical account of the cognitive research results relevant to the teaching and learning and postsecondary level physics content courses. Mestre's superimposed these results over the current levels of which postsecondary physics courses are taught and learned by preservice teacher candidates. The results of this research include a list of what the literature and research suggests bettering the preparation of preservice physics teachers. While the list provided by Mestre is designed for physics, the overall ideas presented have deeper meaning towards science teacher preparation as a whole as it identifies the need for pedagogical strategies in these science content courses to be more meaningful for students and their learning. All it takes is one department, like physics in this case, to encourage its professors to provide more opportunities for meaningful, deep, rich and complex learning to be constructed by students both part of, and outside of, the teacher education program. It is then that teacher education reforms outside the walls of the education building become possible (Stotsky, 2006).

Science Methods Courses

In the semester or two before entering the student teaching phase of the teacher education program, elementary student teacher candidates typically enroll in a science methods course. The perceived function and strategic organization of the science methods course is critical in helping hone the craft of science teaching and encouraging a strong sense of science teaching self-efficacy. Anderson (2002) provides useful insight into the nature of science methods courses from an operational definition perspective; and context within the total teacher education program perspective. The purpose of Anderson's study was to: (a) report research based definitions and ideas of the role and logistics of science methods courses; (b) construct a new definition that integrates those purported in the literature; and (c) provide suggestions into the implementation of such a new definition and organizational definition of science methods courses while noting some pitfalls that may ensue. Data were derived and collected from published literature and research. Anderson notes that the literature promoted three different notions of what defined a science methods course. These notions include: (a) "a launching pad for a career-long process of professional development" (p. 269); (b) "foundation for a successful student teaching experience" (p. 269); and (c) "the linchpin of the teacher education program" (p. 269). Anderson revealed that these three ideas are not mutually exclusive but rather help the position from which developing an effective science methods course begins. The science methods course, Anderson advocates, must therefore be the, "foundation of a science teacher's professional development, both individually and programmatically" (p.270). The implications from this study provide a new vision of the function science methods courses play in the larger role of teacher education programs. Anderson concludes that a science methods course:

> … with a holistic orientation, a focus on integrating philosophical, psychological, sociocultural, and subject matter perspectives, and preparation for career-long professional development has the potential of integrating theoretical and practical dimensions of the program; i.e., bridging the gap between theory and practice, between course work and student teaching. (p. 270)

Kelly (2000) reports the theoretical and practical rationale for developing a constructivist base elementary science methods course and the results of a four year study of this course. Kelly identifies the benefits of developing learning centers, peer teaching experiences, and practical experiences with the learning styles of elementary students. This research adds to the mosaic of information that suggests that a holistic, constructivist-oriented science methods course can enhance pedagogical knowledge, science knowledge and increase science teaching self-efficacy. More importantly, Kelly suggests that a possible result of an effective science methods course is the transferring of the constructivist learning by preservice elementary teacher candidates to constructivist framed teaching once those candidates become in-service teachers.

The purpose of Carter and Sottile's (2002) work was to examine the critical factors that influence dispositions of preservice elementary teacher candidates as a result of participating in a constructivist based science methods course. The results of the examination identified that the constructivist orientation increased the levels of science teaching self-efficacy amongst the preservice elementary teacher candidates. A relevant implication of this work is the suggestion that improvement in science teaching self-efficacy, as a subsequence of a constructivist framed methods course, will be seen longitudinally when the preservice teachers become in-service teachers. This point is the reason for continued research and effort to reform science teacher education and preparation (Czerniak, 1998).

Johnson, Kahle, and Fargo (2007) identify the relationship between constructivist based science methods course and levels of science teaching self-efficacy. More specifically, the study shows how active learning and teaching style affects preservice elementary teacher candidates' beliefs and attitudes of science teaching. The results of the relationship analysis showed that well designed methods courses that incorporate hands-on activities with opportunities to construct new ideas about science intertwined with teaching and learning strategies had positive impact in elevating levels of science teaching self-efficacy.

Factors Affecting Science Teaching Self-Efficacy

Mulholland, et al., (2004) investigated science teaching efficacy of 314 preservice elementary teachers using the STEBI-B. The variables used for grouping in the analysis were gender and high school science subjects. The authors researched two questions in their study: (a) did the number of high school science subjects taken have an effect on levels of science teaching self-efficacy?; and (b) did the particular high school science subjects have an effect on levels of science teaching self-efficacy? Mulholland, et al., indicate that the number of subjects of high school science courses had no effect on either PSTE or STOE. If it is not the number or subject area of the high school science courses, then it may in fact be the quality of experiences in those courses. As such, one of the grouping variables within this study was selected to be the perceptions of prior school science experiences (Enochs & Riggs, 1990).

The purpose of Young and Kellogg's (1993) study was to compare the experiences of preservice elementary teachers and other nonscience majors with science majors within science and mathematics training. Young and Kellogg indicate that although both groups of participants received roughly equal training in both subject areas, there was a noticeable difference in the attitudes and beliefs towards science between the groups. Young and Kellogg report that, "elementary teachers' attitude toward science warrants concern" (p. 279). Appleton (1995) reiterates this concern in attitudes and beliefs. In response to calls by teacher educators in Australia to provide more science area units in the science methods courses, Appleton studied the changes in perceptions of science teaching self-efficacy pre and post methods courses that contained only minimal amount of science content. The results, as reported by Appleton (2007), suggest that the need for more science knowledge within the science methods course is substantiated. What this outcome means is that methods courses need a careful blend of pedagogical knowledge and content knowledge. This union of pedagogical and content knowledge will help increase the levels of science teaching self-efficacy amongst preservice elementary teachers.

Young and Kellogg (1993) and Appleton (1995), coupled with Olson and Appleton (2006), state the same concern about the need for more science content courses. Their worry regarding the lack of content within a science methods course has relevance to this study because they speak of the continuing anxiety regarding in-service elementary teachers' levels of science teaching self-efficacy and how this may translate into elementary classrooms. More specifically, what these referenced studies have provided is the foundation from which this study has been developed. There is a need to improve the training and preparation of preservice elementary science teachers, from both the content area courses as well as the methods courses.

The notion of improving preservice teacher candidates' levels of self-efficacy has become a popular research focus (Palmer, 2006). Palmer's paper was to investigate the sources of self-efficacy in an elementary level science methods course. Using formal and informal surveys as the data collection tool, Palmer deduced that the main source of self-efficacy was cognitive pedagogical mastery. Palmer identified the overwhelming position that many preservice elementary teachers have low science teaching self-efficacy.

Schoon and Boone (1998) and Moore and Watson (1999), studied the effects of increasing the number of postsecondary science courses in preservice elementary teacher candidates' programs of study on levels of science teaching self-efficacy. The results from both studies identify that such an increase had little or no effect on changes in science teaching self-efficacy as a whole. However, Bleicher (2004) and Bleicher and Lindgren (2005) have shown that the number of science courses taken does effect the PSTE subscale but not the STOE subscale.

The perception of prior school science experiences was examined by Tosun (2000) as a source of information for guiding reform of preservice teacher education. Tosun reports that within the interview process, descriptors used by preservice teacher candidates to reflect previous school science experiences were overwhelmingly negative. These sentiments, more so than achievement in these courses, had great impact on influencing levels of science teaching self-efficacy. This lack of school science experiences is important as it provides insight into the context from which the pre-test results of the STEBI-B can be seen through. Bleicher (2004) re-examined the internal validity and reliability of the STEBI-B as an instrument for measuring science teaching self-efficacy. In the analysis, six descriptive variables were examined for relationships with PSTE and STOE. The background variables were: (a) age; (b) ethnicity; (c) teaching experience; (d) gender; (e) number of science courses taken; and (f) previous school science experience. Age, ethnicity and teaching experience show no relationship to either PSTE or STOE. Gender, number of science courses taken, and previous school science experience demonstrate a relationship with the PSTE subscale, but not the STOE subscale.

Bloom’s Taxonomy

Bloom’s Taxonomy is a method of dividing learning into three domains of behavior: cognitive, affective, and psychomotor (Bloom & Krathwohl, 1956). Cognitive behavior is defined as the ability to perform complex mental. Affective behavior relates to an individual’s emotion, mood, or feeling, while psychomotor behavior is associated with physical movement, coordination, and use of motor skills (Mosby’s Dictionary of Medicine, Nursing, & Health Professions, 2006).

Knowledge areas require one to know specific facts, have the ability to identify concepts, and recite definitions. The ability to remember specifics is the main psychological process involved here; whereas, in higher levels of cognitive behavior, remembering is only part of a more complex process. Questions at the knowledge level are usually asked in a multiple-choice format and are answered correctly more often than when asked at the higher levels of understanding (Bloom & Krathwohl, 1956; Fitzpatrick, 2008).

Comprehension is the next step up the hierarchical order. This comprehension is most likely the level of cognitive ability taught in schools and colleges (Bloom & Krathwohl, 1956). This level goes beyond remembering material and represents the lowest level of understanding. At the comprehension level, students can communicate effectively about a topic, interpret it, and make inferences accordingly. They truly understand the meaning and intent of the material they are working with (Bloom & Krathwohl, 1956).

The third level of Bloom’s taxonomy in the cognitive domain is application. This level builds upon the comprehension phase. There is an understanding that an individual must really comprehend a topic in order to apply it. In the application phase, an individual can apply appropriate application without having to be asked to do so or be prompted as to the correctness of the application, and the learner does not have to be shown how to do the application (Bloom & Krathwohl, 1956). During the application phase, individuals will commonly manipulate the problem to make it more familiar to them and to aid in finding a solution. An example would be applying a mathematical formula to unfamiliar data to derive a solution (Fitzpatrick, 2008).

Analysis is the fourth level of the taxonomy's hierarchical order. During this phase, individuals can simplify the material into its basic parts and detect relationships in the way the parts are organized. Building on the mathematical example above of deriving a solution, individuals should be able to analyze the potential effects of that solution in a specific circumstance (Fitzpatrick, 2008).

The fifth level of the cognitive portion of Bloom's taxonomy is synthesis. This level is the process of working with pieces of information and mixing them in a way that creates a pattern or structure that was absent before. Synthesis is more complete than the previous levels as it involves working with different parts and materials that, when combined, form a complete product. Synthesis of a product takes time: days, not hours to complete (Bloom & Krathwohl, 1956).

The highest level of Bloom's taxonomy is evaluation. This phase is a combination of all the previous levels with the addition of criteria and values. Evaluation is the final phase in the cognitive domain; however, it makes a critical link with the affective domain due to the values component (Bloom & Krathwohl, 1956). During this phase, individuals are expected to judge the product/information that they are reviewing (Fitzpatrick, 2008). Even though evaluation is listed as the final phase of the cognitive domain, it is possible that it may lead to the attainment of new knowledge, a new effort at comprehension or application, or a new analysis and synthesis (Bloom & Krathwohl, 1956). For the purposes of this study, the synthesis and evaluation domains were the two areas used in the instrument.

Chapter Summary

The literature review provides a general background of the necessity to reform science teacher education, and the steps being taken to accomplish that task. One method to improving both the quality of teacher education programs and of the preservice teachers graduating from those programs is by acknowledging the value of a strong sense of teacher self-efficacy among preservice teacher candidates and developing that sense of teacher self-efficacy among preservice teacher candidates and developing that sense throughout the teacher education program. The commitment to bolster the science teaching self-efficacy of elementary teacher candidates is the responsibility of the entire college, not only the science methods professors.

CHAPTER III

METHODOLOGY

The purpose of this study was to investigate the relationship between in-service teachers' science self-efficacies as it relates to their level of science content knowledge. The researcher used an instrument that combined Enochs and Riggs (1990) STEBI instrument and science content questions from a northwest Florida school district's elementary science series. This chapter includes the research question and hypotheses as well as a description of the study design, the participants in the study, the instruments used, and the procedure used in the study.

Research Question and Hypotheses

The researcher investigated the following question for this study: Is there a relationship between levels of elementary teachers' science self-efficacy and teachers' science content knowledge?

From this research question the following hypotheses were generated:

H_0: There is no relationship between levels of elementary teachers' science self-efficacy and teachers' science content knowledge.

H_1: There is a relationship between levels of elementary teachers' science self-efficacy and teachers' science content knowledge.

Research Design

This study was an exploratory study examining the connections between self-efficacy and science content knowledge. Exploratory research is often conducted because a problem has not been clearly defined as yet or because its real scope is as yet unclear (Warner, 2008). When doing this type of research, the researcher has the opportunity to become familiar with the problem or concept to be studied and perhaps generate hypotheses to be tested. It is the initial research before more conclusive research is undertaken. The researcher uses exploratory research to determine the best research design, data collection method, and selection of subjects.

Participants

According to the 2010 United States census, this county in northwest Florida has a total population of 178,019 residents with 8.1% employed by the military. The county is 80.29% white, 9.64% African American. The national average for persons with an associate degree or higher, is 34.86%, this county has 37.23% of the total population who have at least one degree. The largest employer is educational, health and social services which employ 17.9% of the civilian population, next is the arts, entertainment, accommodation and food services with 14.09% employed, followed by the retail industry with 11.74% employed (Okaloosa County, 2010).

The researcher asked 806 in-service elementary school teachers from one county in northwest Florida to participate in the study through a county-wide email request (Appendix A). Kindergarten and first-grade teachers were included in the participation request even though there are no Bloom's taxonomy level questions of synthesis and evaluation from those grade levels available for use in the survey. Regardless of the elementary grade level taught, all teachers are required to take the same science preparatory classes and attend the same science trainings; therefore, all elementary teachers were eligible to participate. Additional demographic information was not collected for this study.

Gaining Permission

The researcher obtained permission to conduct the study from the University of West Florida's Institutional Review Board, (Appendix B), and the participating school district (Appendix C). All participants were made aware of the purpose of the study as well as their role in the study. Confidentiality and data security are a high priority to the researcher. No psychological stress, negative health effects, unwanted solicitation, intrusion of privacy, or economic loss was associated with this study. Consequently, there were no foreseeable risks associated with participating in this study.

Information pertaining to who has access to the collected data, study results, and how the data will be stored was provided to all interested parties. Information pertaining to the purpose of the study: (a) participant expectations, (b) associated risks, (c) confidentiality, (d) data collection and storage, and (e) the participant's freedom to withdraw from the study at any time without negative consequences was provided to all parties in the email invitation.

Moreover, responses were completely anonymous and were automatically aggregated and compiled in a spreadsheet; consequently, no responses were linked to the teachers or to their respective schools. All data were stored in a password protected electronic format with limited access. The results of the study will be used for scholarly purposes only and the data will be destroyed in 5 years.

Sampling and Recruiting

The sample for this study was a *convenience sample*. Convenience sample refers to a data-providing group that serves as the basis for inferential statements by its readily available status relative to the researcher (Warner, 2008). Kindergarten through fifth-grade teachers were sent an email requesting their input by completing a 54-question instrument through SurveyMonkey®. An opportunity to be included in a random drawing for two $50.00 Target® gift cards was incentive for participation.

While taking the instrument, respondents could not continue to the next page of the instrument until all answers were marked on each page. Teachers who did not complete all 54 questions on the instrument did not have access to the email address that allowed them to participate in the Target® drawing. The email address on the last page of the instrument was different than the address on the original email to teachers. If a teacher replied to the researcher's original email address, they would be asked to email their information to the email address listed at the end of the instrument.

Teachers were given two weeks to complete the instrument. Two follow-up emails were sent as reminders of the completion deadline. The first reminder was sent one week after the initial email, and the second reminder was sent the day before the survey closed. The majority of responses were received during the first 24 hours and the final 24 hours.

Instruments

Science educators have conducted extensive research on the effects of efficacy on science teaching and learning. Riggs and Enochs (1990) developed an instrument, based on the Gibson and Dembo (1984) approach, to measure in-service teachers' self-efficacy of teaching science–the *Science Teaching Efficacy Belief Instrument* (STEBI). The STEBI served as the basis of measuring in-service teachers' science self-efficacy and was combined with 29 science content knowledge questions collected from the county science curriculum to form the data collection instrument.

Science teaching efficacy belief instrument. Gibson and Dembo (1984) developed one of the earliest instruments designed to measure self-efficacy beliefs in teachers. The STEBI was scored by following the guidelines listed by Gibson and Dembo in the scoring instructions for the STEBI. Gibson and Dembo's instrument contained two subscales. The first scale measured teachers' beliefs that they felt confident to teach effectively and that they could help improve student achievement, which is referred to as *personal teaching efficacy*. The second scale measured teachers' belief that their impact on student achievement was limited by external factors, such as a student's socioeconomic background and home environment, referred to as *teaching efficacy*. Gibson and Dembo's instrument measured a general pedagogical self-efficacy, not specific to any content area (Bleicher, 2004).

Building on Gibson and Dembo's 1984 study, Riggs and Enochs (1990) developed an instrument designed to measure in-service science teaching self-efficacy beliefs. The STEBI (later referred to as STEBI-A) contained 25 items measuring two subscales with the names more clearly denoting their relationships with Bandura's (1977a) two-factor theory, personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE; Bleicher, 2004). Enochs and Riggs (1990) developed the STEBI-B in order to measure science teaching efficacy beliefs in preservice teachers. When developing the STEBI-B, Enochs and Riggs dropped two of the original items from the STEBI-A, modified the verb tenses in the items to reflect the future orientation to the teaching of preservice teachers, and maintained the naming of the two scales. In the current study, the researcher explored science self-efficacy and content knowledge of in-service teachers; therefore, the 25 question STEBI-A form was used.

Enochs and Riggs' (1990) found that the STEBI is a valid and reliable tool for studying elementary teachers' beliefs toward science teaching and learning. With this tool, a more complete perspective of elementary science teaching is possible, since it allows the investigation of teacher belief systems to supplement the existing research base, which includes studies of teachers' attitude and behavior in the area of science teaching.

Since the development of the STEBI in 1990, there were no studies that reexamined its internal validity and reliability until 2004 when Robert Bleicher administered the STEBI-B to 290 preservice elementary teachers. He conducted a factor analysis of the two subscales and found the results comparable to those reported by Enochs and Riggs (1990). His comparison of the means showed that gender, number of science courses taken and school science experiences had significant associations with PSTE. His means and standard deviations were similar to those found by Enochs and Riggs. The eigenvalues for the PSTE were 5.30 and for the STOE, were 3.14. The two factors were moderately correlated (r=0.124), signifying that they are related but independent constructs. Bleicher (2004) indicated that the general homogeneity of the two scales was upheld. In this study the items from the STEBI-A were used to collect data related to science teacher self-efficacy.

Science content knowledge instrument. The purpose of this instrument was to establish a level of science content knowledge in public school in-service teachers from a northwest Florida county. The researcher developed this instrument by using the elementary science test bank from the approved science series adopted in the county. These questions were publically available to teachers, students and parents through various resource materials given to students throughout the year.

The questions for this researcher's instrument were selected by accessing the test generator CD that was part of the resources given to teachers upon receipt of the science series. The researcher chose the first through fifth grade science questions since there were no science tests on the CD for Kindergarten. In the answer section of the test bank CD, there is a list of identifying categories used to classify each question. Those categories include: (a) points given, (b) level of difficulty, (c) reference number, (d) objectives, (e) state standard code, (f) key, and (g) miscellaneous information. In the objectives section, the individual question was categorized according to Bloom's taxonomy levels. All of the first through fifth grade unit and chapter questions were reviewed, and questions were selected based on Bloom's highest taxonomy levels of synthesis and evaluation. It was necessary to choose those levels of questions because teachers must show comprehension at the levels that are expected of their students (NCT Q, 2010). Those questions were further narrowed down to questions that did not have graphics due to the limitations of SurveyMonkey®. The result was 29 multiple choice questions from the science series test bank. The first three questions had three possible answers; the remaining 26 questions had four possible answers (Appendix D). Correct answers were measured by using the answer key available in the textbook. Correct answers were given a value of one, and incorrect answers were given a value of zero. Correct answers are highlighted by bold print in the dissertation appendix.

The researcher piloted the instrument with five elementary school teachers before presenting it to the teachers in the county's school district. During the pilot, the five teachers were asked to record the amount of time it took to complete the survey, and notate any spelling or grammatical errors. The pilot group took an average of 24 minutes to complete the survey and one misspelling was found and corrected. The data collected from the pilot group were not used in the final survey results.

Procedure

Upon approval of the University of West Florida Institutional Review Board (Appendix B), the county's school board (Appendix C), and completion of the pilot, an email was sent to kindergarten through fifth grade elementary school teachers requesting their participation in a survey (Appendix A). Kindergarten teachers were included because they receive the same training as all other teachers on different grade levels. The researcher explained in the email the instrument was a tool necessary to establish the need for more science content training and support during professional development and curriculum trainings. The data from this instrument will add to the existing body of research regarding training elementary teachers in science content. Once the data were downloaded from SurveyMonkey®, the researcher used a Pearson product moment correlation (*r*) procedure to measure that association between the predictor (self-efficacy) and the criterion (science content knowledge).

Chapter Summary

A description of the proposed study method is provided in this chapter. The researcher includes the research questions and hypotheses as well as a description of the: (a) research design, (b) study participants, (c) procedure to gain permission for the study, (d) sampling and recruiting procedures, (e) instruments used in the study including reliability and validity information, and (f) procedure of the study. The results of the study are discussed in detail in chapter four.

CHAPTER IV

RESULTS

The purpose of this study was to investigate how science teaching self-efficacy relates to science content knowledge. The results of the analysis used to examine science self-efficacy and science content knowledge among in-service elementary teachers are described in this chapter. The reliability of the STEBI-A and the content knowledge questions were examined. The STOE and PSTE subscales were also evaluated to the content knowledge questions to determine their relationship.

Sample Size

The sample for this study consisted of 97 out of 806 in-service elementary classroom teachers from a public school district in northwest Florida. There were 140 participants who completed the first 25 questions, but only 97 participants completed the entire instrument, giving the researcher a 12% response rate. The data from the 43 participants who did not complete the entire instrument were omitted from this analysis to maintain focus on the relationship between science self-efficacy and science content knowledge.

Of the 97 participants, 37 sent the information necessary for the Target® gift card drawing. The eligible names were placed on an Excel spreadsheet then cut apart so individual names could be drawn from a hat. A colleague of the researcher randomly drew two names, and those winners were informed of their prize through county email. The gift cards were sent through the county mail system with a request to acknowledge receipt and a thank you card for participation.

Summary of Data

A variety of statistical methods were used to analyze the data provided by the research instrument. First, data were screened for outliers and missing data. There were two outliers, but removing them from the data did not reflect a significant change so they remained in the final analysis. Then, a Pearson product moment correlation statistical test was used to assess the relationship between the independent variable of science self-efficacy and the dependent variable of science content knowledge. Next, a Kuder-Richardson-20 (KR-20) reliability coefficient was used to determine the reliability of the content knowledge survey questions. A KR-20 reliability coefficient was used to assess the homogeneity of response across items when the items are dichotomous, such as right/wrong or true/false (Warner, 2008, p. 855).

The results of this study indicated a strong correlation between science self-efficacy and science content knowledge as indicated in the scatter plot (Figure 1).

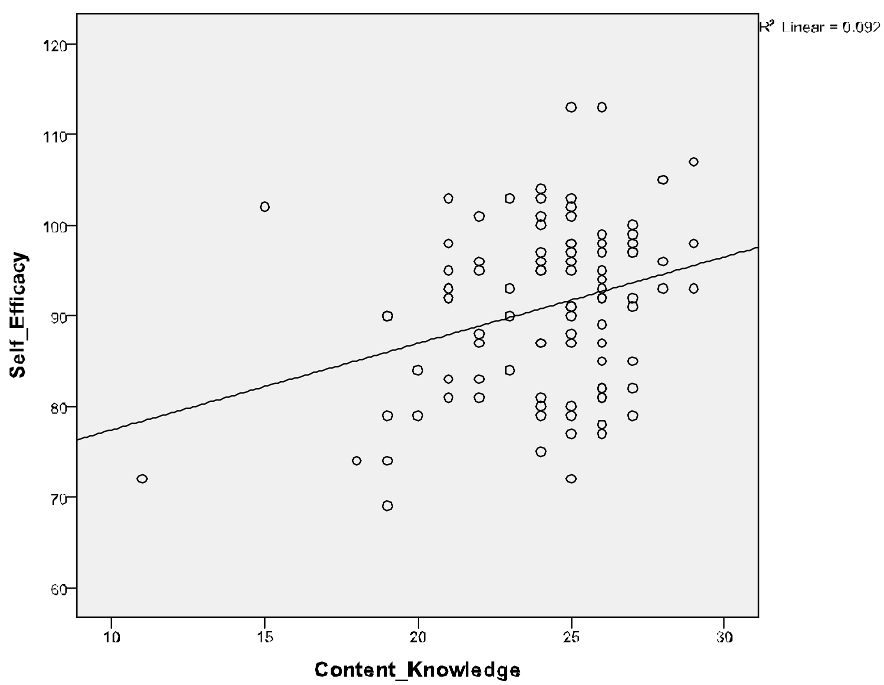

Figure 1. Correlation between science self-efficacy and science content knowledge.

Correlations between the items on the research instrument were also analyzed for reliability by calculating a Cronbach's alpha (α) reliability coefficient. Cronbach's α "assesses the degree to which responses are consistent across multiple measures of the same construct" (Warner, 2008, p. 1005). The minimum Cronbach's α required to demonstrate internal consistency for this study was set at .01 following the guidelines for basic research established by Warner (2008, p. 854). All measures of this survey indicated a Cronbach's α reliability coefficients greater than 0.80. Internal consistency of the content knowledge instrument was measured using a KR-20 of 0.650. This level of reliability was sufficient for the present study.

Research Question

The STEBI-A instrument used in this study has two subscales, PSTE and STOE within the survey items. The PSTE range scores had a minimum of 13 and maximum of 51 with a mean of 28.6, a standard deviation of 7.834 and a Cronbach's alpha of .911. The STOE range scores had a minimum of 16 and maximum of 47, with a mean of 30.65, a standard deviation of 6.45, and a Cronbach's alpha of .842.

The research question was: is there a significance between levels of elementary teachers' science self-efficacy and teachers' content knowledge? A Pearson product moment procedure was performed to assess whether teacher science self-efficacy relates to science content knowledge. The correlation of the 25 STEBI-A questions to the content knowledge questions was statistically significant, $r = .291$, $p = .004$.Therefore, the results show that there is a significant statistical relationship between the teachers' science self-efficacy and science content knowledge and the null hypothesis was rejected.

Chapter Summary

This chapter indicates the results of a study in which the researcher examined the relationship of elementary teachers' science self-efficacy and science content knowledge. The hypothesis tested was found to be statistically significant. The implications of these findings and present recommendations for future research are discussed in chapter five.

CHAPTER V

CONCLUSIONS

The purpose of this study was to investigate perceptions of science self-efficacy among in-service elementary teachers as it relates to science content knowledge. This chapter includes: (a) an overall summary of the study and findings; (b) a discussion of the findings; (c) implications for the nation, school districts and teachers; (d) limitations and (e) recommendations for future research.

Study Summary

In the spring of 2012, 97 in-service teachers from public elementary schools in one county of northwest Florida voluntarily participated in a study in which they completed an instrument that assessed the teacher's science self-efficacy and science content knowledge. The instrument was sent through the county email system and participants were given two weeks to complete the questions. Participants were also availed of the opportunity to email contact information to the researcher to qualify for one of two $50.00 Target® gift cards. Two teachers were randomly selected for the gift cards and were notified through email of their win. The gift cards were sent to the winners through the county mail system.

Data collection. Data were gathered from the STEBI-A which contained 25 items scored on a 5 point Likert scale, ranging from *strongly disagree* to *strongly agree*. The researcher used the instrument to ask participants to respond to statements regarding their science teaching self-efficacy and science content knowledge. The first 25 questions of the instrument contained two subscales; Personal Science Teaching Efficacy (PSTE); and Science Teaching Outcome Expectancy (STOE). The PSTE subscale indicated teacher candidates' beliefs about their ability to teach science, while the STOE showed the beliefs of having future students learn adequately from their science teaching. The issue of context is critical to this study as it places the in-service elementary teachers' responses in perspective. In an effort to better the content knowledge of elementary science teachers, teachers need to engage in the science classroom with a higher perception of science teaching self-efficacy (Enochs & Riggs, 1990).

Discussion. The findings of this study are consistent with the findings of other researchers in the area of affecting changes in science teaching self-efficacy. Enochs and Riggs (1990) assert that long term intensive professional development is needed in order to affect the personal science teaching efficacy of an individual. Ramey-Gassert, et al., (1996) report that professional development sessions created to change science teaching self-efficacy could be viewed differently by participants at various points in the research, often when data is gathered qualitatively.

Science self-efficacy can change in any given situation (Bandura, 1977a). This self-efficacy change is mainly because there are a range of other obstacles that can inhibit the successful teaching of science, including availability of resources (Tschannen-Moran, et al., 1998), pressure to meet district standards and benchmarks (Lee & Houseal, 2003), lack of time (Ross & Mason, 2001), and managing the behavior of children as they interact with each other and with the manipulative materials (Mulholland & Wallace, 2001)

Implications of the Study

Based on the historical background, literature review, data analysis, and interpretation of the results of this study, one can derive several implications. The data results of this study indicate the need for more teacher science content knowledge training in order to improve science knowledge, science self-efficacy, and interest in teacher science education. In order to implement this increase in content knowledge training, a closer examination of local and national implications needs to be conducted.

National and state implications. In a report to the President, the PCAST (2010) address the importance of STEM teacher training in colleges and high schools:

> The majority of partnerships between high schools and colleges and universities that aim to increase the number of students entering STEM pathways do so indirectly by providing better teacher training and support, which in turn can lead to more students interested in STEM disciplines and better prepared to enter college. Such programs can train high school teachers to use new tools for active learning that engage students in hands-on STEM activities. These programs also can provide on-site coaching and leadership development for principals and other administrators. (p. 31)

The Department of Education must have a national strategy in place to infuse STEM into all educational programs (Goals 2000: Educate America Act, 1994). Race to the Top Program Executive Summary ([RTTTPES], 2009) will reward states that have demonstrated success in raising student achievement and have the best plans to accelerate their reforms in the future. These states will offer models for others to follow and will spread the best reform ideas across the country.

District and school implications. As district personnel and school administrators consider the RTTTPES (2009), the personnel and administrators need to consider the priority of placing an emphasis on science, technology, engineering and math:

> To meet this priority, the State's application must have a high-quality plan to address the need to: (i) offer a rigorous course of study in mathematics, the sciences, technology, and engineering; (ii) cooperate with industry experts, museums, universities, research centers,

> or other STEM-capable community partners to prepare and assist teachers in integrating STEM content across grades and disciplines, in promoting effective and relevant instruction, and in offering applied learning opportunities for students; and (iii) prepare more students for advanced study and careers in the sciences, technology, engineering, and mathematics, including by addressing the needs of underrepresented groups and of women and girls in the areas of science, technology, engineering, and mathematics (p. 4).

The American Recovery and Reinvestment Act of 2009 (ARRA) provides $4.35 billion for the Race to the Top Fund. Districts that have demonstrated success in raising student achievement and have the best plans to accelerate their reforms in the future will be the recipients of ARRA funding. Schools and districts must: (a) adopt standards and assessments that prepare students to succeed in college and the workplace and to compete in the global economy, (b) building data systems that measure student growth and success, and inform teachers and principals about how they can improve instruction, (c) recruiting, developing, rewarding, and retaining effective teachers and principals, especially where they are needed most, and (d) turn around lowest-achieving schools (RTTTPES, 2009).

Palmer (2010) investigated the effectiveness of particular sources of science professional development for enhancing the science teaching self-efficacy of in-service teachers. Palmer showed that increases in self-efficacy were mainly due to cognitive mastery (i.e., perceived success in understanding how to teach science) and in situ feedback i.e., verbal persuasion given after observation of the teacher teaching his or her own class. Palmer further recommends that professional development programs offer a combination of out-of-school experiences, such as workshops, with in-school experiences situated in the teacher’s own classroom. Palmer suggests that schools should focus on a useful set of sub skills (i.e., earth science, physical science, etc.)

so a teacher's science self-efficacy can increase to the point where they are willing to do more science teaching in general, and thereby begin the process of becoming lifelong learners in science education.

Implications for teachers. Being cognizant of the professed struggles of teaching science when it is an uncomfortable subject for certain teachers made this researcher interested in investigating ways to possibly affect change in a teacher's science teaching self-efficacy. Teachers with low science teaching self-efficacy tend to avoid teaching science resulting in a deficiency in their students' learning (Ramey-Gassert, et al., 1996). Many elementary teachers do not teach science through inquiry as required by the National Science Education Standards. Effective science professional development must include collaboration with colleagues (NRC, 1996). Alternatively certified teachers are at a higher risk of becoming overwhelmed by teaching partially because of the lack of methods courses taken (NCES, 2009). The use of a mentor is highly recommended, especially for alternatively certified individuals, to help inexperienced teachers implement new strategies in the classroom (Shea, 2002).

The main purpose of this quantitative case study was to analyze the relationship between science self-efficacy and science content knowledge. With an increasing concern regarding the current quality of elementary level science teaching (NRC, 1996) and the ability of new teacher education graduates to temper that trend, efforts are needed to improve the science teaching self-efficacy of in-service elementary teachers. In-service elementary teachers must leave teacher education programs with a greater belief in their ability to teach science.

Many states involve classroom teachers in the design aspects of the science curriculum and accountability assessments. Because teachers are closer to the science curriculum than any other segment of the educational community, it is necessary that they participate in this process

(Marzano, Kendall, & Cicchinelli, 1999). Teachers can use their experience to guide the structure and content of the curriculum and accountability assessments, thereby helping to ensure and protect the breadth and depth of the science curriculum (Hess & Brigham, 2000).

Limitations of the Study

There are several limitations to this study. The first limitation lies in the fact that the researcher offered the survey three weeks before the state proficiency testing a time when teachers are generally tasked with extra lessons to teach, tutoring and remediation. This particular period of time in the school year was also when there were several other surveys asking for teacher input. There was a principal evaluation survey, a custodian survey and two other doctoral dissertation studies that all requested voluntary time from teachers. This survey may have had more of a response if it had been given earlier in the school year. As the school year progresses, teachers are often given more tasks and responsibilities that take up an increasing amount of their time.

A second limitation to the study focuses on the subject of science when there is the overall disinterest in science (Organization for Economic Co-Operation and Development [OECD], 2003). The national spotlight again shines on the dwindling number of students entering the sciences as a profession, with international reports highlighting the nation's lost standing in world rankings and the popular press reporting the poor achievement of students in science classes (Lemonick, 2006). The study could be done with any core subject to evaluate the relationship between self-efficacy and content knowledge.

Another limitation was the lack of demographic data collected at the beginning of the survey. Information regarding years of teaching, level of education, number of science trainings attended, age, gender, and level of interest in science could have been helpful in establishing a better foundation to the study. The information from these areas could also precipitate future research and development of science training geared toward a more specific population.

An additional limitation of this study is that it only focused on the science self-efficacy of in-service elementary teachers. Because self-efficacy is an issue for teachers in the early childhood level, middle, and high school levels, the factors affecting science self-efficacy are not necessarily the same as those in an elementary school environment. There are several other external factors that are unique to each educational level, such as; availability of resources, time, collegial support, and administrative support.

Finally, the STEBI-A used in this survey uses a Likert scale ranging from *strongly disagree* to *strongly agree*. Going from *strongly disagree* to *strongly agree* is the reverse direction used in the original STEBI created by Enochs and Riggs (1990). When compiling and analyzing the data, it is important that the scoring is also reversed, otherwise the results will indicate an opposite correlation. It is highly recommended that future researchers take care to use the original Likert scale.

Recommendations for Future Research

After conducting the research for this case study, this researcher recognized a need for more research in the area of increasing in-service teachers' science content knowledge, which increases science teaching self-efficacy. Administrators, science coaches, teachers, and parents should have an awareness of the importance of self-efficacy in the classroom. Much data on preservice teachers has been compiled over the last decade (Czerniak, 1998; Enochs, Scharmann & Riggs, 1995; Ginns & Tulip, 1995). Several researchers report that the longer a teacher was teaching, the harder it was to change their self-efficacy (Appleton & Kindt, 2002; Ginns & Watters, 1999; Tschannen-Moran et al., 1998).

One of the main aims of many professional development programs has been to enhance teachers' elementary science teaching self-efficacy, yet there is no consensus on the best way to do this (Appleton & Kindt, 2002; Ginns & Watters, 1999; Tschannen-Moran, et al., 1998). In future studies, it would be important to determine the effectiveness of the sources used and how those sources are delivered in professional development trainings. Additional research into the area of how content knowledge can support teacher efficacy along with increasing the knowledge of students is also needed.

Conclusion

Perceived self-efficacy encompasses people's beliefs about their capacity to produce designated levels of performance that exercise influence over events affecting their lives (Appleton, 2006). Beliefs contained in self-efficacy determine how people feel, think, motivate themselves, and behave. A person with high science teaching efficacy will be likely to approach teaching science with confidence, rather than viewing it as a threat or giving up quickly when faced with a difficult situation. Limited content and pedagogical content knowledge and low efficacy have been linked to teachers avoiding science in the classroom. When individuals do teach science, it is usually within their comfort zone where they feel they can control the classroom. This comfort zone, in turn, can limit student engagement (Appleton, 2007). Although not always obvious or easily defined, teachers' attitudes and beliefs influence the sum total of their actions in the classroom. This includes lesson planning and delivery, assessment strategies, and interactions with students and parents (Jones & Carter, 2007).

The aim of studies on self-efficacy is to better inform teacher educators. This research-based information enables them to provide an opportunity for in-service elementary teachers to develop increased self-efficacy and outcome expectancy beliefs. Upon this foundation, the goal is to build a better capacity for in-service teachers to translate an increased science self-efficacy and science content knowledge foundation into the classroom. From this, students will use the science skills learned and confidence gained to build a better future in the field of science.

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APPENDIXES

APPENDIX A

Email Sent to Elementary Teachers

Email Sent to Elementary Teachers

April 2, 2012

Dear Elementary Teachers,

My name is Mary Jo Wimsatt and I am a 5th grade teacher at [redacted]. I am completing my doctorate in education at The University of West Florida, and this survey is one of the last steps in the process to complete my degree.

The purpose of this research is to investigate the role of teacher perceptions and teacher training as these factors relate to elementary level science content knowledge. More specifically, you will be asked to answer questions regarding your beliefs about those factors that may create challenges for you as you prepare for and teach science lessons.

The potential benefits of this study are to add to the existing body of research regarding training elementary teachers in science content. There are no potential risks of participating in this survey, and the survey should only take about fifteen minutes to complete. Your responses are completely anonymous as they will be automatically aggregated and compiled in a spreadsheet; consequently no responses can be linked to you or to your school. All data will be stored in a password protected electronic format. The results of the study will be used for scholarly purposes only and the data will be destroyed in five years.

All Okaloosa County elementary teachers will be invited to complete the online survey using *Survey Monkey*, an easy to access and use online survey program. By clicking on the https://www.surveymonkey.com[redacted] link, you acknowledge that you have read this information and agree to participate in this research. You are always free to withdraw your participation at any time without penalty.

Any teachers who wish to be entered into drawings for **two $50.00 Target gift cards** can opt into participation in the drawing by entering an email address at the end of the survey. These emails will not be affiliated with any set of responses, but will allow the researcher to enter interested participants into the drawing and to contact the two gift card recipients at the end of the study.

If you have any questions, feel free to contact me at [redacted]. Your participation is sincerely appreciated!!

Sincerely,
Mary Jo Wimsatt, Ed.S
[redacted]

APPENDIX B

University of West Florida Institutional Review Board Form

University of West Florida Institutional Review Board Form

Ms. Mary Jo Wimsatt April 13, 2012
[redacted]

Dear Ms. Wimsatt:

The Institutional Review Board (IRB) for Human Research Participants Protection has completed its review of your proposal titled "A Quantitative Approach to the Relationship Between In-service Teachers' Self-efficacy and Science Content Knowledge," as it relates to the protection of human participants used in research, and granted approval for you to proceed with your study on 04-13-2012. As a research investigator, please be aware of the following:

* You will immediately report to the IRB any injuries or other unanticipated problems involving risks to human participants.

*You acknowledge and accept your responsibility for protecting the rights and welfare of human research participants and for complying with all parts of 45 CFR Part 46, the UWF IRB Policy and Procedures, and the decisions of the IRB. You may view these documents on the Research and Sponsored Programs web page at http://www.research.uwf.edu/internal. You acknowledge completion of the IRB ethical training requirements for researchers as attested in the IRB application.

*You will ensure that legally effective informed consent is obtained and documented. If written consent is required, the consent form must be signed by the participant or the participant's legally authorized representative. A copy is to be given to the person signing the form and a copy kept for your file.

*You will promptly report any proposed changes in previously approved human participant research activities to Research and Sponsored Programs. The proposed changes will not be initiated without IRB review and approval, except where necessary to eliminate apparent immediate hazards to the participants.

*You are responsible for reporting progress of approved research to Research and Sponsored Programs at the end of the project period 04-13-2013. If the data phase of your project continues beyond the approved end date, you must receive an extension approval from the IRB.

Good luck in your research endeavors. If you have any questions or need assistance, please contact Research and Sponsored Programs at 850-857-6378 or irb@uwf.edu.

Sincerely,
Dr. Richard S. Podemski, Associate
Vice President for Research
And Dean of the Graduate School
Dr. Carla Thompson, Chair
IRB for the Protection of Human
Research Participants
CC: Melanie Pelton, Karen Rasmussen

APPENDIX C

County Research Request Form

County Research Request Form

MIS 1117
Rev. 12/11

RESEARCH REQUEST FORM

Please submit four copies to the Chief Officer for Quality Assurance & Curriculum for review by the Research Request Committee.

I. Name and address of person requesting research: Mary Jo Wimsatt,

Date: February 23, 2012

Telephone: ______________ E-mail:

Means of Gathering Data:

X Survey __ Questionnaire

__ Test: ______________ (name) __ Other: ______________ (specify)

State problem or title of study: A quantitative approach to the relationship between elementary teachers' self-efficacy and science content knowledge.

Purpose of study: To investigate how elementary teachers' perceptions of science teaching self-efficacy differ according to personal science expectancy and how it relates to science content and knowledge.

Additional pertinent information: The survey will be sent to teachers through Microsoft Outlook and the results will be compiled through SurveyMonkey.

II. Procedure (a 1-2 page narrative should accompany this form with a more thorough description of the proposal):

Group/s to be included in research: X Teachers (specify): All OCSD elementary teachers

______ Students ______ Administrators ______ Other (specify): ______________

Number to be involved in research: 23 Schools ______ Students

Survey/questionnaire administered to staff: Time to complete: 15 – 20 minutes

Survey/questionnaire administered to students: Time to complete: N/A

Test administered to students: Time to complete: N/A

Survey, questionnaire or test administered to students: _____Whole class _____ Small groups _____ Individually

Description of student population to be used: N/A

Technology requirements of participants: N/A

Findings must be provided to the Okaloosa County School District.

____
Signature of Applicant

III. Approval:

______________________ UWF/Doctorate in Education
Major University Professor University/Level of Degree Sought

______________________ ______________________
Chief Officer for Quality Assurance & Curriculum Chairman, OCSD Research Committee

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APPENDIX D

Science Content Knowledge Questionnaire

Science Content Knowledge Questionnaire

#	Question
26	Two pots have holes in the bottom. One pot has sand. One has soil. You put 3 cups of water in each. More water comes out of the **sand** cup. What can you record? A Sand and soil hold the same amount of water. B Sand holds more water than soil. **C Soil holds more water than sand.**
27	On Friday, Rashad measures how much water fills a bottle. He observes that it holds 3 cups. On Sunday, he measures how much water fills the same bottle. How much water does the bottle hold on Sunday? A 2 cups **B 3 cups** C 4 cups
28	Which animal looks like its parents when it is born? **A a bear** B a butterfly C a frog
29	Which meaning do scientists use for the word *investigate*? **A** to ask a lot of questions **B** to use a hand lens to look for clues **C to use a planned way to find answers to questions** **D** to try to find answers to some questions by guessing
30	A teacher shows the class a picture of the sun. She shows another picture of a star pattern, as seen from Earth, and points to the brightest star. What information does the class know about the sun and the star from the pictures? **A** The sun is larger than the star. **B** The star is brighter than the sun. **C The star and the sun both give off light**. **D** The star and the sun are both the same size.
31	Onisha wants to sort 20 objects into groups by their color. She wants to record what object was in each group. Which would be the best way to record her sorting? **A** list all the objects and put a checkmark by all the blue objects **B make a bar graph that shows how many objects of each color there are** **C** draw each of the objects she sorted and staple each drawing into a group **D** make a chart and list the objects into groups the way she sorted them
32	A scientist had two cups of water that were the same size and temperature. He wrapped one cup in black construction paper and the other in white construction paper. He put both cups in the sunlight. After 10 min, he measured the temperature of the water in each cup. The water in the cup wrapped in black paper was hotter than the water in the container wrapped in white paper. The scientist concluded that all dark colors absorb more heat. Which question should the scientist be asked about his conclusion?

	A What size container did you use? **B** How did you attach the paper to the glass? **C** **How do you know that all dark colors absorb heat**? **D** Do you think the light was reflected into the water?
33	Nolan picks up a book from his desk and hands it to his teacher. His teacher sets the book down and slides it across a table. Which action produces the **most** heat? **A** **sliding the book across a table** **B** handing the book to his teacher **C** setting the book down on a table **D** picking the book up from his desk
34	Alethia is doing an experiment. She places a plant in the darkest corner of a room. She wants to see if the plant will grow toward the window and will observe the plant for 1 month. How should Alethia record her observations each week? **A** She should look at the plant each day and decide if it is leaning more than it was the day before. Then she should write about her findings. **B** **She should pin a chart to the wall behind the plant. Each day, she should use a marker to draw and date the location of the stem.** **C** Each day, she should use a ruler to measure the height of the plant and the height of the pot the plant is in. **D** She should carry the plant to a straight line in the room, such as a door frame. She should decide if the stem looks more bent than it looked the day before.
35	The robber fly is an arthropod. Which of the following characteristics is shared by **all** arthropods? **A** They all live in water. **B** They all can fly. **C** **They have a hard, outer covering**. **D** They give birth to live young.
36	Kiera is planning an investigation of fossils that scientists have found where she lives in Florida. Which would be her **best** source of information? **A** science dictionary **B** book about dinosaurs **C** **local science museum** **D** television show about rocks
37	Jamal's class is making a list of ways that the space program has affected Florida. Which of the following is the **most** important way that having the space program in Florida has helped Florida universities? **A** They have better buildings. **B** **They do more space research.** **C** More people attend the universities. **D** More roads are built to the universities.
38	Air is an important resource. However, by burning fossil fuels, we can pollute the air. Which of the following would **not** reduce pollution but would help keep people safer when pollution levels are high? **A** develop cleaner fuels **B** **provide pollution warnings**

C develop cars that pollute less
D develop non-polluting ways to make energy

39 In the 1200s, sailors used a type of rock called lodestone as a compass. They hung the lodestone on the end of a string. The sailors knew that the lodestone always pointed north. How was the lodestone acting?

A **as a magnet**
B as an insulator
C as a conductor
D as a source of energy

40 Taylor tosses a ball into the air. Taylor knows that the energy of the ball changes as it leaves her hand, goes to its highest point in the air, and then comes back down. Which of the following **best** shows how ball's energy changes?

A kinetic energy □ potential energy
B potential energy □ kinetic energy
C kinetic energy □ potential energy □ kinetic energy
D **potential energy □ kinetic energy □ potential energy**

41 Devon writes a summary of a lesson about heat. Which statement should Devon include in her summary?

A Heat always moves from cold objects to warm objects.
B Heat is transferred only by the radiant energy of the sun.
C Heat is a measure of the hotness or coldness of an object.
D Heat is the transfer of energy between objects of different temperatures

42 The table shows the travel times and distances for four cars.

Car	**Distance in kilometers (km) and miles (mi)**	**Time (hr)**
A	300 km (about 185 mi)	3
B	200 km (about 125 mi)	2
C	400 km (about 250 mi)	4
D	300 km (about 185 mi)	2

Imagine that the speed limit was 110 km/hr, or 70 mph. Which car drove faster than the speed limit?

A A
B B
C C
D **D**

43 Two flowering bushes of the same type grow in two different large pots next to each other in a yard. One is pink and the other is blue. What is the cause of the difference in color?

A **effect of a trait**

	B effect of the rain **C** effect of the sunlight **D** effect of the soil environment
44	A pond is a small, enclosed body of fresh water that can be rich in wildlife such as frogs, tadpoles, salamanders, and more. One year, the area around a pond gets very little rainfall, and the pond becomes smaller. Which organism will probably be harmed the **most** by the decrease in the pond's size? **A** **fish** **B** trees **C** grass **D** insects
45	Scientists always base their explanations on information, or data, they collect. This information is sometimes listed in a table. For example, the information in the following table was collected by Florida International University. People were asked what they would do if a hurricane were approaching. (table below) How can scientists use this information? **A** to explain where people went when they evacuated **B** to explain why people decided to remain in their homes **C** **to explain why people need to be better informed about the importance of evacuation** **D** to explain how people followed certain evacuation plans when a hurricane was approaching
46	On a field trip to a science museum, Lee saw photographs of asteroids and comets that astronomers took using telescopes. What could Lee look for in the photographs to tell a comet from an asteroid? **A** **a long tail** **B** a small size

Year	Would not evacuate (%)
1992	18
1993	25
1994	35
1995	34
1996	39
1997	36
1998	35
1999	46

	C a rocky surface **D** an irregular shape
47	Antonio observes the weather one afternoon. He concludes that thunderstorms are likely. Which observation **best** supports his conclusion? **A** There is a light wind. **B** The temperature is 23 °C (75 °F). **C** The winds are blowing from the east. **D** **The clouds are mainly cumulonimbus**.
48	Sergio wanted to find out if changing the temperature of a solution changed how quickly salt dissolved in it. First, he tested a control solution at room temperature, or 25 °C, and measured how fast salt dissolved in the solution. Next, he cooled solution A to 10 °C and heated solution B to 40 °C and added salt to each. How quickly did the salt dissolve in solutions A and B compared to the control solution? **A** faster for both solution A and solution B **B** faster for solution A and slower for solution B **C** **slower for solution A and faster for solution B** **D** slower for both solution A and solution B
49	What effect will one positive charge have on another positive charge? A **They repel each other from a distance**. B They attract each other from a distance. C They repel each other only when they touch. D They attract each other only when they touch.
50	Berto makes an electric circuit using two batteries, two lights, two insulators, and two conductors. Which of the following changes to the circuit could Berto make to increase the current flow? **A** remove a light **B** remove a battery **C** **remove an insulator** **D** remove a conductor
51	Bianca pushes an empty box across a flat surface with little effort. She then fills the box up with books and tries to push it. What will **most likely** happen? **A** The box will be easier to move because Bianca's push will have less effect on the heavier box. **B** The box will be easier to move because Bianca's push will have a greater effect on the heavier box. **C** **The box will be harder to move because Bianca's push will have less effect on the heavier box.** **D** The box will be harder to move because Bianca's push will have a greater effect on the heavier box.
52	Abdul wants to test a hypothesis he has about sweat evaporation and body cooling. He swabs one of his sister's arms with water. He swabs her other arm with rubbing alcohol. Then he asks her to describe which liquid feels cooler as it dries. His sister says that the arm with rubbing alcohol feels cooler. Why is Abdul's test **not** a scientific way of testing evaporation and cooling? **A** No evaporation takes place.

	B He does not apply the test on his own arms. **C** **His sister's opinion is not a verifiable observation**. **D** The amounts of water and alcohol are not the same.
53	Organisms that live in coral reefs need warm, shallow seas to survive. Which of these environmental changes would be the **greatest** threat to coral reefs? **A** a beaver dam **B** open-pit mining **C** **rising sea water level** **D** using land for farming
54	Mr. Lee is a scientist who is studying an extinct bird. He wants to learn more about how it lived. Which feature of the bird would be the **best** thing for him to study to discover what the bird ate? **A** **beak** **B** feet **C** tail **D** wings

*Answers in bold are the correct answer