A CASE STUDY OF THE EFFECTS OF INQUIRY BASED PROFESSIONAL DEVELOPMENT THROUGH THE USE OF A MENTOR ON AN ALTERNATIVELY CERTIFIED ELEMENTARY TEACHER'S SCIENCE TEACHING SELF-EFFICACY

by

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A thesis submitted in partial fulfillment of the requirements
for the degree of Master of Education
in the Department of Teaching and Learning Principles
in the College of Education
at the University of Central Florida
Orlando, Florida

Spring Term
2007

ABSTRACT

One alternatively certified elementary teacher was the subject of this sixteen week research study on science teaching self-efficacy. The researcher taught inquiry based student level science lessons to the fourth grade teacher. The teacher participant, in turn, taught those same lessons to her class while the researcher observed and took field notes. The participant responded to specific open ended questions in a journal after each science experience and also completed three interviews with the researcher. Each sequential lesson from the researcher was then modified based on participant needs. The participant completed the STEBI (Science Teaching Efficacy Belief Instrument) as a pre and post test to measure the effects of the above mentioned activities. The collected data from the STEBI was reported quantitatively. The collected data from the reflective journal entries and interviews were reported qualitatively. After careful analysis of the data gathered for this case study, the researcher came to the conclusion that inquiry based professional development through the use of a mentor affected the alternatively certified elementary teacher's science teaching self-efficacy. The subject maintained a positive attitude about the use of a mentor for the duration of the study and her Personal Science Teaching Efficacy increased or stayed the same on all of the STEBI questions. Limitations of the study as well as recommendations for further research were also discussed.

I dedicate this work to my loving Savior for enabling me to complete this task; my husband, Alan, for his prayers, patience, and love; my family and friends for their prayers and understanding of limited time; my chairperson, Dr. Jeanpierre, for guiding me through the process,Dr. Morrision-Shetlar and Dr. Romjue for being supportive, Debbie for dedicating so much of her time and effort to making this thesis possible; and Brooke for reminding me about the light at the end of the tunnel.

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CHAPTER 1: INTRODUCTION

The science teaching self-efficacy of teachers is an important indicator of the type of instruction they will provide for their students (Sottile, Carter, & Murphy, 2002). As an elementary science teacher and coach, I believe it is my responsibility to determine effective professional development activities to increase science teaching self-efficacy of the teachers I work closely with each year. Although there are many strategies for affecting the science teaching self-efficacy of individuals, this study focused on inquiry based professional development with a mentor. By identifying the most effective strategies for affecting a change in science teaching self-efficacy, I hoped to increase a teacher's positive beliefs towards science teaching as well as increase her content knowledge and use of effective science teaching strategies. I hoped to utilize the results from this study to guide my professional development activities in future planning sessions with teachers at my school. Increased science teaching self-efficacy has been linked to increased student self-efficacy as well as achievement (Morrell & Carroll, 2003). The use of mentors in professional development has been linked to creating a positive school environment as well as increased effort in subject areas from participants (Joyce & Showers, 1996).

Prior to the start of the study, I researched strategies that had proven effective in changing science teaching self-efficacy in individuals. By analyzing the science professional development opportunities that were offered at my school, I hoped to create a program that would positively affect science teaching self-efficacy. I worked closely with teachers from six grade levels and observed which teachers appeared to be receptive to change within their current practices. Inquiry based lessons were further researched to scrutinize the role it had in effective science instruction. Through the creation of a mentoring relationship with my subject, I hoped to create a bond that would allow praise and criticism to be considered genuine as these are important components to effecting change in self-efficacy. I also hoped that the relationship would allow for honest reflections on instruction as well as accurate feedback on the professional development. I hoped to create connections and make inferences based on the results of the unique relationship with one teacher to possibly guide future mentoring opportunities with other teachers.

Purpose

The purpose of this study was to examine the effects that a mentoring relationship coupled with the use of inquiry based professional development had on an alternatively certified elementary teacher's science teaching self-efficacy. Using data collected throughout the study, I wanted to identify specific strategies that would positively affect a teacher's science teaching self-efficacy so I could utilize the strategies with other teachers in the future. I hoped to change student perceptions of science through creating change in their teacher's beliefs about science through positive experiences and successes in teaching science (Haney, Lumpe, & Czerniak, 2002).

Research Questions

1. What were the effects of inquiry based professional development on an alternatively certified elementary teacher's science teaching self-efficacy?

2. What were the effects of reflective practices with a mentor after instruction on an alternatively certified elementary teacher's personal science teaching self-efficacy?

Data for this study were gathered using teacher-researcher created journal prompts and interview questions, field notes, and observations. The Science Teaching Efficacy Belief Instrument (STEBI) created by Enochs and Riggs in 1990 was used as a pre and post test for this study.

Rationale

As a third grade teacher, I always enjoyed teaching science to my students. For years, I was the only one on my grade level that taught science. My first year, I was nervous, but once I saw the excitement of my students and the connections to other subjects that they made during science instruction, I worked harder at preparing hands on, minds on lessons. At that point, I became so enthusiastic about teaching science that my eagerness affected two of the teachers on my grade level and they too began to teach science. We spent a lot of time together discussing appropriate questions and I shared with them the problems my students had with the content and how I addressed those problems. They would try the lessons and share their experiences with me. It became a mentoring situation and I liked being the expert in science instruction!

When the opportunity arose for me to transfer schools and become a science lab teacher, I was thrilled to take on a new challenge. I went from teaching all subjects to twenty students all day for five days a week to teaching only science to 450 students that I only saw once a week for forty minutes. After one year of adjusting to the complete change in school, curriculum, and schedule I was given the responsibility and opportunity to encourage the teachers at my school to teach science effectively. My principal removed science lab from the special area schedule and allowed me to create my own time frames for each grade level. Kindergarten, first, and second grades began to come to the lab for twenty five minutes per week, third grade for fifty minutes, and fourth and fifth grades for sixty minutes. The teachers were required to stay and participate in each lab lesson.

I also added the planning half days each nine weeks. This allowed me to work with the teachers to plan out the entire nine weeks of science instruction so that the concepts were being reinforced between the classrooms. The change in our student's understanding of science content as well as the increase in excitement from the teachers was amazing. The weekly journal entries and data tables from students began to show more details and deeper understanding of the concepts. I implemented Scientist of the Month which allowed students to share their enthusiasm with their peers and parents. Two students per month were chosen to research a science concept and report one fact about that concept on our school news. In return, they received a certificate and a pin. At first the students were passive and embarrassed, but after a few months, students began stopping me in the hallway and requesting to be the Scientist of the Month. Once the students began to display excitement for science content, the teachers began to pay attention. Teachers who despised teaching science, as well as the teachers who avoided teaching science at all costs, began to come and ask for advice on how to teach lessons. The teachers began stopping me in the hall to share science stories about the experiments in their classrooms. The changes in our school atmosphere in regards to science grew rapidly and in an incredibly positive direction.

It was around this time that I began thinking about a topic for my thesis. I was in my second semester of the Lockheed Martin program and things were working so well in my classroom and with the planning days that I was nervous to change anything major in my practice because all eyes were on me each day of every week. Teachers can be critical! I continued to become more curious about what things made the difference between the teachers who embraced the science changes with no qualms and the teachers who accepted the changes with criticisms at every turn. On the heels of those thoughts came the observation that most of the teachers who were willing to try new things in their science curriculum were teachers who appeared confident in the subject matter as well as maintained a positive attitude about change. All of these things coupled with the responsibility of being in charge of the science program for our entire school made the topic for my research clear.

Significance of Study

Much research has been completed on effecting change in the science teaching self-efficacy of pre service teachers (Enochs & Riggs, 1990; deLaat & Watters, 1995; Ginns & Watters 1999). Relationships have been detected between a teacher's self-efficacy in science with student achievement and beliefs about science learning (Andersen, 2004). However, little data has been collected in regards to teachers that are already teaching in classrooms (Appleton, 2003; Ginns & Tulip, 1996).

Piaget pioneered the documentation of the effects of inquiry science on children by encouraging students to participate in experiments that they designed instead of responding to prescribed methods from an adult (1952). The National Research Council emphasizes that communication as an important part of the inquiry process (1996). In order to allow students to learn science to the highest potential, they must be given ample opportunities to discuss thought processes while participating in experiments (Haney, 2002). Parallels exist between the learning process for children and the learning process for adults (Enochs & Riggs, 1990). Therefore, strategies that have proven effective for children learning science concepts apply to adults as well.

The use of constructive and specific criticism and authentic praise from a mentor are considered effective strategies to alter teaching practices (Feldman, 1999). Reflective thinking and discussion about teaching practices are also effective ways to change teaching behaviors (Jarvis & Pell, 2004). Bandura & Locke (2003) suggested that self-efficacy may be the most important factor in predicting future behavior. Current research on the topics of science teaching self-efficacy, mentor-mentee relationships, and reflective thinking helped create the beginning of my own research melding these areas of focus together in one study.

Assumptions

Based on researched literature in the areas of constructivism, mentor relationships, effective professional development, and science teaching self-efficacy, as well as my personal teaching experiences, I began this study with a few assumptions. My first assumption was that I could create a mentor relationship with my subject that would allow open and honest communication since my position in considered a nonevaluative role. I also assumed that the subject would take the time to reflect upon her experiences during the professional development I provided as well as diligently reflect upon her lessons in the journal provided. A third assumption was that the study would affect the teacher's science teaching self-efficacy. It was also assumed that I would analyze the data generated in an objective manner.

Limitations

The first limitation to this study was the amount of time utilized for the collection of data. Research was restricted to sixteen weeks in the 2006-2007 school year. Another limitation to the study was a large upset in normal scheduling routines at school that resulted in the cancellation of several scheduled observations of the subject as she taught the lessons to her students. Several of the scheduled visits were cancelled because of testing schedules, picture day and bus evacuation schedules, and workshops. The data for this study were collected through the use of one alternatively certified fourth grade teacher, in her second year of teaching that willingly participated. The sample did not represent a range of grade, experience levels, or certification types.

Terms

Alternative certification: Refers to non traditional teaching certification. An individual, in the state of Florida, that possesses a bachelor's degree may participate in classes to acquire teaching certification. This means that the individual bypasses content and methods classes for the subjects being taught.

Case study: According to Gay, Mills, and Airasian,(2006), a case study is the in depth study of one individual, generally recorded through the use of qualitative data collection methods. Case studies often focus on one person's journey from point A to point B, in this study, measured the science teaching self-efficacy of one fourth grade teacher from the beginning of the professional development until the end.

Guided inquiry: Refers to lessons that allow inquiry thinking and discussion to occur in a safe classroom environment. The teacher provides choices for students in scientific discoveries (Furtak, 2005). In this study, guided inquiry means that the topic was already chosen for the subject and that open ended questions were utilized repeatedly during each professional development meeting.

Inquiry: The National Science Education Standards (NRC, 1996) regard inquiry as a process of examining the world, taking note of patterns, making predictions based on those observations, experimenting with the predictions, recording the results, and sharing those results with others. Inquiry involves critical thinking, the use of logic, and the willingness to consider new ideas. The use of inquiry science in classrooms allows for authentic and autonomous learning. It includes hands-on activities, scientific readings, teacher demonstrations, time to investigate, an abundance of questions to help guide the learner in creating their own knowledge about the topic, and an opportunity to report findings with others (Pierce, 1999, p.5). Inquiry also helps learners apply constructed knowledge to new situations to further deepen scientific concepts (Piaget, 1968).

In service teacher: Refers to a teacher that is currently involved in the education of students.

Mentee: Refers to the beginning teacher that is being mentored by the experienced teacher (Shea, 2002).

Mentor: Refers to a person who builds a relationship with another individual and utilizes that bond to encourage, teach, offer support and suggestions, and become a helper in self-reflection (Shea, 2002).

Pre service teacher: Refers to a person enrolled in college level courses studying to be a teacher.

Professional development: Refers to goals set by an individual to affect teacher learning in a certain area. Clear goals, consistency, time to observe effective strategies in use, opportunities to practice ideas or theories presented, duration longer than four consecutive weeks, reflective thinking practice, and a long term mentoring relationship are all components that reflect effective professional development (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003).

PSTE: Personal Science Teaching Efficacy is one of two components that Bandura (1977) named as self-efficacy. Enochs and Riggs (1990) created the title for this part of self-efficacy and began using the acronym PSTE. This refers to the beliefs held by a teacher about their own personal ability to teach science effectively.

Self-efficacy: Refers to a person's belief about their ability to complete a task effectively as well as the belief that certain actions will result in certain outcomes. Bandura (1977) pioneered the research in this area and other researchers built upon this theory extending in to the self-efficacy of teachers (Enochs & Riggs, 1990; Gibson & Dembo, 1983).

STEBI: The Science Teaching Efficacy Belief Instrument was developed by Enochs and Riggs in 1990 to measure the science teaching self-efficacy of pre service and in service teachers. It is a Likert scale with positively and negatively loaded statements to ensure validity and reliability.

STOE: Science Teaching Outcome Expectancy is one of two components that Bandura (1977) named as self-efficacy. Enochs and Riggs (1990) created the title for this part of self-efficacy and began using the acronym STOE. This refers to the beliefs held by a teacher about their ability to effect change within students.

5-E model: Bybee was credited with developing the widely accepted 5-E model for inquiry instruction. The five stages are: engage, explore, explain, extend, and evaluate. Each lesson begins with an engagement activity to stimulate questions and curiosity from the learners as well as providing a focal point for the concept. The exploration stage allows students to actively participate in constructing knowledge creating a need for utilizing scientific processes such as observing, hypothesizing, and recording data. Throughout the explain stage, students are required to articulate findings as the teacher continually asks probing questions to assess understanding of the concept. The extensions are opportunities for the learner to take the constructed knowledge and apply it to a new, but similar, situation. The evaluation stage results in a final product that incorporates the learner's understanding of the entire inquiry lesson (Bybee, 1997).

Summary

The primary focus of this study was to record the effects of an inquiry based professional development experiences through the use of a mentor on an alternatively certified elementary teacher's science teaching self-efficacy. Chapter two, the literature review, began with an overview of the interest surrounding science teaching self-efficacy over the last several decades. The major themes discussed were self-efficacy, inquiry, professional development, alternative certification, and the use of a mentor. The review ended with a demonstration of the need to further study ways to affect the science teaching self-efficacy of in service teachers. Chapter three gave a detailed description of the methods used to gather data throughout this study including the selection of the participant, setting of the study, instruments used to collect data, as well as an analysis of the data. Chapter four discussed the connections between the data I collected and my research questions. Chapter five completed the thesis and recommended further research involving effective professional development to create changes in the science teaching self-efficacy of in service teachers. A replication of the study, on a much larger scale, was also recommended to discern if the research could be generalizable to other areas of socioeconomic status as well as ethnicities and experience levels of the teachers.

CHAPTER 2: LITERATURE REVIEW

Introduction

For more than twenty years, researchers have been studying the effects of self-efficacy in teachers (Andersen, Dragsted, Evans, & Sorensen, 2004; Bandura & Locke, 2003; Bleicher & Lindgren, 2005; Ramey-Gassert, Shroyer, & Staver, 1996; Roberts, Henson, Tharp, & Moreno, 2000; Ashton, Webb, and Doda, 1983). Various studies have been conducted to discover ways to measure and alter a science teacher's self-efficacy (Enochs & Riggs, 1990; Ginns & Tulip, 1995). Other countries, such as Denmark, England, Australia, and Germany have shown interest in changing the self-efficacy of teachers (Andersen, Dragsted, Evans, & Sorensen, 2004; Khourey-Bowers & Simonis, 2004). One finding that the related literature has in common is that self-efficacy affects the delivery of instruction. To date, data on the most effective methods to alter a teacher's self-efficacy is inconclusive (Andersen, Dragsted, Evans, & Sorensen, 2004; Enochs & Riggs, 1990).

The self-efficacy of experienced teachers is more difficult to alter than the self-efficacy of inexperienced teachers (Czerniak, 1990) Early science teaching experiences shape teaching strategies for years to come (Ginns & Tulip, 1995). The majority of the research conducted, both in and out of the United States, has focused on altering the science teaching self-efficacy of college students enrolled in education courses (Bleicher & Lindgren, 2005; Morrell & Carroll, 2003; Wingfield & Ramsey, 1999; Andersen, Dragsted, Evans, & Sorensen, 2004). While the importance of this common practice is recognized, little research has focused on changing the science teaching self-efficacy of teachers once certification has been earned (Haney, Lumpe, & Czerniak, 2002; Ramey-Gassert, Shroyer, & Staver, 1996; Roberts, Henson, Tharp, & Moreno, 2000; Sottile, Carter, & Murphy, 2002). Focusing energy and resources on building the self-efficacy of pre service teachers is a logical place to start, however, what about the teachers who are already in the classrooms (deLaat & Watters, 1995; Scott, 2005)? The bulk of the research conducted on in service teachers is dated (Riggs, 1998).

Bandura's studies in self-efficacy, especially in regards to teacher behavior, provided the theoretical framework for this study. The self-efficacy of teachers has been found to be directly related to their performance in the classroom (Bandura, 1993; Bandura, 1977). It is possible, through specific types of professional development, to alter a teacher's self-efficacy (Bandura & Locke, 2003).

The themes within this literature review helped create an understanding of the importance of the role that science teaching self-efficacy can have on science education and possible ways to alter the science teaching self-efficacy of teachers (Andersen, Dragsted, Evans, & Sorensen, 2004; Bandura, 1977; Enochs & Riggs, 1990). The prevailing themes in this review of literature are the self-efficacy of teachers, inquiry, science professional development, and the use of a mentor.

Self-Efficacy

Self-efficacy, in the capacity of teachers, is derived from Bandura's (1977) cognitive self-efficacy of individuals. The theory is based on the idea that self-efficacy is comprised of two parts: A person's belief about their own perceived ability to complete a task effectively and believing that certain actions will result in certain outcomes. According to Bandura, it may be possible to predict how a person may react to certain situations once the self-efficacy of that person has been studied. If a person is found to have low self-efficacy in both components, it may be appropriate to assume that they will lack confidence and fail to follow through with certain tasks.

After conducting many studies, Bandura (2003) concluded that a person’s perceived ability to perform a task successfully was directly linked to the amount of motivation and performance accomplishments that would be displayed by an individual. Performance is not the only demonstration of ability, if an individual believes that he or she cannot complete a task successfully, the amount of true ability becomes insignificant to the individual. The tasks that are perceived to be possible will likely be the only tasks attempted. Since self-efficacy is dependent upon the successes or failures of an individual within a particular task, it is not unusual for the measure of self-efficacy to fluctuate within a short period of time (Bandura & Locke, 2003). In general, the higher the perceived self-efficacy is, the more time an individual will devote to a difficult task without giving up entirely. People will only attempt tasks that are within their self-efficacy range. If they do not believe that they will receive positive results from an activity, they will try to avoid the task.

Bandura (1993) found that efficacy beliefs are produced through the following processes: cognitive, motivational, affective, and selection. Cognitive processes that indicate a high self-efficacy include setting personal goals, visualizing success, using skills under pressure, and persevering without support from others. Conversely, cognitive processes that indicate a low self-efficacy would include setting goals and not attempting to complete them, not setting goals at all, visualizing failure and worrying about all the things that could go wrong, having adequate skills and not utilizing them under pressure, and giving up when a failure does occur. This is especially prevalent in subjects that lack a support system. Motivational processes would include setting goals based upon the level of self-efficacy. A person with high self-efficacy will continue facing challenges to achieve and a person with low self-efficacy will become easily defeated when faced with challenges. Affective processes would include the level of control over disturbing thought patterns. An example would be continually thinking about the potential points of failure in a particular task to the detriment of attempting the task. Selection processes would include deciding what tasks the person is able to successfully complete. After looking at a certain task, the person will decide if he or she is able to complete it successfully. If the person believes that they can, they will attempt it and vice versa.

In 1983, Ashton, Webb, and Doda completed a study of self-efficacy specifically regarding teachers, resulting in the increased research of other professionals in this area (Morrell & Carroll, 2003; Bleicher & Lindgren, 2005; Enochs & Riggs, 1990). Building from Bandura's theory, they proposed that the self-efficacy of teachers is comprised of teaching efficacy, personal efficacy, and personal teaching efficacy. According to the results from the above study, teaching efficacy is similar to Bandura's outcome expectancy. The study found that teachers will teach in the manner that they believe students will learn best. For example, if a teacher believes that students will learn best from a textbook without the use of cooperative learning, that is the way the material will be presented to the child. Conversely, if the teacher believes that certain students cannot learn no matter how the material is covered, the teacher will not put forth the effort needed to reach that student. Personal efficacy refers to the teacher's efficacy in all aspects of life, not just teaching. Personal teaching efficacy is comprised of teaching efficacy and personal teaching efficacy (Ashton, Webb, & Doda, 1983; Gibson & Dembo, 1984; Khourey-Bowers & Simonis, 2004; Tschannen-Moran, Woolfold-Hoy, & Hoy, 1998). Personal teaching efficacy is considered an accurate predictor of teacher behavior in regards to the effectiveness of instruction. The strategies needed to build a teacher's self-efficacy in a subject area would be different from the strategies needed to change a teacher's beliefs about student outcome (Ginns & Tulip, 1995; Ginns & Watters, 1999). Any given teacher could hold beliefs that he or she is capable of teaching the material effectively but also lack confidence in his or her ability to affect a change in the students (Ashton, Webb, & Doda, 1983; Watters & Ginns, 1995; Gibson & Dembo, 1984). Therefore, personal teaching efficacy and student outcome beliefs are related, but not dependent upon one another. Changes in the two parts of self-efficacy tend to occur when each area addressed through professional development separately (Enochs & Riggs, 1990; Riggs, 1998; Ashton, et al., 1983).

In 1990, an instrument to measure a teacher's self-efficacy in the area of science was developed by Riggs and Enochs. They believed that if measuring self-efficacy would lead to an accurate prediction of a person's behavior in general and then more specifically to the teaching environment that an instrument that measured science teaching self-efficacy would be a good predictor of whether or not a given teacher would be effective in the area of science instruction (Riggs, 1998). The STEBI assessment has two scales to measure the two parts of self-efficacy. PSTE questions measure the Personal Science Teaching Efficacy and the STOE questions measure the Science Teaching Outcome Expectancy. In 2004, Bleicher retested the validity and reliability of the STEBI-B by reconstructing the testing and analysis that Enoch and Riggs performed in 1990. Bleicher concluded that PSTE and STOE can affect each other, but are also independent of one another. It is important to note that problematic results were discovered in the STOE portion of the STEBI. Some of the questions evaluating STOE were worded in such a way that the results were skewed. Bleicher and Lindgren (2005) suggested a change within the wording of these items may make the STOE portion of the instrument considerably more valid. There were no problems found within the PSTE portion of the instrument. Further explanation of the process Bleicher and Lindgren used to develop these conclusions was written in Chapter three. The STEBI is widely accepted as a science teaching self-efficacy instrument for both pre and in service teachers (Andersen, Dragsted, Evans, & Sorensen, 2004; Czerniak, 1990; deLaat & Watters, 1995).

Inquiry

The National Science Education Standards (NRC, 1996) require science instruction to include the use of inquiry strategies. The NSES standards document (1996) also states that a minimum of sixty percent of science instruction in elementary school should consist of inquiry based activities. Yet, Jeanpierre (2006) found that full inquiry as presented in the NSES(NRC, 1996) is not supported in many K-8 science classrooms. According to Schwab (1962), children create new experiences by first recalling what they know and then applying new knowledge to the prior information. Inquiry allows students to use their own questions about the world to create investigations and explorations to discover basic scientific truths simultaneously enhancing basic science skills that all humans inherently possess (Pearce, 1999).

Piaget (1968) believed that learning hinged upon the theory of equilibrium and that reaching equilibrium is an active process meaning that the individual must be involved in actions. If an individual is presented with an event that contradicts what is already understood to be the truth, an investigation will naturally take place in order to discover a new answer that is logical. The old “truth” cannot be uprooted without an experience with the new “truth”. Inquiry allows these experiences to create new knowledge within our students (Pearce, 1999; NRC, 1996; Dewey, 1916; Schwab, 1962; Crawford, 2000).

National standards emphasize the investigative nature of science and the importance of students’ active engagement in the construction of scientific ways of knowing and doing (NRC, 1996; AAAS, 1993). Many teachers struggle with what traits are essential to inquiry in a classroom and will actually avoid inquiry for fear of implementing the wrong ideas (Haney, Lumpe, & Czerniak, 2002; Crawford, 2000). The connection between past experiences and the problem posed, designing experiments to find an answer to the problem, the collection of data through investigating, the construction of meaning through the analyzing of data collected, collaboration with peers, and communicating results with the scientific community are all traits commonly associated with inquiry based learning (NRC, 2000; AAAS, 1993; Pearce, 1999; Exploratorium Institute for Inquiry, 1996). Crawford (2000) understood that the role of the teacher in an inquiry classroom changes based on the needs of the students. Effective questioning tactics employed by the teacher as well as the student continually asking questions to explore each concept on a deeper level are an integral part of inquiry (Blosser & Hegleson, 1990; Pearce, 1999; Crawford, 2000).

As defined by the National Research Council (2000), essential features of an inquiry classroom are learners involved in the process of discovering the answers to scientific questions, priority given to evidence which is communicated by the student through justifications and explanations of the phenomena observed, the community of learners valuing alternate ideas and learners being open to changes within their own beliefs based on other's findings. The various levels of inquiry are commonly viewed as a continuum with teacher directed activities on one end and student chosen tasks on the other end (NRC, 2000). The inquiry continuum focuses on the aforementioned essential inquiry classroom traits and gives examples of variations in each for each of those traits. For example, the essential trait of students becoming engaged in scientific questions spans the continuum from the learner posing a question to the teacher providing the question. When the student poses question and creates an investigation around that question as well as making the decisions how to collect, analyze, and share data from that investigation, on the commonly accepted continuum this practice is considered the highest amount of student self-direction and the lowest amount of teacher direction, commonly referred to as open inquiry (Petto, Patrick, & Kessel, 2005; Pearce, 1999; NRC, 2000; Exploratorium Institute for Inquiry, 1996; Furtak, 2005). On the opposite side of said continuum, when the teacher (or a textbook) poses the question, gives the data to be analyzed to the student, provides the evidence for the student, and gives steps and procedures for the communication of data the inquiry being demonstrated is the highest amount of teacher direction and the lowest amount of student self-direction, commonly referred to as partial or guided inquiry (Petto, Patrick, & Kessel, 2005; Pearce, 1999; NRC, 2000; Exploratorium Institute for Inquiry, 1996; Furtak, 2005).

Students and teachers beginning to experience inquiry often have the most success beginning on the side of the continuum that is mostly teacher directed until students become accustomed to seeking more than one answer to a question and have a deeper understanding that teachers do not hold all the answers (NRC, 2000; Exploratorium Institute for Inquiry 1996). This is a gradual process that allows time for the students and the teacher to adjust to the shift of control within the classroom (Pearce, 1999). These steps require a safe classroom environment where students are able to build their confidence in communicating ideas that may or may not be the standard answer (Blosser, 2000; Rowe, 1973; Pearce, 1999; NRC, 2000). Inquiry learning and teaching mostly utilizes the higher levels of Bloom’s Taxonomy such as synthesis, evaluation, and application (Blosser, 2000).

In the community of inquiry within a classroom, teachers and students share the responsibilities for learning and collaborating to construct knowledge and strengthen science process skills (Hand & Keys, 1999). The role of the teacher begins to shift, changing from the possessor of all knowledge to the facilitator of knowledge. In an inquiry classroom, teachers help guide students to discoveries through the use of discrepant events and questions (Furtak, 2005; Fuller, 1969). Research shows that teachers with higher self-efficacy in the area of science teaching are more likely to incorporate inquiry student-centered teaching methods. In a study conducted by Czerniak in 1990, it was recorded that teachers with lower science teaching self-efficacy are more likely to use teacher centered methods. Many teachers believe that to employ inquiry techniques would be transforming a tranquil classroom into chaos. Pierce (1999) argues that inquiry looks and sounds very different from traditional learning, but it actually is a controlled chaos where students are actively learning, moving around the classroom, and engaged in different tasks at the same time.

The art of questioning to elicit student understanding without imposing teacher understanding upon students is a learned skill (Groisser, 1964; Blosser, 2000). Many times, teachers will allow their facial expressions or own beliefs about the procedures for a certain experiment or even the outcome to dissuade student's from pursuing their own line of thinking (Blosser, 2000). This takes away a core component of inquiry and teachers must practice how to guide students through questions instead of reverting to being the holder of all knowledge (Lake, 1973; Pearce, 1999). According to Blosser's research study (2000), some teachers believe that in order to learn anything students must be able to recite facts first and that this belief is actually contrary to the body of research that says that thinking is a way of learning. The types of questions that teachers pose within the classroom will influence the learner's level of thinking. In 1973, Rowe, throughout the course of a research study, discovered that the types of questions teachers ask should assist students in learning to think for themselves'. Rowe (1973) also found that asking fewer questions that have more than one right answer as well as increasing wait time will actually increase the level of thinking that students do. Recommendations from multiple research studies called for asking the types of questions that will encourage students to analyze their thinking on a deeper level include, asking for examples to help build connections between what was learned and similar phenomena in our world, asking for a summary of what was learned to aid in metacognition of what was experienced, asking about inconsistencies in arguments presented by classmates to further experience critical thinking, asking about alternatives to experiments to further prompt ideas for future inquiry, asking how data may be classified, compared, and what other ideas it may support in order to encourage a deeper analysis of the data presented, and asking about assumptions which helps students practice the justifications behind thinking (Blosser, 2000; Raths et al., 1986; Crawford, 2000).

In order to provide a sequential format to inquiry, instructional models are commonly used. An instructional model is a framework that any investigation may be placed. The work of Piaget (1975) and the theory of development helped serve as a catalyst for the learning cycle, which is an instructional model. The original learning cycle was pioneered by Atkin and Karplus (1962) and consisted of exploration, invention, and discovery. This learning cycle was the basis for an inquiry model known as 5E (Bybee, 1997). The 5E model includes the engage stage which consists of activating prior knowledge to attract the student's attention, the explore stage which allows student's an opportunity to observe, hypothesize, as well as organize and record data, the explain stage which has students communicating the results of an investigation, the extend stage allows students to apply knowledge from previous stages to a similar problem, and the evaluate stage consists of opportunities for the teacher to assess student understanding of the topic through various methods (Bybee, 1997).

In 2005, Bleichner and Lindgren reported that teaching science content through inquiry strategies can be considered an impossible task for a teacher that has low science teaching self-efficacy. However, teachers need to learn through inquiry methods in order to help understand possible student pitfalls in learning through inquiry (Luft, 2001; Akins, 2005).

Professional Development

Many researchers agree that effective models of professional development contain certain components, including, but not limited to: contextual planning, collaborations such as mentoring relationships, immersion in inquiry including demonstration lessons, and reflective practices (National Research Council, 2000; Watters & Ginns, 1997; Loucks-Horsley, Love, Stiles, Mundry, and Hewson, 2003; Morrell & Carroll, 2003; Ramey-Gassert, Shroyer, & Staver, 1996). Professional development opportunities are considered essential for the continual growth of teachers (National Research Council, 2000).

When creating a professional development model, one important context to consider is the amount of support shown by fellow teachers, administration, and families of students enrolled at the school (NRC, 1996). Watters and Ginns (1997) found that within a school environment that is not supportive of science instruction, teachers with low to moderate self-efficacy are not likely to employ science teaching strategies presented at professional development sessions because of a lack of encouragement. This is an external factor that cannot be controlled by researchers or by developers of effective professional development (Ramey-Gassert, Shroyer, & Staver, 1996).

The National Science Education Standards (NRC, 1996) state that effective professional development consists of collaborative efforts between colleagues. Based on the findings of multiple research studies, it is documented that many elementary teachers possess a perceived lack of background knowledge about science topics, do not display self-motivation, do not seek out change on their own, tend to rely on others for science teaching ideas, and are uncomfortable with science in general (Morrell & Carroll, 2003; Shallcross, 2002). Pairing an experienced teacher with an inexperienced teacher that is currently displaying needs in the area of science instruction can be accomplished through a mentoring situation. Ramey-Gassert, Shroyer, and Staver's research study (1996) recorded that teachers with low science teaching self-efficacy improved their science teaching when they were able to collaborate with teachers that they felt were effective at instructing students in science. It is also recommended that science professional development be presented by an experienced teacher through the context of inquiry to teach specific content lessons that the inexperienced teacher will need to teach to students (NRC, 2000). Attending quality workshops given by competent and respected personnel, receiving the materials needed to teach science, and being supported by educators who were interested in teaching science helped build the confidence of teachers with low Personal Science Teaching Efficacy (Morrell & Carroll, 2003; Ramey-Gassert, Shroyer, & Staver, 1996; Roberts, 2000; Yager, 2005).

Participants in science professional development should also be immersed in inquiry experiences including, but not limited to, demonstration lessons (Akerson & Hanuscin, 2005). In 1993, Bandura reported that modeling expected behaviors and success in participation in a specified event can increase self-efficacy of an individual and that efficacy beliefs can be strengthened through completing challenging tasks. In one study conducted by Bleicher and Lindgren (2005), teachers participated in constructivist science learning. There was a positive correlation between teacher success in authentic inquiry-based professional development activities and the level of science teaching self-efficacy. As a result of the correlation, recommendations were made that professional development use authentic inquiry-based teaching tasks to enhance teacher performance. Interventions, such as professional development sessions, have the biggest impact on teachers who begin a development activity with a low PSTE (Bandura & Locke, 2003; Bleicher & Lindgren, 2005; Wingfield & Ramsey, 1999). Four to six weeks, with sessions occurring two to three times per week appears to be the ideal amount of time for a professional development program to effect change in a teacher's PSTE (Roberts, Henson, Tharp, & Moreno, 2000).

Science content tends to be taught in the same manner it was learned (Gibbons, Kimmell, & O’Shea, 1997). Many teachers that have low science teaching self-efficacy recall negative experiences with science in the past, suggesting that this may be a factor in low science teaching self-efficacy (Ramey-Gassert, Shroyer, & Staver, 1996). If teachers have experiences that allow them to learn science successfully, then they will likely be confident to teach that same concept to their students (Bleicher & Lindgren, 2005; Gibbons, Kimmell, & O'Shea, 1997; Loucks-Horsley et al., 1998; Lieberman, 1995). Specific methods courses for science content are an example of one part of an effective professional development program (Roberts, Henson, Tharp, & Moreno, 2000; Wingfield & Ramsey, 1999). Further research established that providing teachers with professional development opportunities that are intended to help teachers understand science concepts on a deeper level will create changes within teaching methods (Cohen & Hill, 2000). The changes in teaching practices could be due to the increase of self-efficacy in the area of understanding science content (Sottile, Carter, & Murphy, 2002; Scott, 2005). PSTE scores have also been linked with the amount of progress made by an individual within a professional development course (Khourey-Bowers & Simonis, 2004). However, increasing core content knowledge with no other development or support is not likely to increase science teaching self-efficacy (Morrell & Carroll,2003;Tosun, 2000).

Alternative Certification

Alternative certification programs exist because of the shortage of teachers in classrooms (U.S. Department of Education, 2002; Houston, Marshall, & McDavid, 1993; Laczko-Kerr & Berliner, 2003; Steadman & Simmons, 2007). Many states have created programs of alternative certification for interested adults that have earned a bachelor's degree in any field of study (Jelmburg, 1996). Alternative certification programs differ in structure, purpose, and content depending upon the state. However, commonalities in the programs across the states are mentoring, certification exams, and classes with required coursework (U.S. Department of Education, 2002).

The Florida Alternative Certification program was developed based upon the twelve "Educator Accomplished Practices" that traditional Florida teacher preparation programs require documentation of proficiency in order to meet graduation requirements (Suell & Piotrowski, 2006). The twelve proficiencies are assessment, communication, continuous improvement, critical thinking, diversity, ethics, human development and learning, knowledge of subject matter, learning environment, planning, role of the teacher, and technology (Florida Alternative Certification Program, 2002). An individual enrolled in this program will be observed, complete specific tasks for each competency, and are assigned a mentor while working towards teaching certification.

Research studies have documented that alternatively certified teachers and traditionally certified teachers demonstrate similar levels of capability within the classrooms (Suell & Piotrowski, 2006; Houston, Marshall, & McDavid,1993; and Jelmburg, 1996). However, it was discovered that alternatively certified teachers tend to show less competency than traditionally certified teachers in the first few months of their teaching assignment (Steadman & Simmons, 2007). Houston, Marshall, and McDavid (1993) acknowledged that after approximately 8 months in the classroom, the gap between traditionally certified teachers and alternatively certified teachers closed demonstrating no statistical significance between the two in instruction and job satisfaction.

Mentors are recognized as being an integral part to the success of an alternative certification program (Steadman & Simmons, 2007; Nagy & Wang, 2007). A teacher assigned to be a mentor for an alternatively certified teacher normally has less resources to draw upon and spends more time on pedagogy and methods than a mentor of a traditionally certified teacher (Steadman & Simmons, 2007; Houston, Marshall, & McDavid, 1993).

Mentoring

According to Odell & Ferraro (1992), mentoring has emerged as an effective way to retain new teachers. Teachers, in general, appreciate and rely upon collegial interaction and support which makes mentoring relationships a vital component of school professional development programs (Appleton & Kindt, 2003). Mentoring, in the context of education, is considered to be an open and honest relationship between a beginning teacher (mentee) and an experienced teacher (mentor) (Shea, 2002; Hudson, 2005; Forbes; 2004; Jarvis, McKeon, Coates, & Vouse, 2001; Butcher, 2002). Mentoring has been linked to creating changes within a teacher's science teaching self-efficacy (Hudson, 2005).

According to Shea (2002), there are four types of mentoring situations; highly structured, short term, highly structured, long term, informal, short term, and informal, long term. The highly structured but short term is a relationship that is formed to accomplish short term goals, whereas the highly structured but long term is a relationship that is formed to help the mentee master a specific area or in preparation to take over a position. The informal and short term refers to a type of mentoring that normally occurs when a new teacher needs help once or twice and does not necessarily constitute a relationship. The informal and long term is commonly known as friendship mentoring where the mentor becomes available as needed to listen, share ideas and advice, and discuss problems.

Joyce and Showers (1996) stated that co-teaching is a form of mentoring. The co-teaching relationship can be between experienced and inexperienced teachers or teachers with similar years of experience. Science teaching self-efficacy can be enhanced through the observation of effective science teaching (Riggs, 1998). The main component of this type of mentoring is that each teacher observes the other teaching content lessons. The use of reflective practice is an essential component of effective mentoring (Cox, 2005; Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003). In order for beginning teachers to recognize valuable instructional strategies in action they must have the opportunity to discuss specific events observed and create connections with the mentor teacher through these considerations (Fletcher, 1998). This time of discussion of strategies observed includes a time of questioning as well. The specific use of constructive feedback can create positive changes in science teaching self-efficacy by building the confidence of the teacher (Riggs, 1998; Hudson & Skamp, 2004). However, unless specifically requested, constructive criticism and advice are not advised in this type of relationship.

The attitude of a mentor towards science instruction can directly influence the mentee's perceptions of science teaching, in a positive or negative manner (Riggs, 1998; Hudson & Skamp, 2004). In many elementary schools, dynamic teachers are automatically expected to become a mentor to a beginning teacher because many principals do not understand that not every effective science teacher will be an effective science mentor (Brooks & Sikes, 1997, Shea, 2002, Hudson & Skamp, 2004). Effective science teaching mentors normally have certain personal attributes (Hudson, 2005). Supporting the mentee's attempts to teach science, being attentive to the mentee's communication about teaching science, instilling positive attitudes and confidence about teaching science, and assisting the mentee to reflect upon the improvement of science teaching practices are the essential qualities that a mentor must possess (Hudson, 2005; Tomlinson, 1995).

A mentoring relationship for science teachers should focus on content and pedagogy specific to the subject area (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003). The mentor must have enough experience in the science content areas and feel comfortable in teaching through inquiry to help the mentee increase core science concepts necessary to student success (Luft, Roehrig, & Patterson, 2002). It is also necessary that the mentor and mentee recognize that they are both capable of bringing experience and ideas to the frequent conversations (Shea, 2002). The exchange of knowledge strengthens the trust between mentor and mentee creating a greater opportunity for change within both parties (Fletcher, 1998). A vital component of an effective mentoring situation is that both parties discuss and agree upon the goals and purposes of the relationship (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003). When the mentor and mentee are working towards the same goal it helps increase the level of interactions between the two (Butcher, 2002). Research has also shown that one strategy to increase instructional efficacy is to participate in a mentoring relationship (Gold, 1996).

Summary

Self-efficacy is comprised of two components; the belief that a person can accomplish certain things and the belief that certain actions will result in certain outcomes (Bandura, 1977). Science teaching self-efficacy refers to a teacher's belief about their ability to teach science effectively as well as their beliefs that teaching science in a certain manner will result in content being learned (Enochs & Riggs, 1990). As educators, we must make every effort to encourage teachers to develop strong science content knowledge and effective science instruction strategies.

Inquiry is supported as a key instructional strategy for effective science teaching (NRC, 1996). Teachers have to be taught how to utilize the full continuum of inquiry in classrooms in order to promote higher level thinking (AAAS, 1993). Questioning is an important aspect of inquiry and intentionally helping teaching learn to effectively question students during science will result in the development of a stronger science content base for all students.

Professional development is a common practice to help teachers learn new strategies such as inquiry (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003). The use of a mentor is a unique form of professional development that allows beginning teachers to learn from veteran teachers and vice versa (Hudson, 2005).

With further research into the types of inquiry based professional development that can cause changes to science teaching self-efficacy more teachers will be able to obtain a deeper science content knowledge that will benefit students. In this literature review, science teaching self-efficacy was looked at, specifically in the areas of the effects of inquiry based professional development with a mentor. For teachers to convey a love of science to their students, they must first believe that they can teach science effectively and that their actions will impact student belief and behaviors (Bandura & Locke, 2003). The design of this study was presented in chapter three. Additionally, sample size, school setting, participant information, procedures, and instruments utilized to collect and analyze data were also explained.

CHAPTER 3: METHODOLOGY

Introduction

The purpose of this study was to examine the effects of an inquiry based professional development on an alternatively certified elementary teacher's self-efficacy through the use of a mentor. The data obtained in this study were gathered through quantitative and qualitative methods. The quantitative measure used was the Science Teaching Efficacy Belief Instrument (STEBI) developed by Riggs and Enochs in 1990. The qualitative data were collected using multiple sources: interviews, journal entries, observations, and field notes. The STEBI was given as a pre and post test to measure the subject's science teaching self-efficacy. The setting, subject, design, instruments, data collection, and analysis of the study were reported in this chapter.

Design of Study

This qualitative case study concentrated on the effects of inquiry based professional development on an alternatively certified elementary teacher's science teaching self-efficacy through the use of a mentor. Case studies are a type of ethnographic research that often focuses on one case, is carried out in a natural setting, involves face to face contact with a participant, uses multiple data collection methods, and requires that researchers become reflective about their impact on the participant (Gay, Mills, & Airasian, 2006). Qualitative research also relies on data collection in a natural setting as well as providing the researcher with the opportunity to collect and analyze visual data using rich narrative language (Gay, Mills, & Airasian, 2006).

Primary data were collected through the STEBI pre and post test, interviews with the subject about science teaching, teaching the subject inquiry science lessons while collecting field notes, subject journaling, observations of the subject's science teaching, and discussions following lessons.

Qualitative methods in this case study were essential to accurately portray the experiences of the subject throughout participation in the inquiry based professional development as well as reactions to the mentor relationship. Qualitative research was selected as the main overarching design of the study. Through qualitative methods, I was able to collect rich, narrative data that demonstrated the subject's thoughts, beliefs, attitudes, and reactions in various parts of the research conducted. Gathering data qualitatively also allowed me to study underlying patterns and the resulting outcomes of the subject's interactions with the inquiry based professional development and the use of a mentor. Frequent interactions and observations enabled me to collect detailed descriptions of actions, thoughts, and beliefs of the subject through each part of the research.

Data were collected and triangulated from numerous sources to increase trustworthiness and credibility (Mills, 2003). According to Oliver-Hoyo and Allen (2006), the triangulation of qualitative data includes the careful reviewing of multiple sources of data in order to provide the most accurate picture of a situation. Researcher observation notes, journal entries from the subject, interviews, the Science Teaching Efficacy Belief Instrument (STEBI) pre and post test, and notes from researcher led professional development sessions all contributed to the triangulation of data. To expose common themes, the findings were compared to verify regularity. The data were also member checked by the subject to ensure accurate depictions of events as they occurred. Themes and patterns emerged as a result of collecting data from a variety of sources related to science instruction and the link to science teaching self-efficacy.

School Setting

The school involved in this particular research and collection of data served students from pre-kindergarten through fifth grade. The school was located in Orlando, Florida. As an aviation and aerospace magnet school, the curriculum integrated these themes whenever there was a clear connection to the state benchmarks however, the main focus was on increased science experiences. The school was an exceptional student education hub for the county, which serviced a wide variety of educational needs. The inclusion of exceptional students in regular education classrooms was common practice at this school. The school population was 480 students. Approximately 48% of the students served at this school qualified for free or reduced lunch. The racial distribution of this school was 44% Hispanic, 38% Caucasian, 13% African-American, and 5% other.

Subject

The subject chosen for this research was a fourth grade female, mid forties, Caucasian teacher. She had one full year of teaching experience at the school. At the time of my research, she was beginning her second year of teaching fourth grade. She previously worked for the Juvenile Justice System and had entered the Alternative Certification Program to earn her degree in elementary education. The criteria for selection for this case study began with which grade level science teaching time aligned with my planning time. From that point, the criteria became which teacher on the fourth grade team was interested in the devotion of after school hours to work together to change their science instruction. The subject was chosen purposively as a result of several conversations about my research. She expressed beliefs of self-doubt when teaching science and often asked questions about science lessons that she was required to teach. The subject felt very unsure of her own content knowledge and very uncomfortable about student questions, as she felt she would not be able to answer many of the questions. When approached about this research, she was excited and willing to provide her time and effort with the expectation that she would feel more comfortable teaching science after working more closely and more often with me. Her excitement to participate and to change her beliefs about science instruction contributed to the selection of this participant. It is important to note that since the teacher was alternatively certified, she did not have any methods or content courses in the area of science.

Instruments

The purpose of this study was to study the effects of inquiry based professional development through the use of a mentor on an alternatively certified elementary teacher's science teaching self-efficacy. The instruments in this action research study were selected and developed based on the extent to which each instrument would aid the gathering of data to answer the research questions. Instruments utilized in this research were, interview questions, journal entries, field notes, observations, and the Science Teaching Efficacy Belief Instrument (STEBI).

Interviews

Interviews were needed in order to gain a full understanding of the subject's perspective throughout the study. The use of continuous communication afforded the opportunity to ask follow up questions to interesting points that the subject discussed. Interview sessions occurred after each of the subject's observations of my teaching, my observations of her teaching, inquiry based professional development sessions, and other times throughout the data collection period. While open communication existed throughout the study, there were three formal interviews; a pre interview, midway interview, and a post interview utilizing the same six questions each time (Appendix E). The questions focused on the subject's beliefs and perceptions about her science instruction. The purpose of three interviews was to track progress in the subject's beliefs and beliefs about her ability to teach science effectively as well as help promote reflective thinking about the professional development. All other interviews consisted of open dialogue about the subject's perceptions about lessons. Every interaction that I had with the subject was recorded by hand. Each time we met, I would read the prior entries to the subject and change phrasing as need to be accurately capture her candid beliefs about each aspect of the research.

Journal Entries

The purpose of journal entries throughout the research was to encourage the subject to participate in reflective thinking practices as well as ensure the accuracy of the researcher's field notes (Shea, 2002; Mills, 2003). The journal also allowed opportunities for the subject to capture her beliefs immediately after experiencing science teaching and learning. The journal, as well as interviews, created continuous discussion between the subject and me. Journal entries consisted of the subject responding to all interactions in a spiral bound notebook. Each time she observed me teaching a science lesson, she would respond in her journal. Each time she taught science in her classroom, she would respond in her journal. It was requested that she respond specifically to five questions concerning her perceptions and beliefs about teaching science at least once a week and the rest of the entries would be more general (Appendix F).

Field Notes

Field notes were notes taken as the subject was observed teaching science and during each teaching of inquiry lessons. Rich and descriptive language was used to describe the teacher's actions, words, and facial expressions throughout each experience. The researcher used a spiral bound notebook for the collection of qualitative data. A laptop was often utilized to gather data during the professional development sessions and to record any unscheduled conversations related to the research questions.

Observations

Observations were utilized by both the subject and the researcher. The subject was able to observe the researcher teaching science content to her fourth grade class once a week. Many of the concerns the subject had about teaching science involved her students specifically. Since she was able to watch someone else teach science to the same group of students, she was able to identify specific strategies to make inquiry lessons run more smoothly than the attempts she had tried by herself in the past. It also helped create another aspect for continuous communication and built her confidence about attempting difficult topics in her classroom. The units studied by the students coincided with the content covered in the professional development. The lessons within the professional development were expected to be taught to the subject's fourth grade class by the subject as the researcher observed.

Science Teaching Efficacy Belief Instrument

In 1990, an instrument to measure a teacher's self-efficacy in the area of science was developed by Enochs and Riggs. Science teaching self-efficacy was considered to be a good predictor of whether or not a given teacher would be effective in the area of science instruction, this research resulted in the development of an instrument used to measure the science teaching self-efficacy of an individual (Riggs, 1998). This began with the STEBI-A for in service teachers. STEBI (Science Teaching Efficacy Belief Instrument) is intended to measure the efficacy of a teacher in science instruction. As research continued on, Enochs and Riggs (1990) recognized the need for an instrument that would measure the self-efficacy of pre service teachers so that college level classes could modify instruction. This resulted in the STEBI-B. Both of the STEBI assessments have two scales to measure the two parts of self-efficacy. PSTE questions measure the Personal Science Teaching Efficacy and the STOE questions measure the Science Teaching Outcome Expectancy. The tenses within the questions were altered to be directed at pre service teachers more than in service teachers. For example, a question that was initially worded with present tense verbs describing current behaviors within the classroom were changed to reflect future tense verbs describing the expected behavior once the student was a teacher in a classroom. Currently, the STEBI-B is widely accepted as a science teaching self-efficacy instrument for both pre and in service teachers (Bleicher & Lindgren, 2005).

The STEBI is a validated, reliable, and widely accepted tool used to measure an individual's science teaching efficacy (Enochs & Riggs, 1990). It is a Likert-type scale with possible responses ranging from strongly agree to strongly disagree. On a positively worded question a strongly agree response is assigned the score of five. Each response there after is assigned a descending number. A strongly disagree statement is assigned a one. For the questions that are negatively phrased, a one is considered strongly agree and a five is considered strongly disagree. The instrument was designed in this format to help ensure that the test taker read each item carefully and to reduce the risk of a participant answering with all fives to earn a high score. With creating positively and negatively worded questions, Enochs and Riggs (1990) created an instrument that the average participant would not be able to easily discern which questions should have a high number and which should have a low number. This helped increase the validity of the results. However, results tend to skew when an individual earns a high overall score in the beginning of a study. This makes it difficult to measure actual growth within self-efficacy in science teaching because the individual began the study with a strong PSTE not leaving much room, if any, for improvement to be documented (Roberts, Henson, Tharp, & Moreno, 2000).

In 2005, Bleicher and Lindgren retested the validity and reliability of the STEBI-B by reconstructing the testing and analysis that Enoch and Riggs performed in 1990. The re-examination of the STEBI-B found that the 23 items had similar loadings when compared to prior evaluation of the items. Bleicher and Lindgren also concluded that PSTE and STOE can affect each other, but are also independent of one another. It is important to note that problematic results were discovered in the STOE portion of the STEBI. Some of the questions evaluating STOE were worded in such a way that the results were skewed. For example, some of the items asked about more than one event within the same question. The teachers who were interviewed after taking the STEBI reported that it was difficult to choose a number that correctly reflected their thinking because they agreed strongly with one part of the question and disagreed strongly with another aspect of the same question. Bleicher and Lindgren (2005) suggested a change within the wording of these items may make the STOE portion of the instrument considerably more valid. However, there were no problems found within the PSTE portion of the self-efficacy instrument.

The STEBI (Appendix D) was used as a pre and post assessment of the subject's science teaching self-efficacy. The survey contained 23 Likert-type questions, however, the professional development was aimed at affecting only the Personal Science Teaching Efficacy (PSTE) because Bleicher and Lindgren (2004) concluded that Personal Science Teaching Efficacy and Science Teaching Outcome Expectancy can affect each other but are also independent of one another. Khourey-Bowers and Simonis (2004) recommended that PSTE and STOE be analyzed separately. Ramey-Gassert, Shroyer, and Staver reported that PSTE and STOE are affected through different types of development. The discernment between the areas in regards to professional development affected questions 2, 3, 5, 6, 8, 12, 17, 18, 19, 20, 21, 22, and 23. However, all 23 questions were analyzed.

Methods

The procedures for the collection and analysis of data for this qualitative case study were detailed in the following explanation.

Data Collection and Analysis

In April of 2006, an Internal Review Board (IRB) Committee form (Appendix A) was submitted and approved by the Office of Research of the University of Central Florida. After receiving University approval, principal consent was requested and granted (Appendix B). Following principal consent, subject information and consent form was given to the participant (Appendix C) and signed by the subject. The form was explained to the participant and a copy was given to her. I requested that the subject create a pseudonym for all data collection to protect her privacy. All data were collected with the understanding that it would be confidential unless the subject chose to share the findings with someone. The pre and post test, interview, observation, and field notes were stored in a locked filing cabinet. The files created on my personal laptop were stored only on a password protected flash drive.

Throughout the course of this research, the subject and I completed three science units, The Water Cycle, The Solar System, and Airports. We began a fourth unit on Physical and Chemical Changes.

Professional Development

All professional development sessions centered on the use of guided inquiry through the 5E model utilizing modified county created lab lessons with the supplication of children's literature relating to each topic and websites. Twice a week for a minimum of two hours per day, I would meet with the subject and teach each lesson to her, using the same open ended questions and inquiry methods that she was expected to implement with her own students. The subject would then have the opportunity to teach each lesson back to me, while I asked typical fourth grade student questions, to create a higher comfort level with student science questions.

The qualitative data collected from the inquiry based professional development sessions were analyzed in search of patterns in the subject's reactions and beliefs about science instruction. The data were separated into separate emotions at different times in science lessons and compared my observations (field notes) to her personal thoughts (journal entries). This procedure helped to triangulate the data gathered as well as guide future professional development sessions.

Mentoring

Throughout the course of this qualitative case study, I created a relationship with the subject. We exchanged phone numbers and often communicated on weekends and weeknights as questions arose about the lessons. I would visit her classroom just to check on her and to answer questions as needed about content area. She would often return to me after learning the inquiry lesson to reiterate what to do with her class and how to respond when the children asked questions that she did not know the answers to. I would speak with her, on average, twice a day each day throughout the duration of the study.

During the professional development sessions, the subject was comfortable enough to voice any and all concerns she may have for the implementation of any part of each inquiry lesson. She was also able to ask any science content questions about subjects she did not fully understand. From the beginning, we were able to have honest and open communication. I never spoke with other teachers or the administration about her participation. If she brought the subject up, I praised her in front of others for giving her time, energy, and effort to improving her science instruction. This positive reinforcement helped strengthen the trust between us.

The mentoring data was analyzed through the use of continuous dialogue and reflection. After each interaction with the subject, I would reflect upon her facial expressions as I relayed information and observations, her tone of voice, and her words. The purpose of this was to recognize her various levels of comfort and discomfort throughout science instruction. My goal as a science mentor was to put the subject at ease with science instruction without compromising the content needed to effectively teach the benchmarks. As I analyzed the data generated from each interaction, modifications were made for future meetings to ensure the subject's level of trust and comfort was maintained.

Interviews

To collect data on the subject's beliefs about teaching science and her needs for professional development sessions, interviews were given throughout the research. The first official interview using formatted questions (Appendix E) was given during week one of the study. The second interview was conducted during week eight and the final interview was given during week sixteen. There were many interactions throughout the research with the subject about her comfort levels without the use of the official questions. These conversations followed the general outline of the interview questions but were informal.

The data generated from the interview questions were sorted into sections related to the subject's emotions and beliefs through each part of the inquiry based professional development. The data were then analyzed throughout different parts of science instruction in order to recognize any patterns that occurred in the subject's beliefs about her ability to teach science effectively.

Journal Entries

Throughout the duration of the study, the subject responded to specific prompts (Appendix F) at least once a week. Every time the subject observed a science lesson or taught one, she wrote in her journal capturing her beliefs about each lesson and questions that she had about content or student questions that she could not answer. The writing helped to capture her reflective processes about her teaching methods. Once a week we would discuss what was written.

Each week the subject's journal entries were collected and typed by the researcher. The entries were correlated to the interview and observation notes to discover patterns within lessons that described the subject's beliefs in her ability to teach science effectively throughout each stage. Additional purposes was to have the opportunity to adjust interactions based on the subject's needs as well as the triangulation of data.

Field Notes

Copious field notes were taken throughout the course of this action research study. Once a week, the researcher and subject would review the notes together and make any necessary changes. Questions asked by the subject were recorded as well as the researcher's responses.

The field notes gathered were analyzed weekly by the researcher to look for patterns in the subject's beliefs about teaching science effectively. The shared knowledge of everything in the notes helped build trust for the mentoring aspect of the research. The subject was aware that she was able to defend any field notes I took and that her perceptions would be added to the record.

Observations

During the study, I observed the subject teaching lessons that she experienced through professional development sessions to her students. I recorded specific questions she asked the students, her facial expressions, her tone of voice, the time and date of each lesson, the topic being taught, as well as questions I had for her about certain procedures or choices made during science lessons. Once a week, we would discuss the observations, further encouraging my role as a mentor to the subject.

The observation notes were also separated into sections, as the previous data collection methods, in order to search for patterns in the subject's reactions to any aspect of the study or her own beliefs about her ability to teach science effectively.

Science Teaching Efficacy Belief Instrument

The STEBI was used to collect pre and post information about the subject's science teaching self-efficacy. The STEBI was administered in week one of the study and again in week sixteen.

The STEBI results were first separated into two sections to observe the changes in the subject's Personal Science Teaching Efficacy (PSTE) and Science Teaching Outcome Expectancy (STOE). This study focused on altering the PSTE as changing each part of self-efficacy requires different types of professional development. Each set of quantitative data were analyzed to observe any changes to the subject's science teaching self-efficacy. The positively and negatively loaded questions were coded as P or N and the change was indicated through the use of +, -, or = as well as the number change. For example, if the subject answered a positively loaded question prior to the study with a two and then at the conclusion of the study answered the same question with a four, the analysis would show: P (for positively loaded), +2 (amount of numbers increased) which would indicate an increase in that part of science teaching self-efficacy.

Summary

The purpose of the study was to examine the effects of inquiry based professional development through the use of a mentor on an alternatively certified elementary teacher's science teaching self-efficacy. The goal of my study was to discover a method that would allow me to positively impact the science teaching self-efficacy of an elementary teacher so that I can transfer that knowledge to other teachers that I coach in science.

Chapter three described the design of this action research study. The school setting and choice of subject were outlined as well as the methods employed to accurately gather data. Descriptions of instruments utilized and a brief description of the analysis of data were also included. I examined the data gathered from interviews, journal entries, field notes, observations, and the Science Teaching Efficacy Belief Instrument, used as a pre and post test, to determine patterns about what methods were most effective in changing an alternatively certified elementary teacher's science teaching self-efficacy. I also utilized this data to further decide the topics to be covered in each professional development session with the subject.

In depth conclusions from the analysis of data gathered are discussed further in chapter four.

CHAPTER 4: DATA ANALYSIS

Introduction

This qualitative case study examined the effects of inquiry based professional development through the use of a mentor on an alternatively certified elementary teacher's science teaching self-efficacy. Qualitative research allowed me to capture, through the use of rich narrative data, the perceptions and beliefs of the subject being studied in regards to science instruction. The use of a case study allowed me to spend a large amount of time with the subject and increased the opportunities to record narrative data. One fourth grade teacher voluntarily participated in the study in the fall of 2006. This chapter discussed the effects of inquiry based professional development through the use of a mentor on her science teaching self-efficacy.

Data collection methods for this study were the Science Teaching Efficacy Belief Instrument, observations, interviews, journal entries, and field notes. The triangulation of data was accomplished through the use of multiple data sources. The research questions for this study were:

1. What were the effects of inquiry based professional development on an alternatively certified elementary teacher's science teaching self-efficacy?
2. What were the effects of reflective practices with a mentor after instruction on an alternatively certified elementary teacher's personal science teaching self-efficacy?

During weeks one and sixteen, the subject completed the Science Teaching

Efficacy Belief Instrument (Enochs & Riggs, 1990). Interviews, journal entries, observations, and field notes were used to collect qualitative data about the perceptions and beliefs of the subject before, during, and after science teaching. The following section presented an overview of a typical meeting with the subject prior to the study, an overview of a typical meeting with the subject during the study, and data analysis. Data analysis involved examining the information collected and finding common themes or patterns within data sources (Mills, 2003). Throughout my research, I examined the data collected and reported patterns about the subject's science teaching self-efficacy based on the research questions.

Typical Interactions with Subject Prior to Study

Typical interactions with the subject, referred to as Daphne from this point on (the pseudonym she chose), happened on a regular basis. We had several types of meetings that occurred approximately five times per week in addition to several phone calls per week. Often we would meet in her classroom after the students left for the day. We also had impromptu meetings in the hallways throughout the day and would often seek one another out. Daphne would approach me with questions about content and format of lessons, to make sure she understood what we had talked about before or to ask for materials for her science lessons. I would approach her to solidify important points that had been discussed when we met together. I often emailed her encouraging notes as well. The phone calls were normally in the evenings or on the weekends but sometimes occurred during the day between our classrooms.

Prior to the beginning of this study, Daphne and I would occasionally speak with one another in the halls and once a week when her class would come to the science lab. We were friendly, but not close and rarely spoke about science instruction. One day, near the end of the 2005-2006 school year, we had a long discussion about science instruction. Daphne shared her beliefs of inadequacy about teaching the subject effectively. She shared with me that she believed that her students were not receiving good science instruction when she taught the lessons in her classroom. Daphne began paying closer attention to aspects of science teaching that she had questions about, as well as content and methods of delivery. She hoped to use the list to get many of her questions answered for the next time she taught the lessons. She shared with me that when she taught science lessons, the students were disinterested and her lessons lacked flow. Daphne felt that she spent the majority of the lessons reading directly from a piece of paper that was intended to be a guide, not a script. She mentioned each time we spoke that when she taught science it just was not the same as when she observed me teaching her class in the science lab. Daphne also shared with me that if it were not for the planning days that I held with her grade level and the spreadsheet that we created that had each science lesson for the entire nine weeks penciled in on it, she would not teach science at all. Repeatedly she mentioned how uncomfortable she felt with science and the questions from her students that she believed she could not answer correctly. She was very self-conscious of anyone observing her while teaching science, especially since it was her first year as a teacher. Her classroom management plan was not routinely effective and science instruction, especially labs, made the classroom climate more difficult for Daphne to control. Several times she mentioned that she would love to have a science textbook to have the students read instead of attempting hands on activities. After speaking for more than an hour, I shared my research questions with her and asked if she would be willing to participate in my study on science teaching self-efficacy. She was eager to participate and wanted to begin immediately. We set a date to begin working together on science instruction during pre-planning week of the 2006-2007 school year. My relationship as a mentor to Daphne began at that particular moment. Each time we passed one another in the hallway after her agreement to participate in the study, she would reference how excited she was to begin. She began to come to me with science content and delivery questions even though the research had not officially began.

Typical Interactions with Subject Once Study Began

Initially, I arranged with my principal to utilize my planning time to spend as much time as possible in Daphne's room each week for observations. However, due to unexpected scheduling changes such as benchmark testing, field trips, guest speakers, and workshops, we had to alter the original schedule. The changes actually created more opportunities for Daphne and me to communicate. We had to inform each other of any changes with our schedules which opened the lines of communication outside of school. We exchanged cell phone numbers as well as home phone numbers. I explicitly told her that I was available for any science questions she had at any time.

Twice a week we met after school in her classroom, whether I was able to observe her that week or not. On average, we would meet for three hours each Thursday and Friday. The first thirty minutes of each meeting were normally spent discussing her fifth grade daughter as well as student or parent concerns that Daphne was dealing with. Although the study did not involve personal issues as a research question, accepting the role of a mentor did include listening and open communication on all topics. After catching up on each other's lives, we would move to the science lessons that she taught that week. Daphne would share her thoughts and beliefs about each lesson as well as ideas for improvement. We would discuss strategies that she observed in the science lab while I was teaching her students that she wanted to try. If there was a portion of the lesson that she believed her students did not understand, we would discuss ways to reteach the concept. I also helped her develop simple forms of informal assessment for science benchmarks. For example, allowing the students to use white boards to answer science content questions at the beginning and end of a lesson to see what prior knowledge the students were bringing to the lesson and to check their understanding after the lesson.

Normally, we would look at the spreadsheet that was created for each nine weeks of science instruction and discuss the lessons for the following week. I would teach the lesson to her using the same materials that Daphne would utilize the following week with her students. She would learn the concepts through guided inquiry in the same manner that her students would learn the concepts. Daphne was subjected to the same types of questions and learning that she was expected to use with her students.

Each Thursday, Daphne's class came to the science lab where she observed me as I taught an inquiry based science lesson related to the concept being taught in her classroom. Each Thursday afternoon when we met, we would discuss what strategies, especially questioning strategies, that Daphne observed me using in the science lab. We also discussed how Daphne could utilize the strategies in her own classroom during science instruction.

On Friday afternoons, we would discuss Daphne's journal entries and I taught her another lesson for the following week. Fridays were normally the day to verbally run through the lessons one more time and answer any questions that Daphne still had. Often we would turn to books and internet resources to answer her questions. This helped solidify the answers because she had to search for answers and utilize her own understanding of each concept. On Fridays, Daphne also practiced teaching each lesson to me as though I were a student.

Science Teaching Efficacy Belief Instrument

Research question one: What were the effects of inquiry based professional development on an alternatively certified elementary teacher's science teaching self-efficacy?

Research question two: What were the effects of reflective practices with a mentor after instruction on an alternatively certified elementary teacher's personal science teaching self-efficacy?

To fully understand the effects of inquiry based professional development and reflective practices with a mentor on an alternatively certified elementary teacher's science teaching self-efficacy, it was necessary to first measure Daphne's science teaching self-efficacy. The Science Teaching Efficacy Belief Instrument (STEBI) was utilized to quantitatively obtain this information prior to the beginning of this study (Appendix D).

Prior to any interactions with Daphne in regards to this study, I gave her the STEBI to complete. The pre test consisted of 23 items that Daphne responded to by circling one of the following options: strongly agree, agree, undecided, disagree, or strongly disagree. The items were positively and negatively worded questions to measure Personal Science Teaching Efficacy (PSTE) and Science Teaching Outcome Expectancy (STOE) (see Table 1).

Table 1: STEBI Results

Question Number	Positively or Negatively Worded	PSTE or STOE	Daphne's Pre Test	Daphne's Post Test	Difference
1	P	STOE	3	5	+2
2	P	PSTE	4	5	+1
3	N	PSTE	1	2	+1
4	P	STOE	4	4	=
5	P	PSTE	2	4	+2
6	N	PSTE	4	4	=
7	P	STOE	4	3	+1
8	N	PSTE	2	4	=
9	P	STOE	4	4	=
10	N	STOE	3	3	=
11	P	STOE	3	4	+1
12	P	PSTE	2	4	+2
13	N	STOE	4	4	=
14	P	STOE	4	4	=
15	P	STOE	4	4	=
16	P	STOE	4	5	+1
17	N	PSTE	2	4	+2
18	P	PSTE	2	4	+2
19	N	PSTE	2	4	+2
20	N	PSTE	1	2	+1
21	N	PSTE	2	4	+2
22	P	PSTE	2	4	+2
23	N	PSTE	2	4	+2

PSTE and STOE are related but not dependent upon one another. The professional development activities needed to create a change in each area varies greatly (Enochs & Riggs, 1990; Bleicher & Lindgren, 2005). I was primarily interested in altering the PSTE of the subject and the methods chosen aligned with this purpose. Research has shown that changes in STOE are more difficult to measure than changes in PSTE. Long term professional development sessions are recommended to affect changes in STOE. I focused on how to alter Personal Science Teaching Efficacy because of time constraints and a deeper professional interest for that aspect of science teaching self-efficacy.

The questions that measured PSTE revolved around teacher responses to science questions from students and the teacher's beliefs and perceptions about the ability to teach science concepts effectively (Appendix D). Questions 5, 12, and 18 measured the subject's beliefs in her abilities to transfer science content knowledge to students. Daphne's score increased by two points on each question. Question eight measured content knowledge confidence as well. Daphne's score stayed the same on the pre and post test for question eight. Her science content knowledge appeared to be positively affected by the inquiry based professional development as well as the reflective thinking with a mentor.

Questions 2, 3, 19, and 23 measured the subject's beliefs in her science teaching skills. These questions also measured the subject's willingness to seek out new methods. On questions two and three, Daphne's scores increased by one point. Questions 19 and 23 reflected a two point increase. These results suggested that the professional development and use of a mentor positively affected Daphne's science teaching self-efficacy in the area of her beliefs in her delivery methods and perseverance to teach science effectively.

Questions 6, 17, 21, and 22 measured the subject's perceptions about her inquiry science abilities. The questions focused on responding to student questions that were not part of a scripted lesson as well as her ability to manage experiments. Daphne's responses for question six on the pre and post test remained the same. Her responses for questions 17, 21, and 22 increased by two points. These results indicated a positive impact on Daphne's science teaching self-efficacy from the inquiry based professional development and the use of a mentor.

Question 20 focused on the subject being observed by the principal. The question asks if the subject would choose science as the subject for an observation. During the pre test, Daphne laughed at that question and said she'd never allow the principal to observe her teaching science because it would turn out horribly. During the post test, she again mentioned this question. Daphne said that she would be more likely after the inquiry based professional development through the use of a mentor to invite the principal to observe her teaching a science lesson, but that it would still not be her first choice. Her score on question 20 increased by 1 point, which may indicate that her level of science teaching self-efficacy has increased in this area as well.

According to the results from the STEBI, Daphne's Personal Science Teaching Efficacy was positively changed as a result of inquiry based professional development, reflective thinking, and the use of a mentor. The questions answered relating to PSTE improved 85% from the pre test to the post test while 15% of the answers remained the same. Daphne's Science Teaching Outcome Expectancy resulted in 60% of the answers staying the same and 40% of the answers improving. Her STOE was positively affected but the changes were limited compared to the increased PSTE scores.

Conflicted Reactions to Inquiry Based Professional Development

> Research question one: What were the effects of inquiry based professional development on an alternatively certified elementary teacher's science teaching self-efficacy?

The first theme that emerged from the data was the conflicted reactions that Daphne had throughout the research. Through continuous analysis of the qualitative data gathered, it was unclear if the inquiry based professional development was effecting positive or negative changes in Daphne's science teaching self-efficacy. Often the meetings would conclude with positive remarks and the next school day, she would react with uncertainty to the things that she was excited about implementing from the previous day. Examples were chosen from different stages in the research with the purpose of illustrating typical interactions. Many of the examples were believed to convey the significance of the changes in Daphne's science teaching self-efficacy as well as the peaks and valleys in her perceptions and beliefs about science that she experienced throughout the research. The following section reported the conflicted reactions to the inquiry based professional development sessions with Daphne.

Prior to teaching any inquiry lessons to Daphne, in August 2006, I observed her as she taught a science lesson in her classroom that she planned without my assistance. The purposes of the initial observation were to acclimate the students to seeing me in the classroom, acclimate Daphne to teaching while I was in the room, and to record qualitative beginning data to assist in analyzing data on the effects of inquiry based professional development on Daphne's science teaching practices. The first lesson observed was on the water cycle. Daphne expressed a high level of comfort with this topic and planned a lecture lesson that involved science journals and note taking. The majority of the lesson consisted of Daphne at the front of the room asking recall questions. Her responses were mainly "yes, that's right" or "no, not quite, but close" when the students answered. The general impression from the lesson was that the teacher held the correct answers. If a student gave what appeared to be a "wrong" answer, Daphne did not normally pursue the answer to discover the line of thinking that may or may not relate to the topic.

When the students answered questions and had their hands raised, Daphne became very animated and excited throughout the lesson. It was obvious when she was comfortable and enjoying teaching. However, when the students would begin to fidget or did not know the answer to a prescribed question, her face would fall and she continued to look to me for support, although I did not give any. It was during these same moments that she would begin to lose track of the lesson and the frustration was obvious through the expression on her face. It was much like a roller coaster with many ups and downs throughout the 45 minutes I spent in her classroom.

After school on the same day of the lesson, Daphne requested that I share my observation notes with her in detail. She expressed an interest in areas of improvement. Before sharing the notes with her, I requested that she tell me how she felt about the lesson and what she would change if she were to teach it again the following day. Through the entire meeting, she continued to regard me with wary eyes even though she felt extremely confident about the water cycle lesson. We discussed the notes and I drew attention to the level of questions present in the lesson. Daphne admitted that higher level thinking questions were something that she struggled with and that during her formal observations from administration the same point was brought to her attention. At that point, I knew that when I taught inquiry lessons to her, we would generate a list of open ended questions for Daphne to use with her students to promote a deeper level of thinking in her classroom. She expressed discomfort at the idea of presenting questions to her students that she may not know the definite answer to. We discussed the importance of allowing her students to think deeply and that it was acceptable for the students to see that the teacher does not know all the answers. She appeared surprised at the notion that it was good for the students to know that teachers are always learning and seeking out information for their own betterment.

We also discussed the roller coaster of emotions that flew across her face throughout the science lesson. Daphne laughed in recognition and explained that what I observed on her face was exactly what was on her mind at each moment in time. She explained that teaching science terrified her and the thought of the students asking questions that she did not know the answer to made her not want to teach it at all. She then confided, “If it were not for the nine week planning days, the rest of my team teaching science, and your support, I would not be teaching science at all. I'd avoid it like the plague if I could get away with it." (8-22-06)

Daphne replied to the same set of questions 3 times throughout the research (Appendix G). The initial interview took place before any professional development sessions, the second interview was given at the midpoint of the research, and the final interview was after the last observation of Daphne's science teaching. From the initial interview, it was obvious that Daphne did not harbor positive beliefs toward science instruction. She referred to being a very concrete learner and the lessons that I planned to teach to her revolved around hands on inquiry learning. She maintained a level of enthusiasm about beginning the lessons as well as repeatedly referring to the positive changes she would like to make in regards to her science instruction.

From the first time I interviewed Daphne to the last time, she consistently, on each question, demonstrated an increase in positive perceptions and beliefs about her abilities to teach science effectively. For example, she initially felt intimidated by the thought of teaching science, then said that she did not feel comfortable teaching it, and by the last interview she stated that she felt uncomfortable with *some parts* of teaching science. Daphne's ideas for improving her beliefs about teaching science progressed from looking to other professionals for validation of ideas in the first interview, to feeling as though her science content knowledge and instruction was improving at a slow rate, to an allowance of validation for science ideas that Daphne and her students generate instead of relying on other teachers' ideas. Her reflective thoughts about herself as a science teacher progressed as well. At first, she felt scared at the thought of teaching science, then she felt good about units that she knew a lot about but still nervous about units she felt she did not have a lot of content knowledge, and by the final interview she still questioned her choices but did not speak about feeling scared.

Initially, Daphne was apprehensive about teaching science effectively, but as she participated in more inquiry professional development, her attitude began to change in a positive manner. By the conclusion of the study, Daphne's perceptions and beliefs about her ability to teach science effectively mirrored the STEBI results discussed earlier. There is a clear progression of confidence in her personal beliefs about her abilities to teach science effectively.

Inquiry Based Professional Development Sessions

The first unit that I utilized inquiry methods to teach Daphne was the water cycle. She began this unit with a positive attitude because she taught it to her students the year prior to this study and believed that the lessons were mostly successful. Daphne also kept a file of ideas from other fourth grade teachers about ways to enhance the water cycle unit and was confident that she understood it well enough to relay the information correctly to her students. This unit utilized the 5E model as developed by Bybee (1997). This model consisted of five stages of instruction; Engage, Explore, Explain, Extend, and Evaluate.

We met after school in her classroom and Daphne began the meeting by discussing how much prior knowledge her students had about the water cycle. She was extremely positive with her comments, "I have been looking forward to starting to learn how to teach science better", as well as full of ideas for this unit. However, her excitement quickly faded when she discovered which lesson she would be learning during that first professional development session. The lesson involved student brainstorming about ways that people use water and recording an idea for each letter of the alphabet. This information would be recorded on a chart so it could be referenced throughout the unit. The second part of the lesson was giving each student a common job of a person that relies on water for their work and then creating a web of yarn representing that everything uses water each day. Daphne was terrified of this part of the lesson because she believed she had failed miserably teaching it the prior year.

> "Last year, the students were so confused and then I became confused about what I was doing and got so frustrated with their behavior that I just yelled for everyone to drop their yarn and line up silently. We returned to the classroom and did book work instead of the hands on lesson. I was so frustrated and have been dreading this lesson." (8-26-06)

We discussed and addressed each issue she had with the yarn lesson the year prior to the beginning of my research. The purpose of this discussion was to ensure that Daphne was comfortable with the purpose, procedures, and content so she could be more confident about her ability to teach this particular lesson. After hearing the above comment, I wanted to ensure that Daphne had enough confidence in the topic to persevere through the lesson if some of the management issues from the year prior appeared. I also wanted to give her strategies and suggestions for the parts of the lesson she was hesitant about to help it go more smoothly. I proceeded to give her chart paper to create her A to Z chart and helped her brainstorm things that we use water for every day of our lives. She repeatedly referred to the fact that the chart was a disaster last year.

> "The students whined the whole time and wouldn't even try to come up with things for the hard letters. I mean, anyhow, what do you put for X? Nothing. What is there? I can't think of anything, can you? I hope this goes better this year, but I don't have a lot of faith in it. I hate this lesson." (8-26-06)

Before we finished with the chart, we were laughing and she started to speak positively about this part of the lesson.

> "I think this will go okay. My students love science this year and are easier to handle". (8-26-06)

I gave Daphne a card labeled "grocer" and myself a card labeled "farmer" for the next part of the lesson. I had blue yarn cut out in 3 feet lengths. Each of us had to explain how we used water for our job and then tied our yarn to a chair labeled "water". I tied several other pieces of yarn to the chair to represent other students and their jobs so that all of our pieces were intertwined and connected to the source of water. Daphne asked multiple questions and referred to the disastrous lesson from the year before several times. Each concern she brought up, I addressed with a solution. For example, the year before, all of the yarn was cut the same length and all of her students were standing too closely to one another creating behavior issues. I first asked her for ideas of how to solve that problem this year and she came up with several such as cutting the yarn in different lengths so that the students would be staggered and hopefully cut down on the behaviors. Every time she asked a question or brought up a former or potential scenario I responded with a redirected question to her.

> “You keep asking me questions. I thought you’d be giving me answers, not questions (laughing). This is what you do to the kids when you’re teaching a lesson in the science lab.” (8-26-06)

By the end of the professional development session, Daphne said tentatively that she felt okay about teaching the lesson. She was still very hesitant about teaching it because of her experience the year before. I encouraged her and requested that she teach the lesson back to me so I could ask her questions like her students would. One of the things that scared her the most was the questions that the students might ask and she might not know the answer. She went through the lesson smoothly and even when I asked questions that stumped her, she replied appropriately.

> “Well, I’m not sure of the answer to that. Why don’t you write that question down and we’ll do some research about it later?”(8-26-06)

We both left the meeting feeling very positive about the interaction and eager to observe the student reactions to the lesson. At this point, I was optimistic that Daphne’s level of confidence in this lesson had risen to a point that she would be successful on the day she was teaching it and I decided to observe the yarn and chair activity. When I read her journal from our first session, her thoughts were very different from the words she spoke when we were working together. For example, the entry began by saying that she was excited to teach the water cycle and the next sentence said that she hated the yarn and chair activity. The comments above indicated that she was more comfortable with the yarn and chair activity by the end of our time together than she was at the beginning of the session. The journal entry contradicted that conclusion.

The following day, Daphne approached me in the hallway bouncing up and down with excitement. She explained that the A to Z chart part of the lesson was flawless, the students were engaged and happy, and she was ecstatic that it went so smoothly. Immediately after this positive rush of beliefs, she described how much she dreaded the fact that she had to “do the yarn thing” the next day and expressed regret at the fact that I would be observing her teach the yarn part of the lesson instead of the A to Z chart.

> “I cannot believe how great the A to Z chart went. I didn’t believe it to be possible, but the kids were involved the whole time!” (8-27-06)

The journal entry from the same day expressed a level of excitement that I had not observed from Daphne, in regards to science, other than the event in the hallway.

During the observation of Daphne’s teaching, the apprehension was obvious in her facial expressions. The first five minutes were very difficult and she appeared distracted and nervous. However, once the students began to engage in the questions that we prepared together, she began to smile and uncrossed her arms. Once the lesson moved to tying the yarn to the chair, Daphne began to become uncomfortable again. At one point she turned to me and requested that I help with the discipline. The struggle to stop the lesson and give up was apparent on her face and in her tone with the students. Her voice became shrill and her facial muscles tightened. I observed her take a very deep breath and it appeared as though she was counting to herself. All of a sudden, she asked a question that we had prepared together, “Why do you think we need to conserve our use of water?”, and the students’ focus returned. Once the students were engaged in learning, her face relaxed and her shrill tone disappeared. She began to have fun with their questions. Each lesson that she taught became more enjoyable to observe because her face would light up when the students were excited. However, she often spent too much time on a certain point and the students would start getting restless. Whenever this happens, her face would fall and the worry lines between her eyebrows would furrow down resulting in an expression of anxiety.

> “I hate this lesson so much. It was horrible and I feel so embarrassed. The only good thing is that I didn’t give up and make them go back inside. I wanted to, but I didn’t.” (8-28-06)

The journal entry from this part of the lesson confirmed my observations.

Each week, we spent at least four hours together working on science lessons for the following week. Daphne’s ideas became more inquiry oriented and she became more adept at expressing her understanding through words.

> “Well, I think that I should start the lesson by just writing the planets on the board in order and talking to them about the characteristics of each planet. Then we can do a Venn diagram about the planets but not until I give them the information. I don’t know if they’ll actually remember it. Maybe I should make copies of it for them?” (9-1-06)

> “After the chromatography lab that you did yesterday, my kids had so many questions. I think I’m going to let them test out some of their ideas. I made a list

> of some of them yesterday. They want to test different colors of markers, not just black and they want to test different liquids, not just water. I'm excited to see what happens because I don't know myself! Do you know what will happen? Wait! Don't tell me, I want to be surprised. I think that the other colors will work if they aren't a primary color because the black separated into primary colors because it was a mixture. I'm not sure about the liquid. I don't think it should make a difference, but I don't know." (11-19-06)

Each subsequent observation of Daphne's science teaching yielded more effective management, thought provoking questions, and appropriate responses to questions she did not know the answer to. Daphne also began to realize that it was acceptable that she did not have all the answers to everything the students would ask. She transitioned from a direct instruction teacher to an inquiry oriented teacher mainly through the types of open ended questions she began utilizing on a regular basis throughout her lessons.

> "Ummm…(looking around especially at me)I'm not really sure. (would start to explain something and looked pained)Wait, I don't think that's right. Let me get back to you." (8-30-06)
>
> "That's a great question. I wonder how you could find out the answer to that?" (12-1-06)

She also began to become aware of the fact that her students were retaining science content better when she referred them to websites, books, and other classmates for answers to questions that, prior to the study, she would have answered herself. Daphne realized through her own participation in inquiry based professional development that her students would probably learn content much better utilizing the same strategies that I used with her. As she came to this realization, she began to incorporate more inquiry strategies in her classroom.

> “Well, the water just never runs out, so you could be drinking the same water dinosaurs did.” (Response to student question on 8-28-06)
>
> “How can we find out if food coloring and water mixed together is a physical or chemical change? What could we do?” (Response to student question on 12-1-06)

The lessons that Daphne had positive experiences with the year before were lessons that she displayed more confidence about and was excited to teach. The inquiry methods, especially the questioning strategies, intrigued her as this was an area on her formal observations that had been brought to her attention by an administrator. Each lesson that I taught to her using the 5E method went more smoothly than the one prior and the number of questions, as well as the quality, increased. Daphne progressed from asking me approximately ten questions in an hour during our first meeting to asking me approximately 35 questions in an hour by our last meeting. Each round of questions were more probing and focused on content more than lesson management each time. Daphne started the study with questions such as how to handle certain materials and what to do if students were upset about partner choices. She progressed to recognizing the types of questions her students were asking her and predicting the questions they might ask for each lesson.

Example of an initial question: “The boys always start drama when they’re in groups and the girls won’t stop talking long enough to finish their work. What can I do to keep them working on the project since I won’t be teaching directly off the board?” (8-21-06)

Example of a later question: “You know my kids, they love to stump me! I know someone is going to ask me how baking a cake is a chemical change but mixing marker colors is a physical change, even after the experiment. What should I say?” (11-20-06)

Daphne’s reactions to each part of the research involving the inquiry based professional development varied. Sometimes the reactions were positive and showed indications of a possible high level of science teaching self-efficacy and other times the reactions were negative indicating a possible low level of science teaching self-efficacy. However, the analysis of the Science Teaching Efficacy Belief Instrument, the interview questions, and field notes indicated that Daphne progressed from a teacher who relied on knowing all the answers to student questions and mostly utilizing direct teaching to a teacher that realized that not knowing everything is another vehicle to teach students if harnessed properly. Daphne also recognized that questions can create a positive climate in the science classroom as well as help facilitate deep and thoughtful discussions with students. Daphne realized that the use of inquiry strategies is an effective way to teach science as indicated by her belief that she learned more science through the professional development sessions than she would have by researching and reading on her own.

Reflective Thinking with a Mentor

Research question two: What were the effects of reflective practices with a mentor after instruction on an alternatively certified elementary teacher's science teaching self-efficacy?

The second theme emergent from the data collected was the presence of positive perceptions, actions, beliefs, and comments regarding the use of reflective thinking with a mentor. After each lesson taught to Daphne, each lesson she observed me teaching in the science lab, and each science lesson she taught in her own classroom, Daphne would record her beliefs and thoughts about teaching science to help chronicle her journey. As a result of reflective practices through the use of a mentor, Daphne's science teaching self-efficacy increased.

Daphne observed me teaching science content to her fourth grade class during the school year before the research began. She continued observing me teach science to her 2006-2007 school year students. Prior to the research, it was not required that Daphne take note of specific strategies and areas of content as she observed. One of the first lessons that she observed me teach to her students was an outside scale model of the solar system using trundle wheels to measure metrically where each planet's picture would be located. When we later discussed the lesson, Daphne began by saying that she was very happy that she did not have to teach the lesson herself because she was not sure that she could have maintained a level of decorum with her students. I requested that she share specifics from the lesson that she would have been uncomfortable teaching.

"Well, when he asked you why Pluto was being included even though scientists decided it wasn't a planet anymore. I would not have known what to say and probably would have let them talk me into taking Pluto out of the picture. Also, when they started fighting over the trundle wheel and whose turn it was, I think I would have taken it away from them instead of asking them what number they were assigned earlier as a way to remind them that they'll all get a turn. Also, I don't know a lot about the planets, why they stay where they are, how they move around. It seems so abstract to me and I'm afraid I would have messed up this introduction lesson. (laughing) That's why I'm so thankful that you got to teach this one!"

Student speaking to me during solar system lesson: "Pluto's not a planet anymore. I saw it on the news."

Me: "What did you hear?"

Student: "I heard that some scientists don't think it's big enough to be a planet so they kicked it out."

Me: "Well, what do you think about that?" (allowed class responses)

Me: (to whole class) "Why do you think that I left Pluto in our solar system activity even though some scientists believe it should not be considered a planet anymore?" (allowed student responses) (9-4-06)

Daphne indicated that she liked how I returned the responsibility of thinking of a reasonable explanation back to the students by asking more open ended questions because they came up with some very interesting ideas that she never would have thought of on her own. I then spoke with her about the importance of allowing student ideas to help a science lesson flow and that sometimes they can see an angle that the teacher or a textbook may not recognize.

From the beginning of the research, Daphne treated our daily interactions with a positive attitude. At least once a week she mentioned that she enjoyed the time planning together and that it made her feel better to know that she had someone to help her. She would often laugh and tell people that I could not escape from her science questions because she even had my home phone number.

> "I'm just so glad to get some help with teaching science. Give me reading to teach any day! It's OK until they start asking questions. They get me all confused and I start to think that they're right. Now I can try to think of questions that they'll ask me while I'm learning the lesson and hopefully that will help me teach science better." (9-4-06)

Prior to the study beginning, Daphne spoke with the other fourth grade teachers about participating in my research. Each time I would pass Daphne in the hall, she would refer to the beginning of the research and how excited she was to start so she could be a better science teacher.

> "She's going to make me a better science teacher. You guys know how much I don't like teaching science, especially when the kids start asking me questions. I get to meet with her twice a week for hours and she's going to answer any question I have. I feel special." (8-15-06)

Throughout the study, I observed Daphne speaking with her fellow fourth grade teachers about the things that we were working on. Each time she spoke about the research in front of others, she always had a smile on her face. She would tell anyone that would listen about how happy she was to learn new science concepts. By the middle point of the study, Daphne began answering her fourth grade team's questions about science with confidence.

> "Oh, you wouldn't believe it! We worked on that mixture and solution thing forever yesterday and I thought I really had it down. I thought my examples would be good. My kids though! They had so many questions, I had to start writing them down so I could talk with Michelle and figure out what to do. I tell you what, I don't know what I'd do with all their questions if she weren't helping me." (10-5-06)

This situation resulted in a phone call. We discussed what Daphne thought the answer was to each question and then looked up verification of her ideas online. We then compiled a list of current and accurate websites to help her with the information. Then we created a list of questions for her to ask her students about each idea they had and how some simple and cheap experiments could be set up in order to test each idea they had. By the end of the conversation, Daphne was excited to discuss the topics with her students the following day. Several mini science experiments in Daphne's classroom were the final result of this interaction.

By the end of the study, Daphne was still discussing the research with her team of fourth grade teachers.

> "I can't believe it's almost time for this to be over. I'm going to miss meeting each week. Yeah, it was a lot of time, but I feel like I learned enough that I could even share some of it with you guys. I just wish her research took place during the electricity and magnetism unit!" (11-20-06)

Once the trust was established with Daphne, her confidence level with teaching science appeared to rise. Unfortunately, it was unclear if she was beginning to believe that she was becoming a better science teacher or if she was giving me too much credit for her successes.

At the beginning of the research, the mentoring part of the interview questions were not applicable since Daphne and I had not spent much time together yet and the questions focused on changes from the interactions from the study. The interview questions helped illustrate her beliefs towards the mentoring aspect of the research from the middle and end points (see Appendix H). For example, when asked what things from the study have impacted her beliefs about teaching science effectively, Daphne responded, both in the mid interview and the final interview, that her beliefs were affected positively because of our discussions. She mentioned how comfortable she felt because she could ask any question and I was not going to act as though she should already know the answer. Daphne also discussed that the added support of a mentor gave her the confidence to attempt more group and hands on activities. She discussed how the lessons being broken down into small steps helped her realize how to implement the same strategy with her own students because it worked so well for her. Daphne also talked about the enjoyment she felt working with me on science lessons and that she finally learned it is acceptable for the teacher to not know all of the answers. The answers that Daphne provided for these interview questions indicated that her science teaching self-efficacy was positively affected because of the use of reflective practices with a mentor.

From the first week of the research to the sixteenth week, Daphne's use of me as her mentor increased. I kept track of our interactions in my field notes and specified which one of us was the initiator of the contact as well as the date and subject of the talk. At the beginning of the study, I was initiating approximately 80% of the interactions whether it was by phone, face to face, or email. At the mid point, we were approaching one another equally. By the conclusion of the study, Daphne was approaching me with more frequency in regards to science instruction, at almost 75% of the interactions begin initiated by her. She began coming to my room in the mornings to ask questions about the science lessons that she was teaching each day, even though we had worked on them the night before. She was emailing questions as well as phoning my home to share successes in the lessons or possible pitfalls she thought about.

After the official ending of the research, Daphne continued with the same open dialogue about her science teaching and she continued to seek me out for help with science lessons. She also mentioned, on several occasions that just because we were not meeting on a schedule anymore, that I needed to expect to still hear from her often. The confidence that Daphne gained from our mentor-mentee relationship indicated an increased science teaching self-efficacy. Each time I met with Daphne, the questions would come in a barrage from both of us. She began to predict what types of questions I would ask her and give me the answers before I could ask. Whenever this happened, she would smile and say "see, I'm learning so much right now! Aren't you proud?" I continued to give Daphne positive comments during each interaction. Concerns were dealt with matter of factly and Daphne normally agreed and recognized each concern as it was presented to her. She felt extremely comfortable in explaining her side of the observation.

> Mentor: "OK, you ended up having the exact problem in this lesson (building an airport model) that you predicted when we met last to plan it. Tell me what we decided you would do if (a student) tried to correct you on your airport facts?"
>
> Daphne: "Well, we decided that I wouldn't let (a student) distract me from the purpose of my lesson which was to teach them some of the parts of an airport. And tried that, but I know when (a student) got started today, I just didn't handle it well and the lesson went downhill from there."
>
> Mentor: "So how could you have handled it differently so the rest of the students did not lose instructional time because of (a student)?"
>
> Daphne: "Well, I think I should have sent (a student) to time out, moved his name down and continued with the lesson. Then I could have talked to him separately but the rest of the class could still have learned about the airport parts. Instead, I let (a student) run away with the lesson and waste our time. But, I think I brought it back OK, we only lost about 5 minutes and I think the rest of the lesson went well. The students were engaged and I felt very comfortable teaching the parts because of the research you and I did together." (9-20-06)

Daphne's journal entries that reflected her beliefs during and after each science lesson that she taught conflicted with the interactions that we had in person. She continued, in her journaling, to make positive references to having a mentor that helped her with science instruction. However, her own perceptions of each lesson were different from our meetings about each lesson. For example, we met after her students began building the parts of an airport that they learned about previously and my notes reflected deep, open ended questions, good management, and the appearance of ease in her expressions, voice, and body language. However, when I read her journal entry about the same lesson, I found that she focused a lot of her attention on the small things that she felt could have gone better like one student question that flustered her because she did not have a rote answer to give. Instead of focusing on the fifteen questions that she handled appropriately, she focused on the one that did not go well. This indicated that Daphne tended to be very hard on herself and expected that everyone else would be as well. Since she focused so much energy on the one question that did not go as planned, I focused on building up the other fifteen that she handled perfectly in order to build her confidence in open ended science questions.

Daphne maintained a positive attitude about the use of a mentor throughout the research through interviews and observations, field notes, and journal responses. During oral reflection within two hours of each lesson, she expressed doubt in each of her lessons and I would continue giving her positive feedback about her ability to teach science effectively. When we were finished meeting each time, she would have taken the positive feedback and accepted it but when the journal entries were read, they reflected the same doubts about her ability to be an effective science instructor. However, the STEBI results (see Table 1) and the interview questions (see Appendices G and H) show that the use of a mentor in conjunction with inquiry based professional development positively affected Daphne's science teaching self-efficacy.

Summary

This purpose of this case study was to record the effects that inquiry based professional development and the use of reflective thinking with a mentor had on an alternatively certified elementary teacher's science teaching self-efficacy. Analysis of data revealed several themes about the subject's beliefs in her abilities to teach science effectively as she learned science through inquiry, taught science through inquiry, and worked with the support of a mentor throughout the whole process. The first theme was that although data conflicted somewhat in regards to the inquiry based professional development, the subject's science teaching self-efficacy increased from the beginning of the research to the end. The second theme was the subject's continuous positive attitude about the use of a mentor even when she doubted her own abilities.

When analyzed together, the data from the subject's STEBI pre and post test, journal entries, interviews, field notes, and observations indicate that this fourth grade teacher may have had a higher science teaching self-efficacy at the conclusion of this study compared to the onset of the study. It appeared that inquiry based professional development as well as reflective thinking with the use of a mentor may have created positive changes in the subject's perceptions and beliefs about her abilities to effectively teach science.

In chapter five, a discussion of the findings and conclusions drawn from those findings were discussed. Suggested avenues for further research were also indicated.

CHAPTER 5: CONCLUSIONS

Introduction

Being cognizant of the struggles of teaching science when it is an uncomfortable subject for certain teachers made me extremely 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, Shroyer, & Staver, 1996). Many elementary teachers do not teach science through inquiry as required by the National Science Education Standards (Jeanpierre, 2006). 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 (U.S. Department of Education, 2002). 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 qualitative case study was to analyze the effects of inquiry based professional development through the use of a mentor on an alternatively certified elementary teacher's science teaching self-efficacy.

As the study proceeded, I became more aware of the importance of creating quality sustainable professional development for inservice science teachers. I observed a fourth grade second year alternatively certified teacher's reactions to inquiry professional development and the use of a mentor to aid in reflective thinking practices. Data were collected through a pre and post test, the Science Teaching Efficacy Belief

Instrument, journal entries, observations, field notes, and interviews. The collection of data over a sixteen week period led to the analysis of how the actions I took with the subject resulted in changes to her science teaching self-efficacy.

The research questions were:

1. What were the effects of inquiry based professional development on an alternatively certified elementary teacher's science teaching self-efficacy?

2. What were the effects of reflective practices with a mentor after instruction on an alternatively certified elementary teacher's personal science teaching self-efficacy?

Throughout the study I taught the subject several inquiry science lessons using the 5E model developed by Bybee in 1997. This is the same model that the subject was expected to utilize to teach the concepts to her students. I also made myself available for open and continuous dialogue in the capacity of a mentor. The subject recorded her beliefs and thoughts about each science interaction that we had in a journal. I observed her teaching science lessons and she also completed a pre and post test to demonstrate the effects of the research on her science teaching self-efficacy. By the end of the study, two themes had emerged. The first theme was conflicted reactions to the inquiry based professional development as recorded in the journal entries, field notes, and observations. The second theme was that the subject maintained a positive attitude about all of the practices we used, especially the mentor-mentee relationship. The frequency of questions asked by the subject and the depth of questions asked were also patterns recorded.

Conclusions

This case study took place in an elementary school in Central Florida. Data were collected from one second year alternatively certified teacher in a fourth grade classroom. Based on my analysis of data, I offered conclusions as they relate to each research question.

Research question one: What were the effects of inquiry based professional development on an alternatively certified elementary teacher's science teaching self-efficacy?

The observations, field notes, interviews, journal entries and Science Teaching Efficacy Belief Instrument revealed conflicting reactions by the subject to inquiry based professional development. At the beginning of each session, the subject tended to speak negatively about her abilities to teach the science lesson effectively to her students. She often voiced doubts in her knowledge about the topic as well as trepidation at students asking questions she may not know the answers to. By the conclusion of each session, she normally showed excitement about the lesson and would make comments about how prepared she felt as well as indicating that the student questions could not be tougher than the ones I asked her and she answered appropriately, not always with a "correct" answer, but without getting flustered. These results indicated positive changes in her science teaching self-efficacy. However, in analysis of journal entries, she tended to doubt her abilities as an effective science instructor. This indicated that additional research is needed to futher investigate this apparent conflict. The STEBI results showed an increase in science teaching self-efficacy at the conclusion of the study. The answers to the interview questions also indicated growth in the subject's beliefs about her ability to teach science.

These findings are consistent with the findings of other researchers in the area of affecting changes in science teaching self-efficacy. Enochs and Riggs (1990) asserted that long term intensive professional development was needed in order to affect the Personal Science Teaching Efficacy of an individual. Ramey-Gassert, Shroyer, and Staver (1996) reported that professional development sessions developed to change science teaching self-efficacy could be viewed differently by participants at various points in the research, often when data is gathered qualitatively. Self-efficacy can change in any given situation (Bandura, 1977).

> Research question two: What were the effects of reflective practices with a mentor after instruction on an alternatively certified elementary teacher's personal science teaching self-efficacy?

Consistently throughout the study, the subject maintained positive interactions with me as her mentor. She demonstrated a high comfort level early in the research. There was no point during the study that she seemed uncomfortable asking questions about any science topic. Initially, her questions were followed with self-deprecating comments such as "I know this is a stupid question" or "Don't laugh at me for not knowing this". However, through the open communication and the purposeful lack of judgment, the subject increased her use of me as a resource throughout the weeks. By the conclusion of the study, all aspects of data indicated an increase in her science teaching self-efficacy as a result of our mentor-mentee relationship.

Discussion

The purpose of this case study was to study the effects of inquiry based professional development through the use of a mentor on an alternatively certified elementary teacher's science teaching self-efficacy. The research began with the assumption that the nature of the professional development and a mentoring relationship would result in some changes to the subject's science teaching self-efficacy. Our mentor-mentee relationship was built quickly around open and honest communication and positive feedback from me concerning her science lessons. Sixty percent of elementary science instruction should utilize inquiry investigations (NSES, 2000).The science lessons used in the professional development all utilized the 5E model as described by Bybee (1997). This model is widely considered an effective way of teaching inquiry science to learners.

Based on the data collected in this study, I believe that a combination of factors influenced the subject's science teaching self-efficacy. The subject's commitment to the journal entries, observations, and meetings were one contributing factor, as well as her desire to change her science teaching. I also believe that the data supports that the open communication on a mentor-mentee level contributed to the changes in her science teaching self-efficacy. We both worked diligently to communicate with one another often and openly. As a science coach at my school it was my responsibility to follow up with the teachers on a weekly basis. With the subject, that responsibility was compounded as we exchanged phone numbers and scheduled large blocks of time to work together on science. The correct mentoring climate can be an effective way to alter a teacher's Personal Science Teaching Efficacy (Hudson, 2005).

Throughout the study, I taught the subject science content through inquiry lessons that utilized open ended questions. After participating in each lesson, she would teach it to me before teaching it to her students. Each success built her confidence in her abilities to teach science effectively. Each meeting built her trust in our relationship that allowed her to not know everything. Through participating in the lessons, she discovered how to relinquish some of her teacher control, moving her closer to becoming a facilitator of science knowledge. The subject continuously participated in reflective practices through each stage of the science lessons. Reflective practices are a core component in an effective professional development program (Mundry & Hewson, 2003).

This case study allowed me to help the subject to change her science practice. Considering that coaching teachers in science instruction is one part of my job, this study allowed me to discover effective ways to possibly alter science teaching self-efficacy. By reflecting on the data, I am now able to develop a more comprehensive professional development model for my school.

The results of this case study have allowed me to become more aware of the various types of mentoring relationships and how important that connection can be to professional development being effective in science. In order for new teachers to recognize that certain instructional strategies are beneficial, a strategy must be observed, reflected upon, and a mentor made available to answer questions (Fletcher 1998). The results also enabled me to recognize low science teaching self-efficacy and an effective way to alter it. Throughout the study, I have shared the ongoing results with my school community during planning days. My subject has shared her positive beliefs and changes with colleagues as well. She is proud of her involvement in this project, especially her newfound pleasure in teaching science. This information has been shared so that when a teacher appears to be avoiding science instruction in their classroom, the true reason can be discovered. Once the level of self-efficacy is realized, the proper professional development can be applied in order to help affect positive changes. Self-efficacy is an accurate predictor of future behavior (Bandura, 1977). If a teacher is unwilling to attempt teaching science in year one of the career and nothing happens to shift that paradigm, chances are in year ten of the career science teaching will still not occur. Sharing the results of this case study with my principal enabled her to see options when dealing with teachers that are not teaching science.

I believe in creating relationships with teachers and searching for the root problem when they avoid teaching science. Open and honest communication coupled with the correct type of professional development can create positive changes. In order to create these changes, coaches have to make a conscious effort to search out reasons for science avoidance instead of applying arbitrary consequences for not teaching a unit. Science teaching self-efficacy can be affected and the more administrators, teachers, and coaches that realize the effects self-efficacy has on teaching practices, the more room for positive changes in education. However, one limitation of this study is the sample size. The results are not generalizable but I have learned a great deal about factors that can alter a teacher’s science teaching self-efficacy. The results indicated a need for further research into the characteristics of inservice teachers whose science teaching self-efficacies are positively altered through inquiry professional development and mentors.

Limitations

This case study focused on one alternatively certified fourth grade teacher. One of the factors in working with her was because of her willingness to change her science teaching. Throughout the research, I encountered several cancelled observations because of testing schedules, field trips, and the need to teach the classes that were scheduled to come to the science lab during the times Daphne would make up science lessons disrupted by the aforementioned circumstances. Based on these limitations, I would recommend that more research occur with a larger group of inservice teachers spanning across several grade levels lasting for longer than sixteen weeks. I recommend that a study be conducted comparing the changes in PSTE of an alternatively certified elementary teacher to the changes in PSTE of a traditionally certified teacher. I would also recommend that the researcher be able to focus on observations without teaching students simultaneously.

Recommendations

After conducting the research for this case study, I recognize a need for more research in the area of changing inservice teachers science teaching self-efficacy. Much of the current research focused on pre service teachers. Administrators, science coaches, teachers, and parents should have an awareness of the importance of self-efficacy in the classroom. Much data focused on preservice teachers has been compiled over the last decade (Enochs & Riggs, 1990; Czerniak, 1990; Ginns & Tulip, 1995) Several researchers reported that the longer a teacher was teaching, the harder it was to change their self-efficacy (Appleton & Kindt, 2003;Ginns & Watters, 1999; Tschannen-Moran, Woolfold-Hoy,& Hoy, 1998). Perhaps the subject's realization of an area of need and willingness to change created the atmosphere for Daphne's changes to occur. The changes that occurred may be related to Daphne's prior experience with the Juvenile Justice System. Perhaps the roller coaster of emotions I observed throughout her lessons were related to her prior training. I encourage a broader study involving more teachers of various levels of experience to compile a list of observable characteristics that correlate to science teaching self-efficacy.

APPENDIX A: UNIVERSITY OF CENTRAL FLORIDA IRB APPROVAL

University of Central Florida

Office of Research & Commercialization

May 1, 2006

Michelle Thrift
3739 S. Ferncreek Avenue
Orlando, FL 32806

Dear Ms. Thrift:

With reference to your protocol #06-3486 entitled, **"The Effects of Inquiry Based Professional Development on an Elementary Teacher's Science Teaching Self-Efficacy,"** I am enclosing for your records the approved, expedited document of the UCFIRB Form you had submitted to our office. **This study was approved on 5/1/06. The expiration date will be 4/30/07.** Should there be a need to extend this study, a Continuing Review form must be submitted to the IRB Office for review by the Chairman or full IRB at least one month prior to the expiration date. This is the responsibility of the investigator. **Please notify the IRB office when you have completed this research study.**

Please be advised that this approval is given for one year. Should there be any addendums or administrative changes to the already approved protocol, they must also be submitted to the Board through use of the Addendum/Modification Request form. Changes should not be initiated until written IRB approval is received. Adverse events should be reported to the IRB as they occur.

Should you have any questions, please do not hesitate to call me at 407-823-2901.

Please accept our best wishes for the success of your endeavors.

Cordially,

Barbara Ward

Barbara Ward, CIM
UCF IRB Coordinator
(FWA00000351 Exp. 5/13/07, IRB00001138)

Copies: IRB File
Bobby Jeanpierre, Ph.D.

BW:jm

12201 Research Parkway • Suite 501 • Orlando, FL 32826-3246 • 407-823-3778 • Fax 407-823-3299

APPENDIX B:
PRINCIPAL CONSENT LETTER

Orange County Public Schools

Durrance Elementary

Aerospace and Aviation Magnet School

8101 Benrus Street

Orlando, Florida 32827

March 1, 2006

To Whom It May Concern:

Michelle Thrift has discussed her research questions and methods with me for completion of a thesis for the UCF/Lockheed Martin master's degree program. I am aware that she will be gathering data during the fall of the upcoming school year. I officially give my permission for Michelle to conduct research this fall.

If you have any questions, you may contact me at abbes@ocps.net.

Thank you,

Susan Abbe

Susan Abbe

Principal, Durrance Elementary

OC
PS

Phone: 407/858-3110

Fax: 407/858-2225

"The Orange County School Board is an equal opportunity agency."

APPENDIX C:
SUBJECT CONSENT LETTER

REVISED 4/29/2006

Dear Educator,

My name is Michelle Thrift and I am the Science Lab instructor at Durrance Elementary. This position also allows me the opportunity to provide inquiry based professional development opportunities to our teachers. I am currently engaged in my Master's Program at the University of Central Florida. My thesis is based on working with an elementary teacher to study self-efficacy in the area of teaching science. During this academic year, I am inviting the educator to participate in this study.

The teacher participant involved in this study will take a pre and post test evaluating self-efficacy in the area of teaching science. I will be teaching inquiry based science lessons to the participant prior to the participant teaching the lessons to his/her students. The participant will be expected to keep a journal for each science lesson that he/she is involved in for the duration of my data collection. The participant will also be interviewed by me about his/her reactions to the professional development and the teaching of lessons to his/her students. All of the information obtained through this process will be kept anonymous and confidential. The participant's name will not be used in any part of the data collected. A pseudonym will be used in order to protect the participant's identity. The data gathered will be used in the writing and defending of my thesis for my Master's degree at the University of Central Florida. Data will be collected during the regular school contracted hours at Durrance Elementary. The teacher that participates in this research will meet with me at least twice a week for a minimum of six weeks. There will be no penalties for choosing not to participate in the research and there will be no rewards for the teacher who does participate. The teacher may choose to stop participating in the study at any time.

In order to collect data from the teacher participant journal entries, professional development sessions, interviews, and pre and post test, I need your written permission to do so. This study will be conducted during the regular contracted hours at Durrance Elementary. If you agree to participate in this research study, please sign the attached consent form and return it to me as soon as possible.

Sincerely,

Michelle Thrift

Contact Information—UCF Faculty Advisor
Bobby Jeanpierre, Ph.D.
Assistant Professor, Teaching and Learning Principles
University of Central Florida
4000 Central Florida Blvd.
Orlando, FL 32816-1250
407-823-4930
E-mail: bjeanpie@mail.ucf.edu

APPROVED BY
University of Central Florida
Institutional Review Board
5/1/2006 SFD
CHAIRMAN

REVIS[illegible] 4/29/2006

Information regarding your rights as a research participant may be obtained from:

Barbara Ward, CIM
Institutional Review Board (IRB)
University of Central Florida (UCF)
12201 Research Parkway Suite 501
Orlando, Florida 32826-3246
Telephone: (407) 823-2901

I have read the procedure described above. I voluntarily agree to participate in the procedure, and I have received a copy of this description. I am at least 18 years of age and able to give my own consent to participate in this study.

I, ______________________________, have read and understand the letter for
(participant's name)
participation in "The Effects of Inquiry Based Professional Development on an Elementary Teacher's Science Teaching Self-Efficacy" research study.

_____ Yes, I agree to participate in the study.

_____ No, I will not participate in the study.

____________________________ ______________

Participant's Signature (agreement to participate) Date

APPROVED BY
University of Central Florida
Institutional Review Board
5/1/2006 SFD
CHAIRMAN

APPENDIX D:
SCIENCE TEACHING EFFICACY BELIEF INSTRUMENT

Science Teaching Efficacy Belief Instrument

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters to the right of each statement.

SA	=	STRONGLY AGREE
A	=	AGREE
UN	=	UNCERTAIN
D	=	DISAGREE
SD	=	STRONGLY DISAGREE

1. When a student does better than usual in science, it is often because the teacher exerted a little extra effort.	SA A UN D SD
2. I will continually find better ways to teach science.	SA A UN D SD
3. Even if I try very hard, I will not teach science as well as I will most subjects.	SA A UN D SD
4. When the science grades of students improve, it is often due to their teacher having found a more effective teaching approach.	SA A UN D SD
5. I know the steps necessary to teach science concepts effectively.	SA A UN D SD
6. I will not be very effective in monitoring science experiments.	SA A UN D SD
7. If students are underachieving in science, it is most likely due to ineffective teaching.	SA A UN D SD
8. I will generally teach science ineffectively.	SA A UN D SD
9. The inadequacy of a student's science background can be overcome by good teaching.	SA A UN D SD
10. The low science achievement of some students cannot generally be blamed on their teachers.	SA A UN D SD
11. When a low-achieving child progresses in science, it is usually due to extra attention given by the teacher.	SA A UN D SD
12. I understand science concepts well enough to be effective in teaching elementary science.	SA A UN D SD
13. Increased effort in science teaching produces little change in some students' science achievement.	SA A UN D SD

14. The teacher is generally responsible for the achievement of students in science. SA A UN D SD

15. Students' achievement in science is directly related to their teacher's effectiveness in science teaching. SA A UN D SD

16. If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher. SA A UN D SD

17. I will find it difficult to explain to students why science experiments work. SA A UN D SD

18. I will typically be able to answer students' science questions SA A UN D SD

19. I wonder if I will have the necessary skills to teach science. SA A UN D SD

20. Given a choice, I will not invite the principal to evaluate my science teaching. SA A UN D SD

21. When a student has difficulty understanding a science concept, I will usually be at a loss as to how to help the student understand it better. SA A UN D SD

22. When teaching science, I will usually welcome student questions. SA A UN D SD

23. I do not know what to do to turn students on to science. SA A UN D SD

APPENDIX E:
INTERVIEW QUESTIONS

Interview Questions

1. How do you feel about your ability to teach science effectively?

2. How does it make you feel when you teach a science lesson?

3. What do you think would improve your feelings about teaching science?

4. Has anything from this study affected your feelings, positively or negatively, about your ability to teach science?

5. What specific strategies, if any, did you implement with your students as a result of the professional development you participated in?

6. What did you learn, if anything, from planning lessons with the support of someone else?

APPENDIX F:
JOURNAL REQUIREMENTS

Journal Requirements

Write for at least 5 minutes after each professional development session, planning session, or science lesson that you teach.

1. How did the event make you feel in regards to science instruction?

2. How did the students respond to the science instruction? (in general, do not use names of students or specific stories)

3. What went well?

4. What did not go well?

5. What will you attempt to change for next time?

APPENDIX G:
INTERVIEW RESPONSES FOR RESEARCH QUESTION ONE

Questions	First Interview 8-25-06	Mid Interview 10-9-06	Final Interview 12-1-06
How do you feel about your ability to teach science effectively?	"I feel intimidated. Like I don't have enough knowledge and won't be able to relay to them what they need to know."	"I'm still not comfortable with it. Like yesterday when you were in here and they were talking about the rotation thing and all of them missed out on that part…that tells me I didn't do a good job"	"I mean, I'm still uncomfortable with certain aspects of it. The stuff that interests me will probably always be easier to teach. I don't feel like I could teach science effectively other than the parts I'm familiar with."
How does it make you feel when you teach a science lesson?	"Scared…hesitant…I always question myself. Is this really the right path as I'm asking the students the questions. Simple machines was different when I taught it because I found a website that I understood and then I knew that I could relate the concept to them…the food chain…ugh…there were so many choices…it was overwhelming."	"I was feeling pretty good about the water cycle but not we're on the solar system and I feel like I'm starting all over again. That I'm starting all over where we were with the lessons because I was reading so much during the water cycle because I could answer the questions they had if they asked me one and now I feel like I can't answer the questions."	"I still question as to whether or not I did the right thing (while teaching a lesson). The kids are so different this year. The kids this year will remember what I said a solution and mixture are so that makes me even more feel the need to be better at it."
What do you think would improve your feelings about teaching science?	"I'm a very concrete person. If you were very specific with me, then I'd know…like the water cycle, we did it in the lab (science) last year, I observed you teach it in the lab (science), I heard what other teachers tried out for that topic, so I think I might teach it better and enjoy it more this year."	"Four more years of experience…I picked four because it sounded like a good number. Last year I was here (points at the floor) and this year I'm at my ankles and if I add two inches each year, then I'll get there eventually. And some of the kids know so much more about the solar system than I do."	"Keeping an open mind…keep exploring…like this today exploring mixture and solution, the kids know that I don't know everything and that we all make mistakes. Over time, I think my feelings will improve as I become more aware, Sitting here talking with you about all of this has helped. Being receptive to their ideas and thoughts and their questions has helped too."

APPENDIX H:
INTERVIEW RESPONSES FOR RESEARCH QUESTION TWO

Questions	First Interview 8-25-06	Mid Interview 10-9-06	Final Interview 12-1-06
Has anything from this study affected your beliefs, positively or negatively, about your ability to teach science?	Not Applicable	"Positive…because, like I told you the other time., I can talk to you one on one and get my questions answered without feeling stupid or rushed because you take the time to really answer them until I really understand it. Negative…you still made me do that yarn experiment that I hated. The resources are also good…I think they're helpful, age appropriate, and fit into what I was doing. I wish that our schedule would have stayed on task here at school but all those changes (testing and workshops) messed up the roll we were on."	"I think they've (beliefs) have changed positively because I've overcome some of my fears (about science). I still don't like that chair lesson and still have a mental block with it. I feel like I did a better job with the water cycle and solar system this year. I feel like I've learned a lot this year too. The discussions back and forth between us and me being able to ask you questions before teaching the lesson. The lesson feedback was nice because it made me think that I wasn't doing as bad as I think I am in my own head."
What specific strategies, if any, did you implement with your students as a result of the professional development you participated in?	Not Applicable	"I've done more group work so far this year than I did the entire year last year. I made some of the resources into centers to integrate into my reading block. I was able to get away more from the journals (science lab) than last year and had the kids do presentations to help with my science grades."	"I did more with hands on stuff and I did do teaching (direct), but they were able to touch more. I did more groups and projects this time. Because the airport went so well, the one you made me put them in groups for, it made me want to try so many more group projects. I've learned not to force my opinions and visions on them so much and to let them (students) have a chance to think for themselves."

Questions	First Interview	Mid Interview	Final Interview
What did you learn, if anything, from planning lessons with the support of someone else?	Not Applicable	"Like the kids, when I had a sub, I assigned this story and when I came back, they were confused and they said they didn't understand it. I broke it down into pieces with them and most of them knew the information but didn't realize that they knew it. You did that with me. You broke it down for me and then I felt a little more confident in teaching it. I still have a mental block, I had one in high school and I still have some of it ."	"That it's OK not to know everything and there are other ways to present things. I feel like time has flown. I know that it was a positive experience because I haven't been wondering "when is it ever going to end?" You and I sitting down together, I enjoyed these times when we could sit down and discuss the lessons line by line and I could ask questions."

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