Pre-service elementary science teaching self-efficacy and teaching practices: A mixed-methods, dual-phase, embedded case study

Cheryl Ramirez Sangueza
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PRE-SERVICE ELEMENTARY SCIENCE TEACHING SELF-EFFICACY AND
TEACHING PRACTICES: A MIXED-METHODS, DUAL-PHASE,
EMBEDDED CASE STUDY

by

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ABSTRACT

Pre-Service Elementary Science Teaching Self-Efficacy and Teaching Practices: A Mixed-Methods, Dual-Phase, Embedded Case Study

by

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This mixed-method, dual-phase, embedded-case study employed the Social Cognitive Theory and the construct of self-efficacy to examine the contributors to science teaching self-efficacy and science teaching practices across different levels of efficacy in six pre-service elementary teachers during their science methods course and student teaching experiences. Data sources included the Science Teaching Efficacy Belief Instrument (STEBI-B) for pre-service teachers, questionnaires, journals, reflections, student teaching lesson observations, and lesson debriefing notes. Results from the STEBI-B show that all participants measured an increase in efficacy throughout the study. The ANOVA analysis of the STEBI-B revealed a statistically significant increase in level of efficacy during methods course, student teaching, and from the beginning of the study to the end. Of interest in this study was the examination of the participants’ science teaching practices across different levels of efficacy. Results of this analysis revealed how the pre-service elementary teachers in this study contextualized their experiences in learning to teach science and its influences on their science teaching practices. Key implications involves the value in exploring how pre-service teachers interpret their learning to teach
experiences and how their interpretations influence the development of their science teaching practices.
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DEDICATION

To mom and dad ~ Because of you, I can.
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CHAPTER 1

INTRODUCTION

“If the artist does not perfect a new vision in his process of doing, he acts mechanically and repeats some old model fixed like a blueprint in his mind” (Dewey, 1934, p. 50). Anderson’s (2006) “Traditional-Reform Pedagogy Continuum” (p. 822) describes the old model as the teacher being the dispenser of knowledge and the student being an absorber of information. In the old model, student work is exemplified by the regurgitation of memorized information. This old model is referred to as traditional teaching (Anderson, 2006). He describes the “new orientation” (p. 822) as the teacher as a facilitator of learning and the student as an interpreter and explainer of knowledge. In this new goal, student work demonstrates reasoning, problem-solving, and application of content. This new goal is referred to as reform teaching or inquiry teaching (Anderson, 2006).

As an instructor of elementary science methods courses and a supervisor of elementary student teachers, I found that my students were trapped in the cycle of repeating the old model of ineffective traditional science teaching and resistant to the goal of reformed inquiry science teaching. My instructor experiences in how to teach science in tandem with my reading on the Social Cognitive Theory (Bandura, 1986) and self-efficacy guided my thinking on how to meet the needs of pre-service elementary teachers learning how to teach science. Grounded the construct of self-efficacy, which is embedded in the Social Cognitive Theory (Bandura, 1986), this study sought to understand pre-service elementary science teachers’ needs for support and guidance by
investigating science experiences that shaped their self-efficacy and their development of effective science teaching practices during student teaching.

Current literature indicates that experiences in an elementary science methods class can increase self-efficacy (Bleicher, 2007) and that efficacy supports the development of teacher effectiveness (Gibson & Dembo, 1984). Findings also show that teacher efficacy has a powerful relationship to student achievement (Ashton, 1984). However, research also reveals that experiences in student teaching cause self-efficacy to decline (Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998) and ineffective science teaching strategies are utilized during student teaching (Plourde, 2002). Student teaching is the pivotal point between pre-service and in-service teaching and the decline in efficacy found during student teaching is detrimental for the development of effective teaching practices (Gibson & Dembo, 1984).

As articulated above, self-efficacy in an elementary science methods class and in student teaching has been studied as independent entities, but both relate directly to the quality of classroom teaching. On one end of the spectrum, research on self-efficacy and methods class experiences focus on identifying and categorizing experiences that increase self-efficacy (Bleicher, 2007), while on the other end, research on self-efficacy and student teaching experiences focus on the factors associated with and teaching practices that accompany the decline of science teaching self-efficacy (Plourde, 2002). Efforts to increase self-efficacy during science methods courses are moot if that efficacy is diminished during student teaching. What we do not know is what happens between the two ends of the spectrum. My study was designed to address that gap in our understanding.
To bridge this divide between efficacy gained in science methods class and what happens during student teaching, and to better understand what pre-service elementary student teachers need to teach reformed inquiry science, the research questions that framed my study were: 1] What science experiences influence science teaching self-efficacy in pre-service elementary teachers and 2] How are science teaching practices depicted across different levels of efficacy during student teaching?

In this chapter, I first identify the problem. The problem is addressed by discussing the issue, the population, and how both impact reform-based science teaching. Through the use of Social Cognitive Theory (Bandura, 1986) and self-efficacy (Bandura, 1986) the development of pre-service elementary teachers’ science teaching practices are explored.

Identifying the Problem

A clear connection exists between how pre-service and in-service elementary teachers with low levels of self-efficacy in science teaching tend to teach science and the impact of their practices on the development of science education reform (Davis, Petish, & Smithey, 2006). As explained next, the teaching practices of those with low levels of efficacy do not support reformed science education.

"Scientific literacy is the capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity" (PISA Assessment Framework, 2003, p. 133). Science education reform strives to ensure all students achieve scientific literacy. However, a gaping disparity exists between what science education reform requires from elementary teachers and how they teach science.
Science education reform is defined by the projects and standards designed to improve science education. Projects such as *Project 2061: Science For All Americans* from the American Association for the Advancement of Science (AAAS, 1990) outline grade level benchmarks to ensure progress toward science literacy, and their goal is to develop science literacy by targeting grade level scientific habits of mind such as keeping accurate records of data collected and using evidence to support claims. Standards, such as the National Research Council’s (NRC) (1996) National Science Education Standards spell out science learning and teaching expectations. These reform efforts emphasize that science teachers must be able to create learning environments where *all* students are guided toward scientific literacy (AAAS, 1990) in an authentic inquiry environment while paralleling in-class experiences with local and global realities (NRC, 1996).

Standards for science teachers (NRC, 1996) state that all science teachers must be able to plan inquiry based science programs and facilitate effective learning environments. Teachers must also be able to assist diverse groups of students to become reflective thinkers cognizant of scientific inquiry. Not only must all elementary educators instruct in a manner described by teaching standards, but they must also follow curriculum standards across the physical, earth, and life science disciplines. To meet this hefty demand, elementary teachers must grasp scientific concepts and processes, pedagogical knowledge, and current science issues (NRC, 1996).

The demand is especially challenging for pre-service elementary teachers because their dispositions hinder the development of their teaching practices toward what reform science teaching necessitates. An alarming percentage of elementary teachers feel unprepared and unqualified to teach science (Tilgner, 1990). Pre-service elementary
teachers’ lack of confidence, fear, and avoidance toward science prevent them from learning what is necessary to meet the needs of science reform (Appleton, 2006). Czerniak and Chiarelott (1990) add that, “[S]cience education suffers from teachers’ inadequate preparation and negative attitudes…” (p. 49). A common characteristic of pre-service elementary teachers is that they often report that their negative prior experiences with science have caused them to fear and avoid science (Davis, Petish, & Smithey, 2006). They are the victims of ineffective science practices and confidence-damaging experiences through an apprenticeship of observation (Lortie, 1975) and the effects of their experiences are difficult to overcome (Borko & Putnam, 1996). Research portrays pre-service elementary teachers as having a weak connection with science (Appleton, 2006; Loughran, 2006a), and their negative science experiences result in their limited science content knowledge and ability to teach science effectively (Appleton, 2006; Tilgner, 1990).

Connection Between Issue, Population, and Reform-Based Science Teaching

Pre-service elementary teachers are depicted as fearful and anxious about learning and teaching science (Tilgner, 1990), thus they lack the confidence necessary to even try (Loughran, 2006a). Borko and Putnam (1996) state that in learning to teach, a learner “interprets events on the basis of existing knowledge, beliefs, and dispositions” (p. 674) and suggest “how and what individuals learn is always shaped and filtered by their existing knowledge and beliefs” (p. 674). They also warn that the filtering process that shapes how and what teachers learn impedes efforts to change. A teacher’s fear and tendency to avoid science (Loughran, 2006a) clearly hinders the advancement of science reform and stymies student achievement (Tschannen-Moran, Woolfolk Hoy & Hoy,
Fear, anxiety, and a lack of confidence clog the filter that pre-service elementary teachers use when learning how to teach science.

Feiman-Nemser and Remillard (1996) indicate that, “while current beliefs and conceptions can serve as barriers to change, they also provide frameworks for interpreting and assessing new and potentially conflicting information” (p. 80). In other words, pre-service elementary teachers’ beliefs about their capacity to learn and teach science influence their ability to assess new information. Thus, given their histories, pre-service elementary teachers tend to enter education programs with a predisposition not conducive to the demands of reform science education (Appleton, 2006; Davis, Petish, & Smithey, 2006). Their view (negative or otherwise) about their ability to teach science is their lens for learning new information.

Pre-service elementary teachers need to learn how to design and execute science teaching practices that create content rich environments ripe with inquiry learning experiences to enhance their students’ scientific literacy. To do this, pre-service elementary teachers’ filters must first be cleared so their beliefs about their ability to learn and teach science can change. Therefore, changing pre-service elementary teachers’ deeply anchored feelings about their inability to teach science is the prerequisite to educating them on how to teach science. Learning about the role efficacy plays in influencing pre-service elementary teachers’ confidence and improving their ability to teach science effectively (Pajares & Schunk, 2001) was the impetus behind this study.
Social Cognitive Theory and Self-Efficacy as the Framework

Since these issues of efficacy are integral to pre-service elementary teachers’ development of science teaching practices, then it is imperative to explore the connections between what reinforces and undermines their efficacy and the development of their science teaching practices. The Social Cognitive Theory (Bandura, 1986) that frames learning informs how I view this interaction.

Social Cognitive Theory

Bandura’s (1986) Social Cognitive Theory (SCT) evolved from his Social Learning Theory (SLT) (1977). SLT (1977) developed from behaviorism and was the bridge between behaviorism and cognitive learning (Bandura, 1977). Behaviorist theorists such as Ivan Pavlov, John Watson, and B.F Skinner focused on observable behaviors and posited that the linear, unilateral stimulus-response relationship predicted the chance that learning would happen (Phillips & Stolis, 2004). By focusing only on the observable behaviors in their stimulus-response position, they discounted the role of the mind in learning (Phillips & Stolis, 2004). Bandura (1977) bridged the behaviorists’ theories of observable behavior in learning with his cognitive theories by suggesting that observation and modeling facilitated learning. His direction continued to broaden the notion of behavior and learning by introducing the concept of the cognitive processes that regulate behavior and learning. To best describe the direction of his focus on the cognitive aspect of behavior, Bandura (1986) developed and defined his SCT.

In Bandura’s Social Cognitive Theory (1986), cognitive processes mediate the relationships between the triad of personal factors, environment, and behavior and are the mechanisms that motivate behavior and learning. He coined this triad “Reciprocal
Determinism” (Bandura, 1986, p. 22) because of the reciprocal influential factors of each element of the triad on one another. Within his SCT triad, the personal factors that influence behavior toward learning include characteristics such as expectations, beliefs, goals, and self-efficacy. Applying Bandura’s SCT (1986) to learning to teach science, the notion of self-efficacy suggests that if pre-service elementary teachers start believing that they can learn and teach science, they will exhibit practices that foster their beliefs.

Self-Efficacy

In the context of my study, science teaching self-efficacy and confidence to teach science are used interchangeably. Self-efficacy is a person’s belief in his or her ability to accomplish a task (Bandura, 1977) successfully and is said to be an influential element for change in behavior because it promotes effort and perseverance (Hoy & Spero, 2005; Pajares, 1996; Schunk, 1989). As confidence about ability to accomplish a task is increased so are subsequent actions, and the cycle continues shaping beliefs about ability (Schunk, 1991; Tschannen-Moran, Hoy & Hoy, 1998). As people develop their confidence about their capacity to achieve, their actions pave the way to their success. For example, as one builds confidence in the capability to accomplish a task, their motivation, effort, and actions work toward the achievement of that task (Tschannen-Moran, Woolfolk Hoy & Hoy, 1998). Influencing efficacy itself does not promise competency in a task, but it does shape the motivation and skills necessary to becoming competent (Bandura, 1986; Schunk, 2000).

The construct of self-efficacy has been modified to address specific fields in education such as teaching self-efficacy (Gibson & Dembo, 1984; Tschannen-Moran, Woolfolk Hoy & Hoy, 1998) and pre-service elementary science teaching self-efficacy (Riggs &
Enochs, 1990), but all are grounded in the same theoretical construct proposed by Bandura (1977). The difference is that each branch of self-efficacy study in education uses language specific to their field in their efficacy measures. In regard to my study, increasing science teaching self-efficacy can potentially calm the fears that impede pre-service elementary teachers’ progress as science learners and teachers and create the mindset needed for their development toward reform minded science teaching.

*Four Sources of Self-Efficacy*

An elementary science methods class is an influential point of intervention because not only can experiences in a methods class change the impact of negative prior science experiences (Bleicher, 2007), but also it is where experiences known to increase efficacy have been effectively implemented (Howitt, 2007). A science methods class is an environment suitable for increasing science-teaching efficacy because course objectives can be framed by Bandura’s (1986) four sources of efficacy. Intervention during this time is fitting since pre-service elementary teachers’ introduction to teaching science occurs in an elementary science methods class and Bandura’s (1986) self-efficacy construct suggests that efficacy is most impressionable at an early stage of learning. Bandura’s (1986) four sources of efficacy are discussed in this particular view because it highlights how I have operationalized the construct for the purposes of my study.

*Mastery experiences.* Bandura’s (1986) first source of efficacy is mastery experience, which is the actual doing of the task. In thinking about the mastery experience in the context of a science methods class, it offers pre-service elementary teachers the opportunity to practice teaching science. These experiences range from giving students the opportunity to teach a lesson to their class (Sherman & MacDonald, 2007) and hands-
on science content experiences (Bleicher, 2007) to site-based methods classes where students are able to engage in authentic teaching experiences (Wingfield & Ramsey, 1999). Bandura (1997) states that, “the development of efficacy beliefs through mastery experience creates the cognition and self-regulative facility for effective performances” (p. 80). This means that that the mindset needed for pre-service teachers’ success is created as they increase their belief that they can learn and teach science.

**Vicarious experience.** Vicarious experience is another source of increasing self-efficacy and comprises what one learns by observing others (Bandura, 1986). Vicarious experiences in methods class range from witnessing demonstrations to observing peers and experienced practitioners teach (Bleicher & Lindgren, 2005; Sherman & MacDonald, 2007; Wingfield & Ramsey, 1999). The concept of vicarious experience is informed by Vygotsky’s (1978) theory of assisted performance that addresses how learning happens through social interaction. Vygotsky’s (1978) zone of proximal development (ZPD) is evident in the concept of Bandura’s (1986) vicarious experience because these serve as a reference point or as a model of what can be done. Vicarious experiences and ZPD allow for reflection on a situation in relationship to self and gives the learner the chance to mediate what they can do based on what they are observing.

For pre-service elementary teachers, watching experienced practitioners or peers serves as a source of increasing their efficacy by having the opportunity to see how they measure up to observed teaching practices. If an individual has minimal self-efficacy or poor prior experience regarding the completion of a task, watching another perform the task may have more influence on efficacy than doing the task for the first time (Bandura, 1986). For pre-service teachers who are anxious about teaching science, watching others
may serve as an effective tool to increasing efficacy. Lastly, vicarious experiences do not only benefit those who lack efficacy or experience. Bandura (1997) states that if models can demonstrate improved ways of doing a task, one knowledgeable and confident in that task will still benefit. Therefore, vicarious experiences in a methods class offer the opportunity for students of all efficacy levels to learn by providing reference points and models from a range of confidence and ability.

*Verbal persuasion.* The third source of self-efficacy is verbal persuasion (Bandura, 1986). Verbal persuasion is the feedback and verbal motivation one receives and it offers a platform to discuss completed or observed science teaching practices (Brand & Wilkins, 2007). A methods class provides the stage for verbal persuasion from both instructor and peers by engaging in discussions about science learning and teaching experiences. Verbal persuasion can give an individual enough confidence to attempt a task, but can have counterproductive outcomes when verbal persuasion crosses into unrealistic expectations (Bandura, 1986). For example, if pre-service teachers accept they can teach a science lesson and an opinion from someone they value verbally confirms their perception, then their efficacy may increase. However, if verbal motivation statements exceed what they think they can do, the pressure they feel to meet expectations may have an adverse affect on their efficacy (Bandura, 1986).

*Physiological and affective states.* Affective states encompass the feelings that are behind experiences (Bandura, 1986). Recognizing the value of affective states offers students the opportunity to be in a learning environment with supportive teacher feedback and non-threatening teaching demeanor (Howitt, 2007). The physiological and affective state of mind are physical and emotional responses to any of the three sources of
experience previously mentioned, suggesting that any combination of the three aforementioned sources of efficacy has the potential of reducing stressful physiological and affective states (Howitt, 2007).

The influences of the four sources of efficacy are not equal and do not operate independently of each other (Bandura, 1997). In other words, each source and the different combinations of sources interacting have different effects on different individuals based on context and circumstance. Although effects vary, the accepted generalization is that the four sources play a part in increasing self-efficacy (Bleicher, 2007; Howitt 2007). Bandura’s (1986) self-efficacy construct suggests these opportunities influence confidence, but little is known about how these experiences that influence efficacy in methods course apply to the development of science teaching practices during student teaching. We also do not know the extent to how contributors to efficacy are shaped and apply to different contexts and experiences.

As will be further discussed in Chapter 2, what we do know is that efficacy is challenged during student teaching and their teaching practices fail to develop (Tschannen-Moran, Woolfolk Hoy & Hoy, 1998). To better understand how to combat ineffective science teaching practices, this study explored science experiences that increased efficacy and continued to cultivate effective teaching practices during student teaching. Bandura’s SCT (1986) was the lens for the design and analysis of my study because it provided the framework for viewing the participant’s contributors to self-efficacy and its impact on their science teaching practices during student teaching. Self-efficacy was the construct that guided this study because it provided a key factor for the
needed change in pre-service elementary teachers’ beliefs and practices toward learning and teaching science.

The Effects of Self-Efficacy

Contrary to findings about pre-service elementary teachers with low levels of science teaching self-efficacy, elementary science teachers with high efficacy create positive learning environments (Ashton & Webb, 1986) in which “academic rigor and intellectual challenge are accompanied by the emotional support and encouragement necessary to meet that challenge and achieve academic excellence” (Pajares & Schunk, 2001, p. 13). Teachers with high efficacy have beliefs about science that parallel science reform and they are more inclined to learn and use teaching strategies that science reform necessitates (Czneriak & Shriver, 1994; Guskey, 1988). They have a sense of responsibility to the success of their students (Ashton, 1984) and have a higher commitment to teaching (Coladarci, 1992). Teachers with high efficacy also have a positive influence on student achievement (Brophy, 1979; Dembo & Gibson, 1985; Pajares, 1996; Schunk, 1989; Tschannen-Moran, Woolfolk Hoy & Hoy, 1998).

These personal characteristics contribute to self-regulatory behaviors, which operate by providing individuals with the opportunity to influence their own cognitive process (Zimmerman, 2000). The concept of self-regulation asserts that highly self-regulated persons use their cognitive processes to choose, use, and refine strategies in their endeavors (Zimmerman, 2000) and Bandura (1977) conceptualizes the construct of self-efficacy as a mechanism of self-regulatory behavior and behavioral change. Exploring the contributors and responses to self-efficacy in pre-service elementary teachers teaching science is foundational to the development of the teaching practice that science education
reform requires because self-efficacy is the beginning point that shapes the cognitive processes necessary to refine strategies.

Seeing the tremendous difference between teachers with low and high levels of efficacy and knowing that high efficacy teachers have a positive influence on student achievement were the arguments for exploring experiences that increase efficacy and continue to support the development of effective teaching strategies through student teaching in my study. It is also the argument for the need to address efficacy to change behaviors so pre-service elementary teachers can shift from perpetuating ineffective science teaching techniques to supporting the progress of reform science education.

Pre- and in-service elementary teachers who have low self-efficacy in teaching science behave in a manner counterproductive to both effective science teaching and the advancement of science education reform. Exploring the science experiences that positively influence pre-service elementary teachers’ efficacy through student teaching is valuable because efficacy beliefs influence a teacher’s perseverance in challenging situations (Gibson & Dembo, 1984) and is imperative because the decline in efficacy during student teaching prevents the teacher development needed for quality science teaching (Plourde, 2002).

Based on what has been discussed, we know pre-service elementary teachers with poor histories in learning science enter their science methods class with low self-efficacy. We know that methods class experiences tend to increase efficacy because they enter their science methods class with a low level of science teaching self-efficacy and a minimal knowledge of teaching science. We know that increased efficacy influences the development of teaching practices, and we also know factors that cause efficacy to
decrease during student teaching. What we do not know is which science experiences continue to increase efficacy and shape effective teaching practices during student teaching. In learning about what contributes to levels of efficacy and how those levels evolve we will be better equipped to help K-12 students achieve scientific literacy.

“One’s beliefs, intentions, knowledge frames, and skills interact continuously in classroom teaching” (Clift & Brady, 2005, p. 311). As I began this chapter, this interaction can take the form of learning reformed science teaching or repeating traditional science practices. Exploring science experiences that increase self-efficacy levels and continue to support pre-service elementary teachers during student teaching is inherently valuable because confidence affords them the mental mindset needed to develop reformed science teaching practices (Zimmerman, 2000). An invaluable effect of increased efficacy in elementary teachers who teach science is that ultimately their motivation, commitment, and ownership of responsibilities as learners and teachers of science become the model for their students (Brophy, 1979; Gibson & Dembo, 1984; Schunk, 1989). How research has explored pre-service elementary teachers science teaching self-efficacy is discussed in the next chapter.
CHAPTER 2

REVIEW OF THE LITERATURE

The construct of self-efficacy suggests that experiences may shape pre-service teachers’ beliefs about their ability to teach science. Because of the impact positive self-efficacy has on teacher effectiveness, understanding the influences on and the effects of efficacy are essential. The purposes of this literature review were to explore the research on pre-service experiences that shape science self-efficacy and to review the research on the effects and limitations of pre-service science teaching self-efficacy. Exploring experiences that influence science-teaching self-efficacy during the pre-service period is important because it clarifies the perspective of the issue and identifies areas that need further research. To address the said purpose and importance of this literature review, 36 articles were reviewed.

Literature Review Methodology

In my search for seminal articles in pre-service elementary teachers science teaching self-efficacy, I noticed a trend in science education studies. Preceding the onset of elementary science teaching self-efficacy studies, the National Science Teaching Standards were heavily reviewed. Studies ranged from connecting the curriculum to National Standards to what the National Standards indicated regarding reform in science teacher education. The degree to which teacher educators were adequately preparing our teachers as per the standards segued to research on teacher understanding and perception of learning and teaching science, science teacher beliefs, and efficacy.
Interestingly noted was the move toward studying the affective domain of the teacher. This trend indicated the significance in valuing the teacher as the change agent in improving education and that external elements such as technology, standards, and strategies were a distant second to understanding effective teaching. The pendulum has swung from focusing on independent teaching strategies (i.e., a checklist of things to do in a classroom) to focusing on teachers’ being (i.e., understanding the teacher as person with history that shapes them as learners and teachers). The selection of the articles used in this literature review is addressed next.

Criteria for Inclusion and Exclusion of Articles

The criteria for this literature review were defined by my focus on understanding science methods class experiences that influence science teaching self-efficacy in pre-service elementary teachers and the effects of science teaching self-efficacy during student teaching. A preliminary search was conducted for articles in self-efficacy and a myriad of articles surfaced. Studies found ranged from self-efficacy in different subjects to different education levels. Thus, the search was refined using the keywords self-efficacy, elementary, and science. Because self-efficacy is believed to be content and context specific (Bandura, 1986) and because pre-service elementary teachers are fearful about teaching science (Tilgner, 1990), studies that focus on subjects other than science, a grade level other than elementary, or a time other than pre-service or novice teachers were beyond the scope of this review. Studies not cited in this literature review also included ones that mentioned self-efficacy simply as one of the outcomes but do not use self-efficacy as its primary lens or guide when evaluating a program or teaching strategy. For example, in Weinburg’s (2007) article, “The Effect of Tenebrio Obscurus on
results relate primarily to content knowledge but overt variables influencing self-efficacy are not addressed. Given that the purpose of the literature review was to find patterns in the research on self-efficacy, articles without detailed discussion about the influences of self-efficacy do not contribute to the focus of the review.

Research that overtly addresses factors that influence self-efficacy in pre-service or novice elementary teachers teaching science are introduced and synthesized in this chapter. This review represented the diverse field of self-efficacy as it evaluated self-efficacy from different angles including evaluating for influences of self-efficacy through participant history and characteristics, different methods course strategies, and student teaching experiences.

Search Criteria

Given the said criteria, I conducted a search for empirical studies within the last decade in the Educational Full Text and ERIC databases using different combinations of the aforementioned keywords, self-efficacy, elementary, science, and teacher. Based on titles and abstracts, articles that clearly did not address the focus of this review as previously discussed were eliminated. From this search, a total of 13 articles were accepted from the Educational Full Text and 14 articles from ERIC.

Lastly, a Google Scholar Search was completed using all the keywords mentioned and the results did not offer any articles different than those already accepted or eliminated. At this point, the reappearance of familiar articles validated each study as a contributor in the field of self-efficacy related to elementary science teaching. Also, articles that were consistently cited were evaluated and nine were added for use in this literature review. As
one of the final searches, Educational Full Text and ERIC were searched again using the keywords beliefs and attitudes. What resulted from this additional search was the confirmation that the articles already accepted were the ones that sufficiently address the focus of this literature review and no new articles were added. Therefore, this chapter offers a comprehensive review of the research on the factors affecting self-efficacy in pre-service and novice elementary teachers teaching science by summarizing and critiquing 36 current empirical studies.

In the first section of the literature review, a discussion of the construct from which self-efficacy is viewed contextualizes the studies in this review and a description of the background and findings of each article reviewed follows. The second section addresses the implications of the patterns and critiques found in the research for teacher educators. The last section addresses the influence of self-efficacy for teacher effectiveness and how the research applies to my study.

Literature Review

The studies cited in this literature review are grounded in the work of Bandura’s (1977) Social Cognitive Theory and the construct self-efficacy. Bandura (1977) conceptualizes efficacy as a mechanism for behavioral change and the studies discussed show how Bandura’s (1986) four sources of efficacy serve as a guide for research in pre-service elementary teachers’ development as science teachers. To measure efficacy, majority of the studies reviewed used an instrument that Enochs and Riggs (1990) developed. The validated quantitative measure for levels of science teaching self-efficacy is the Science Teaching Efficacy Beliefs Instrument (STEBI) that Riggs and Enochs
(1990) developed and the STEBI-B (Enochs & Riggs, 1990) is a modified version used for pre-service teachers teaching science. The STEBI surveys are each 23-item surveys with a five-point rating scale that ranges from strongly agree to strongly disagree. Together, Bandura’s (1986) SCT provides a lens from which to view teachers’ perception of their efficacy while Enochs and Riggs’ (1990) instrument tests for levels of and gains in self-efficacy.

Outline of Review

Articles that addressed pre-service elementary teachers’ previous experiences that shaped their relationship with science are introduced first. Second, science teacher preparation experiences and their influences on efficacy are addressed. Third, the impacts of pre-service teaching experiences on self-efficacy are discussed followed by the influences of in-service experiences on self-efficacy. The fifth section addresses the impact of self-efficacy. The patterns and critiques in the research and implications for teacher education end this literature review. Concluding this chapter is a discussion of the value in enhancing self-efficacy in pre-service elementary teachers teaching science as it applies to my study.

Elementary Teachers’ Previous Experiences

One angle that addresses the influence of self-efficacy in pre-service elementary teachers teaching science is their previous experiences in science. Jarrett (1999) believed that teachers avoid teaching science because of their own lack of positive science experiences. The purpose of Jarrett’s (1999) study was to see if a correlation exists between science experiences and interest in science and their confidence to teach science. To examine this, Jarrett (1999) evaluated data collected over three years from 112
graduate students who were enrolled in a field-based science methods course at a southern university. The science methods course in the study was designed for students who have their bachelor’s degree in fields other than education, meaning it was more pedagogically oriented to help make up for the students’ lack of education courses. Jarrett (1999) evaluated pre and post quarter surveys where students rated their interest and confidence in science and answered open-ended questions about their memories about past science classes. Open-ended questions were coded and analyzed via SPSS and percentages were used as descriptors for background experiences (Jarrett, 1999). She found that for elementary school experiences, over 60% of the participants recalled negative experiences and that elementary school science experiences were the greatest predictors of both initial interest in science and initial confidence in teaching science. Jarrett (1999) concluded that experiences in elementary school science have long lasting effects, interest and confidence are related, and “an increase in competence accompanies an increase in confidence” (p. 56).

Moore and Watson (1999) studied 69 East Carolina University undergraduate elementary education majors to identify differences in characteristics between those who were interested in science and those who were not. Given that students in this program were required to declare a subject area of concentration, Moore and Watson (1999) compared characteristics of those who declared a concentration in science and those who elected for different subjects. Of the 69 participants, 38% declared science as a subject area of concentration (Moore & Watson, 1999). The researchers administered Haury’s (1984) Locus of Control in Science scale (LOCIS) and a questionnaire they developed that asked about past science experiences to evaluate possible factors influencing
participants’ decision to pursue a science concentration. The LOCIS scale is an 18-item instrument using a five-point Likert scale measuring for reactions concerning a situation involving an area of science to see if participants have an internal or external locus of control. Moore and Watson (1999) found no significant difference between the two groups of participants when they evaluated the LOCIS and its correlation to those opting for a path in science and those not. However, they did find valuable information from their questionnaire. Results from their questionnaire indicated that the group who selected science as a concentration had a more positive recollection of school science experiences and commented more often about positive and supportive teacher demeanor (Moore & Watson, 1999). They also found that 40% of the science group, as opposed to less than 10% of the non-science group, felt encouraged to pursue science classes by parents and teachers. Also 77% of the science group, as opposed to 2% of the non-science group, reported that their feelings toward science were positively influenced by college science experiences. Overall factors that influenced feelings toward science were teacher characteristics and methods, and student characteristics. Similar to the findings in Jarrett’s (1999) study, Moore & Watson (1999) emphasized that, “teachers at all levels should be made aware of the strength and longevity of the effects of their own actions on students’ comfort with science” (p. 47). This statement further exemplified the need to find what experiences increase teacher effectiveness since a teacher’s impact has both strength and durability in students’ future with science.

In line with the two previously described studies, Tosun (2000b) examined the influence of prior science course experience and achievement on the science teaching self-efficacy of 36 fourth-year undergraduate pre-service elementary teachers enrolled in
an integrated math, science, and social studies elementary methods class. Tosun (2000b) analyzed pre and post STEBI-B (Enochs & Riggs, 1990) surveys using SPSS and compared those results to self-reported achievement and experience responses from a two-page science questionnaire to evaluate for possible influence. Responses to the questionnaire were divided according to high and low self-reported science achievement, experience, and history (Tosun, 2000b). The researcher found significant differences between the self-efficacy scores of the pre and post test of both high and low groups, but no significant difference between the low and high groups themselves, meaning that regardless of what group participants started in, the methods course increased efficacy for everyone. Evaluating the number of college science classes participants reported taking, Tosun (2000b) found that 66% of the participants took biology in college, 29% took physical science, 17% took college earth science and only 14% had college level chemistry, suggesting since students had minimal exposure to college science experiences, methods classes were bound to increase efficacy. Tosun (2000b) stated, “this should not be taken as to totally dismiss the role of science content knowledge, but to point to the notion that teacher education programs must be sure to address teacher self-efficacy beliefs” (p. 29).

Using the participants’ data from the previous study, Tosun (2000a) looked for relationships between prior science experiences, achievement, and beliefs toward science teaching. For this study, Tosun (2000a) excluded data from two male participants to avoid effects of higher efficacy and added participant interviews to the data sources. Tosun (2000a) explained that of the students who completed the questionnaire mentioned earlier, 15 were willing to participate in an interview. From the sample of 15 who were
willing to be interviewed, three participants from the high and three participants from the low groups were randomly selected and “transcripts were coded and analyzed for patterns and themes” (Tosun, 2000a, p. 375). In addition to reiterating his previous findings, Tosun (2000a) found that regardless of location in the high or low achieving group, participant descriptors of science experiences were predominantly negative. This finding suggests that negative feelings have more of an impact on self-efficacy than achievement in science (Tosun, 2000a).

Bleicher (2004) reexamined “the internal validity and reliability” (p. 383) of the STEBI-B (Enochs & Riggs, 1990) instrument and explored possible relationships between participant characteristics such as gender, age, and science experiences and self-efficacy. Bleicher (2004) administered the STEBI-B to 290 students enrolled in different sections of an elementary science methods course at a university in Florida and analyzed completed surveys by factor analysis through SPSS. In reexamining the STEBI-B for validity, Bleicher (2004) found that “the basic integrity of the PSTE and STOE scales was upheld… with the exception of two items on the STOE” (p. 388). Bleicher (2004) found that the two items on the questionnaire in question were the only two items that used the word “some” to describe the word “student” as shown below:

Item 10: The low science achievement of some students cannot generally be blamed on their teachers.

Item 13: Increased effort in science teaching produces little changes in some students’ science achievement (p. 387).

After interviewing students, Bleicher (2004) found that the qualifier “some” influenced students to respond differently than when responded to the questions without the
qualifier. For example, regarding item 10, a student commented that they would have opted for agree as a response if the questioned had implied all low achieving students instead of just some (Bleicher, 2004). Bleicher (2004) removed the word “some” from both questions, administered a revised form of the STEBI-B to an additional 86 participants similar in demographics and found that, “this revision appears to clarify the intention of the items and increases the reliability of the instrument” (p. 388). Regarding student demographics, Bleicher’s (2004) findings support Jarrett’s (1999) and Moore and Watson’s (1999) findings suggesting that positive science experiences and more science courses indicated higher self-efficacy scores. In line with what Tosun (2000a) suggests, Bleicher (2004) also found that males tend to have higher self-efficacy scores.

Summary of previous science experiences. Research has shown patterns that shape pre-service elementary teachers’ relationship with science. Common patterns found in the research are: that negative science experiences are a major reason why teachers feel ill equipped to teach science, that prior science school experiences are the biggest predictors of both interest and confidence to teach science, and that the impact of prior science experiences have long lasting effects (Bleicher, 2004; Jarrett, 1999; Moore & Watson, 1999). Two additional important points are that regardless of baseline efficacy scores, the descriptors of prior science experiences are generally negative (Tosun, 2000a), and that elementary science methods courses offer a fitting venue to increase self-efficacy (Bleicher, 2004). What is seen in the studies about the impact of prior experiences is the value of considering self-efficacy beliefs when working with pre-service teachers teaching science. When discussing the limitation of the research in field of science teaching self-efficacy, Bleicher (2004) commented on the need for longitudinal studies.
In the next section, articles that examine pre-service experiences that influence efficacy are discussed.

Science Teacher Preparation Experiences That Influence Efficacy

In addition to prior science experiences that shaped pre-service teachers’ beliefs about teaching science, studies also evaluated the effects of experiences in teacher preparation programs on self-efficacy. One aspect of teacher preparation programs that influenced teachers’ self-efficacy was mandatory content courses.

Science content courses impact on efficacy. Weld and Funk (2005) explored changes in attitudes, intentions, and perceptions of self as a biology teacher in a biology class designed for freshmen elementary education majors. To evaluate for changes, Weld and Funk (2005) collected pre and post attitude and intention surveys from 61 freshmen pre-service elementary education majors at a mid-sized Midwestern university. From the 61 completed surveys, a random sample of six participated in telephone interviews. The interviews were guided by the following four categories of interest that were intrinsic to the survey:


Informal observations of the six participants were also completed and all quantitative and qualitative data were triangulated to evaluate for changes in the four aforementioned areas. Weld and Funk (2005) found that participants showed significant growth and gains
in all four areas, implying that participants increased confidence in teaching biology, competence in comprehending and applying curriculum, growth in pedagogical skills, and increased in perception of effectiveness as a biology teacher. Weld and Funk (2005) stated, “by teaching about life science through inquiry… they adopted characteristics of life-long learners who recognize that there is more to learn and were curious to know more” (p. 201). Given that previous studies in this review suggested that prior science experiences influenced teacher beliefs about teaching science (Bleicher, 2004; Jarrett, 1999; Moore & Watson, 1999), it is of great value to consider changing mandatory content courses from a traditional style of teaching to a manner which models inquiry teaching methods.

Stalheim-Smith and Scharmann (1996) looked at 28 elementary education students enrolled in an enriched math and science curriculum at Kansas State University and reported the results of an introductory biology class designed around the needs and interest orientations of elementary education majors. They evaluated STEBI-B (Enochs & Riggs, 1990) scores, previous grades, and class tests using SPSS and statistical measures for grade distributions. Stalheim-Smith and Scharmann (1996) found that the 28 participants evaluated outperformed all the traditionally taught biology classes. They asserted that science content courses do not need to be simplified for elementary education students and related their success to the opportunity to apply the science they were learning in a safe learning environment. Stalheim-Smith and Scharmann (1996) stated,

Perhaps by aiding the students’ chances of success in rigorous science courses, science instruction in higher education may be able to perform a more worthwhile
service for both a traditionally science-anxious groups of learners, and potentially even more importantly, for the future students this traditionally anxious group will teach in the elementary school classroom. (p. 177)

What they advocated was maintaining the rigor of science content courses but teaching it with the needs of pre-service elementary teachers in mind. Stalheim-Smith and Scharmann (1996) suggested if content courses create the safe learning environments and make the learning of the content practical, perhaps pre-service teachers will have a more positive and productive learning experience.

The articles in the next section address influences of methods classes on self-efficacy. Methods classes “have been found to be a vehicle for change in pre-service elementary teachers’ attitude, confidence, and efficacy” (Howitt, 2007, p. 43), thus research on self-efficacy in methods classes make up the bulk of this literature review. The following studies represent the various influences and effects of elementary science methods experiences on pre-service teachers’ science self-efficacy.

**Elementary science methods courses on self-efficacy.** Palmer (2002) investigated factors in a science methods class responsible for inciting change in attitudes in four pre-service elementary teachers who had completed their undergraduate degree in an area other than education. At the end of a semester, a science methods class of 30 was asked if anyone felt their attitude had changed from negative to positive. From the responses to that question, the researchers found four females who volunteered to participate in 30-minute individual interviews. In transcribing and coding interview transcripts, Palmer (2002) found that not one single overt factor had changed their attitudes, but a combination of factors. Palmer (2002) categorized factors that influenced attitudinal
changes under the following three broad headings: “personal attributes of tutor (instructor), specific teaching strategies, and external validation” (p. 133). The findings clearly indicated that both the instructors’ demeanor and teaching strategies had a significant impact on changing attitudes. These findings suggested that teacher educators should embody the traits and model the teaching strategies that pre-service teachers are expected to learn.

Rice and Roychoudhury (2003) completed a self-study to assess how a methods teacher served as an influence on her students’ confidence. The data sources for this self-study include video taped classes, teacher notes, student comments about their readiness to teach, course evaluations, and interviews. Rice and Roychoudhury (2003) analyzed data by watching over 40 hours of video together, reading through interview transcripts, and coding behaviors and responses. Similar to Palmer (2002), they found that students asserted the importance of seeing strategies modeled by teachers as a factor influencing their confidence. Rice and Roychoudhury (2003) also found that the teacher influenced her students’ confidence by having enthusiasm in science while modeling effective teaching strategies in a safe learning environment. However, the researchers found that no matter what, students experienced obstacles in gaining confidence. For example, Rice and Roychoudhury (2003) found that students commented on university and program constraints such as class size, pressure for certification, and weakness in content as barriers to increasing confidence. Students also pointed out how teachers modeling ineffective teaching behaviors or teaching in an authoritative manner can impede confidence (Rice & Roychoudhury, 2003).
Both Palmer’s (2002) and Rice and Roychoudhury’s (2003) studies are important because they illustrated how teacher demeanor and teaching strategies can positively or negatively impact pre-service elementary teachers’ attitude and confidence. Also, what is notable at this time is that researchers speak of the importance of improving attitude, confidence, and self-efficacy almost interchangeably, but with the implication that all enhance teacher effectiveness.

Palmer (2006b) explored the significance of the sources of efficacy in enhancing science teaching self-efficacy by evaluating for experiences influencing efficacy in participants who were enrolled in a science methods course. Participants in this study were in their final undergraduate year at an Australian university. He administered pre and post STEBI-B (Enochs & Riggs, 1990) surveys and three informal surveys, one each given during their fifth week of instruction, the eighth week, and at the end of the semester. The informal surveys were designed to inquire about particular sources of efficacy within the course. In evaluating the 108 pre and post STEBI-B surveys, Palmer (2006b) found significant increases in self-efficacy scores, and responses from the three informal surveys supported that finding.

Also, by analyzing and coding responses from the three informal surveys, Palmer (2006b) claimed to have found new sources of efficacy. He categorized his newfound sources of efficacy as: cognitive content mastery (understanding content), cognitive pedagogical mastery (understanding how to teach science) and cognitive self-modeling (imagining self teaching), and found that majority of the participants commented about cognitive pedagogical mastery as a source of efficacy. By finding new categories of efficacy, Palmer (2006b) suggested that other significant sources of efficacy may be
found outside the four that Bandura (1986) asserts. Two important elements concerning Palmer’s (2006b) findings must be addressed. One issue is that since Palmer (2006b) stated that this course did not provide mastery experiences (Bandura, 1986), omission of comments about mastery experiences was not an indicator of its lack of value. Also, Palmer’s (2006b) newfound categories of sources of efficacy are open to scrutiny because his categories may be considered subcategories of Bandura’s (1986) sources. For example, it appears that Bandura’s (1986) mastery experience (successful experience in teaching science) would encompass Palmer’s (2006b) cognitive content and pedagogical mastery because successful teaching implies knowing content and how to teach it. Although finding other sources of efficacy may prove to be valuable, what was important here was that Palmer’s (2006b) study supported the value of self-efficacy and the need to incorporate it in science methods classes.

Yoon, Pedretti, Bencze, Hewitt, Perris, and Oostveen (2006) examined the value of observing expert teaching via video as a method to learn content and pedagogical skills to increase self-efficacy. Yoon et al. (2006) directly addressed Bandura’s (1986) vicarious experience source of efficacy by focusing on the effects of pre-service teachers observing expert teaching. Yoon et al. studied 12 first and second year graduate pre-service elementary science teachers enrolled in a science methods course at the University of Toronto by evaluating responses in questionnaires, activity sheets, taped discussions, reflections, interviews, and field notes collected before, during, and after video observations. All participants were female and the majority had minimal to no experience in science.
Yoon et al. found that their baseline data indicated that their participants had low self-efficacy due to weak subject matter knowledge and used this information for comparison of effect on content knowledge. They also found that watching cases of experienced teachers teaching allowed participants to apply previous experience and find value in the case no matter what their level of confidence or experience. For example, by watching exemplary teaching, participants were able to discuss their personal experiences in relation to the expert teaching they were watching. Also, watching the exemplary case video proved to be beneficial because it offered opportunities for participants with different degrees of knowledge to engage. In their evaluations of discussions, reflections, and interviews, Yoon et al. found that no matter what level of content knowledge or confidence, participants were able to extract individually meaningful information from watching the video. Although content knowledge was not influenced by this vicarious experience, Yoon et al. believed that because of this ongoing “community of practice” (p. 32), self-efficacy was positively impacted.

Bleicher (2007) looked at the relationship between the changes in self-efficacy and science understanding in 70 pre-service elementary teachers enrolled in three science methods courses at a large urban university. Bleicher (2007) evaluated changes by triangulating quantitative and qualitative data from pre and post STEBI-B (Enochs & Riggs, 1990) and conceptual understanding surveys, midterms, field notes, and journal entries. Similar to Yoon et al. (2006), Bleicher (2007) found that a weak grasp of science understanding correlated with low self-efficacy and that vicarious experiences influenced confidence. Like Jarrett (1999), Bleicher (2007) found that the influences of a methods course can counteract the negative influences of prior science experiences. As a result of
the study, Bleicher (2007) suggests that hands-on activities develop participants’ understanding of science concepts, and that a relationship exists between the increase in understanding concepts and an increase in self-efficacy.

Brand and Wilkins (2007) evaluated Bandura’s (1986) four sources of efficacy as a means of examining the development of 44 pre-service elementary teachers enrolled in a masters level integrated science and math methods course. Brand and Wilkins (2007) used Bandura’s (1986) four sources of efficacy as guide to code and analyze written reflections and found that all four sources impacted self-efficacy, with mastery experiences having the most influence. Regarding vicarious experiences, participants discussed how observing each other and learning together was powerful and they implied that by experiencing the rewards of learning together, they were more apt to incorporate the strategies in their teaching (Brand & Wilkins, 2007).

In regard to the third source of self-efficacy, verbal and social persuasion, participants commented that because they were able to discuss in a safe and supportive environment, barriers such as stress and anxiety were minimized. The safe environment contributed to the last source, the affective state, where participants commented about feeling more open to learn (Brand & Wilkins, 2007). Although Brand and Wilkins (2007) addressed Bandura’s (1986) four sources of efficacy individually, they, like Bandura (1986), suggested that one source might have existed as a function of or in combination with the others.

Watters and Ginns (2000) investigated how a student-centered science methods course influenced students’ motivation and confidence to teach science and researched their interest by evaluating 154 pre-service undergraduate students who were enrolled in a
science education class during the third year of their four-year program. Watters and Ginns (2000) evaluated pre and post STEBI-B (Enochs & Riggs, 1990) surveys, classroom observations, journals, and five end-of-course focus group sessions with 22 participants in each group. Watters and Ginns (2000) analyzed the STEBI-B using SPSS and the qualitative data by coding to examine for any relationship between teacher behavior and student efficacy concerns. The researchers found an overt increase in self-efficacy with hands-on activities, teaching relevant content, and reflections stated as influential factors (Watters & Ginns, 2000). In support of Jarrett’s (1999) findings, Watters and Ginns (2000) stated, “student-centered instructional strategies that address the dimensions of meaningful learning and motivation and affect can change beliefs about ability to teach science” (p. 317).

Bleicher and Lindgren (2005) also looked at the design of a methods course and evaluated the relationships between science understanding and self-efficacy of 49 pre-service elementary teachers enrolled in a constructivist designed science methods class. Like the majority of the studies cited so far, Bleicher and Lindgren (2005) used a mixed methods design and evaluated pre and post STEBI-B (Enochs & Riggs, 1990), surveys, observations, and journals. Participants perceived having the opportunity to witness demonstrations and hands-on experiences in science were the most influential factors in developing content understanding and that elaboration via discussion was also a critical feature for complete understanding. Through their evaluation of the data, a significant correlation was apparent between conceptual knowledge and self-efficacy (Bleicher & Lindgren, 2005). In sum, participants felt that hands-on experiences lead to increased content knowledge, which lead to increased self-efficacy.
Adding to findings about student-centered teaching (Watters & Ginns, 2000) and constructivist designed classes (Bleicher & Lindgren, 2005), Howitt (2007) investigated what aspects of a holistic teaching approach influenced participants’ confidence toward teaching science. The holistic teaching approach adopted for this class came from models that implied the need for different levels of perspectives to consider the whole teacher. Howitt (2007) studied 28 pre-service elementary education teachers during the end of their science education class taken during their second year of a four-year undergraduate program at a university in Australia. In this study, Howitt (2007) evaluated class evaluation forms and a survey that asked participants to rank factors in the order of significance in improving their confidence to teach science. Some factors that participants were asked to rank were: “science content knowledge, science pedagogy, reflection, learning environment, and teacher educator” (Howitt, 2007, p. 46).

Howitt (2007) found a range in student responses indicating that, like Palmer (2002), no single factor was responsible for increasing confidence and what was important was that teacher educators know that a balance and mix of different factors increase the chance of impacting confidence. In evaluating the ranking method used in the survey she administered, Howitt (2007) found that students ranked practicum experience as the most important factor in impacting confidence, followed by the teacher educator, pedagogical content knowledge (PCK), and the learning environment. This finding supported the findings that mastery experiences (Bandura, 1986) and the teacher educator play an invaluable role in influencing pre-service teachers confidence (Howitt, 2007; Palmer, 2002; Rice & Roychoudhury, 2003).
In looking at self-efficacy from another angle, King and Wiseman (2001) analyzed the differences in efficacy beliefs between students who completed an integrated instruction methods course and students who completed a traditional science methods course. King and Wiseman (2001) investigated differences by administering a STEBI-B (Enochs & Riggs, 1990) survey to approximately 120 students who completed an undergraduate integrated methods course at a large mid-western university and to a cohort of students who completed a more traditional methods course at another university. According to King and Wiseman (2001), the major difference between the two groups was that the traditional methods course focused on effective science teaching strategies with no overt connections between the different subjects, and the integrated group’s methods courses integrated different subject contents and projects.

Interestingly enough, in King and Wiseman’s (2001) ANOVA comparison of means, they found no statistically significant differences between the two groups with regard to their end of semester self-efficacy scores. Their finding suggested that a class that integrates subjects is no more effective in influencing self-efficacy than a traditional science methods class. The value of this study was that it opened the door to many questions. The researchers did not collect baseline self-efficacy scores, so it is not possible to consider gains that might have resulted from either methods course. Therefore, although scores appeared to be similar, the influence of either class cannot be obtained. In its most simplistic analysis, the results from this study indicated that the issue was not whether to teach an integrated or traditional methods class, but how to teach students to teach science.
Moseley, Reinke, and Bookout (2002) examined whether an outdoor education program influenced the efficacy beliefs of 72 pre-service elementary education teachers in their last year of their undergraduate program. The outdoor education program, Adventures Beyond the Classroom (ABC), was a program that allowed students in a science methods class to “design, plan, and teach environmental education lessons in an outdoor setting” (Moseley et al., 2002, p. 11). Prior to the three-day experience where pre-service teachers worked in teams to teach roughly 450 sixth graders, pre-service teachers worked for a month in their methods class planning activities.

To evaluate the program’s influence on efficacy, Moseley et al. (2002) administered a pre and two post STEBI-B (Enochs & Riggs, 1990) surveys to two groups of participants. The first group served as a control group and completed a STEBI-B pre and post test before the three-day ABC experience and were administered a second posttest immediately after the ABC experience (Moseley et al., 2002). The second group completed a STEBI-B pretest before the ABC experience, a posttest immediately after the ABC experience, and a second posttest seven weeks after the experience (Moseley et al., 2002).

Moseley et al. found that self-efficacy seemed to be high before the three-day experience and the three-day teaching experience had no effect on self-efficacy. Moseley et al. suggested that the effects of the three-day experience did not influence self-efficacy because the heavily guided month long pre-teaching experience enabled them to feel prepared. However, because students were given materials, guidance, and little opportunity to divert from the plan, they had a false sense of how simple it was to design projects. Moseley et al. also suggested that perhaps no effect existed on self-efficacy
because the program focused on having students execute the activity and was not focused on having students learn how to develop a lesson and teach it.

This implied a noteworthy difference between simply giving students the means to teach and teaching them how to teach. Although Moseley et al. did not find any significant increase in self-efficacy, they did find that efficacy significantly decreased after seven weeks. Moseley et al. suggested that the decrease occurred because students were soon exposed to the reality of the difficulty in planning and developing their own lessons. Although teaching experiences have their benefits, this study showed a negative consequence to simply giving students a prepackaged lesson to teach. Similar to the message from King and Wiseman’s (2001) study, Moseley et al.’s message was that regardless of the design of a methods class, teacher educators must be cognizant of how their actions affect learning how to teach science.

Sherman and MacDonald (2007) sought to describe the experiences of 31 pre-service elementary teachers who had earned their undergraduate degree in a field other than education and were enrolled in a 10-week science-teaching module. The module included two courses that were co-taught and designed with reflection, trips, and team teaching experiences (Sherman & MacDonald, 2007). Sherman and MacDonald (2007) evaluated end-of-practicum surveys that inquired about perceptions about the module, self-ratings on confidence and content knowledge, and transcripts from interviews that were conducted a year after the completion of the module.

Sherman and MacDonald (2007) found that the team teaching that was modeled in the methods class was sought out in the workplace. This finding supported others that assert teaching strategies have a significant influence on students (Bleicher, 2004; Moore &
Watson, 1999; Palmer, 2002; Rice & Roychoudhury 2003). Like others, Sherman and MacDonald (2007) expressed that although prior science experience may negatively influence efficacy in teaching science (Jarret, 1999; Moore & Watson, 1999; Watters & Ginns, 2000), an increase in content knowledge and confidence in teaching science may increase interest and motivation in learning to teach science.

Wingfield and Ramsey (1999) evaluated the effects of a site-based program that included both methods class and authentic teaching experiences on the efficacy beliefs of 131 pre-service undergraduate elementary education majors at the University of Houston. Wingfield and Ramsey (1999) administered pre and post STEBI-B (Enochs & Riggs, 1990) surveys for mean score gains and follow up questionnaires for perceptions on what elements of the program influenced self-efficacy, and then a sample population was interviewed. Similar to the results of Brand and Wilkins (2007), Wingfield and Ramsey (1999) found that successful teaching experiences had the most significant influence on self-efficacy. Participants also mentioned that a benefit of the site-based program was the opportunity to observe classroom teachers, methods teachers, and peers teach (Wingfield & Ramsey, 1999), which like Yoon et al. (2006), supported Bandura’s (1986) vicarious experience as a source of efficacy.

Palmer (2006a) assessed the durability of self-efficacy beliefs in pre-service elementary teachers up to one year after their methods class. Of the over 150 students enrolled in a one semester science methods class, 55 participants in this study completed pre and post science methods class STEBI-B (Enochs & Riggs, 1990) surveys and a STEBI-B survey nine months later. Eighteen participants were interviewed a year after the course (Palmer, 2006a). Data were analyzed using repeated measures ANOVA to
compare means over time and interviews were transcribed and coded for sources of self-efficacy and the value of each source.

Palmer (2006a) found that the pre and immediate post STEBI-B scores showed statistically significant gains, indicating efficacy was positively influenced by the methods course. Palmer (2006a) reported that the delayed posttest showed that 73% of the participants did not change in efficacy while 27% either increased or decreased. This suggested that for the majority of the participants the self-efficacy gained in their methods class lasted at least for a year. Because the researchers did not specify what occurred during the year mentioned, the data was simply a reflection of a time span and not an effect of an intervention such as student teaching.

Lastly, Lindgren and Bleicher (2005) examined factors that led to the understanding of a particular teaching strategy, the learning cycle. They evaluated the pre and post learning cycle tests, journals, self-reported confidence statements, and transcripts from focus group discussions of 83 pre-service elementary teachers enrolled in multiple sections of a science methods course taught by the same instructor. Lindgren and Bleicher (2005) categorized groups of students based on their evaluations into successful students (20.5%), enthusiast students (20.5%), disinterested students (20.5%) and fearful students (32.5%). The disinterested and fearful groups made up over half the class population and they were identified by their strong disinterest and fear of science. This demographic supported what was reported in the previously cited studies of pre-service elementary teachers’ disposition toward science.

Lindgren and Bleicher (2005) also found that regardless of group identification, students mentioned that changing mindsets were initially difficult because what they
were learning was opposite of how they learned, that they did not want to teach as they were taught, that they needed multiple exposure and experience, and that the chance to explore was the key to engaging in activities. To encourage successful experiences in an elementary science methods course, Lindgren and Bleicher (2005) suggested that teacher educators’ model desired teaching behaviors and offer students multiple experiences.

**Summary of the impact of science content and methods courses on self-efficacy.** The most evident pattern in the research on the influence of science content courses and elementary science methods courses supported Bandura’s (1986) assertion that both mastery and vicarious experiences are vital elements in influencing self-efficacy (Bleicher, 2007; Brand & Wilkins, 2007; Howitt, 2007; Palmer, 2006b; Sherman & MacDonald, 2007; Weld & Funk, 2005; Wingfield & Ramsey, 1999; Yoon et al., 2006). Another clear pattern in the research findings was that both teacher demeanor and strategies employed have significant impact on attitudes toward and confidence in teaching and learning science (Howitt, 2007; Palmer, 2002; Rice & Roychoudhury, 2003; Sherman & MacDonald, 2007; Watters & Ginns 2000; Weld & Funk, 2005).

The findings suggested that to increase self-efficacy, pre-service elementary teachers learning to teach science required ample successful experiences teaching science and the opportunity to observe experts modeling effective teaching strategies. These findings tied to the focus of my study by offering a variety of potential categories of experiences that are believed to increase efficacy. My study extended on the notion of the current literature by addressing the influences of efficacy on the development of science teaching practices.
Not as overtly stated, but certainly as important, research also suggested that creating a community that encourages discussions and constructive critiques about experiences is beneficial (Bleicher & Lindgren, 2005; Brand & Wilkins, 2007; Yoon et al., 2006). Discussion allows for the sharing of different views of an occurrence, thus exposes participants to diverse angles of an experience. In addition to the obvious impact of the combination of discussion and mastery and vicarious experiences, one very interesting point quietly surfaced. Multiple researchers cautioned to ensure experiences were designed to teach pre-service teachers how to teach (King & Wiseman, 2001; Moseley, Reinke & Bookout, 2002), and not just show them lessons to teach. Simply giving students lessons to teach resulted in low efficacy because students did not learn how to teach.

Researchers found that students gained a false sense of confidence because of how easy it was to teach using a pre-made lesson with constant expert guidance (Moseley et al., 2002). These students quickly learned that real classroom environments do not have that sort of guidance and their confidence fell. The program was an example of the repercussions of having students do pre-made activities instead of teaching them how to execute effective lessons.

Similar to Bleicher’s (2004) comment about limitation of the research in field of science teaching self-efficacy, Brand and Wilkins (2007) called for the need for longitudinal studies. Lastly, it was clear that it was in the combination of successful experiences and modeling of expert teaching in an active and safe learning environment where methods classes influenced confidence and self-efficacy. These elements have been shown to be doable and effective in the controllable confines of methods classes,
but next we will see what happens when pre-service elementary teachers teaching science enter the student-teaching stage of their pre-service experience.

The Impact of Pre-service Teaching Experiences on Self-Efficacy

In addition to evaluating the effects of prior science experiences and methods courses on pre-service elementary teachers’ efficacy in teaching science, research looked at how student teaching impacted their efficacy. Student teaching is generally considered a highly beneficial element of pre-service education preparation by student teachers and teacher educators (Guyton & McIntyre, 1990). However, reactions to low teacher efficacy and a poor attitude toward teaching can be a detriment to student teachers (Feiman-Nemser, 1983). In looking at the student teaching period, we obtain a more complete understanding of how pre-service elementary teachers develop into classroom teachers.

Plourde (2002) investigated the influence of student teaching on the efficacy of three groups totaling 59 pre-service elementary teachers teaching science from a large western university. Plourde (2002) collected pre and post student teaching STEBI-B (Enochs & Riggs, 1990) surveys and conducted a t-test to evaluate for significant mean differences. Plourde (2002) found that after one semester of student teaching, self-efficacy scores decreased and that the barriers pre-service teachers encounter for the first time in student teaching, such as insufficient materials, support, and classroom management, was what contributed to their decline in efficacy. Plourde (2002) recommended that because student teaching was when pre-service teachers seemed to decrease in efficacy and exhibit ineffective science teaching behaviors, we must use this time to hone in on the reasons teachers are not teaching science effectively and find ways to fix them.
Hancock and Gallard (2004) examined 16 undergraduate pre-service teachers who were both completing field experiences and enrolled in a science methods course to evaluate the influence of field experiences on their beliefs. To evaluate their beliefs, data such as drawings of self as a teacher and as learner of science, teacher artifacts, and interviews were collected and analyzed (Hancock & Gallard, 2004). Of the five participants who agreed to be case studies, only one case was discussed in the article.

Hancock and Gallard (2004) stated that learning through experience and reinforcing and challenging existing beliefs impacted perspectives. The conflict between being taught student-centered approaches and employing teacher-centered methodologies in their field experiences was what Hancock and Gallard (2004) were referring to when they stated that the challenge of beliefs impacted perspectives. They found that this conflict negatively impacted their ability to teach science. Hancock and Gallard’s (2004) findings supported Plourde’s (2002) stance to use field experience as a time to focus on why teachers are not teaching science effectively to find ways to fix it.

Utley, Bryant, and Moseley (2005) explored the change in math and science teaching efficacy beliefs of 43 pre-service elementary teachers in their last year of their undergraduate program at a mid-western university. Utley et al. (2005) tracked changes in participant beliefs through their methods course and student teaching by administering the STEBI-B (Enochs & Riggs, 1990) and the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI-B) (Huinker & Enochs, 1995) survey at the beginning and end of their methods class and at the end of their student teaching. Using SPSS analysis, Utley et al. found a positive correlation between the math and science teaching self-efficacy, implying that efficacy was not content specific. Utley et al. also found that although the
methods course increased efficacy, like Plourde’s (2002) finding, efficacy scores 
decreased by the end of student teaching.

Like Plourde (2002) and Moseley et al. (2002), Utley et al. suggested that the “slap of
reality” identified by many researchers (Corcoran, 1981; Veenman, 1984) was why 
efficacy decreased during student teaching. Utley et al.’s finding paved the way for my 
study because although it supported the common finding of increased efficacy found after 
methods courses and a decrease in efficacy found during student teaching, what it did not 
do was explore what experiences in methods class fostered the development of effective 
teaching practices during student teaching.

Morrell and Carroll (2003) investigated the impact of a science content course, science 
methods course, and student teaching on self-efficacy. Morrell and Carroll (2003) 
examined the impact of the three pre-service phases by administering a STEBI-B (Enochs & Riggs, 1990) survey at the beginning and end of each phase to 172 undergraduate 
elementary education students. From the paired t-test, Morrell and Carroll (2003) found 
that the content class and student teaching showed no significant gains in self-efficacy 
scores, but the methods course showed a significant gain. Based on their findings, 
Morrell and Carroll (2003) suggested that increasing content knowledge does not 
necessarily increase efficacy and designing methods courses to increase self-efficacy can 
be done using Bandura’s (1986) guidelines. They hypothesized that no gains occurred 
during the student teaching time because participants were entering this phase with high 
efficacy.

Cantrell, Young, and Moore (2003) combined all the factors reviewed so far and 
investigated the effects of prior science history, a science methods class, and student
teaching on efficacy. Cantrell et al. (2003) started with 268 undergraduate elementary education majors in a program in the Rocky Mountain West. Because of attrition over time, the embedded group, which represented the final number of participants in the study, consisted of the only 12 participants who appeared in all three data sets. The seminar group consisted of 154 participants who were enrolled in three one-hour introductory classes. Each class focused on one of the three branches of science. The methods group consisted of 84 participants who were enrolled in an integrated math, science, and technology methods class and a three-week practicum, and the student teaching group consisted of 54 participants (Cantrell et al., 2003).

Within the seminar group, Cantrell et al. found that self-efficacy means were higher for males and that more science classes yielded higher efficacy scores. In the methods group, science teaching self-efficacy means again differed by science background, but no longer by gender. As for the student teacher group, Cantrell et al. did not find any significant differences for any variables in relation to efficacy scores. Cantrell et al. did find that over time, significant increases occurred in efficacy scores and those who took more science classes were “more likely to develop higher science teaching efficacy beliefs” (p. 188). Students in the study reported that the amount of time spent teaching science in a real setting with support and guidance greatly influenced efficacy.

What this suggested about student teaching was that fostering efficacy during genuine teaching experiences may minimize the decrease in efficacy commonly found during this phase. The researchers concluded with a list of recommendations for teacher educators, and their suggestions served as a summary for the literature review so far. Cantrell et al. recommended:
1. Provide early opportunities to teach science. This suggestion supports Bandura’s (1986) mastery experience and the findings cited in this paper (Bleicher, 2007; Brand & Wilkins, 2007; Sherman & MacDonald, 2007).

2. Offer opportunities for extra-curricular science experiences. This suggestion addresses the finding that science experiences influence efficacy (Cantrell et al., 2003; Jarrett, 1999; Moore & Watson, 1999).

3. Develop a community of learners. This suggestion addresses the benefits discussed in students communicating and learning with and from each other. (Yoon et al., 2006)

Summary of the impact pre-service teaching experiences on self-efficacy. An important pattern found from this research was that the pivotal time between end of science methods class and before their first year of teaching was when pre-service teachers exhibited ineffective teaching behaviors and when their efficacy in their ability to teach science decreased (Plourde, 2002; Utley & Bryant, 2005). It is in this phase of their education when students face new barriers and they experience a conflict between what was taught to them and what they find themselves doing as teachers (Hancock & Gallard, 2004). These findings strongly suggest that teacher educators need to consider this critical time with more caution. Student teaching is the last experience students receive before entering the field of education as professionals.

Since research shows that science methods classes can successfully increase self-efficacy, finding what experiences from science methods class continues to support pre-service elementary teachers through challenging student teaching experiences will prove to be valuable. To best serve pre-service teachers’ needs, research must look beyond what
causes declines in efficacy as a method to fix the problem and look at what contributes to the development of effective teaching practices as a method of building on what works. Also clearly missing from the research were teaching observations over time. Relying on an efficacy score and responses to surveys limited the understanding of the effects of efficacy. Observations of participant teaching practices over time triangulated with all the commonly collected data sources is what is missing from current literature. When discussing the limitation of the research in field of science teaching self-efficacy, Utley and Bryant (2005) commented on the need for longitudinal studies.

*The Influence of In-Service on Self Efficacy*

To add to the discussion of self-efficacy, studies summarized next addressed in-service teaching. Findings common to pre and in-service experiences that increase efficacy strengthened the argument for recognizing the importance of addressing efficacy to increase teacher effectiveness.

Posnanski (2002) inquired about the impact of the design of a professional development on participants’ self-efficacy. Elements such as activities and teaching strategies in the professional development program were designed based on Bandura’s (1986) four sources of efficacy in hopes of enhancing the efficacy of their participants. The program’s goal was to increase efficacy in elementary teachers teaching science and hoped to do it by extended, applicable, teacher specific training (Posnanski, 2002). The participants in their professional development were elementary teachers teaching science with a range of 1-17 years of experience. Pre and post STEBI (Riggs & Enochs, 1990) surveys, open-ended questionnaires and program artifacts were collected from 31 of the 43 total professional development participants.
Data were analyzed via SPSS and via a phenomenological inquiry approach to evaluate participants’ experiences as reported by their completion of three open-ended questions in a survey (Posnanski, 2002). In his analysis, Posnanski (2002) found that self-efficacy did increase, that a majority of the participants stated that the program had a significant impact on their ability to use inquiry teaching methods, and that it was the mastery experiences that played a vital role in increasing efficacy. Results from this study, like findings from the previous sections, indicated that professional development must include mastery experiences (Brand & Wilkins, 2007; Cantrell et al., 2003; Posnanski, 2002). Posnanski (2002) also suggested that professional development programs include a team of teachers from the same school to create a community of learners who will pass on what they have learned to others in their school.

Khourey-Bowers and Simonis (2004) investigated the impact of a professional development program in chemistry that was specifically designed to influence self-efficacy in middle school teachers. However, they also evaluated the program’s impact on content knowledge and pedagogical content knowledge (PCK). This annual professional development program lasted 10 full days over a period of 10 months and the program design included: “(a) instruction in fundamental chemistry concepts; (b) modeling the learning cycle through exploring, concept development, and application; and (c) guided discussion in underlying learning theories that address inquiry strategies, teaching for conceptual change, and other classroom-supportive theories” (Khourey-Bowers & Simonis, 2004, p. 180).

To investigate the effects of the professional development program, Khourey-Bowers and Simonis (2004) administered pre and post STEBI (Riggs & Enochs, 1990) surveys.
and post session evaluations, and conducted interviews with select participants. Data were analyzed via SPSS and coding for the influence of the elements of instruction during the professional development. Khourey-Bowers and Simonis (2004) evaluated four years of data with cohorts from each year ranging from 31-37 participants and with each group having primarily elementary certified teachers. Khourey-Bowers and Simonis (2004) found that not only did self-efficacy increase significantly in each group, but content knowledge and PCK increased as well. Like Posnanski (2002), Khourey-Bowers and Simonis (2004) found that gains in efficacy could be attributed to mastery experiences, and that hands-on activities deemed usable in their classrooms contributed to the increase in content knowledge and PCK.

Wingfield, Freeman, and Ramsey (2000) examined whether teachers who participated in a site-based teacher education program maintained efficacy in teaching science after their first year of teaching. Wingfield et al. (2000) mailed 124 STEBI (Riggs & Enochs, 1990) surveys to first year teachers who showed significant gains in self-efficacy scores following their methods and practicum courses at a site-based program, and 31 were completed (Wingfield et al., 1999). Post methods class STEBI-B (Enochs & Riggs, 1990) means were compared to the mean of the mailed STEBI survey using SPSS t-test. Wingfield et al. (2000) found that the overall mean remained statistically the same, implying that the high efficacy ratings from the participants’ methods class remained through their first year of teaching. Wingfield et al. (2000) suggested that because the self-efficacy gains were so significant in their site-based experiences, this one-year follow up study supported the value of site-based programs. However, given the less than half response rate, one must be cautioned about their summary of the data.
Summary of the impacts of in-service on self-efficacy. Evaluations of self-efficacy from professional development experiences echoed findings from self-efficacy studies in science content classes, science methods courses, and student teaching. Like many of the findings from the pre-service elementary science teacher preparation studies, the professional development findings agreed that mastery experiences and vicarious experiences (Bandura, 1986) were valuable methods of increasing efficacy. Exposure to and use of applicable activities and the opportunity to observe expert teachers who use reform-based strategies were reported effective means of increasing self-efficacy (Khourey-Bowers & Simonis, 2004; Posnanski, 2003). The value of influencing self-efficacy can be seen in the next segment where the impact of self-efficacy is addressed.

The Impact of Self-Efficacy

Articles reviewed next discuss the characteristics of pre and in-service teachers with low and high efficacy. Schoon and Boone (1998) sought to find relationships between science teaching self-efficacy and the science content alternative conceptions they held. Schoon and Boone (1998) administered the STEBI-B (Enochs & Riggs, 1990) and a survey that measured science alternative conceptions to 619 upper-level undergraduate pre-service elementary teachers who had not yet completed student teaching. By employing the “stochastic model to convert raw scores of coded responses to true measures” (Schoon & Boone, 1998, p. 558), they found that a relationship between number of correct science content answers and higher efficacy scores but found no relationships between the number of alternative conceptions and efficacy. This finding implied that although content knowledge and self-efficacy were related (Bleicher & Lindgren, 2005; Palmer, 2006b; Sherman & MacDonald 2007), having alternative
conceptions in science remained a problem for pre-service elementary teachers teaching science (Schoon & Boone, 1998).

Alternative conceptions in science are a problem in science teaching because the researchers found relationships between low self-efficacy and particular science misconceptions. For example, “planets can only be seen with a telescope, electricity is used up in appliances, and north is toward the top of a map of Antarctic” (Schoon & Boone, 1998, p. 563) are some of the alternative conceptions held by participants with lower self-efficacy. Schoon and Boone (1998) suggested that not understanding fundamental science information such as planets can be seen with the naked eye or that electricity is not used up prevents the comprehension of concepts built from those core facts. This finding was significant because it allowed us to evaluate the areas science education needs to address. Teachers with alternative science conceptions in fundamental concepts in science perpetuate the cycle of poor science education.

Ginns and Watters (1999) investigated the relationship between efficacy beliefs and science strategies used by three female beginning elementary teachers in Australia. Ginns and Watters (1999) evaluated STEBI (Riggs & Enochs, 1990) surveys given during the middle of their first year and at the beginning of their second year, questionnaires, and an interview and a classroom observation. Of the eight teachers studied, three data sets were selected as representative of the group showing “high and low scores to find contrasting behaviors and beliefs” (p. 291). Ginns and Watters (1999) found that although self-efficacy beliefs did not appear to completely influence participants’ decisions in using science programs, the ability to recall and reflect upon previous successful experiences helped in guiding teachers to implement effective teaching strategies. Based on their
findings, Ginns and Watters (1999) stated three assertions regarding what is needed to enhance science-teaching self-efficacy:

Assertion 1: Pre-service teachers need to have successful experiences, and be made aware of those successful experiences, during their teacher education program.

Assertion 2: Science courses in pre-service programs must provide more authentic practices and experiences, and be the source of credible role models, for participants.

Assertion 3: Experienced peer teachers, school principals, and teacher educators must provide continuous and positive feedback to reinforce beginning teachers’ beliefs about their ability to teach science. (pp. 308-309)

Their assertions directly aligned with Bandura’s (1986) four sources of efficacy and were also emphasized in previously cited studies (Brand & Wilkins, 2007; Cantrell et al., 2003; Posnanski, 2002; Rice & Roychoudhury, 2003).

Beck, Czerniak, and Lumpe (2000) sought to understand factors that influence K-12 science teachers’ use of constructivist teaching strategies. They evaluated the influences on the use of constructive teaching strategies through a description of the participants’ attitudes and beliefs. They first mailed open-ended questionnaires to 500 random participants from the Science, Math and Technology Education Center at the University of Toledo to find patterns of beliefs of teachers intent to use the following five components of constructivism: “a) personal relevance; b) scientific uncertainty; c) critical voice; d) shared control; and e) student negotiation” (Beck et al., 2000, p. 323). Based on patterns found in the responses to the open-ended questionnaires, Beck et al. created five
questionnaires for each of the five components and mailed each questionnaire to 100 teachers in the northwest region of Ohio.

Descriptive statistics and correlations were calculated for each of the groups of questionnaires using SPSS (Beck et al., 2000). Beck et al. found three themes that describe the attitudes that played an integral part in predicting the adoption of constructivism. The first theme they found was that the staff development where participants used science content applicable to their teaching facilitated positive attitudes. This theme supported Bandura’s (1986) beliefs about mastery experiences. The second and third themes Beck et al. found were about obstacles to constructivist teaching. Participants felt planning for constructivist teaching and learning it took too much time, and that materials available to them did not align with constructivist teaching. By referencing Bandura’s (1986) ideas about beliefs and attitudes, the implication in the study was that beliefs and attitudes related to the intention and confidence to implement constructivist teaching. Again, what this study lacked was the observation of teaching practices to triangulate with scores and responses to open-ended questions.

Haney, Lumpe, Czerniak, and Egan (2002) explored the relationships between elementary teachers’ efficacy beliefs about teaching science and their ability to effectively teach science by administering the STEBI (Riggs & Enochs, 1990) and the Context Beliefs About Teaching Science (CBATS) (Lumpe, Haney, & Czerniak, 2000) to acquire efficacy and belief information. Haney et al. (2002) also used the Horizon protocol, which included interviews and observations, to evaluate classroom practice. Participants completed the questionnaires before their enrollment in a two-week summer institute designed to improve content knowledge, pedagogy skills and ability to use
science materials. The participants were interviewed and observed in their classrooms after the two-week institute (Haney et al., 2002). Six teachers representative of a large urban district in northwest Ohio were evaluated. Haney et al. found that participants with high efficacy scores had better designs of lessons and teaching evaluations and low scores struggled with many elements of effective teaching. Haney et al. also found that for five of the six participants, beliefs were predictors of classroom action. Although this study used teaching observations to evaluate classroom practice, the researchers only conducted one observation of each participant.

Appleton and Kindt (2002) qualitatively explored the features of nine beginning elementary teachers’ development in their roles as science teachers by evaluating interviews, field observations, and informal conversations. The researchers found that “unless they had a high motivation to teach science, they were unlikely to persist with trying to teach science during their early teaching experiences…” (Appleton & Kindt, 2002, p. 55). Appleton and Kindt (2002) also found that the novice teachers utilized low risk and predictable science activities, which was indicative of their lack of confidence in teaching science.

Lastly, Czerniak and Shriver (1994) sought to validate the construct of science teacher self-efficacy by evaluating the STEBI-B (Enochs & Riggs, 1990), teacher efficacy scale, and journal entries of 35 pre-service elementary education students enrolled in a methods class during year one of their two-year study. The researchers followed a subset of 14 participants into their first year of teaching during the second year of the study. The responses to five reflection questions showed the differences between teachers with high and low efficacy. In the self-evaluations of teaching strategies used, the high efficacy
group reported using learning centers, small group discussions, and integrated science whereas the low efficacy group made no mention of these strategies.

Although experiments reportedly lasted about the same amount time, the high efficacy group used discussions and group work whereas the low efficacy group used demonstrations and lectures. When asked for reasons why they chose the strategies they employed, the high efficacy group discussed student learning and supported their statements with educational theory. The low efficacy group stated concerns about student behavior and whether or not their activities were fun. In the participant’s responses to the strengths and weaknesses of their lessons, the high efficacy group again used educational theory to support the value of their lessons, referenced science goals in their planning, and addressed student learning in contrast to the low efficacy group who discussed having right answers and success in having control.

When addressing the weaknesses of their lesson, the high efficacy group discussed their inability to offer more attention to students and the low efficacy group were again concerned with the behavior of the class. Lastly, participants were asked for reasons why their lessons were a success or failure. The high efficacy group took responsibility for successes and failures of their lesson, but more attention was on their own abilities as an effective teacher indicating that high efficacy teachers are more reflective about their practice. The high efficacy group again made statements focusing on student learning. The low efficacy group continued their trend of responses and commented on the amount of correct answers as indicators of success and referenced not having control as failures.

In sum, teachers with high efficacy were clearly cognizant of the learning process and were aware of their roles in the process. On the other end of the spectrum, low efficacy
teachers conducted low risk and predictable activities (Appleton & Kindt, 2002) and based the success and failure of teaching on the amount of concrete facts learned and student behavior. Czerniak and Shriver (1994) ended by stating, “given the beliefs and patterns of behavior that differentiate high efficacy and low efficacy teachers, science educators should continue to focus on strategies…to increase students’ levels of science teaching efficacy” (p. 85). Czerniak and Shriver’s (1994) findings clearly pointed to how teachers with high efficacy teach in a manner that science education reform requires. Teachers with high efficacy reflected about their practices using educational theory and science standards as a guide. Referencing educational theory and science standards to assess their practices indicated an awareness of pedagogical content knowledge, which directly aligns with the standards described by NRC (1996).

Summary of the impact of self-efficacy. An overt finding when looking at how self-efficacy impacted teaching behaviors was how attitudes played a significant role in teachers’ ability and willingness to use effective teaching strategies (Appleton & Kindt, 2002; Beck et al., 2000; Ginns & Watters, 1999; Haney et al., 2002). In line with the previous summaries in this literature review section, having positive science experiences to recall and reflect upon helped teachers develop effective teaching strategies (Ginns & Watters, 1999). At this point, what was also blatantly evident was the ecology of elements that impact self-efficacy and how the cycle of positive and negative efficacy perpetuated itself.

In reviewing the literature on self-efficacy in pre-service and novice teachers teaching elementary science, it was obvious how elements such as prior experiences, mastery and vicarious experiences, positive teacher demeanor, and relevant content all interact during
all phases of a learner’s academic career to influence self-efficacy. The ultimate value in understanding the importance in increasing self-efficacy in teachers is in recognizing that students benefit from efficacious teachers. As seen from the Cznerniak and Shriver’s (1994) study, overwhelming differences appeared in teaching behaviors between high and low efficacy teachers. Also in their study was the propensity of highly efficacious teachers to teach in a manner that promotes science education reform.

Patterns in the Research and Implications for Teacher Educators

Three overarching patterns were apparent in the research cited. The first pattern addressed how pre-service elementary teachers in education programs developed through science experiences. Specifically, that prior science experiences had a strong and lasting influence on self-efficacy (Jarrett, 1999; Weld & Funk, 2005), efficacy increased during methods classes (Bleicher, 2007), and self-efficacy declined during student teaching (Moseley et al., 2002; Plourde, 2002). These findings are mentioned together because they summarized how pre-service elementary teachers in education programs developed through science teaching. To better understand what is happening to pre-service elementary teachers regarding learning to teach science, research in this field needs to expand their data sources by including observations of teaching practices throughout their student teaching experiences and triangulate observations and interviews with data sources commonly collected.

The second pattern found was that no matter where in the continuum of learning to teach science participants were, it was clear that Bandura’s (1986) mastery and vicarious experiences were two sources of efficacy that increased confidence (Bleicher, 2007;
Hancock & Gallard, 2004; Posnanski, 2002; Sherman & MacDonald, 2007; Wingfield & Ramsey, 1999). Studies cited reported mastery experiences in the form of teaching science lessons to classmates in science methods class (Brand & Wilkins, 2007) and teaching science during student teaching (Hancock & Gallard, 2004). Other possible sources of mastery experiences not addressed in the studies are tutoring, acting as a docent on a field trip, and being a guest speaker. The more pre-service teachers gain science teaching experience, the more they have to recall and reflect upon in their first year of teaching.

Vicarious experience in the context of teaching science is observing others successfully teach science lessons. Vicarious experiences existed when pre-service teachers watched and critiqued expert case videos (Yoon et al., 2006) and expert teachers teach (Rice & Roychoudhury, 2003). Mastery and vicarious experiences (Bandura, 1986), paired with discussion about those experiences have been reported to have the most impact on self-efficacy.

The last pattern found in the review of literature was the call for the longitudinal studies of self-efficacy. Studies in every group summarized called for the need for longitudinal studies (Bleicher 2004; Brand & Wilkins, 2007; Posnanski, 2002; Utley & Bryant, 2005). The call for longitudinal studies is a weakness in the field that my study addressed. Given that pre-service elementary teachers tend to enter science methods classes with negative feelings about science and that efficacy decreases during student teaching, understanding the experiences that contribute to long lasting efficacy must be a serious consideration. Understanding the influences and effects of self-efficacy informed my study by highlighting the gaps and weaknesses in the field.
Critiques of the Research

The research addressed in this part of the proposal offered information invaluable to our understanding of the sources and the effects of self-efficacy. However, some critiques about the research are discussed next. Although many studies gathered data in the same manner, only one study critiqued that a lack of a control group was a limitation, thus a threat to the internal validity of the findings (Tosun, 2000b). However, many studies discreetly implied they were more exploratory than claiming generalizable findings. For example, results and discussions often addressed how a particular methods course (Palmer, 2002) or particular instructor (Rice & Roychoudhury, 2003) influenced the efficacy of their participants, indicating that the study was exploring the effects of that class or instructor and not generalizing about all classes and instructors. Although findings cannot be universal, one way broad statements can be made is if enough studies report similar results and patterns regardless of design.

A second critique was that many of the studies required that participants recall information that was vital to the evaluation and meaning of the data. The issue at hand is that research suggested that poor science experiences are to the detriment of science learning, but it counts on the accuracy of participants’ recollection of poor experiences to make their claims. Another critique was the fact that some studies had a small sample size (Haney et al., 2002; Wingfield et al., 2000). This both weakens the integrity of the statistical results and leads one to question the scope of the representation of the data evaluated. For example, one might suggest that unhappy participants may not take the time to complete questionnaires and only those who have increased efficacy may be motivated to participate and share experiences. Although the use of small sample sizes is
often frowned upon, its value is that it allows for the collection of rich qualitative data and mixed method design used by many studies in this review.

Another critique is related to the question of a ceiling effect in regard to the STEBI-B’s (Enochs & Riggs, 1990) ability to measure gains in efficacy in participants who have scored high on the efficacy instrument. The concept of the ceiling effect suggested that because the STEBI-B cannot measure beyond its own highest score, the STEBI-B does not have the capability of measuring efficacy gains if participants score high on initial efficacy measures. Although Morrell and Carroll (2003) were the only researchers that mentioned the possibility of a ceiling effect, many studies reported no significant increase in efficacy (Moseley et al., 2002; Palmer, 2006a; Wingfield et al., 2000). Because of the question of a ceiling effect, one has to wonder if reports of “no significant increase in efficacy” implied no actual statistical changes in efficacy or a reflection of the limits of the instrument used to measure self-efficacy.

Lastly, the limitations that point to the need for my study were in the fact that studies about the methods course experiences that influence efficacy and efficacy during student teaching were evaluated as separate entities. What we need to learn about to improve science teaching is the relationship that connects the methods course experiences and the effective teaching strategies during student teaching. What we also need to learn are what are the actual teaching practices of student teachers and how do they relate their development to what they learned in methods class. We need to ascertain this information via teaching observations and interviews throughout their student teaching period.
Self-efficacy for Teacher Effectiveness and its Application to My Study

Research clearly illustrate that increasing science teaching self-efficacy increases teacher effectiveness. Negative experiences in and negative attitudes toward science prevent the learning of science, including how to teach it. This barrier renders teachers unable to teach in the manner that science education reform demands, thus impedes the progress toward quality science education.

The literature identified successful sources of efficacy used during elementary science methods courses and discussed factors during student teaching that corroded the confidence that was built. This phenomenon was the impetus behind my drive to explore sources of self-efficacy in pre-service elementary teachers teaching science that continue to support them through student teaching experiences.

When science self-efficacy is high and teachers have the confidence to learn to teach science, effort and persistence to learn increases (Pajares & Schunk, 2001; Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998). High efficacy in science teaching is also associated with an increased sense of commitment to teaching science (Coladarci, 1992) and the willingness to implement reform efforts (Ghaith & Yaghi, 1997; Guskey, 1988). The effects of increasing and sustaining self-efficacy in pre-service elementary teachers who teach science puts teachers on the path to becoming effective science teachers and influential players in science education reform. Research in the field of science teaching efficacy has informed us who are likely to mechanically repeat the old model and who are likely to adopt reformed science teaching. My study expanded on current findings and explored the development in inquiry science teaching in pre-service elementary teachers.
with different levels of science teaching self-efficacy. The next chapter details the design of my study.
CHAPTER 3

METHODOLOGY

My reading of the literature related to the influences of elementary pre-service teachers’ science-teaching self-efficacy on their development of science teaching practices piqued my interest about the influences of efficacy. My study, framed by Bandura’s Social Cognitive Theory (1986), involved a year long investigation of the influences of learning science and learning how to teach science on pre-service elementary teachers’ science teaching self-efficacy and their science teaching strategies employed during student teaching.

The goal of my study was to address the problem that many elementary teachers who teach science fail to meet the requirements that science education reform necessitates (Davis, Petish, & Smityey, 2006). I met my goal by addressing the need for longitudinal studies in this field (Bleicher 2004; Brand & Wilkins, 2007; Utley & Bryant, 2005; Posnanski, 2002). Specifically, my study categorized pre-service contributors to science teaching self-efficacy and characterized teaching strategies employed during student teaching. Two research questions framed this study: 1] What science experiences influence science teaching self-efficacy in pre-service elementary teachers and 2] How are science teaching practices depicted across different levels of efficacy during student teaching?

Research Design

My study was classified as a dual-phase, mixed-methods embedded case study design that included two phases. The two phases as described in the next section transpired over
the academic school year 2008-2009. The findings from Phase I were used to identify and characterize the telling cases selected for Phase II. A telling case (Mitchell, 1984) is one that allows for a theoretical unfolding of constructs (i.e., the influences of self-efficacy on the development of science teaching practices). For this study, the validated Science Teaching Efficacy Belief Instrument (STEBI-B) (Enochs & Riggs, 1990) that measures pre-service self-efficacy in teaching science was used to identify the telling cases. The process used to identify the telling cases is explained later.

In the context of my study, quantitative and qualitative data were collected over an academic school year to characterize telling cases to address the research question, “How are science teaching practices depicted across different levels of efficacy during student teaching?” According to Creswell (2008), the use of mixed-methods research allows qualitative data to explain and elaborate on the meaning of statistical data, which maximizes the strength of both qualitative and quantitative research. Quantitative and qualitative data result in the ability to triangulate data for a deeper understanding of the complexity of the phenomenon studied (Yin, 2003).

Also, an embedded case design was the most suitable design for my study because the characterization of the different levels of efficacy offered a more detailed contextualization of the influences of self-efficacy on the development of science teaching practices. Lastly, the dual-phase design of my study maximized the mixed-method embedded case design and allowed for observations over time to describe developmental trends in science teaching practices. A dual-phase mixed-methods embedded case study design was the best method of research for this study because the
quantitative and qualitative data sources complimented each other and provided a rich
description of the telling cases over time.

Research Context

My year-long study was conducted in two phases. Phase I occurred in two elementary
science methods course in a large southwestern university during the fall 2008 semester.
Two different instructors taught the two traditional elementary science methods courses,
and the goal of the classes was to teach pre-service elementary teachers how to teach
science. I was one of the instructors of the two Phase I elementary science methods
courses used in my study.

These two traditional methods courses were selected to maintain consistency in the
participant pool as opposed to inviting participants from alternative route to licensure
courses also taught at the university. Because alternative route to licensure students are in
a unique program of study and are teaching full time, they have issues distinctive to their
experiences. Pre-service elementary education students enrolled in the traditional
elementary science methods class are generally in their last year of the elementary
education program and are also enrolled in their Practicum II field experience course.
Practicum II requires students to be in the classroom twice a week for three hours a day.
These students remain the same classroom for about 84 hours a semester.

Phase II occurred during spring 2009 student teaching experiences. Generally, student
teachers spent their first week observing. During subsequent weeks students increased
their teaching load by approximately 25% each week. Students were expected to teach
full time during weeks 6 – 12 and their teaching load decreased by approximately 25%
each week until the end of their 16-week semester. During this time, student teachers
were required to have at least four lessons formally observed. Supervisors were encouraged to conduct as many informal observations as possible for a comprehensive view of the growth of their student teachers. To meet the requirements of the program and the needs of the study with utmost integrity to both, I blended complying with the observation requirements of the program, while meeting the needs of the requirements necessary for completion of the study.

Phase II occurred in two public elementary schools located in two different regions of one school district in one southwestern United States. The school district has seven regions, is the 5th largest school in the United States, and has over 300,000 students. One of the two schools was located in the northeastern region of the school district. This school reported having a 1.7% Asian, 81.3% Hispanic, 11.5% Black, and 5.3% White student population. They listed 65.7% of their students as Limited English Proficiency (LEP) and 89% of their student population eligible for Free and Reduced Lunch (FRL). This elementary school did not demonstrate Adequate Yearly Progress (AYP) during the school year 2008-2009 (2008-2009 School Accountability Report). This school followed the traditional nine-month academic school calendar.

The second elementary school was located in the southwestern region of the school district. This school reported having an 11.1% Asian, 12.9% Hispanic, 5.2% Black, and 70.2% White student population. They had 3.4% of their students listed as LEP and 6.9% of their student population eligible for FRL. This school was recognized by the [State] Department of Education as a High Achieving Elementary School (2008-2009 School Accountability Report). This school followed a year-round (12-month) academic school
calendar. The multi-track year round school calendar adopted by the school district offers staggered breaks for students in five different tracks.

Participants

First, I describe the selection process of the embedded case participants and briefly introduce each case. Then, I discuss my participant observer role as the methods instructor for one of the classes in Phase I, the supervisor during Phase II, and the researcher in this study.

Selection Process

During the first week of Phase I, I introduced my study to the two aforementioned elementary science methods classes offered during fall 2008. I discussed the purpose and requirements of the study to each class and invited all pre-service elementary teachers who were enrolled in those methods class to participate in the study.

From my science methods class 21 students volunteered to participate, and from the second science methods class, eight volunteered. A total of 29 pre-service elementary teachers agreed to participate during Phase I and were potential participants for Phase II. Evaluating for the richest data sets from Phase I further narrowed the scope of potential participants to serve as telling cases for my study. The richest data sets were defined as participants with completed data sources and having near matching scores in the low, medium, and high level of efficacy from both classes. The six richest data sets from the 29 Phase I pre-service elementary teachers were pulled as a purposeful sampling for Phase II and for data analysis for my study.

In each class, a median split of initial STEBI-B (Enochs & Riggs, 1990) scores separated the high and low levels of efficacy, and the median participants were identified
as medium level. Three participants from each class, one from each of the three levels of efficacy, with near matching scores were identified as the six participants in the study. For anonymity, the six participants were assigned pseudonyms. As seen in Table 1, the six participants were representative of the three levels of efficacy from both classes (A= students from my methods class, B=students from the other methods class) and served as the telling cases.

Table 1

*Student Teacher Participants*

<table>
<thead>
<tr>
<th>Rank</th>
<th>Participant</th>
<th>Methods Class</th>
<th>Level of Efficacy</th>
<th>Score out of 65</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Nancy</td>
<td>B</td>
<td>Low</td>
<td>36</td>
</tr>
<tr>
<td>5</td>
<td>Sandy</td>
<td>A</td>
<td>Low</td>
<td>38</td>
</tr>
<tr>
<td>4</td>
<td>Whitney</td>
<td>A</td>
<td>Medium</td>
<td>41</td>
</tr>
<tr>
<td>3</td>
<td>Karen</td>
<td>B</td>
<td>Medium</td>
<td>44</td>
</tr>
<tr>
<td>2</td>
<td>Sharon</td>
<td>B</td>
<td>High</td>
<td>50</td>
</tr>
<tr>
<td>1</td>
<td>Ann</td>
<td>A</td>
<td>High</td>
<td>52</td>
</tr>
</tbody>
</table>

True to an embedded case design, the participant selection method offered sub-units for a more diverse data set than analyzing data from participants with only high levels of efficacy from one class. This process of purposeful selection (Glesne, 2006; Marshall & Rossman, 2006) allowed for a comparison of common patterns found among different levels of efficacy for a richer description of each level. Lastly, for consistency of the data,
only females were selected for participation during Phase II and for final data analysis because males tend to have higher levels of science teaching self-efficacy (Tosun, 2000a; Bleicher, 2004).

**Student Teacher Participants**

The six participants selected for the telling cases were student teachers during Phase II. They were selected from among the participants in Phase I according to their scores on the STEBI-B (Enochs & Riggs, 1990) survey to represent student teachers having low, medium, or high levels of science teaching self-efficacy. The six participants are briefly described in pairs according to their levels of efficacy.

Nancy and Sandy were categorized as having low levels of science teaching self-efficacy. These two participants were two of the four assigned to the elementary school located in the northeastern region of the school district. At the time of the study, Nancy was a 33-year-old single student who was the only participant working full time during student teaching. Nancy was assigned to a fourth grade class. Sandy was a 24-year-old single student who worked part time during student teaching. Sandy was assigned to a first grade class.

Whitney and Karen were categorized as having medium levels of science teaching self-efficacy. These two participants were the other two of the four assigned to the elementary school located in the northeastern region of the school district and both were assigned to the same third grade team. At the time of the study, Whitney was a 24-year-old single student who worked part time during student teaching. Karen was a 24-year-old married student with a toddler.
Sharon and Ann were the participants who were categorized as having high levels of science teaching self-efficacy. Both participants were assigned to the elementary school located in the southwestern region of the school district. At the time of the study, Sharon was a 29-year-old married student with a child in second grade. Due to track breaks in a year round school schedule, Sharon divided her time between a third and fourth grade class during student teaching. Ann was a 22-year-old single student. Ann was assigned to a second grade class during her student teaching. While her cooperating teacher was on track break, Ann moved to a fourth grade class for two weeks.

Researcher Role

During Phase I, I was one of the two instructors of the elementary science methods course and the researcher. As an elementary science methods instructor, it was my role to teach current elementary science teaching methods to students. During Phase II, I was the supervisor of the embedded case study participants. As supervisor, it was my role to guide and mentor professional development during student teaching. I mentored student teachers by consulting them based on observations of their teaching and professional practices and to offer guidance when deemed necessary by the supervisor or student teacher. Therefore, it was imperative I remain in constant communication with the student teachers for a two-way discourse.

Because I was an instructor of one of the participating science methods classes and the supervisor of the participants during their student teaching, I played a participant-observer role (Glesne, 2006; Marshall & Rossman, 2006; Spradley, 1980). Since I was an ordinary participant in the environment studied, Spradley (1980) labels this participant-observer role a “complete participant” (p. 61). According to Spradley (1980), I fit this
role because of my complete immersion in the study of the situation. My full immersion rendered me accessible to collect authentic observations of the participant’s realities from an insider’s point of view (Yin, 2003).

To ensure integrity and trustworthiness in the data collected, all processes of data collection and analysis were made apparent to all participants. First, the purpose and design of the study were completely disclosed at the beginning and throughout the study and participation in this study was completely voluntary. Second, any discomfort that the students may have felt about the completion of any data collection tools was minimized by the fact that all data were analyzed after grades were submitted. Third, all data collection sources were imbedded as part of the requirements during student teaching. This aspect minimized the feeling of being overwhelmed by adding to student teaching responsibilities.

Data Sources

To address my research questions, “What science experiences influence science teaching self-efficacy in pre-service elementary teachers” and “How are science teaching practices depicted across different levels of efficacy during student teaching” in my dual-phase, mixed-methods embedded case study, a myriad of data sources were collected. Yin (2003) asserts that “various sources are highly complementary” and advises for the collection of multiple data sources for data triangulation. The design and use of data from Phase I, and interviews, observations, and physical artifacts from Phase II complemented each other by providing documentation over time of teaching experiences, reflections, and evaluations to investigate the research questions. Table 2 lists the data sources used
during my year-long study. The data sources are introduced in the order presented in Table 2.

Table 2

*Data Sources*

<table>
<thead>
<tr>
<th>Data Sources</th>
<th>Phase I</th>
<th>Phase II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Beg</td>
<td>Mid</td>
</tr>
<tr>
<td>STEBI-B (Enochs &amp; Riggs, 1990)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Method Class Questionnaire 1</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Journals</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Methods Class Questionnaire 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student Teaching Questionnaire 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid-Term Reflection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekly journal summaries</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Weekly observation summaries</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Lesson self-evaluation summaries</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Weekly debriefing summaries</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Student Teaching Questionnaire 2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**29 participants**

**6 participants**
Quantitative Data Source

The validated and widely used Science Teaching Efficacy Belief Instrument (STEBI-B) (Enochs & Riggs, 1990, see Appendix A) was the survey I utilized to collect the quantitative data. To measure levels of and changes in science teaching self-efficacy in elementary teachers, Riggs and Enochs (1990) developed the STEBI, and the STEBI-B (Enochs & Riggs, 1990) is a modified version used for pre-service elementary teachers. According to Enochs and Riggs (1990), the STEBI-B instrument is a 23-item survey with a five-point ordinal rating scale that ranges from strongly disagree (1) to strongly agree (5), inferring the higher the score, the higher level of efficacy a participant measures. In Enochs and Riggs (1990) design of the STEBI-B survey, the 23 items are broken down into two subscales; the Personal Science Teaching Efficacy (PSTE) consists of 13 items and measures science teaching self efficacy and the Science Teaching Outcome Expectancy (STOE) consists of 10 items and measures outcome expectancy. The 13 PSTE items were the only ones used in the analysis of each participant’s science teaching self-efficacy scores because they directly relate to the scope of my study, which was science-teaching self-efficacy.

I administered the pre STEBI-B to the participants during the first week of the Phase I semester. The purpose was to record baseline quantitative self-efficacy scores and, as discussed earlier, to identify participants for Phase II of the study. I also administered the STEBI-B survey during the last week of the Phase I semester. The STEBI-B survey was also administered at the beginning and end of Phase II. The purpose of administering the STEBI-B multiple times over the course of my study was to track any changes in efficacy
During the participants’ methods course and student teaching. The triangulation of qualitative data sources further clarifies what the efficacy scores actually mean.

Phase I Data Sources

The Phase I data sources were administered and collected during the fall 2008 science methods course. As seen in Table 2, surveys, questionnaires, and journal prompts were the class artifacts that served as the data sources for this phase. According to Creswell (2008), surveys are methods in research that describe “attitudes, opinions, behaviors, or characteristics of the population” (p. 388) that can be evaluated to identify baseline levels, trends, and gains. Therefore, questionnaires and journals were the best method to ascertain rich descriptions that augmented the quantitative measure of efficacy. Each data source is introduced next.

Methods class questionnaire 1. I electronically dispersed the Methods Class Questionnaire 1 (see Appendix B) during the first week of the Phase I semester. The purpose of this questionnaire was to capture a historical snapshot of each of the participants to probe for possible antecedents of efficacy and to obtain a baseline personal description of their initial efficacy levels. What about and how participants recall their science experiences paint a picture of their relationship with science, therefore, the Methods Class Questionnaire 1 focused on recollections of science during elementary, high school, and college, and self-reported levels of efficacy about their ability to teach science and science content knowledge.

Journal prompts. I emailed three identical journal prompts (see Appendix C) that asked participants to identify and describe class experiences that have increased, decreased, and/or have had no influence on their confidence. Journal prompts were
emailed the fourth week, ninth week, and fourteenth week of the semester. The purpose of the journal prompts was to track the development of and influences on efficacy.

Methods class questionnaire 2. During the last week of the semester, I electronically dispersed the Methods Class Questionnaire 2 (see Appendix D) to the participants. The purpose of this questionnaire was to ascertain participants’ feelings of efficacy and competency toward teaching science post methods class and to follow up on the Methods Class Questionnaire 1. Therefore, this questionnaire centered on self-reported experiences in methods class that not only shaped their efficacy, but also shaped their perceived levels of science content knowledge and their ability to teach science.

Phase II Data Sources

All Phase II data sources were administered during the spring 2009 student teaching semester. As seen in Table 2, surveys, questionnaires, journal prompts, reflections, and most important, observations and debriefings were the class artifacts that served as the data sources for this phase. Each data source is introduced next.

Student teacher questionnaire 1. I administered the Student Teacher Questionnaire 1 (see Appendix E) to the participants a week before the first day of the semester during our initial supervisor-student teacher meeting. This questionnaire was designed to acquire descriptions about what methods course experiences each participant believed would support their student teaching experiences and descriptions of their feelings about teaching science.

Weekly journal submissions. The participants were required to submit weekly journals electronically (see Appendix F for journal prompts). The intentions of the journals were to track how participants viewed and evaluated their student teaching experiences. To
achieve its purpose, the journals prompted participants to describe one positive and one challenging teaching event they experienced that week, how they felt, what they learned about themselves as a teacher, what they learned about their students, and what about their pre-service experience influenced how they acted or responded to the event.

At the eighth week of student teaching, the prompt was modified (see Appendix G for modified journal prompt) to direct participants to describe a positive and a challenging event in a math, science, or social studies teaching experience, how the preparation of the lesson contributed to what happened, what they learned about their teaching practice, what they learned about their students, how their methods class influenced what they did, and any additional information. I made the modification because I deemed it imperative to guide the student teachers in focusing on different aspects of their teaching practices. Modifying the journal prompt forced students to be cognizant about, and reflect upon, their teaching practices in content areas they had previously not addressed and encouraged them to move beyond the rudimentary elements they were continually reporting. Each of the six participants completed a total of 14 regular weekly journal entries which were generally a typed, single-spaced, one page long document.

In addition to the regular weekly journal entries, participants completed a midterm teaching reflection (see Appendix H for reflection prompt). The midterm reflection was administered during the eighth week of instruction and was designed to serve as a midpoint self check of progress. In total, all six participants completed 15 journal entries.

Observations. To fulfill the dual role as supervisor and researcher without interfering with the requirements of the field experience program, student teachers were required to schedule four lessons to be formally observed and evaluated as required by the program.
To meet the needs of data collection for this study, student teachers were also required to schedule three science lesson observations. To ensure the student teachers were not overwhelmed with scheduling lesson observations, I made it clear that the observed science lessons for this study could be a part of the four observed lessons as required by the field experience program.

To record my observations of teaching in real time, I used a chart (see Figure 1) to record a detailed log of classroom events in 5-minute increments.

<table>
<thead>
<tr>
<th>Mins</th>
<th>Time</th>
<th>Description of events</th>
<th>Noteworthy comments, practices, demeanor, students</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-15</td>
<td></td>
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<td></td>
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<td>15-20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-25</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Figure 1. Classroom Observation Tool*

This classroom observation tool was designed to gather a detailed chronological narrative account of teacher practices and classroom activities. The classroom observation tool was used during the four formal classroom observations required by the program and for any additional observations necessary for this study.

Lessons were defined as the course of instruction that focused on one concept. In the course of one school day, teachers generally taught a lesson in reading, math, social studies, and science. A lesson generally ranged from 30 to 60 minutes. During an entire observed lesson, I typed student-teacher interactions, classroom management procedures, and questioning techniques on my laptop. Actual and described teacher talk and action,
student response, and whole classroom interactions were recorded as they occurred. The purpose of the observations was to document science-teaching practices over the course of the semester.

My observations of each participant’s teaching practices were guided by the expectations of the elementary education program. Given the College of Education’s Field Experience Performance Evaluation (see Appendix I), I summarized what I expected participants to demonstrate development toward mastery of using the following three Student Teaching Expectations (STE): 1] ability to manage whole and small group instruction and behavior 2] ability to demonstrate effective content building teaching practices such as scaffold knowledge, reinforce prior knowledge, and engage students in meaningful discussions, and 3] ability to execute an age appropriate, content rich lesson.

The demonstration of inquiry based teaching (Anderson, 2006) was the desired outcome because inquiry teaching is the underpinning goal of science methods education. These STEs were my framework in evaluating the progress of the student teachers.

Pre-post science lesson self-evaluations. The Science Lesson Self-Evaluations (see Appendix J) were completed by each of the six student teacher participants following each of their observed science lessons. A week before each participant was scheduled to teach a science lesson, I emailed a Science Lesson Self-Evaluation form and reminder to complete the pre-lesson reflection questions. The purpose of the Science Lesson Self-Evaluation was to gather evidence about how participants felt before and after the planning and execution of their lesson, how they evaluated their planning and teaching practices, and how they thought their science methods course influenced their practice. To accomplish its purpose, the pre and post evaluation asked questions about their
feelings, evaluations of their planning and practice, and recollections of the influences of
methods class experiences on their practices.

Lesson Debrief. I conducted lesson debriefs with the student-teacher participants
following each of the science lessons observed. The lesson debriefs were based on how
students felt about their lesson and data recorded in my observations notes. To start the
debriefing, I asked what they thought was their strength and weakness about the lesson.

As debriefs were conducted, I typed field notes on the computer. Audio recordings
were not used because the realities of the school day were not conducive to the set up,
time, and environment needed for a quality-recorded discussion. Each debriefing
generally lasted 15-30 minutes.

Student teacher questionnaire 2. The Student Teacher Questionnaire 2 (see Appendix
K) was electronically administered to the student teacher participants during the last week
of their student teaching semester. The purpose of the open-ended Student Teacher
Questionnaire 2 was to acquire information about their perceptions of their student
teaching experiences, their ability to teach science effectively, and how their methods
class prepared them for what they experienced. To achieve its purpose, the questionnaire
consisted of questions such as, “describe your overall elementary student teaching
experiences,” “how prepared do you feel you are to teach elementary science,” and “how
did your science methods class prepare you for student teaching”.

80
Data Analysis

The overarching goal of my year-long study was to explore sources of efficacy and their impact on science teaching practices, and I do so by addressing the questions, “What science experiences influence science teaching self-efficacy in pre-service elementary teachers” and “How are science teaching practices depicted across different levels of efficacy during student teaching.” In this section, I describe the strategy used to explain how the data were analyzed.

Data Organization

Preliminary analysis entailed data organization. Data were organized as a chronological compilation of the raw data from all data sources into one computer file for each embedded case titled Level I Analysis (see Appendix L for file template). This case study database was imperative to the success of data analysis because of the need for a central location of all documents (Yin, 2003). Also the organization of raw data in one chronological document allowed for a more comprehensive perspective of a participant than reviewing one data source independent of the others.

Subsequent to compiling all data for each participant in each of their case study database, data analysis continued. How I identified the contributors of efficacy and how I characterized the six telling cases from the data are explained next. First, the analysis for the quantitative STEBI-B (Enochs & Riggs, 1990) survey is explained. Second, I describe the strategy used to identify the contributors of efficacy in Phase I. Third, I describe how I continued to identify contributors of efficacy and analyzed the participants’ professional practices in Phase II. Lastly, I discuss the strategy used to complete a cross case analysis.
**Quantitative Analysis**

Total PSTE scores from the Phase I pre-STEBI-B (Enochs & Riggs, 1990) survey were used to identify initial levels of efficacy and total PSTE scores from the Phase II post-STEBI-B were used to report changes in efficacy. As stated earlier, the survey utilizes a five-point rating scale that ranges from strongly disagree (1) to strongly agree (5). The range of possible scores for the 13 PSTE-B questions is 13 - 65, with 65 indicating the highest level of efficacy. For the 13 PSTE-B items used in my study, a reliability analysis yielded a Cronbach’s Alpha coefficient of .851 and above for each phase, including from the beginning to the end of the study. Enochs and Riggs (1990) showed that the PSTE-B had an alpha coefficient of 0.90. All coefficients were above the adequate level of reliability of .7. A one-way, repeated measures analysis of variance (ANOVA) was performed to determine if any statistically significant differences were found in the changes in the levels of efficacy over time.

For this study a median split of the six participants’ PSTE-B score identified levels of efficacy. All participants were listed in order from the lowest to the highest score. The two scores in the middle (41, 44) were operationalized as the medium level of efficacy, the two scores above the median split (50, 52) were operationalized as a high level of efficacy, and the two scores below the median split (36, 38) were operationalized as a low level of efficacy. The quantitative measure of self-efficacy was used to establish levels of efficacy to characterize and a baseline efficacy score to track changes in efficacy. The triangulation of methods in this study’s dual-phase, mixed-methods embedded case study design, further clarifies the meaning of the rankings and levels.
**Phase I Analysis**

After the chronological compilation of all Phase I data sources, I completed two domain analyses for each participant to identify each participant’s contributors of efficacy. Spradley (1980) describes a domain analysis as identifying a semantic relationship that connects included terms within a cultural domain (or category of meaning) as seen in Figure 2.

![Figure 2](image)

<table>
<thead>
<tr>
<th>Included Terms</th>
<th>Semantic Relationship</th>
<th>Domain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Figure 2. Template map of a domain analysis.*

To identify each participant’s contributors to their efficacy, I used a rational relationship to connect terms related to contributors of efficacy, to efficacy stems I defined as a domain (see Figure 3).

![Figure 3](image)

<table>
<thead>
<tr>
<th>Included Terms (Contributors of efficacy)</th>
<th>Semantic Relationship</th>
<th>Domain (Efficacy Stems)</th>
</tr>
</thead>
<tbody>
<tr>
<td>“watching my peers present,” “writing lesson plans”</td>
<td>Are reasons for</td>
<td>“I am more able,” “I am more confident,” or “I am unable”</td>
</tr>
</tbody>
</table>

*Figure 3. Domain analysis.*
In completing the domain analysis, I first located efficacy stems, which were defined as statements participants made that referred to how they felt “more able,” “more confident,” or “unable” to do a science-teaching related task. Efficacy stems were identified because they imply feelings of ability or inability to accomplish referenced science-teaching related tasks. An efficacy stem such as “I am more able to” suggested a positive influence on efficacy and was coded with a “+” for positive influence. One domain analysis was completed for all efficacy stems indicating a positive influence on efficacy. An efficacy stem such as “I am unable to” suggested a negative influence on efficacy and was coded with a “-“. A second domain analysis was completed for all efficacy stems indicating a negative influence on efficacy. Differentiation between the two was vital in identifying how different contributors of efficacy influenced each participant’s feelings of efficacy.

As I read through the Phase I data sources compiled in each case study’s Level I Analysis database, whenever I saw an efficacy stem, I coded it as a positive (+) influence or negative (-) influence on efficacy and I listed efficacy stems in the appropriate domain analysis chart. I then identified the contributor of efficacy that was connected to the efficacy stem and placed it in the same chart. For example, a participant wrote, “I feel I can effectively engage students in questioning because I did extremely well doing this in my teaching presentation.” In this data point, “I feel I can effectively” was the identified efficacy stem coded as a positive influence on efficacy. The included terms that were identified as a contributor of efficacy were “I did extremely well doing.”

Lastly, I categorized each identified contributor of efficacy by writing a one-word descriptor next to each listed contributor of efficacy. A statement such as “I did
extremely well” was categorized as “experience” because I identified the terms “I did” as an occurrence they experienced. Figure 4 shows an example of the beginning of a domain analysis for this study. My interpretation of this example was that doing well on tasks (experience) and knowing the topic (content knowledge) were categorized contributors of efficacy that positively influenced efficacy. The three most frequently categorized contributor of efficacy became each participant’s reported categories of contributors of efficacy.

<table>
<thead>
<tr>
<th>Included Terms (Contributors of efficacy)</th>
<th>Semantic Relationship</th>
<th>Domain (+ Efficacy Stems)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I did extremely well doing – experience</td>
<td>Are reasons for</td>
<td>I feel I can effectively</td>
</tr>
<tr>
<td>I made a really good lesson plan –</td>
<td></td>
<td>I know I can now</td>
</tr>
<tr>
<td>experience</td>
<td></td>
<td>I am able to</td>
</tr>
<tr>
<td>I know the topic well – content knowledge</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Figure 4. Example domain analysis*

In my next level of analysis, I recoded all efficacy stems and contributors of efficacy in each participant’s domain analysis guided by Bandura’s (1986) four sources of self-efficacy. This level of analysis provided insights that support and augment Bandura’s widely accepted sources of efficacy. The first source of efficacy is mastery experience (Bandura, 1986), and it is how doing a particular task influences efficacy. Coding for mastery experiences was defined by any reference participants made about conducting practices that directly correlated with teaching and all evidence of mastery experiences were marked with a unique colored marking. For example, a statement such as “creating
lesson plans and teaching a mini-lesson made me feel more prepared to teach” was categorized as experience and coded as a mastery source of efficacy.

The second source of efficacy is vicarious experiences (Bandura, 1986) and it is how the observation of others influences efficacy. Coding for vicarious experiences was defined as any reference participants made about observing any practices that related to teaching and all evidence of vicarious experiences were marked with another unique colored marking. For example, references about observing peers or instructors teach were data coded as a vicarious source of efficacy.

The third source of efficacy, verbal feedback (Bandura, 1986), is the verbal motivation one receives. Coding for verbal feedback was defined as participant reported evidence of instructor or peer oral comments that directly related to their preparation for or actual teaching. Examples of verbal feedback were marked with a third unique color. For example, references about comments from classmates regarding a well-designed lesson plan were data coded as verbal feedback.

Affective state is Bandura’s (1986) fourth source of efficacy and encompasses the feelings that result from the first three sources. Statements participants made regarding how experiences made them feel evidenced this source of efficacy. Coding for affective state was completed when identifying efficacy stems as positive or negative influences on efficacy.

Upon completion of the Phase I data domain analysis, a profile of each embedded case was created (see Figure 5) using Spradley’s (1980) componential analysis. This analysis allows the researcher to contrast elements from the different domains (i.e., contributors to self-efficacy), and across participants, resulting in a profile for each participant. Each of
the three categories of contributors of efficacy and all the supporting data were taken from each participant’s domain analysis and placed in each corresponding box. Each participant’s contributors of efficacy and how those contributors influenced their efficacy characterized their profile.

<table>
<thead>
<tr>
<th></th>
<th>Level Of Efficacy</th>
<th>Category 1</th>
<th>Category 2</th>
<th>Category 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nancy</td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sandy</td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whitney</td>
<td>Medium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Karen</td>
<td>Medium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sharon</td>
<td>High</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ann</td>
<td>High</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Figure 5. Participant profile, categories of contributors to self-efficacy*

**Phase II Analysis**

The Phase II data sources (see Table 2), STEBI-B (Enochs & Riggs, 1990), questionnaires, journals, observations, and reflections were compiled in chronological order after the placement of all the Phase I sources in each case’s Level I Analysis database file and the domain analysis was continued in the same manner as described for each participant.

Continuing with the method of domain analysis employed in Phase I, I read through each participant’s Phase II journals, questionnaires, and teaching reflections. I identified efficacy stems and placed them in the appropriate (positive or negative) domain analysis that was created in Phase I. I identified the connecting contributor of efficacy in each statement and placed it in the appropriate domain analysis chart. Each contributor of
efficacy was then categorized and coded using Bandura’s (1986) four sources of efficacy in the same manner data were categorized and coded during the Phase I analysis. This analysis resulted in a continuation of coded experiences that shaped efficacy that was initiated in Phase I.

Professional Practices Analysis

The three aforementioned STEs, 1] ability to manage whole and small group instruction and behavior, 2] ability to demonstrate effective content building teaching practices such as scaffold knowledge, reinforce prior knowledge, and engage students in meaningful discussions, and 3] ability to execute an age appropriate, content rich lesson as prescribed by district and state curriculum standards were my framework when evaluating the progress of the student teachers. To address my second research question, “How are science teaching practices depicted across different levels of efficacy during student teaching?” it was imperative that teaching practices during student teaching be assessed. Phase II data analysis was performed with an eye toward the three STEs. The ability to monitor participation in activities and discussions, disseminate and collect materials, and handle individual and group classroom behavior effectively were the types of practices of interest that supported the first STE because they linked directly to demonstrating capability in managing instruction and behavior.

An element of building content base knowledge includes knowing how to teach concepts strategically so that knowledge is developed. The ability to scaffold knowledge, reinforce prior knowledge, and engage students in meaningful discussions effectively were the types of practices of interest that supported the second STE because those practices implied aptitude in building a content base knowledge.
Lastly, the ability to teach lessons that was appropriate for the grade level was a practice of interest that supported the third STE because it linked directly to demonstrating skill in teaching an age appropriate lesson. Age appropriate teaching practices such as design of activity, language used during instruction, and levels of content were teaching practices of interest.

Data from Phase II journals, teaching observations, pre and post science lesson self-evaluations, and lesson debriefings were compiled into a chart located in each participant’s Level 1 Analysis case study database file. As seen in Figure 6, the chart offered a chronological view of the complete student teaching semester. The top row had all 16 weeks of the semester and each box was filled with the raw data from each corresponding data source.

<table>
<thead>
<tr>
<th></th>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
<th>Week 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student journals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-evaluations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Debriefings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 6. Student teaching semester

To sum up each 5-week segment, I completed an event map (see Figure 7) to illustrate patterns of activity. Event maps (Castanheira, Crawford, Green & Dixon, 2000; Putney, 2007) are visual representations of the activities that make up an event, in this case the
student teaching lessons. I color-coded all observations and student teacher self-evaluations that related to the STEs.

<table>
<thead>
<tr>
<th>STEs</th>
<th>Week 5</th>
<th>Week 10</th>
<th>Week 15</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>My observations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student Reflections</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Figure 7. Event mapping of student teaching practices*

All statements coded for the first focus of the STE were copied into the appropriate box under the appropriate week until the three focus areas at all three times were complete. At week 5, 10 and 15, narrative summaries were completed as Student Teaching Summaries. For example, if my observational comments only negatively addressed the first STE, I surmised that the participant struggled with management and behavior to the point of being unable to demonstrate practices in the other two areas of focus. Also, I surmised minimal progress in the improvement of teaching practices if my observational comments for week 5 and week 10 were similar. Progress was indicated by more positive observational comments in any of the three STEs. Degree of progress was indicated by the kind of positive observational comments made about each of the three STEs.

Student teacher reflections on their observed lessons were also evaluated by the presence of their attention toward the three STEs and summarized in the event mapping. Like teaching practices, the degree of progress was indicated by the shift in reflections.
toward the articulation of the impact of their teaching practices on student learning as prescribed by the three STEs. The summaries of teaching practices and reflections that were completed every five weeks offered a description of professional practices and the development of professional practices during their student teaching semester.

Each participant was characterized through telling cases that were created from their categories of efficacy through domain analysis (see Figure 4) and their teaching and reflection practices (see Figure 7). Each participant’s analyzed categories of contributors of self-efficacy and development of teaching practices were used to characterize each case during the cross case analysis for comparison of development of teaching practice between levels of efficacy.

**Cross Case Analyses**

Lastly, a cross-case analysis was completed. Case data taken from domain analysis charts and the Student Teaching Summary charts were compiled into a three by two matrix of categories (Yin, 2003) of low, medium, and high efficacy, and categories of contributors of efficacy and development of professional practice (see Figure 8).

<table>
<thead>
<tr>
<th>Categories of Efficacy</th>
<th>Low Efficacy</th>
<th>Medium Efficacy</th>
<th>High Efficacy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Development of Professional Practice</th>
<th>Beg</th>
<th>Mid</th>
<th>End</th>
<th>Beg</th>
<th>Mid</th>
<th>End</th>
<th>Beg</th>
<th>Mid</th>
<th>End</th>
</tr>
</thead>
</table>

*Figure 8. Matrix 1, Cross Case Data*
All categories of contributors of efficacy for the two participants identified as having low levels of efficacy were copied from each participant’s domain analysis (see Figure 4) into its designated box. Summaries of professional practices were copied from each participant’s Event Mapping of Student Teaching (see Figure 7) into its designated box. This was done for all three levels of efficacy for contributors of efficacy and development of professional practice. This matrix was completed for comparison of contributors of efficacy and professional practices employed across different levels of efficacy. Emergent from this analysis were similarities and differences between levels.

**Definition of Terminology**

The list of terms below contextualized the terminology used when discussing and characterizing the participants. For a standard conceptual understanding of vernacular used in this study, I operationally defined some frequently used terms below.

*Inquiry teaching*. Inquiry teaching methods are operationalized as the desired teaching techniques as prescribed by the three STEs. More specifically, inquiry teaching methods are teaching practices that incorporates engagement of students not only through hands-on activities, but also through classroom discussions that require scaffolding toward the understanding and application of learned content. Examples of inquiry teaching methods include orchestrating scaffold of content through a combination of group work, hands-on activities, skillful questioning, and discussion and demonstration of an application of knowledge (Anderson, 2006; NRC, 1996).

*Traditional teaching*. Anderson (2006) describes traditional teaching as teacher directed with passive learning environments. Examples of traditional teaching include
teacher lectures and rote memorization of basic scientific facts. With traditional teaching, students regurgitate teacher information and respond to low-level questions (Anderson, 2006).

*Content rich lessons.* Content rich lessons are defined as lessons that teach content suitable for the grade level. Content rich also implies the use of prior knowledge and integrated subject matter to augment the focus content and includes the ability to apply learned information.

*Content knowledge.* The context of content knowledge relates to what topic is being discussed at the time and refers to the level of knowledge participants report having in that specific area of science. Content knowledge can relate to something as specific as knowledge of animals or knowledge of rocks, but in the context of my study, it is not used in terms of knowledge of all science.

*Authentic teaching experiences.* Authentic teaching experiences refer to holistic experiences resembling that of a real elementary school teacher. For example, developing and teaching entire science lessons to elementary students in an elementary school setting.

*Reflections.* Reflections refer to participants’ written response to their observed lessons. Reflections are evaluated based on the level of each participant’s attention of their teaching toward student learning as prescribed by the STEs. Quality reflections refer to participants demonstrating the ability to articulate how to refine their practices toward inquiry based teaching and student learning.
Ethical Considerations

All the data sources and procedures for analysis for this study were introduced and explained to participants. The next chapter describes each case as it relates to the research questions that guided this study. However, before each case is discussed, three ethical considerations must be acknowledged.

Although a mixed-method design combined the strengths of both quantitative and qualitative data (Creswell, 2008) and an embedded telling case design study offered a rich descriptive detail of a phenomenon (Merriam, 1998; Yin, 2003), limitations to the research design existed. First, similar to the limitations found in the current literature, both phases of this study relied on self-reports, perceptions of experiences, and recollections of past science experiences. However, to address this weakness in this field of research, this research design triangulated personal experiences and perceptions with a quantitative measure and observations of teaching over time. The triangulation of the compilation of a variety of data sources was a strength in the case study data collection design (Yin, 2003).

Also, another limitation was the study’s relatively small number of participants. However, given that this study may suffer from critiques about the small number of participants, the merits of a dual-phase mixed-methods embedded case study design allowed for the collection and analysis of rich qualitative data to support statistical findings and investigate a phenomenon over time.

Lastly, Clift and Brady (2005) found that a limitation in the research that addressed methods courses and field experiences was a lack of the prospective teachers’ voice. This study addressed that limitation by relying on the voice of the prospective teachers as they
identified the experiences that influenced their efficacy and reflected on how those experiences shaped their practices. Those voices are heard in the next chapter.
The purpose of this study was to explore how science experiences shaped self-efficacy, and the development of science teaching practices across different levels of efficacy in pre-service elementary teachers. To explore this fully, the outcomes of a domain analysis and a componential analysis for categories of contributors to efficacy, and the products of event mapping for professional practice summaries described in chapter three were used to create telling cases identified with low, medium, and high levels of efficacy.

In this chapter, I first describe the outcome of the STEBI-B (Enochs & Riggs, 1990) quantitative analysis. The outcome of the quantitative analysis segues into the identification of each case’s levels of efficacy, which was based on the results of the quantitative data analysis. This brief introduction illustrates the ranking of each participant relative to the others. Second, each participant’s contributors to self-efficacy and portrayal of development of professional self are depicted in the order of lowest level of efficacy to the highest. Each participant was identified as having a low, medium, or high level of efficacy based on the results of their initial STEBI-B (Enochs & Riggs, 1990) data analysis and the triangulation of qualitative data sources further personifies each level of efficacy used in the case analysis. I conclude the description of individual participants with a profile that summarizes their data. I end this chapter with cross case analyses of the categories of contributors of efficacy and the development of professional self to highlight the unique characterization between different levels of efficacy.
Quantitative Data Analysis

The STEBI-B (Enochs & Riggs, 1990) was the quantitative survey instrument used to measure each participant’s self-efficacy. Data were submitted to a one-way repeated measures ANOVA with time of test (Phase I pretest, Phase I posttest, Phase II pretest, and Phase II posttest) as the repeated measure and STEBI-B PSTE score (range 13 to 65) as the dependent variable. The assumption of sphericity was upheld. The statistical test yielded a significant result, $F(3,15) = 23.258, p < .001, \eta^2 = .823$. Post Hoc Tukey HSD follow-up tests revealed that scores on the Phase I pretest were significantly lower than each of the other three times and that the Phase II pretest and Phase II posttest were significantly different from one another, but that the Phase I posttest was not significantly different from either the Phase II pretest or the Phase II posttest.

These results are interpreted to mean that the changes in efficacy seen in individual participants were collectively statistically significant during their science methods class (Phase I), their student teaching (Phase II), and from the beginning of their science methods class to the end of their student teaching. This finding also showed that changes in efficacy found during the two week break between Phase I and Phase II were not statistically different, suggesting that the time between the two Phases of this study had no statistically significant impact on their level of efficacy.

Introduction of the Participants

Phase I pre STEBI-B PSTE (Enochs & Riggs, 1990) scores are shown in Table 3. Table 3 contextualizes the initial levels of efficacy and shows the ranking of each
participant. In this scale, the closer to the maximum score of 65, the higher the level of efficacy.

Table 3

Self-Efficacy PSTE Baseline Scores

<table>
<thead>
<tr>
<th>Participant</th>
<th>Raw Score (range 13 to 65)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nancy</td>
<td>36</td>
</tr>
<tr>
<td>Sandy</td>
<td>38</td>
</tr>
<tr>
<td>Whitney</td>
<td>41</td>
</tr>
<tr>
<td>Karen</td>
<td>44</td>
</tr>
<tr>
<td>Sharon</td>
<td>50</td>
</tr>
<tr>
<td>Ann</td>
<td>52</td>
</tr>
</tbody>
</table>

According to her Phase I pre STEBI-B PSTE score (36), Nancy started Phase I (science methods class) with the lowest level of science teaching self-efficacy among the six participants. With only two points separating them, Sandy started Phase I with a score of 38. Nancy and Sandy were identified as the telling cases that represented the low level of science teaching self-efficacy.

Whitney and Karen began Phase I with scores of 41 and 44 respectively. In the median split of scores used to identify the three levels of efficacy, Whitney and Karen were the participants who were closest to the median split. Whitney and Karen were
identified as the telling cases that characterized the medium level of science teaching self-efficacy.

Sharon and Ann were identified as the telling cases that characterized the high level of science teaching self-efficacy. Sharon started Phase I with a score of 50. Ann started Phase I with the highest level of science teaching self-efficacy with a score of 52.

Next, individual participants are discussed in the order of lowest to highest level of efficacy. In the explanation of each individual, I address my first research question with the analysis of the categories of contributors of their efficacy. I then begin to address my second research question with the analysis of the development of their professional self. As stated in chapter 3, the professional self was evidenced by the following Student Teaching Expectations (STEs): 1] whole and small group management 2] science content building practices and 3] age appropriate and content rich practices in their science teaching practices and reflections. Those three areas of focus that make up the Student Teaching Expectations (STEs) summarize the College of Education Field Experiences Performance Evaluation. A profile framed by their level of efficacy, concludes each participant and tells the story of the development of their professional self.

The development of efficacy depicted in the profiles resonated with a student teacher’s development in Putney and Broughton’s (2010) study. Parallels between this study’s findings and their developing efficacy stages are made in the profiles. Putney and Broughton (2010) examined the development of a pre-service teacher’s efficacy through a Vygotskian lens and found that “Efficacy Onset” (p. 13) was the early stage represented by the pre-service teacher focusing on her mentor’s actions. “Developing Efficacy” (p. 14) was the next point in the process where the pre-service teacher’s focus shifted to the
understanding the impact of the mentor teacher’s actions on her students. Lastly, “Maturing Efficacy” (p. 17) was described as the shift in the pre-service teacher’s focus to seeing herself as the teacher who influences classroom interactions for student learning.

Low Levels of Efficacy

Nancy and Sandy were identified as the two participants with the lowest levels of science teaching self-efficacy. They were two of the four participants assigned to the elementary school located in the northeastern region of the school district. Nancy was assigned to a third grade class and Sandy was in a first grade class.

Nancy

Based on Nancy’s Phase I pre STEBI-B PSTE score of 36 out of 65, she started the study with the lowest level of self-efficacy. However, as seen in Table 4, her scores indicated an increase in efficacy during both phases of the study.
Table 4

Nancy’s STEBI-B, Personal Science Teaching Efficacy (PSTE) Scores

<table>
<thead>
<tr>
<th></th>
<th>Score</th>
<th>Raw Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline (Phase I, pre STEBI-B PSTE)</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Phase I post STEBI-B PSTE</td>
<td>43</td>
<td>+ 7</td>
</tr>
<tr>
<td>Phase II pre STEBI-B PSTE</td>
<td>42</td>
<td>- 1</td>
</tr>
<tr>
<td>Final (Phase II, post STEBI-B PSTE)</td>
<td>53</td>
<td>+ 11</td>
</tr>
<tr>
<td>Baseline to Final</td>
<td></td>
<td>+ 17</td>
</tr>
</tbody>
</table>

Note: Raw Gain = difference between scores, + = efficacy increase, - = efficacy decrease

This overall increase indicated that Nancy felt more confident in her ability to teach science by the end of student teaching. Although Nancy’s self-efficacy score indicated an overall increase in efficacy, a slight decrease in her scores (-1) was found between the end of Phase I and the beginning of Phase II. For Nancy, the idea of teaching in an authentic classroom challenged the efficacy that she gained during her science methods class. She commented, “I learned important things in methods class, but now I have to do it in front of a real class” (Phase II, Questionnaire 1).

Nancy’s scores also show that her raw gain efficacy score increase (+11) was nearly twice as much during student teaching as it was during her methods course (+7), and that her score increased the most (+17) from the beginning to end of the study. These scores suggested that Nancy’s student teaching experiences had more of an impact on her confidence to teach science than her science methods course. These quantitative data
offer an overview of Nancy’s efficacy levels over the year of the study. To contextualize Nancy’s scores, the analysis of the qualitative data is reported next.

**Contributors to Nancy’s Self-Efficacy**

In my domain analysis of Nancy’s contributors to her efficacy, efficacy stems such as “I am more able,” “I am unable,” or “I feel more confident about” had connecting ideas that were most frequently identified by the categories of experience, content knowledge, and personal enjoyment. Each of those is fleshed out below.

**Experience.** Nancy shared how science related experiences (both positive and negative), or lack thereof, influenced her learning and teaching science. When reflecting about her past experiences, Nancy shared:

I hated science in elementary and never really learned to enjoy it since. The only thing I remember was bombing during the science fairs and being so nervous I messed up on presentations. It’s probably why I’m not good at it now and I’m very nervous about teaching it. (Phase I, Questionnaire 1)

In another reference to a negative experience Nancy wrote, “doing graphs killed my confidence! I hated this assignment and I can’t believe I failed it!! I so need more practice. Yeah [sic], there’s no way I can teach this topic yet” (Phase I, journal). Nancy’s failure in learning science were identified by the connecting ideas, “bombing science fairs,” “messed up,” and “I failed [doing graphs]” were linked to the efficacy stems, “nervous about teaching it,” “no way I can teach this topic,” and “killed my confidence” and suggested that perceived failures in learning science contributed to Nancy’s low sense of efficacy in her ability to teach it.
As exemplified in her data, a lack of science teaching experiences influenced Nancy’s self-efficacy in the same manner as negative science learning experiences. Nancy reported, “in my first practicum, science was only taught twice a week and I was not present when science was being taught. I think this has a huge influence on why I am not confident with science right now.” Nancy also stated, “I have no confidence in teaching physical science because I have no experience in making a physical science lesson let alone teaching one” (Phase I, Questionnaire 1). Nancy made the above statements at the very beginning of Phase I indicating that negative science learning experiences and a lack of science teaching experiences were both contributors to her low sense of science teaching self-efficacy.

Nancy also mentioned positive science learning and teaching experiences in reference to her science methods course experiences. She wrote:

I enjoy doing hands-on activities and they help me practice what and how I am supposed to teach…. Going on field trips was great - they helped me envision how to teach around field trips…. These things make me feel better prepared.

(Phase I, journal)

At the beginning of Phase II, Nancy wrote:

I’m glad I had to teach a lesson and write a lesson plan in my science methods class. At least I know I can do it. Watching my classmates do their presentations and holding onto their lesson plans makes me feel better about teaching too. I have ideas other than what I did and ideas of how to use different techniques.

(Phase II, Questionnaire 1)
For Nancy, recollections of her science methods experiences such as doing hands-on activities, attending field trips, teaching lessons, and observing her peers offered her practice, ideas, and visions of what science teaching might entail which made her feel better prepared to teach science and reflects the increase in her efficacy score during Phase I.

Nancy also commented on what gaining science teaching experiences meant for her during student teaching. At week 3, Nancy wrote, “I’m still nervous in front of the students. I don’t know them all yet…teaching actions are not yet natural either…but I’m definitely more comfortable than I was during the first week!” At week 7, Nancy enthusiastically shared:

Now that I’ve been doing this, being in front of the class, being a part of them, I feel so much more at ease. Just being here, having this day-to-day, real, experience – living the life – this is what I need.

At the end of student teaching, Nancy emphasized the influence of having science teaching experiences when she wrote, “I feel confident about teaching because I was in the classroom everyday and doing 100% of the day. There is no more to explain. I learned how to teach from hands-on experience” (Phase II, Questionnaire 2). Nancy also stated, “Once I felt more comfortable in front of the class, I felt my confidence skyrocket” (Phase II, Questionnaire 2).

Nancy’s STEBI-B PSTE scores supported her report of her confidence being linked to authentic experiences. Nancy’s raw gain during student teaching (+11) was higher than her raw gain during methods class (+7). The authentic teaching experiences during student teaching had more of an impact on her level of efficacy as evidenced in her
increased efficacy scores, student teacher reflections, and questionnaire responses. In addition to Nancy’s science experiences, the domain analysis of categories of contributors to efficacy indicated that science content knowledge also influenced her feelings in her ability to teach science.

**Content knowledge.** At the beginning of Phase I, Nancy shared, “it’s been a while since I had science classes. I don’t remember what science I learned therefore I know I can’t teach them well” (Phase I, Questionnaire 1). At the end of Phase I, Nancy shared, “my understanding of physical science is not as high as life or earth science and I don’t think I can teach a good lesson in it” (Phase I, Questionnaire 2). In these two examples, statements regarding her minimal understanding of science content were linked to her feelings of low efficacy. This evidenced that a lack of content knowledge resulted, for Nancy, in doubts about her ability to teach that content.

Also evident was how Nancy’s efficacy was content specific. For example, additional data illustrated how content knowledge influenced how Nancy felt about her ability to teach. In her week 3 student teacher reflection Nancy shared:

> I was totally unsure and nervous about what I know and don’t know! I didn’t want to ask questions and I was afraid students would ask questions I couldn’t answer. So I ended up blurting out basic facts and information…. I was SO [sic] not confident teaching this lesson and I think my lack of confidence played a big part in teaching it poorly.

Nancy’s uncertainty about science content challenged her confidence and was a factor in her teaching by “blurting basic facts and information,” which is representative of more traditional than inquiry teaching.
On the other hand, by week 7, Nancy boasted:

I think I rocked this lesson because I knew my stuff! Because I knew the topic, it was easy to relate it to other things and ask good questions. It felt good to know what I was talking about…. I feel much more confident- at least with this topic! (week 7, student teacher reflection)

Toward the end of the student teaching semester, Nancy shared, “It felt awesome when I was able to give three different examples so students could understand…. I know I wouldn’t be able to do that if I didn’t have a strong understanding of the animals we were working on” (week 13 student teacher reflection). As exemplified in Nancy’s student teacher reflections and questionnaires, her efficacy was content specific. Also, for Nancy, knowing the content enabled her to “relate it to other things and ask good questions,” which point to more science inquiry teaching practices than the traditional “blurting out the facts.”

Personal enjoyment. For Nancy, enjoying the experience or interest in the topic were the main filters to feeling confident. In her Phase I Questionnaire, Nancy wrote, “It’s easier to come up with a lesson if my interest is higher and it’s easier to research and deliver a lesson on a subject I enjoy…. My motivation and level of comfort is already there.” Nancy perceived it to be easier to teach a lesson in which she had a particular interest. Nancy also wrote, “I have yet to teach an earth science lesson, but I feel I have the potential to deliver a good lesson due to the fact that I find earth science interesting.” In other words, despite her lack of earth science teaching experience, Nancy’s interest in it contributed to her confidence to teach it.
Nancy reported also never having taught a physical science lesson, and she stated, “I’m not too interested in the subject….I don’t feel I can teach this subject at all.” Despite the fact that Nancy expressed having no experience in teaching earth or physical science, she felt that she had the potential to teach the subject she was interested in and she conveyed doubt about her ability to teach the other.

Nancy’s personal enjoyment of an experience also impacted her efficacy during student teaching as evidenced by the fact that Nancy prefaced many of her reflections with whether or not she liked the topic. “I have always been interested in minerals. Doing the research and making this lesson was fun because I wanted to do creative and engaging things” (week 5, student teacher reflection). For Nancy, not only did personal interest contribute to her enjoying research and lesson creation, it also inspired an engaging lesson.

In a later reflection, Nancy reported:

I’ve always liked animals, but not group research with group presentations – and not ones that stretched over weeks!! Figuring out how to do this group project was a serious pain! My heart wasn’t in it and I think that’s why the projects weren’t as good as they should have been. I wasn’t comfortable doing this project and I think it’s because I don’t enjoy this sort of thing. (week 10, student teacher reflection)

For Nancy, although she enjoyed the topic animals, she was not fond of long-term group projects. Nancy and her cooperating teacher collaborated on the design of this project. However, it appeared Nancy’s disinterest toward group projects seemed to be the factor in what she described as poor projects.
Development of Nancy’s Professional Self

The development of professional self for all participants was analyzed using the following three STEs: 1] classroom management 2] science teaching practices and 3] age appropriate and content rich lessons. The demonstration of inquiry-based teaching was the desired outcome because it is the underpinning goal of science methods education. Data were summarized at the 5th, 10th, and 15th week of the 16-week semester as Student Teaching Summaries. Each participant’s portrayal of her development of professional was characterized by the nature of the observed teaching practices and student teacher reflections. Each participant’s profile address how her level of science teaching efficacy was characterized, and concludes her section.

Nancy was assigned to a fourth grade class at an elementary school in the northeast region of the school district for student teaching. The week 5 Student Teaching Summary of Nancy included three observations and three of Nancy’s reflections on those observed lessons during weeks 2 through 5. The observations evidenced that Nancy had “no overt connection between activities within a lesson…” (week 2, supervisor observation notes), and implemented “lesson activities [that were] were independent of each other… [and] need[ed] transitions between tasks,” (week 3, supervisor observation notes). Nancy was also advised to, “work on discussions vs. rapid fire Q/A and focus on content vs. procedures” (week 5, supervisor observation notes). In week 3, I wrote, “effective direction giving, but building content understanding needs attention.” These examples illustrate that the observations were primarily focused on two of the three STEs, which were the need to improve teaching practices and level of content. Also, minimal negative
comments were made about classroom management, indicating classroom management was not a concern.

At week 5, Nancy’s reflections of these lessons resembled vague and overarching descriptions and did not overtly relate to any of the three STEs. In Nancy’s reflection of a week 2 lesson she wrote:

I wasn’t sure about anything about this lesson. I know my uncertainty was an obstacle. It felt like I was just robotically doing things. I’ve been watching my CT and I do what she does….I’m doing what teachers are supposed to be doing, but it’s not happening the way it’s supposed to happen. (week 2, student teacher reflection)

Nancy’s overarching comments such as, “wasn’t sure about anything,” “uncertainty was an obstacle,” “robotically doing things,” and “I’m doing what I’m supposed to be doing, but it’s not happening the way it’s supposed to happen” showed a vague recognition of her teaching issues because she did not address any specific teaching strategies in any of the three STEs. In her week 3 reflection Nancy stated, “I know I need to make better questions and I need to allow students to talk more” (week 3, student teacher reflection). In this reflection, Nancy briefly addressed one STE, a teaching practice.

The nature of my observations and Nancy’s reflections indicated that at this stage Nancy successfully maintained control of her class, but did not demonstrate inquiry teaching practices in a content rich lesson. In other words, at this time Nancy only demonstrated satisfactory teaching practices in one of the three STEs, which was classroom management. Nancy articulated an awareness of her limitations in teaching
when she recalled robotically doing things, but she did not elaborate on the impact of her
limitations or suggest how to overcome them.

The second Student Teaching Summary analyzed at week 10 included four
observations and four of Nancy’s reflections on those lessons during weeks 6 through 10.
The observations evidenced that Nancy demonstrated, “Good multi-tasking for the
management of the small groups….much better connection between elements of your
lesson – it’s flowing better…[and] good whole class wrap up discussion” (week 7,
supervisor observation notes). In week 8, observation notes read, “Follow up on student
comments led to content rich class discussion, questions resulted in student explaining
answers, appropriate pacing” (week 8, supervisor observation notes). Observation data
showed not only did Nancy continue to maintain control of the class, but also she asked
students to explain their understanding and engaged them in discussions about the
content, which demonstrated teaching practices in all three STEs and provided evidence
of progression in her teaching.

At week 10, Nancy’s reflections of these lessons addressed all areas in the STEs,
which indicated progress in her thinking about her teaching. Nancy wrote, “I asked
students to explain their strategies….I designed the lesson knowing I wanted them to
explore different strategies so we can pick the most effective one to use later” (week 8,
student teacher reflection). Nancy added:

I saw my CT do this…and then I saw how the students recalled the different
examples the class brought up and how they were able to talk about the strengths
and weakness of each…The technique gave students ownership of their strategies
and it gave them the opportunity to talk about real examples and pick the best one to use for their next assignment.

Nancy’s thinking matured from simply identifying teaching issues to discussing the purpose behind her lesson design decisions and recognizing the impact of her lessons design on the desired outcomes.

The last Student Teaching Summary of Nancy at week 15 included three observations and three of Nancy’s reflections on these lessons during the weeks 11 through 15. The final summary evidenced “effective scaffold of content for student understanding” (week 11, supervisor observation notes), “smooth transitions and connectivity between tasks, skillful multitasking” (week 12, supervisor observation notes), and “great management of class through activities….students were engaged in a content rich discussion about how to solve the problem!” (week 13, supervisor observation notes). These examples illustrated that Nancy progressed from traditional teaching practices such as “blurting out information,” to inquiry based teaching as evidenced by “scaffold of content” and “students were engaged in a content rich discussion about how to solve the problem.”

At week 15, Nancy’s reflections contained the identification and evaluation of the influences of her teaching practices on student learning. Nancy wrote:

I know sometimes pockets of students were off task. I need to work on sustaining student participation so they are continually engaged…when they remain engaged - when they are doing the activities and talking about what is happening, they are learning… I could have done this better by….” (week 11, student teacher reflection)
Nancy recognized that during this lesson some students were intermittently inattentive, validated why it was important for students to maintain engagement, and suggested how to improve. Regarding the elements of teaching practices and content rich lessons, Nancy shared:

I’ve been thinking about how to best connect what students know to what they need to know by figuring out how they need to learn…I know I want to learn how to tie content all together better– in discussions, activities, and assignments – so students have a better understanding of what we’re learning. (week 13, student teacher reflection)

Nancy’s reflections matured to a level where she addressed the need for cohesive lessons as a means to connect prior knowledge to learning. At this time, Nancy’s reflections were also indicative of progress because it was the first time she discussed her students at the level where she entertained the concept of “figuring out how they need to learn.”

Profile of Nancy

Nancy started the study as the participant with the lowest level of science teaching self-efficacy (36), and she, and another participant Whitney, reported the greatest gain over the time of the entire study (+17). Nancy’s increase in her efficacy during science methods class (+7) was attributed to her exposure to science teaching practical and observational experiences. These experiences provided clear evidence of mastery and vicarious sources of efficacy (Bandura, 1986) and corroborate current literature that states science methods class experiences have a positive impact on pre-service elementary teachers science teaching self-efficacy (Bleichner, 2007; Yoon, et al, 2006).
Nancy’s efficacy score also revealed a notably larger increase in her efficacy gain during student teaching (+11) than during her science methods class (+7). Of the six participants, Nancy’s score increased the most during student teaching. Student teaching had a profound impact on Nancy’s science teaching self-efficacy because of the science teaching practical experiences she gained during this time as evidenced by her statement that she learned mostly because she was in the classroom (Phase II Questionnaire 2).

During the first 5 weeks of her student teaching semester, Nancy’s teaching practices indicated that she had control of classroom management, but her lessons lacked cohesiveness and content. At this time, uncertainty about content challenged her confidence and was a factor in her teaching by “blurting out information” which was more representative of traditional teaching than inquiry teaching. Nancy’s lack of science teaching experiences also affected her confidence at this time as evidenced in her week 3 reflection where she expressed being nervous in front of her students. Nancy’s reflections during the first 5 weeks of student teaching were limited to the vague identification of teaching issues. Nancy was in the “Efficacy Onset” (Putney & Broughton, 2010, p. 13) stage as evidenced by her focus on her cooperating teacher and her cooperating teacher’s success in the classroom (week 2, student teacher reflection).

Progress was evidenced during the next 5 weeks by observation notes that reported connections between activities and content rich discussions in Nancy’s lessons, suggesting elements of all three STEs were evident in Nancy’s teaching. The presence of a more content rich discussion indicated progress from “blurting out information” and was more representative of inquiry based teaching. At this time, the impact of gaining authentic science teaching experiences was clear when she reported, “Just being here,
having this day-to-day, real experience – living the life – this is what I need (week 7, student teacher reflection).

Nancy’s reflections had also shifted from the mention of vague issues to the discussion of the execution of her teaching practices. This finding supports that Nancy progressed into Putney and Broughton’s (2010) “Developing Efficacy” (p. 14) stage and suggests that Nancy’s thinking progressed from focusing on her mentor to focusing on her own teaching practices.

By the last 5 weeks of her student teaching semester, Nancy demonstrated scaffolding of content and skillful multi-tasking in a content rich lesson. Nancy’s progression from content rich discussions during the previous 5 weeks to content rich lessons during this time revealed progress in her inquiry teaching methods. At this time, Nancy’s expressed wanting to “figure out how they [students] need to learn” (week 13, student teacher reflection). Nancy assessed best practices for student learning outcomes in her reflections, which was representative of Putney and Broughton’s (2010) “Maturing Efficacy” (p. 17) stage. This shift suggested that Nancy was thinking about the impact of her practices on student learning.

In her Phase II, Questionnaire 2, Nancy emphasized the influence of having authentic science teaching experiences. Authentic teaching experiences as a contributor to Nancy’s efficacy validated that her student teaching experiences (raw gain, +11) had more of an impact on her efficacy than her student teaching experiences (raw gain, +7).

Nancy started the study with the lowest level of science teaching self-efficacy. However she ended her student teaching experience more representative of an individual with high efficacy than low levels of efficacy. Current literature states that individuals
with higher levels of efficacy have a propensity to teach in line with the instructional practices advocated in the goals of reform science teaching (Czerniak & Shriver, 1994) and confident individuals view difficult tasks as challenges and have increased effort toward success in their challenges (Pajares, & Schunk, 2001). Nancy’s lesson observations were evident of teaching practices in line with the goals of reform science teaching and she persevered through her challenges during student teaching.

For Nancy, what propelled her developing efficacy and teaching practice was her shift in perspective of herself as the teacher as she acquired more authentic science teaching experiences. In seeing herself as the teacher, she became more self-regulatory (Zimmerman, 2000) which strengthened her capability to learn.

Sandy

Based on Sandy’s Phase I pre STEBI-B score of 38 out of 65, she started the study with the second lowest level of science teaching self-efficacy. As seen in Table 5, Sandy’s scores indicated an increase in efficacy from the beginning to the end of the study.
Table 5

*Sandy’s STEBI-B, PSTE Scores*

<table>
<thead>
<tr>
<th>Score</th>
<th>Raw Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline (Phase I, pre STEBI-B PSTE)</strong></td>
<td>38</td>
</tr>
<tr>
<td>Phase I post STEBI-B PSTE</td>
<td>51</td>
</tr>
<tr>
<td>Phase II pre STEBI-B PSTE</td>
<td>49</td>
</tr>
<tr>
<td>Final (Phase II, post STEBI-B PSTE)</td>
<td>50</td>
</tr>
<tr>
<td>Baseline to Final</td>
<td></td>
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Note: Raw Gain = difference between scores, + = efficacy increase, - = efficacy decrease

Although Sandy’s self-efficacy score indicated an overall increase in level efficacy, a slight decrease in her score (-2) was found between the end of Phase I and the beginning of Phase II. For Sandy, being the teacher in charge challenged the efficacy she gained during her science methods class as indicated in her statement, “I learned valuable information last semester…. [But] now I am really going to be the teacher, I’m the one in charge” (Phase II, Questionnaire 1). Like Nancy, Sandy expressed uncertainty about the reality of teaching.

Sandy’s scores also show that her methods class raw gain (+13) was dramatically more than her student teaching raw gain (+1). The difference suggested that the influence of the science methods class had a more significant impact on her confidence to teach science than the impact of student teaching. These quantitative data provide an overview of Sandy’s efficacy over the year of the study. To add meaning to the quantitative overview, the analysis of Sandy’s qualitative data is reported next.


d--- Contributors to Sandy’s Self-Efficacy ---

My domain analysis of Sandy’s contributors of efficacy resulted in identifying efficacy stems such as “I am more able,” “I am able,” or “I feel more confident about.” These efficacy stems had connecting ideas that were most frequently identified by the categories of experience, content knowledge, and personal enjoyment. Each of those is fleshed out below.

**Experience.** When reporting about her experience with science, Sandy stated,

I guess I am indifferent about science. I don’t remember much… I think I hated more than I loved it… I know I don’t have a strong background in science… Right now I’m not sure if I can teach it because my experience with science has been blah [sic] so far… (Phase I, Questionnaire 1)

In this example, Sandy’s lack of memorable experience in learning science contributed to her uncertainty about her ability to teach it.

At the end of her methods class, Sandy reported:

We got to observe and practice inquiry teaching [in science] and I feel much more confident about teaching science! We made lesson plans, we taught a lesson, and we observed our classmates teach a lesson. We then talked about what worked, what didn’t work, what we can improve… we identified traditional and inquiry practices in everyone’s presentations… Being able to do and watch and then evaluate things as a class helped me with what teaching science should look like. I honestly feel I can totally teach science. (Phase I, Questionnaire 2)

Sandy’s methods class high raw gain (+13) was validated by her detailed account of the methods class experiences that contributed to her efficacy. Sandy also wrote, “I am
worried about the fact that I did not get to teach science during my practicum. What we
did in class was great, but I don’t know for sure if I can teach real students because I
haven’t tried it” (Phase I, Questionnaire 2). Sandy’s lack of experience in teaching
science contributed to her doubt of her ability to teach science. However, her method
class raw gain (+13) suggested that practicing and observing teaching practices during
her methods class had more of an impact on increasing her efficacy than the lack of
authentic teaching and learning science experiences tested it.

The lack of authentic teaching experiences had a detrimental impact on Sandy’s
efficacy during student teaching. Sandy shared, “I don’t have enough experience teaching
science to real students at this grade level and I’m worried if I can pull this off” (Phase II,
Questionnaire 1). The lack of teaching experiences was reason for her struggles as
evidenced in her student teacher reflections:

I was not very good at giving directions or really in classroom management…
The content was easy, it’s 1st grade! But I couldn’t really teach because I didn’t
have the students’ attention. I haven’t done this lesson with real students before
and this was exactly what I was worried about. (week 4, student teacher
reflection)

In many of Sandy’s student teacher reflections she used “not having done [this] before
with this grade” as a reason for not teaching well and simply claimed she just needed
experience. In week 7 Sandy wrote, “…my students have moved around independent
learning centers, but I’ve never done a lesson where all the centers are linked and that’s
why it was a little chaotic…I just need to do this several times before I can perfect it.” In
week 10, Sandy wrote, “…wow, this was my first time teaching about magnets to real students and I didn’t know that they’d respond so crazily to all the materials!”

In week 12 she said, “I thought I was getting the hang of this, but every time I teach a topic or try an activity I haven’t done before, I seem to have a hard time. I just need to keep practicing.” In addition to experience, the domain analysis of Sandy’s contributors to efficacy suggested that content knowledge was another category that influenced how Sandy felt about her ability to teach.

*Content knowledge.* When Sandy referenced her lack of content knowledge, she often coupled it with how she compensated:

> I have great confidence in my teaching abilities when given ample time to prepare and refresh myself with the topic… I don’t feel the knowledge I have is sufficient enough, but one must take into consideration that I won’t be doing this alone. I’ll have resources. (Phase I, Questionnaire 1)

Sandy also wrote, “I don’t know [earth science] well enough to teach it with confidence, but maybe if I take time to prepare it, I can teach it ok [sic]” (Phase I, Questionnaire 1).

Regarding physical science Sandy reported, “I feel I have little confidence in teaching physical science because I don’t know much about it, but I’m sure there will be teachers I can collaborate with” (Phase I, Questionnaire 1). Sandy concluded her questionnaire by saying:

> Yeah, I don’t know much about earth and life science, and I certainly don’t know much about physical science…This of course makes me unsure if I can teach, but I’d probably just have to look over the stuff. I’d probably have a hard time with the higher grade levels. (Phase I, Questionnaire 1)
Sandy admitted that not having a strong background in science challenged her confidence to teach, and she suggested that having time to prepare and being resourceful can make up for her insufficient science content background.

At the end of her methods class Sandy reflected:

I feel I have gained valuable information in regards to teaching science… we got to be teachers by making lessons and teaching it, we watched our classmates teach their lessons and we evaluated their teaching practices… And what I learned was you can’t do inquiry if you don’t understand the content. I’m confident I know what inquiry teaching looks like, but I’m not sure if I can do it given what little science I know. (Phase I, Questionnaire 2)

Sandy’s responses regarding how content knowledge impacted her efficacy was inconsistent. Sandy implied that “refreshing my memory and…. not working alone” would be sufficient enough to ensure she teaches well, yet she continually commented about her uncertainty in her ability to teach because of her lack of content knowledge.

What was consistent about Sandy was that when she felt confident about a topic, she felt confident in her ability to teach it: “The parts of a flower lesson was easy! I know the parts of a flower and their roles… asking open-ended questions that would get students making the connections would be easy, like a natural conversation!” (Phase I, final journal).

Personal enjoyment. Like Nancy, what preceded the negative influences of experience and content knowledge was whether or not Sandy enjoyed a particular experience. Regardless of Sandy’s experience or content knowledge, she conveyed confidence in her ability to teach if she found enjoyment or interest in the topic. In her Phase I,
Questionnaire 1 Sandy wrote, “In high school I remember doing this mole project. I totally failed that project, but I had fun. I think I can teach that activity - I’d like to teach something like that because it was memorable” (Phase I, Questionnaire 1). Sandy shared that she failed her project but enjoyed the experience. Her enjoyment of the experience had more influence on her efficacy than whether or not she succeeded in the event. Her personal interest in science experiences, regardless of her academic success, had this same effect on her during student teaching. Sandy shared:

The lesson on eyes was so fun! Making it was fun too – I was so into making this lesson because I was able to be creative for the students… I’ve never done a lesson where all the centers are linked and that’s why it was a little chaotic…But I think it was more a success because we all enjoyed it. (week 7, student teacher reflection)

Sandy also wrote:

I had so much fun designing this lesson! I loved this magnet lesson I saw in methods class so I tried it with my students. This was my first time teaching about magnets to real students and I didn’t know that they’d respond so crazily to all the materials, but I think overall, this lesson was good! (week 10, student teaching reflection)

In these two examples, Sandy brushed off “chaos and craziness” because she had “never taught/done” the lesson, but she emphatically related fun and joy to a successful lesson. In other words, Sandy related personal enjoyment to her ability to teach a lesson, regardless of the academic outcome. Next, the results of my event mapping of Sandy’s development of her professional self are discussed.
Development of Sandy's Professional Self

Sandy was assigned to a first grade class in an elementary school in the northeastern region of the school district for student teaching. The week 5 Student Teaching Summary of Sandy included two observations and two of Sandy’s reflections on those observed lessons during weeks 2 through 5. The observations evidenced that Sandy:

Had great rapport with students and were enthusiastic about this lesson. However your students were rarely on task and were not paying attention. They were all over the place, they didn’t understand what they had to do, and they weren’t listening to you. (week 3, supervisor observation notes)

During week 4, observation comments resembled those written during week 3 with, “…you rarely had the student’s attention, and when you did, it was not for long..”

At this time, observation notes were limited to concerns about classroom management and those issues clearly impeded Sandy’s ability to demonstrate science teaching skills.

At week 5, Sandy’s reflections of these lessons showed that she only responded to her issue about classroom management minimally when she said, “I’ve never done this lesson with this grade level before, so I didn’t know what to expect. I’ve been observing [my CT] and she makes it look so easy” (week 3, student teacher reflection).

Sandy’s week 4 student teacher reflection was similar:

I was not very good at giving directions or with classroom management…. But I couldn’t really teach because I didn’t have the students’ attention. I haven’t done this with real students before and this was exactly what I was worried about…It seems this class is rowdy with [my CT], but she somehow gets teaching done. (week 4, student teacher reflection)
The nature of my observations and Sandy’s reflections indicated that at this time, Sandy did not have the opportunity to demonstrate her science teaching skills in a content rich lesson because she struggled with the management of students. Although Sandy identified that she had issues with classroom management, she made no attempt to elaborate in her reflections on the implications of her issues. In other words, Sandy did not demonstrate teaching or reflecting in any of the three STEs.

The week 10 Student Teaching Summary of Sandy included three observations and three of Sandy’s reflections on those lessons during weeks 6 through 10. Observation notes such as,

You started the lesson using a great strategy to get their attention, but you need to follow through. You only spoke when you had their attention, you paced the beginning well, you made sure they understood the next task… but then 15 minutes into the lesson, you lost them, (week 7, supervisor observation notes) evidenced that Sandy implemented short-lived management techniques. In week 10, observational notes indicated Sandy demonstrated an improvement in her management efforts and teaching practices:

You stepped through the instructions and parts of the lesson at a much better pace with your students. How do you think that influenced the lesson?...When you paced things, I saw that you were able to teach! You asked them meaningful questions and there were a few moments where they were able to apply what they learned. (week 10, supervisor observation notes)

In her week 5 summary Sandy demonstrated no control of her class, but by the end of week 10, Sandy progressed to demonstrating partial control and the potential to utilize
inquiry teaching practices such as meaningful questions and the application of information.

At week 10, Sandy’s reflections of these lessons evidenced a shift in her thinking when she shared:

My students seemed to know more what was expected of them. They were more on task today….I forget how short their attention spans are and breaking down the steps for them made it so they weren’t overwhelmed. When they aren’t overwhelmed, they can concentrate on the task at hand. I noticed that [my CT] tells the students one step, makes them do it, and then asks what they should do next, and they do it, and so forth. It’s tiring, but it’s what needs to be done. (week 10, student teaching reflection)

Sandy’s thinking developed from reflections limited to the identification of an issue in her week 5 summary to articulating the influence her teaching practices had on her students when she related breaking down instructions to her students being on task. As cited earlier, Sandy wrote, “…my students have moved around independent learning centers, but I’ve never done a lesson where all the centers are linked and that’s why it was a little chaotic…I just need to do this several times before I can perfect it” (week 7, student teacher reflection). What was clear at this point was that although a lack of prior authentic teaching experiences did not quell her methods class raw gain (+13), it was a limiting factor in Sandy’s small raw score gain (+1) during student teaching.

Sandy’s last Student Teaching Summary at week 15 included three observations and three of Sandy’s reflections on those lessons during weeks 11 through 15. The final
summary indicated improvement in Sandy’s science teaching practices in areas other than student behavior as evidenced by the observation notes:

You are doing better with getting through more of a lesson! Because the students were on task during parts of this lesson, you definitely were able to address content! Even with the little ones, you had them predicting, questioning, and applying… you even brought up stuff they’ve learned, their prior knowledge! (week 13, supervisor observation notes)

In the next week, observation notes read:

Even though you still do some parts of your lesson in a very teacher centered way, you did engage the students in a meaningful discussion and asked them to justify their answers!! You were able to keep the students focused on the lesson for a longer period of time….You asked a good blend of questions – some direct, some open-ended….Why do you think this lesson flowed the way it did? (week 15, supervisor observation notes)

An improvement in Sandy’s teaching practices was observed because Sandy was able to control her class for a longer period of time, and she demonstrated more inquiry based teaching practices such as questioning and application of information.

At week 15, Sandy’s reflection closely resembled her week 10 reflections. She wrote:

I took time to refine my lesson and I paid particular attention to putting things in smaller chunks. Like I gave the instructions for the first step, I had them repeat it, they went back to their seats, I had them repeat the instructions again, and I gave them a time limit. They knew what they were supposed to do in this small amount of time and that worked perfectly for them…. They were not distracted, so they
were focused on what we were doing. I’ve been watching [my CT] for specifically what she does during different times of a lesson and I think I’m getting it. (week 13, student teaching reflection)

Sandy’s student teaching raw gain (+1) paled in comparison to her methods class raw gain (+13). It was apparent that for Sandy, the lack of authentic teaching practice prior to executing new lessons during student teaching contributed to her struggle with classroom management and both were factors in the decelerated raw gain observed during student teaching.

Profile of Sandy

Sandy started the year-long study with the second lowest level of self-efficacy. Sandy’s increase in efficacy during science methods class (+13) was dramatically larger than the amount of efficacy gained during student teaching (+1). As shown in Sandy’s data presented earlier, her increase in efficacy during methods course was due to the exposure of the science teaching practices through practice and observation. Sandy’s methods class experiences were clear evidence of mastery and vicarious sources of efficacy (Bandura, 1986) and support current literature that states science methods class experiences have a positive impact on pre-service elementary teachers science teaching self-efficacy (Bleicher, 2007; Yoon, et al, 2006).

On the other hand, her relatively small increase in efficacy during student teaching was attributed to her difficulties in implementing the science teaching practices revealed to her during methods class and her lack of authentic experiences in teaching science prior to student teaching. Although minor, the fact that Sandy’s post student teaching efficacy score (50) was lower than her post science methods score (51) support current
literature that suggests science teaching self-efficacy declines during student teaching (Plourde, 2002; Tschannen-Moran, Hoy, & Hoy, 1998; Utley, Bryant, & Moseley, 2005). In addition to experience, content knowledge and personal interest were Sandy’s other contributors to her efficacy.

During the first 5 weeks of her student teaching semester, Sandy’s teaching practices indicated that her inability to keep student on tasks grossly limited her ability to demonstrate science inquiry teaching methods in a content rich lesson. As evidenced in her week 3 observation notes, although she had a great rapport with her students, she had no control over them during the whole lesson. At this time Sandy claimed that a lack of authentic teaching practice in this particular grade impeded her ability to teach (week 3, student teacher reflection).

Like Nancy, Sandy’s reflections during the first 5 weeks of student teaching were limited to the vague identification of her classroom management issues. Both Sandy’s teaching and reflections only addressed one area of the STE (classroom management). As evident in the Sandy’s last excerpt, Sandy’s reflection was symbolic of Putney and Broughton’s (2010) “Efficacy Onset” (p. 13) stage where she focused on how easy teaching was for her cooperating teacher.

Sandy’s teaching practices progressed over the next 5 weeks as evidenced by comments in lesson observations that noted the execution of meaningful questions and application of content (week 10, supervisor observation notes). Implied from this observation was that students were paying attention more often and that some science inquiry teaching methods were present. These comments indicated development in two STEs, which were management and teaching practices.
However, the lack of authentic experiences in a particular task remained a reason for her struggles as she often related her struggles with never having done that particular lesson before (weeks 3, 4, and 7 student teacher reflection). Although Sandy repeatedly described a “lack of experiences,” her reflections did shift from the quick and basic identification of a teaching issue in week 5 to attention in another STE, which was improving her own practices. In her week 10 reflection, Sandy referenced observing a successful practice from her cooperating teacher and addressed adopting that practice. Like Nancy, Sandy’s reflection at this time progressed from focusing on her cooperating teacher (Efficacy Onset) toward focusing on her own teaching practices (Developing Efficacy) (Putney & Broughton, 2010).

During the last 5 weeks of the semester, observation notes said that, “Because the students were on task during parts of this lesson, you definitely were able to address content!” (week 13, supervisor observation notes) which showed improvement in Sandy’s classroom management and comments such as, “you had them predicting, questioning, and applying…” (week 13, supervisor observation notes) were evidence of science inquiry teaching practices. At this time, Sandy’s reflections resembled her previous reflections as she continued to address her own practices. Unlike Nancy, Sandy had not reached Maturing Efficacy (Putney & Broughton, 2010) at the end of student teaching.

Sandy started the study with the second lowest level of science teaching self-efficacy and her profile characteristics closely resembled a low level of efficacy. As evidenced in her struggles to teach, Sandy used ineffective teaching strategies (Plourde, 2002) and as evidenced in her week 15 lesson observation Sandy continued to utilize teacher centered
approaches (Appleton, 2006). Lastly, of the six participants, Sandy increased the least amount (+1) during student teaching. This strongly suggested that the obstacles she faced during student teaching were seen as threats to her efficacy and not as challenges to overcome (Pajares & Schunk, 2001).

By the end of student teaching, Sandy was in the Developing Efficacy (Putney & Broughton, 2010) point of the efficacy continuum. Her position thwarted the development of her efficacy and teaching practices because in her inability to see herself as the teacher who has a direct impact on student learning, she impeded her self-regulatory (Zimmerman, 2000) process and weakened her potential to learn.

Brief Characterization of Low Levels of Efficacy

The domain analyses for the telling cases representing the low level of efficacy indicated that experience, content knowledge, and personal enjoyment were categories of contributors to their efficacy. The most overt similarities between the two cases were their three categories of contributors to efficacy, and the lack of content knowledge and the role that personal enjoyment played as a filter in influencing their efficacy. Another similarity was the participants’ initial teaching practices. The participants with low levels of efficacy started their student teaching semester with minimal demonstration of inquiry teaching practices in a content rich lesson. At the beginning of the semester, both their reflections were limited to a vague identification of problem areas.

Medium Levels of Efficacy

Whitney and Karen were identified as having efficacy scores near the median of the group. Therefore, they represented the medium level of science teaching self-efficacy.
Whitney and Karen were also assigned to the elementary school located in the northeastern region of the school district, and both were assigned to the same third grade team.

*Whitney*

Based on Whitney’s Phase I pre STEBI-B PSTE score of 41 out of 65, she started the study with a medium level of science teaching self-efficacy. However, as seen in Table 6, her scores showed an increase in efficacy during both phases of the study.

Table 6

*Whitney’s STEBI-B, PSTE Scores*

<table>
<thead>
<tr>
<th></th>
<th>Score</th>
<th>Raw Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline (Phase I, pre STEBI-B PSTE)</td>
<td>41</td>
<td></td>
</tr>
<tr>
<td>Phase I post STEBI-B PSTE</td>
<td>54</td>
<td>+13</td>
</tr>
<tr>
<td>Phase II pre STEBI-B PSTE</td>
<td>52</td>
<td>-2</td>
</tr>
<tr>
<td>Final (Phase II, post STEBI-B PSTE)</td>
<td>58</td>
<td>+6</td>
</tr>
</tbody>
</table>

Baseline to Final                  +17

Note: Raw Gain = difference between scores, + = efficacy increase, - = efficacy decrease

Although Whitney’s self-efficacy score indicated an overall increase in science teaching efficacy, a slight decrease in her scores (-2) was found between the end of Phase I and the beginning of Phase II. For Whitney, teaching in an authentic classroom tested the efficacy she gained during her science methods class as exemplified in her statement,
“I am very confident in my knowledge of science, but teaching it in now a real situation is totally scary” (Phase II, Questionnaire 1).

Two important factors for Whitney was that her methods class raw gain efficacy score increase (+13) was more than twice as much as her student teaching raw gain (+6), and that her score increased the most (+17) of all the participants from the beginning to the end of the study. These quantitative data provide an overview of Whitney’s efficacy levels over the year of the study. To contextualize Whitney’s scores, the analysis of the qualitative data is reported next.

Contributors to Whitney’s Self-Efficacy

My domain analysis of Whitney’s efficacy contributors resulted in identifying efficacy stems such as “I am more able,” “I am unable,” or “I feel more confident about.” These efficacy stems had connecting ideas that were most frequently identified by the categories of content knowledge, knowledge of teaching strategies, and personal interest in science experiences. Each of those is fleshed out below.

Content knowledge. Whitney frequently shared how her perceived level of content knowledge impacted her efficacy. Whitney was certain she lacked content knowledge when she started her science methods class. Whitney stated:

I need to learn more about topics before I feel fully able to teach them. The [college] classes I took were primarily the basic levels. I do not feel I know enough to lead an in-depth discussion…. I feel especially apprehensive about teaching more sophisticated topics. (Phase I, Questionnaire 1)

However, by the end of methods class, Whitney realized she had a strong enough content background and shared, “I didn’t realize I knew as much as I did. I was surprised I
understood the science concepts that we talked about in class with ease. I even comprehended the scientific reasoning” (Phase I, Questionnaire 2). Feeling competent about her science content comprehension was a pivotal moment for Whitney as she declared, “Knowing my content is one less HUGE [sic] obstacle!! I am MUCH better prepared and capable of teaching science than I thought and now I can be more excited and less afraid!!” (Phase I, Questionnaire 2).

Whitney’s STEBI-B PSTE scores reflected the impact content knowledge had on her efficacy. Whitney’s raw gain during science method class (+13) was more than double her raw gain during student teaching (+6). Whitney’s realization that she had more content knowledge than she originally thought suggests a profound impact on her efficacy during methods course.

Whitney’s comments during her student teaching also reflected the impact of her content knowledge on her efficacy. She wrote:

I had no problem preparing for this lesson content wise. That made me feel good! I envisioned where to start, what they had to learn, and what use the information had for the next lesson. I saw how I needed to guide their learning. I know it came easy simply because I KNOW THE CONTENT [sic]. (week 3, student teacher reflection)

Whitney held onto the fact that she knew what to teach during student teaching, “I haven’t struggled with the content at all this semester, and I guess I am relieved about that. I know what to teach…” (week 7, student teacher reflection). However, by the end of student teaching, Whitney felt uncertain about the value of content knowledge alone, “I’m not sure if that [content knowledge] matters now. I’ve been struggling with how to
control my class enough to teach…. [and] once they were focused, my lesson was not good enough to keep them focused” (Phase II, final journal).

Although Whitney’s efficacy increased during student teaching, her raw score increase (+6) was less than half the increase during science methods course (+13). Learning that “knowing it [science] and knowing how to do it [teach science] are two different things” (Phase II, final journal) decelerated her efficacy gain because “one made me feel great, the other beat me up” (Phase II, final journal).

*Knowledge of science teaching strategies.* During Whitney’s science methods course, knowing science teaching practices in conjunction with the knowing science content were significant contributors to her efficacy. Whitney wrote, “I thought my science knowledge base was my weakness. What I didn’t know was not science, but how to teach science” (Phase I, Questionnaire 2).

In her second science methods journal Whitney shared, “Observing the presentations has given me a broader perspective regarding the implementation of teaching strategies. I saw some that worked and some that were less efficient.”

Near the end of her science methods class, Whitney wrote:

The science methods class is definitely helping me improve my ability to teach science…. I have already observed and practiced valuable methods and strategies. Now I know some science teaching practices I can use to get my students engaged in exploring, data gathering, and discussing…. That [teaching strategies] combined with the fact that I understand majority of the content makes me feel very competent in my ability to teach science! (Phase I, journal 3)
During her science methods class, discovering the depth of her science content knowledge and acquiring knowledge about science teaching practices contributed to her Phase I efficacy increase (+13) and made her feel competent to teach science.

Whitney summarized the influence of knowing science teaching practices on her efficacy when she wrote:

At the very beginning of the semester, I was very apprehensive about teaching science. Now my worries have diminished greatly for the fact that I have seen and practiced teaching strategies, which will allow me to teach efficient science lessons. (Phase I, Questionnaire 2)

At the end of her methods class, Whitney stated that learning teaching strategies diminished her worries about teaching science. However, by the beginning of student teaching, her feelings changed. Continuing from Whitney’s week 3 student teacher reflection shared earlier, she wrote:

But teaching didn’t go smooth at all. I thought knowing science was the hard part and teaching it was the easy part…. I need to design my lessons better- so students are focused and prepared to engage in the lesson. If I can’t get my student’s attention, I can’t teach the lesson. (week 3, student teacher reflection)

By week 8, Whitney wrote:

My science methods class showed me great science teaching strategies, ideas for implementing them, and resources. I don’t know why it’s not translating to being able to do it…. It is already mid semester and I’m just not sure I can do this. (week 8, student teacher reflection)
Whitney continued to express reservations about her ability to teach science at the end of student teaching as evidence by her final journal entry, “I know I have a solid science foundation, and I know I have improved a little with classroom management. But my lessons are still weak… getting through just one complete lesson is challenging. I don’t think I’m ready to teach [science]” (student teaching, final journal).

It was evident that learning about science teaching strategies contributed to increasing Whitney’s efficacy during science methods class, but implementing them challenged her efficacy during student teaching. This finding points to a gap between science methods courses and the needs of student teachers.

**Personal enjoyment.** Like the previous participants, enjoyment of an event or topic was Whitney’s main filter to feeling confident. When recalling about her school experiences, Whitney wrote:

> I earned good grades in science, but I did not enjoy science. I remember monotonous note-taking and dull worksheets and I was just not interested in any of it. I think the fact that I find no interest or connection to science limits my confidence and makes me nervous about teaching it. (Phase I, Questionnaire 1)

In her first methods journal Whitney said:

> I have learned methods and strategies to make the subject interesting for students and myself. This is very important for me because I believe students are able to identify when a teacher is indifferent towards certain topics and they may even acquire the teacher’s attitude.

These entries evidenced that Whitney felt personal interest contributed to her science teaching self-efficacy as well as influenced her students’ interest.
Whitney also shared the influence of enjoying a topic during student teaching. “The water cycle was something I enjoyed learning and was excited about teaching. The lesson wasn’t perfect by any means, but I can certainly teach it better next time” (week 3, student teacher reflection). As discussed earlier, Whitney struggled and expressed frustration with implementing teaching strategies early in her student teaching experiences. However, as evidenced in her student teacher reflections, her mention of personal interest was the only factor that influenced her ability to perceive success in teaching. Whitney stated:

I love field trips and I think the fish project has been interesting! I’m excited about finishing our fish project with a trip to the fishery! I know I’m still struggling with teaching a full science lesson, but I think this will be a good lesson. (week 7, student teacher reflection)

Low interest in a subject matter also impacted her efficacy. Whitney shared:

I did not enjoy physical science in high school and I still do not now. Today’s lesson was a struggle from the beginning, and feels like a step back. I felt disconnected from the lesson, but I tried to not let it show…. I don’t think I can teach physical science with the same energy and effectiveness as I could something I am enthusiastic about. (week 10, student teacher reflection)

Personal enjoyment was Whitney’s main filter to feeling confident, and it was an important contributor to her science teaching self-efficacy during student teaching.

Development of Whitney’s Professional Self

Whitney was assigned to a third grade class in an elementary school in the northeastern region of the school district for student teaching. The week 5 Student
Teaching Summary of Whitney included three observations and three of Whitney’s reflections on those observed lessons during weeks 2 through 5. The observations evidenced that Whitney was, “very passive when trying to command attention from the students” and that she, “only call[s] on the same three who raise their hands, and you lose the whole class” (week 3, supervisor observation notes). Other supervisor notes within this time read, “You cannot continue with the lesson if the students are not paying attention” (week 2, supervisor observation notes) and, “[Whitney], I can’t evaluate your questioning strategies and level of science content students are learning because we’re still trying to manage the students. Let’s meet…” (week 4, supervisor observation notes). These examples illustrated that at this time, Whitney’s struggle with one STE (classroom management) grossly restricted her ability to demonstrate practices in the other two STEs (teaching practices and content rich lesson).

At week 5, Whitney’s reflections of these lessons showed that she recognized she had issues in her classroom management. Whitney wrote, “The students respond to [my CT]… I need to watch more closely, she has them under control all the time…” (week 3, student teacher reflection). In response to her lesson in week 2, Whitney wrote, “I just kept talking. I know the students weren’t paying attention and getting loud, but I didn’t know what to do, so I kept going. They always listen to [my CT], why don’t they listen to me…” (week 2, student teacher reflection). In her week 4 reflection, Whitney shared, “Standing quiet until they quiet down doesn’t work, I’m tired, and I don’t know what else to do. [My CT] does this and it works for her…” (week 4, student teacher reflection). The nature of my observations and Whitney’s reflections indicated that at this time, Whitney’s inability to maintain student control thwarted her ability to demonstrate
science teaching skills in a content rich lesson. Although Whitney acknowledged that she had issues in classroom management, Whitney did not describe what they were, their cause, or how to improve.

The week 10 Student Teaching Summary of Whitney included four observations and Whitney’s reflections on those lessons during weeks 6 through 10. The observations indicated progress because in week 2 and 4 Whitney was lecturing regardless of student attention and standing quiet until students were quiet. By week 10, observation notes such as, “I see how you used more effective management techniques to grab your students attention! Better voice projection and movement around the room. But you seemed to be spending much of your time doing crowd control” (week 8, supervisor observation notes) indicated that Whitney demonstrated more control of her class.

In week 9, I observed, “During the spurts when students were attentive, you asked good questions and had some discussion! In this time, you asked a good variation of direct and open-ended questions and you facilitated a discussion where they described their findings” (week 9, supervisor observation notes). This observation was on a lesson of the fishery project that excited Whitney. Her week 10 Student Teaching Summary supported that although Whitney still struggled with classroom management, she had moments when she was able to demonstrate more inquiry based science teaching practices as evidenced by the class discussion of their findings.

At week 10, Whitney’s reflections of these lessons articulated evaluations of her teaching practices. Whitney wrote:

I think my presence is more apparent now. I feel they see and hear me. I was louder and more assertive in my speech, and that commanded more attention from
them than before…. [My CT] is very bold and that captures their attention! ….I still need to work on HOW [sic] to teach effectively, maintain that student focus. I remember talking about ‘bite-sized pieces’ in methods class. I spoke with [my CT] about applying that concept to direction giving, and timing on tasks and discussion in my next lesson. (week 8, student teacher reflection)

In another reflection, Whitney shared:

My students were focused at the beginning of this lesson because I paced the different events carefully….but the lesson didn’t end the same way. I think by the end of a lesson, students are tired and they lose focus. I’m getting the hang of the different stages of the lesson… I know I need to anticipate my student’s moods during the different times of a lesson and plan things to offset their behaviors… I’m not sure if I can learn how to do this! (week 9, student teacher reflection)

Not only did Whitney comment on her management techniques for this lesson, but she also addressed her teaching practices and content and stated:

During the first part, I was able to ask a variety of questions that students shared in groups and then we discussed them as a class. I think this worked well because it gave them the opportunity to get their thoughts together and share what they know in an environment where everyone has a chance to speak… today’s discussion seemed to have more content too… (week 9, student teacher reflection)

In the reflections shared, Whitney identified that her lack of presence was an issue, addressed what she did to fix the issue, and assessed what she can do to improve. Also in the reflections was evidence of thought in her teaching practices and level of content.
This level of reflection indicated development because Whitney moved beyond simply identifying an area of concern to addressing all three areas of the STE.

Whitney’s last Student Teaching Summary at week 15 included three observations and three of Whitney’s reflections on those lessons during week 11 through 15. The final summary evidenced:

   Challenging application questions and effective management of time for engaging group activity and discussion during most of the lesson. You still need to work on management techniques – although fewer than before, there were still too many interruptions due to students misbehaving. (week 12, supervisor observation notes)

Observation notes also said:

   When students were on task, there were great examples of inquiry learning, such as students posing questions in their groups, students hypothesizing and problem-solving, the class discussion on ‘what if’ – but it was again interrupted several times with a few students not paying attention and a rapid decline in student attention toward the end. (week 14, supervisor observation notes)

Observation data showed that when Whitney’s students were focused, she demonstrated a command of inquiry teaching practices. However, it was evident that lack of instructional and classroom management prevented Whitney from teaching a lesson free from frequent behavioral interruptions.

At week 15, Whitney’s reflections addressed management issues and multiple teaching practices:

   I’m going to rearrange the classroom. This plan suits [the cooperating
teacher’s] personality and I have been trying to make me fit it. But I think I’ll arrange the class so that suits me…. Maybe I’ll feel more like the class is mine…. Giving instructions in bite-sized pieces worked, but I need to catch them before they start to act up. I need to be clear with setting the rules of engagement in the beginning! What do you think about… I’m starting to truly wonder if I have what it takes… (week 11, student teacher journal)

In the journal above, Whitney took the initiative and sought to create a learning environment suitable for her teaching style. Whitney also assessed her instructional management technique (giving instructions in bite sized pieces) and suggested follow up actions. In another reflection, Whitney wrote:

I think how I had students work and then we discussed, and then work and then discuss, and then work and discuss and compare findings and how that helped with keeping them engaged and focused. By setting a pattern, they knew we’d be discussing what they were responsible for doing. [My CT] has a solid beginning, middle, end routine to her lessons. By setting the lesson so it was chunked smaller, students didn’t feel overwhelmed… it worked for most of my students, but not all. What am I doing wrong? Am I ever going to get over this hump? (week 14, student teacher reflection)

Whitney was aware of how her lack of classroom management impeded her ability to teach science effectively. Although my observations housed comments about her teaching practices, Whitney’s reflections remained focused on her management.

Whitney’s student teaching raw gain (+6) paled in comparison to her methods class raw gain (+13). Although her personal interest in topics such as the water cycle and the
fishery project spiked her excitement about teaching those lessons, the struggle with her classroom management contributed to the decelerated raw gain witnessed during student teaching.

Profile of Whitney

Whitney started the year-long study with an identified medium level of science teaching self efficacy. Both Whitney and Nancy reported the greatest gain over the time of the entire study (+17). However, opposite of Nancy, Whitney’s efficacy gain during methods class (+13) was more than twice as much as her efficacy gain during student teaching (+6). For Whitney, content knowledge, knowledge of teaching strategies, and personal interest in science experiences contributed to her efficacy.

At the beginning of her methods class, Whitney first thought her lack of science content knowledge was going to be a challenge in teaching science and that concern contributed to the lack of confidence. However, she quickly learned that she had a solid grasp of science concepts. The combination of the confidence in her level of science content knowledge and being exposed to practicing and observing science teaching practices clearly contributed to her high gain in efficacy during her science methods class. Whitney’s science methods class experiences were also evidence of mastery and vicarious sources of efficacy (Bandura, 1986) and corroborate current literature that states science methods class experiences have a positive impact on pre-service elementary teachers science teaching self-efficacy (Bleicher, 2007; Yoon, et al, 2006). Although current literature suggests efficacy declines during student teaching (Plourde, 2002), Whitney’s efficacy continued to increase during this time.
During the first 5 weeks of her student teaching semester, Whitney’s teaching practices resembled Sandy’s week 5 teaching practices. Whitney’s inability to control her students grossly limited her ability to demonstrate science inquiry teaching skills in a content rich lesson. At this time, Whitney’s reflection indicated she was aware of her management issue, but offered no analysis about the implications of her issues. Like all the participants before her, Whitney’s reflections indicated she was at the point of Putney and Broughton’s (2010) “Efficacy Onset” (p. 13) because her reflection was limited to how her cooperating teacher successfully handled the class.

Progress in Whitney’s science teaching practices was evidenced during the next 5 weeks by observation notes that reported “longer spurts when students were attentive...a good variation of direct and open-ended questions, [and]...a discussion where they described their findings” (week 9, supervisor observation notes). At this time, Whitney had progressed from struggling with classroom management and exhibiting no inquiry teaching skills to having intermittent control of the class and demonstrating some inquiry teaching practices.

Whitney’s reflections also improved. At the beginning of the semester, Whitney stopped at identifying challenges she experienced. At this time, Whitney identified what had been an issue, addressed what she did to fix the issue, and assessed what she can to improve. This process was reflective of “Developing Efficacy” (Putney & Broughton, 2010, p. 14) where Whitney’s reflections remained focused on her teacher practices.

By the last 5 weeks of the semester, Whitney showed evidence of improved classroom management and the presence of inquiry teaching of a content rich lesson (week 14, supervisor observation notes). Whitney’s progress was evidenced in lesson observations.
that stated although she continued to struggle with classroom management, she exhibited control of her class for longer periods of time. Whitney’s reflections resembled previous reflections where she identified a struggle in her lesson and assessed how to improve. However, although comments about Whitney’s teaching practices were present in her lesson observations, her reflections remained focused on her management problems.

Whitney started the study with a medium level of science teaching self-efficacy, and like Sandy, her characteristics resembled a low level of efficacy. Although Whitney showed signs of improvement in her teaching practices, her struggles to teach evidenced in her lesson observations suggested she used ineffective teaching strategies (Plourde, 2002) throughout the semester. Similar to those with low efficacy, Whitney often reacted to her struggles with management as a threat (Pajares & Schunk, 2001). In Whitney’s week 9, 11, and 14 reflections, she expressed doubt about her ability to overcome her problems with classroom management. Whitney’s reflections remained at the “Developing Efficacy” (Putney & Broughton, 2010, p. 14) stage where her focus was on her own practices. Her position thwarted the development of her efficacy and teaching practices because in her inability to see herself as the teacher who has a direct impact on student learning, she impeded her self-regulatory (Zimmerman, 2000) process and weakened her potential to learn.

Karen

Based on Karen’s Phase I pre STEBI-B PSTE score of 44 out of 65, she started the study with a medium level of science teaching self-efficacy, and scored higher than three of the six participants. It was evident that Karen’s scores increased during both phases of the study (see Table 7).
Table 7

Karen’s STEBI-B, PSTE Scores

<table>
<thead>
<tr>
<th></th>
<th>Score</th>
<th>Raw Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline (Phase I, pre STEBI-B PSTE)</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>Phase I post STEBI-B PSTE</td>
<td>62</td>
<td>+ 18</td>
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<tr>
<td>Phase II pre STEBI-B PSTE</td>
<td>56</td>
<td>- 6</td>
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<tr>
<td>Final (Phase II, post STEBI-B PSTE)</td>
<td>60</td>
<td>+ 4</td>
</tr>
<tr>
<td>Baseline to Final</td>
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<td>+ 16</td>
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</table>

Note: Raw Gain = difference between scores, + = efficacy increase, - = efficacy decrease

Karen’s scores showed dramatic changes in her efficacy throughout the study. Karen’s science teaching self-efficacy scores revealed more than four times raw gain during science methods class (+18) than a raw gain during student teaching (+4). This clearly indicated that although Karen’s efficacy continued to increase during each phase of the study, the impact science methods class had on her efficacy was more profound than the influence of student teaching.

Another dramatic change in Karen’s scores was the decrease in her efficacy score (-6) between the end of Phase I and the beginning of Phase II. Like the participants before her, the idea of transitioning into a real class setting caused anxiety as evidenced in her Phase II Questionnaire 1 when she wrote, “This is it! I’m a little nervous because this is the real deal.” This decrease in Karen’s efficacy score (-6) was larger than the increase in her efficacy score (+4) during student teaching, suggesting that the anxiety she felt
entering student teaching was more of a detriment to her efficacy than the experiences during student teaching were a benefit.

These sweeping changes in Karen’s quantitative data provide an overview of her efficacy levels over the year of the study. To contextualize Karen’s scores, the analysis of her qualitative data is reported next. I continue to address the study’s two research questions by sharing Karen’s contributors to her efficacy and the evolution of her science teaching practices.

**Contributors to Karen’s Self-Efficacy**

Karen scored higher on her pre STEBI-B PSTE survey than three of the six participants, indicating that she initially had more confidence in her ability to teach science than half the participants in this study. However, contradictory to her relatively high level of efficacy, Karen stated, “I avoided science [in college] by taking nutrition classes. I took two nutrition classes and science for every day life. I didn’t want to take science because I was never really good at it. Science is not my strong suit” (Phase I, Questionnaire 1). In her statement, Karen blatantly avoided learning science in college. Karen’s pre STEBI-B PSTE score suggested higher efficacy in teaching science while her statement suggested low efficacy in learning science.

In her Phase I Questionnaire 1, Karen wrote, “Come on now, I know I can learn any elementary science topics with no problem – please, it’s elementary school!” However, when reflecting on an in-class activity about a fourth grade physics lesson, Karen stated, “I didn’t understand the activity AT ALL [sic] because I don’t know anything about physics! How do they expect me to teach this stuff?” (Phase I, journal 2). These two examples illustrated the contradiction between Karen’s teaching and learning science.
levels of efficacy. In these examples, Karen expressed ease in learning elementary science but then stated her inability to comprehend or teach a fourth grade physics lesson.

How these opposing levels of efficacy in learning and teaching science impacted her science teaching practices became evident as her case developed. Similar to the three previous participants with lower levels of efficacy, my domain analysis of Karen’s data resulted in contributors of efficacy identified by the categories of experience, content knowledge, and personal enjoyment in science experiences. Each of those is fleshed out below.

*Experience.* Similar to the three participants who were identified as having lower levels of efficacy, Karen’s data entries suggested that paucity in her experiences in teaching and learning sciences made her feel unprepared to teach it and challenged her confidence as shown in her statement, “I did not have the chance to teach it [science] during prac 1 [sic]…. I know I can’t teach science well yet because I have absolutely no experience and I have bad experiences [learning science] to make up for” (Phase I, Questionnaire 1). Although Karen ranked in the upper-medium range of level of efficacy in comparison to the other cases, her statements were more similar to participants with lower levels of efficacy than participants with higher levels of efficacy. In her second Phase I journal, Karen stated:

> I have not been able to take much of what I have learned and apply it to my practicum class…. I want to use what I’m learning before I have to use it as a real teacher… Right now, I can’t see how things I’ve learned are used in a real classroom and that doesn’t help the fact that I’m afraid to teach science.
Karen expressed concern about not having the chance to apply science teaching techniques, which rendered her unable to negotiate desired teaching practices. At this point, Karen conveyed how a lack of authentic science teaching and how her insufficient experiences in learning science challenged her science teaching self-efficacy.

Although Karen reported how some experiences challenged her efficacy, Karen’s significantly high raw gain (+18) during the methods class was supported by her testimonies about positive learning experiences as exemplified in her journal:

Today we learned about FOSS Kits….We got to explore the materials, read over lessons, and discuss how they can be used. I’m glad we got to mess with them and talk about them…. I thought there was no way I could teach using this! But [the methods instructor] taught one FOSS Kit lesson and it was really fun….At first I was intimidated by FOSS Kits, but I had fun learning about them….The lesson helped me think of how to apply them and now I can totally imagine how to use them. (Phase 1, journal 2)

Karen also wrote, “I am more aware of different experiments and styles of teaching that I can use in the classroom. I am glad that my science methods class has given me some experience in making lesson plans, teaching, and observing others” (Phase 1, Questionnaire 2).

These data points suggested that exposure to science teaching techniques through making lesson plans, teaching to her peers, and observing her peers teach in methods class helped mollify some of Karen’s anxiety in teaching science. Her high increase in raw gain (+18) seen during methods class suggested that those experiences had more of
an impact on increasing her efficacy than the lack of authentic experiences and science content challenged it.

Karen also referenced science teaching and learning experiences as a contributor to her efficacy during student teaching. Karen shared:

It was my first time ever trying that experiment with a real class. If I had the chance to do a dry run, it probably would have gone smoother. I didn’t know what to expect and I couldn’t even imagine what to anticipate! I hate not knowing – it totally makes me feel lost, that there’s no way I can do this. (week 3, student teacher reflection)

Karen also stated, “I hated learning about cycles in school! It was boring and it didn’t make sense. I didn’t want to teach this because I knew I was going to suck [sic]” (week 4, student teacher reflection). Supporting previous accounts of what challenged her confidence, Karen reported that a lack of authentic experience in science teaching limited her ability to envision what to expect while a poor experience in learning science left her feeling unable to teach it. In addition to learning and science teaching experiences, the domain analysis of categories of contributors to efficacy revealed that content knowledge also influenced Karen’s feelings toward her ability to teach science.

*Content knowledge.* Karen believed that she could teach basic science lessons as evidenced by her statement, “I know basic things [in science] so I can survive teaching basic science lessons” (Phase I, Questionnaire 1). However, she realized this was insufficient when she said, “but I know I need much more content knowledge to be a good teacher” (Phase I, Questionnaire 1). Karen dismissed teaching a content rich lesson
when she reported, “I don’t think my students will learn much with what little I know about science, but we’ll certainly have fun!” (Phase I, Questionnaire 1).

At the end of her science methods class, Karen reported:

I didn’t realize how much basic science I DIDN’T [sic] know! I’ve learned so many terms and information and facts and that makes me feel much better about teaching science! I know I’m not a scientist, but I still think I’ll be able to teach science well. (Phase I, Questionnaire 2)

At this time, Karen realized that she had “sabotaged” herself as evidenced in the following excerpt:

Only in retrospect I see how I sabotaged being a good elementary science teacher by avoiding all science classes. I avoided them because I was totally afraid of science. I didn’t think then how avoiding those classes would affect me later. I thought I could teach elementary science with no college classes – come on, it’s elementary science! (Phase I, Questionnaire 2)

The quotes shared typified the conflicting nature between Karen’s relatively high STEBI-B PSTE score and her feelings about learning science, suggesting that her fear of learning science had no effect on her confidence to teach it. Karen’s efficacy appeared specific to teaching science and not learning it. Karen’s high raw gain (+18) by the end of methods class can be explained by the fact that she felt she could teach science regardless of her level of knowledge about it.

Early in her student teaching semester, change in Karen’s feelings about the impact of her content knowledge on her ability to teach was evident when she reported:
I didn’t know the content well enough to ask better questions or to go beyond lecturing. I couldn’t maintain any sort of discussion because I didn’t know enough to talk about. If I don’t know this stuff, how can I teach it?? (week 3, student teacher reflection)

In the example above, Karen connected her lack of content knowledge to lecturing and implied that having content knowledge would enable her to ask meaningful questions and engage in discussion, both of which are elements of inquiry based science teaching. In one lesson, Karen enthusiastically shared:

Finally, I taught something I know well! Nutrition! And that’s why we all had fun and I was relaxed and I could ask meaningful questions! Duh [sic] - I see the difference between what can be accomplished when you actually know something about what you’re teaching! Can’t I just teach nutrition all year, it’s important you know! (week 5, student teacher reflection)

Like Karen’s previous entry, this entry supported the fact that Karen related knowledge of the content to the ability to ask valuable questions and the ability to teach beyond lecturing.

Content knowledge continued to be a major challenge to Karen’s efficacy during student teaching. During a midterm meeting with Karen, she admitted:

This lesson looks like I’m giving facts and asking low level questions because that’s all I can do [she said angrily]. I don’t know enough about the skeletal system to ask higher order questions or I’d be asking questions I don’t know the answer to! I don’t know what to ask and I don’t even know the names and locations of all these bones and I’m afraid they will ask me questions that I can’t
answer. All I seem to know is nutrition! I can’t teach anything else, I don’t know enough to teach ANYTHING [sic] else. (week 7, meeting notes)

In this example, content knowledge clearly influenced Karen’s feelings about her ability to teach. However, at the end of this meeting, Karen also shared, “I still feel I am able to teach science because the students love science and it can be fun.” This is a noteworthy example of Karen’s continued feeling of confidence in her ability to teach science regardless of her admitted struggles with science content. Despite the confidence in science teaching Karen continued to express during student teaching, her efficacy gain during this time (+4) was more than four times less than her efficacy gain during methods course (+18).

Although experience and content knowledge were factors that influenced Karen’s efficacy, like all the participants that preceded Karen, the category that influenced her efficacy regardless of the negative influences of the other two was the personal enjoyment of her experience.

**Personal enjoyment.** Regardless of Karen’s experience or content knowledge, she expressed confidence in her ability to succeed if she found enjoyment or interest in the task itself. In her Phase I Questionnaire 1, Karen wrote:

I’m very confident about teaching life science. I know the last time I took bio was as a freshman in high school and I’ve never taught it, but I enjoy learning and discussing the life around us and living things. I know enjoying what I teach will be make a huge difference in being able to teach it.

Even though Karen admitted she was limited in her knowledge of biology and she had no experience teaching it, her interest in it contributed to her confidence to teach it.
Karen also expressed how her interest in learning about FOSS Kits influenced her efficacy when she shared:

I looked at the FOSS Kit and felt extremely overwhelmed. I thought there was no way I could teach using this! But [the methods instructor] taught one FOSS Kit lesson and it was really fun….I’m interested in learning more about these kits and I totally can see me using them in my class (Phase 1, journal).

This entry validated that the enjoyment of an experience superseded the perceived inability to teaching it as well as provided her motivation to learn more.

Karen also wrote, “I never liked learning the bones or muscles. I prefer growing plants or something. I’m just not interested in it and I don’t think I can get past that to teach it well” (week 7, student teacher reflection). In the same vein, Karen’s confidence and desire to teach a topic was low when she was not personally interested in it as evidenced by a statement she made before teaching a lesson on bones.

*Development of Karen’s Professional Self*

Karen was assigned to a third grade class in an elementary school in the northeastern region of the school district for student teaching. The week 5 Student Teaching Summary of Karen included three observations and three of Karen’s reflections on those observed lessons during weeks 2 through 5. The observations evidenced that “Students were not paying attention….you used too many activities with no connection to each other” (week 3, supervisor observation notes), and that “lecture and questions posed in class had minimal link to objectives or focus of the lessons… too many activities with no purpose” (week 3, supervisor observation notes). In week 4, observation comment showed that Karen’s teaching practice, “needs to encompass much more content…. lacked
consistency and content value….need more attention to classroom management.” Even in the nutrition lesson that Karen enjoyed teaching observation comments read, “students seemed confused by your multi-stepped instructions…lesson needed to be more cohesive… (week 5, supervisor observation notes). These examples illustrated that the observations were primarily focused on the need to improve in classroom management, lesson design, and level of content, which were all three STEs.

At week 5, Karen’s reflections of these lessons showed that she did not articulate teaching practices related to any of the three STEs. In Karen’s reflection of her week 2 lesson she wrote, “I know I need to work on giving better directions. The students were all over the place” (week 2, student teacher reflection). Although Karen made a direct link between her actions and the student’s misbehavior, she made no other comments about this relationship. In her week 3 reflection, Karen said:

I didn’t know the content well enough to ask better questions or to go beyond lecturing. I couldn’t maintain any sort of discussion because I didn’t know enough to talk about. If I don’t know this stuff, how can I teach it?? (week 3, student teacher reflection)

At week 4 Karen wrote, “I didn’t review the lesson before teaching it and I obviously wasn’t organized. I had some friends visit and I didn’t have time to do anything else.” Although Karen wrote this about a formal observation that she invited me to observe, her reflection suggested a lack of concern about the impact of her teaching. The nature of my observations indicated that at this time Karen’s inability to maintain student control and her lack of content knowledge prevented her from demonstrating science teaching skills
as prescribed by the three STEs. Also, Karen’s reflections at this time only articulated the identification of teaching weaknesses and lacked any additional information.

I met with Karen during week 7 because I was concerned about the resistance I felt from her and I wanted to discuss her progress. When I asked her what grade she thought she deserved at this time, Karen hesitated and said, “C.” When asked her why, Karen addressed her late work and the quality of her reflections. I added that I felt she was displaying a casual demeanor toward improved teaching, and a discussion ensued. Karen said:

I know I have been laid-back about things…. I write short reflections that don’t analyze my teaching and I don’t talk about how to improve….I know you’re pushing me to think about my teaching so I can be better and I’m not reflecting deep enough about what I’m doing. (student teaching midterm meeting notes)

When I asked Karen to explain, she replied:

There you go again…. I guess my reflections just offer an observation – like “that lesson didn’t go well and I think because the students weren’t paying attention.”

You want me to explain why I think students weren’t paying attention, you want me to identify and explain what about my lesson caused this. I know I haven’t been doing any of that in my reflections.

I asked Karen why she thought we were conflicting and she said:

I want to believe in my heart I can teach well, I believe I can, but I can’t yet prove that I can. I obviously can’t control the students, and I hate to say that I don’t know enough of some of the content to do something challenging…. I felt great about teaching at the end of my methods class, but now that I have to actually
apply teaching techniques and reflect on things, I see more and more of how I’m not all that [sic]…So I guess I’m rebelling against what you are asking for because it’s making me see what I don’t want to…

By this point, the inconsistency between Karen’s level of confidence and her ability to teach science was blatant. Karen believed in her ability to teach well, but was confronted with the reality of her limitations. From this meeting, goals and standards for reflections and teaching practices were set by Karen and agreed upon by me as her supervisor.

Karen’s demeanor changed after this meeting.

The week 10 Student Teaching Summary of Karen included three observations and three of Karen’s reflections on those lessons during weeks 6 through 10. These observations indicated progress because instead of an incoherent hodgepodge of activities, Karen “used fewer activities within a lesson and the activities scaffold learning better” (week 8, supervisor observation notes). Observation data showed more positive comments about student management and content building strategies, “Better link of activities to each other and to objectives…. Directions for students were in easier steps…. Showing potential for the use of good questions…. Need more content!” (week 9, supervisor observation notes), but concerns about level of content remained.

At week 10, Karen’s reflections had much more information than at week 5, which indicated improved reflections. Karen stated:

I can totally see the difference between taking the time to refine my lesson plan and just rushing through it. Their attention was on the lesson because I chunked the lesson better. I noticed that my CT does his lesson in “pieces” and I guess that’s why things flow better for him. Before, I just read out all the
instructions, but this time, I read out what they were going to do while they
followed along. I gave them how much time they had and then read the
instructions for the next part….The time frame kept them focused. (week 9,
student teacher reflection)

In this excerpt of her reflection, Karen not only identified a management issue she had
been struggling with, but she also contrasted it to what she had been doing and addressed
how it influenced her students behavior. Karen also wrote:

I know I designed this lesson with fewer activities. Previously I planned my
lessons with many things to do so students could be kept busy, but I see now how
the “work” didn’t build on each other to teach anything! It seemed it was easier
for the class to tie concepts together with a few select activities, and that students
were more focused. (week 8, student teacher reflection)

In these reflections, Karen compared and contrasted what she was doing and the
outcomes of her practice to previous practices and their outcomes. By comparing what
she did to what was previously attempted, Karen’s claim for her need for experience to
negotiate best teaching practices was validated.

Karen’s last Student Teaching Summary at week 15 included three observations and
three of Karen’s reflections on those lessons during week 11 through 15. The final
summary stated, “Evidence of better detail in directions, but transitions need to be more
clear… still need more content, Karen…” (week 12, supervisor observation notes), and
“need to pay attention to what students are doing, they [one small group] were off task
for much of the lesson, but you did show ability to give directions in a clear and concise
way” (week 13, supervisor observation notes). In week 14, observation notes read:
Evidence of good monitoring of student participation, asking students to explain their thoughts, questioning strategies… but – inconsistency interrupts flow of class… still needs more content- your lack of knowledge renders you unable to engage students in a meaningful discussion have them apply their knowledge.

(week 14, supervisor observation notes)

Observation data showed that although Karen continued to demonstrate evidence of classroom management skills and science teaching techniques, she was inconsistent with the execution of these practices. Also evident was the need for content in her lessons. Although Karen demonstrated progress toward a more cohesive lesson, her struggles with content were a detriment to her ability to teach inquiry lessons in science.

At week 15, Karen’s reflections were best represented by her last reflection where she addressed her management issues, teaching practices, and level of content present in her lessons, which indicated her increased awareness of her teaching practices. She wrote:

My lessons aren’t as strong as they can be. I know I need to be more consistent with everything – classroom management and the effective teaching of CONTENT [sic] as you always say. My students get rowdy because I start off strong, but I don’t take it to the end… I’ve been watching my CT to see specifically what he does toward the end and he seems to get more strict in his voice and gives more stringent time frames – and it works!… I know my students can’t engage in deeper conversations because my lesson design prevents it and I know it’s because I’m not comfortable with the content… I know I need to do something so my students actually learn. Imagine that. (week 14, student teacher reflection)
As evident in the shift from Karen’s week 5 to week 15 reflection, she improved from short responses with no concern to relating her practices to student learning. This suggested that Karen was more aware of the relationship between her teaching and student learning. In the end, Karen’s reported efficacy scores remained incongruent with her progress, which was more comparable to those with lower levels of efficacy than those with higher levels of efficacy.

Karen ended the study with the second highest science teaching self-efficacy score with a 60 out of 65. However, Karen’s student teaching raw gain (+4) was small in comparison to her methods class raw gain (+18), and her post student teaching self-efficacy score (60) was lower than her post methods self-efficacy score (62). A clear factor that contributed to these dramatic changes in Karen’s efficacy scores was her realization of the fact that her content knowledge was an obstacle to teaching science the way she thought she could.

Profile of Karen

Karen started the study ranking in the middle level of efficacy of the six participants. Karen’s efficacy scores showed dramatic changes over the course of the year study with the highest methods efficacy gain (+18) of all the participants, the highest raw score decrease (-6) between the two phases of the study, and the second lowest student teaching efficacy gain (+4). Like Sandy, Karen had a lower efficacy score (60) at the end of student teaching than at the end of her methods course (62). This indicated that although Karen experienced an overall efficacy gain from beginning to end of the study, her science methods course had more of an impact on her efficacy than student teaching.
Current literature suggests that higher levels of efficacy are associated with behaviors such as being highly receptive to the use of reform efforts (Guskey, 1988), approaching difficult tasks as challenges and not as threats, and creating an environment that is necessary to achieve academic excellence (Pajares & Schunk, 2001). However, Karen’s statements and behaviors contradicted her relatively higher level of science teaching self-efficacy. Like the participants before her, experience, content knowledge, and personal enjoyment were Karen’s contributors to her efficacy. As indicated in Karen’s data, her increase in efficacy during methods course was due to the exposure of the science teaching techniques through practice and observation. Karen’s methods class experiences were clear evidence of mastery and vicarious sources of efficacy (Bandura, 1986) and support current literature that states science methods class experiences have a positive impact on pre-service elementary teachers science teaching self-efficacy (Bleicher, 2007; Yoon, et al, 2006).

Although Karen expressed that the exposure to science teaching methods made her feel more confident to teach science, she also stated concern about her lack of content knowledge and authentic teaching experiences. The conflict between feeling confident and the challenges she faced during student teaching was a clear contributor the deceleration of her efficacy increase during student teaching.

During the first 5 weeks of her student teaching semester, Karen’s lesson observation notes said that students were not paying attention and her lessons utilized many activities that lacked cohesiveness and content (weeks 3 and 5, supervisor observation notes). At this time, the effects of Karen’s lack of content knowledge conflicted with her high level of confidence in her ability to teach science and contributed to her frustrations. In her
reflections, Karen stated, “I know I need to work on giving better directions. The students were all over the place” (week 2, student teacher reflection), that “I couldn’t maintain any sort of discussion because I didn’t know enough to talk about” (week 3, student teacher reflection), and that “I didn’t review the lesson before teaching it and I obviously wasn’t organized. I had some friends visit and I didn’t have time to do anything else” (week 4, student teacher reflection).

Karen was the only student teacher with whom I experienced tension. However, after a midterm meeting with Karen, her demeanor changed. During the next 5 weeks of student teaching, Karen’s teaching practices improved with the utilization of a more focused set of activities that linked to lesson objectives and a demonstrated potential to ask meaningful questions, but the lack of content remained an issue in her lessons and prevented her from teaching inquiry science (weeks 8 and 9, supervisor observation notes). Karen’s reflections also improved from the curt responses to addressing the influence of her management techniques on her student’s behavior. At week 9, Karen wrote, “Their attention was on the lesson because I chunked the lesson better. I noticed that my CT does his lesson in ‘pieces’ and I guess that’s why things flow better for him.” At this time, Karen’s focus was on how her cooperating teacher was successful in his lessons.

During the last 5 weeks of her student teaching semester, Karen demonstrated random control of her class, but for longer periods of time. Also evident during this time were indications of teaching practices such as questioning techniques. However, Karen’s lack of content knowledge continued to hinder her ability to teach inquiry science. Karen’s reflections at this time progressed and addressed the impact the limitations of her lessons
had on her lessons (week 14, student teacher reflection). Also at this time, Karen continued to look at her cooperating teacher for what management techniques he used. This suggests that Karen ended her student teaching in the “Developing Efficacy” (p. 14) stage as described by Putney & Broughton (2010).

Karen started the study with a higher level of efficacy than three of the six participants. However, her characteristics were comparable to those with low levels of efficacy. Although Karen scored higher than half the participants in the study, her lesson observations indicated she used ineffective teaching strategies (Plourde, 2002) throughout the semester and was greatly threatened by her lack of content knowledge (Pajares & Schunk, 2001). In Karen’s week 3 and 14 lesson reflections and in our midterm meeting, she expressed how the limitations her lack of content knowledge gravely challenged her confidence to teach to teach inquiry science.

*Brief Characterization of Medium Levels of Efficacy*

The domain analyses for the telling cases representing the medium level of efficacy indicated that experience and knowledge of teaching strategies, content knowledge, and personal enjoyment were categories of contributors of their efficacy, which were also akin to low levels of efficacy. The most overt similarities between the two cases representing the medium level of efficacy were two categories of contributors to efficacy (content knowledge and personal enjoyment), the role personal enjoyment played in influencing their efficacy, and how struggles in their classroom management resulted in a slow progress toward inquiry based teaching of a content rich lesson.

Another similarity was the participants’ initial teaching practices. Like the participants with low levels of efficacy, the participants with medium levels of efficacy also started
their student teaching semester struggling with classroom management, which impeded their ability to demonstrate science teaching skills. Regarding the quality of their reflections, the participants with the medium level of efficacy started with minimal ability to express ideas past vague descriptions of problem areas.

High Levels of Efficacy

Sharon and Ann were identified as the two participants with the highest levels of science teaching self-efficacy. Both participants were assigned to the elementary school located in the southwestern region of the school district. Sharon was assigned to a fourth grade class and Ann was in a second grade class.

Sharon

Based on Sharon’s Phase I pre STEBI-B PSTE score of 50 out of 65, Sharon started the study with the second highest level of science teaching self-efficacy. Even with an initial high level of efficacy, Sharon’s scores showed an increase in efficacy from the beginning to the end of the study (see Table 8).
Table 8

*Sharon’s STEBI-B, PSTE Scores*

<table>
<thead>
<tr>
<th></th>
<th>Score</th>
<th>Raw Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline (Phase I, pre STEBI-B PSTE)</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Phase I post STEBI-B PSTE</td>
<td>61</td>
<td>+11</td>
</tr>
<tr>
<td>Phase II pre STEBI-B PSTE</td>
<td>56</td>
<td>-5</td>
</tr>
<tr>
<td>Final (Phase II, post STEBI-B PSTE)</td>
<td>64</td>
<td>+8</td>
</tr>
<tr>
<td>Baseline to Final</td>
<td></td>
<td>+14</td>
</tr>
</tbody>
</table>

Note: Raw Gain = difference between scores, + = efficacy increase, - = efficacy decrease

Although Sharon’s self-efficacy score showed an overall increase in efficacy, a slight decrease in her scores (-5) was found between the end of Phase I and the beginning of Phase II. Like the previous participants, Sharon felt the pressure of the reality of teaching as shared in her statement:

> As I’ve said, I’ve subbed [sic], so I feel very natural in a classroom. But I’m still nervous – I think I’m nervous because I have a different mindset now. I’m not just doing somebody’s lesson plan for a day, I need to create lessons and activities that teach students and I’m going to be responsible for everything that goes on day after day after day. The reality of the big picture is much different that popping in for a day and subbing. (Phase II, Questionnaire 1)

Although Sharon’s substituting background can be considered real experiences, she stated that what she lacked was the whole teaching responsibilities over time and she called it “the reality of the big picture.” Sharon’s efficacy scores followed the trend of
changes in efficacy scores seen in the previous participants with a recorded raw gain
during methods class (+11), decrease between the two phases (-5), and a raw gain during
student teaching (+8). Sharon’s quantitative data provided an overview of her efficacy
levels over the year of the study. To contextualize Sharon’s scores, the analysis of the
qualitative data is reported next.

Contributors to Sharon’s Self-Efficacy

My domain analysis of Sharon’s efficacy contributors resulted in identifying efficacy
stems such as “I am more able,” “I am unable,” or “I feel more confident about.” These
efficacy stems had connecting ideas that were most frequently identified by the following
categories: relationship with science; familiarity with science content, teaching practices
and resources; and content knowledge. Each of those is fleshed out below.

Relationship with science. Experience was an identified contributor to efficacy for all
participants thus far because they linked specific experiences such as failing a science fair
project to their confidence in their ability to teach science. However, for Sharon and Ann,
I describe this contributor as a “relationship” because they described how their histories
created a personal connection with science and prepared them to be effective teachers.
Sharon recalled how her relationship with science influenced her confidence to teach
science when she shared,

I enjoyed science classes in school. In elementary school we were explorers. We
planted seeds and tracked their growth, we separated iron particles in the dirt…
and we tracked and discussed the life cycle of a butterfly. I remember being
intrigued with being an explorer…. In college, I remember engaging labs….I took
more than the required number of science classes because I wanted to learn about
the different sciences. All of these played an important part in creating my good relationship with science and I think this relationship is why I feel like I am able to teach science. (Phase I, Questionnaire 1)

Sharon connected her positive relationship with science to her confidence to teach it. In her final methods class questionnaire Sharon confirmed that it was her relationship with science that ultimately had the most influence on her science teaching self-efficacy when she wrote:

I can think back to when I was an explorer and I can now explain how the lessons were designed as more student centered. I think I’m confident with how I “think like a scientist” because it was what was expected of me when I was in school – and I loved it! The things I learned in this class [science methods]…. were important and useful, but I think they made more sense because I connected them to how I learned science. Yeah, I still think that it’s my relationship with science- that has been created over the years- which makes me feel all the more confident to teach it. (Phase I, Questionnaire 2)

Sharon’s score increased (+11) during her methods course, and she stated that what she learned in her methods class made sense because she was able to relate it to her experiences as a learner of science.

Sharon continued to reference the impact of her relationship with science on her efficacy during student teaching. Sharon shared:

I think I am doing well in student teaching for several reasons. For one, learning science and teaching science are not scary for me….The idea of exploring, collecting data, and talking about our findings like scientists has always been a
Sharon’s relationship with science was clearly an influential contributor to her initial high level of and increased efficacy. In addition to her relationship with science, it was evident that the category of familiarity with science content, teaching practices, and resources also contributed to her confidence to teach science effectively.

Familiarity with science content, teaching practices, and resources. At the beginning of Phase I, Sharon reported:

I certainly want to learn inquiry teaching techniques, assessment, issues in elementary science, and all that. But pretty much, right now, I feel if I have the chance to go over materials and content, then I can teach anything. I guess that’s my subbing [sic] mentality. I know it takes so much more to teach and that’s why I’m here - to learn how to put it all together and teach over a period of time.

(Phase 1, Questionnaire 1)

According to the excerpt above, becoming familiar with science content and materials enabled Sharon to teach, but she also stated that she was aware she needed to “learn how to put it all together to teach over a period of time.”

Sharon also shared, “I think knowing how to find and how to use science teaching and classroom resources are vital and would certainly make me feel better about teaching. There are good resources out there and I want to know how to get a hold of them!”

(Phase I, Questionnaire 1). Not only was familiarity with science content a contributor to Sharon’s efficacy, but also familiarity with science resources.

During her science methods class, Sharon learned a new mnemonic to use for teaching metric conversions. She stated, “Although the mnemonic itself was new, the technique
was not. I remember learning the order of the planets using a mnemonic, and I can totally see myself using this” (Phase I, journal 2). This entry evidenced that the familiarity of technique contributed to her confidence in applying it.

In her final methods journal Sharon summarized, “The elements of teaching science become much more natural the more I do it. Being familiar with the patterns of teaching science and knowing what to expect makes me feel comfortable, and this comfort makes me feel confident” (Phase I, final journal). This suggested that the comfort Sharon gained by becoming familiar with the nuances of science teaching contributed to her confidence to teach science.

At the end of her science methods course, Sharon shared:

I have been exposed to science teaching practices that have helped me understand HOW [sic] to teach science lessons. We talked about them, observed them in each other, and practiced them…. I was able to relate these techniques to my experiences as an explorer, so they weren’t some strange “idea” that I had to find a way to use. The fact that these practices seemed somewhat familiar totally made me feel like I can be natural about its use in my classroom! (Phase I, Questionnaire 2)

Sharon associated learning science teaching methods with prior science learning experiences and found comfort in their similarities. This familiarity was an overt contributor to her science teaching self-efficacy.

Coded categories of familiarity of science content, teaching practices, and resources were found in Sharon’s entries during student teaching. In regard to a lack of familiarity with grade level content, Sharon said:
This first lesson could have been better. I was not totally familiar with this grade level content and I was unsure of myself. I never teach anything without spending some time previewing the facts and activities, but I guess I should have taken more time for this lesson. (week 1, student teacher reflection)

Sharon differed from the participants before her because in her reflection, she specified “grade level content” implying uncertainty about the capability of the grade level and not uncertainty about her knowledge of science.

Comments sprinkled throughout Sharon’s lesson reflections such as, “I remember how my teacher [did this] in elementary school” (week 3, student teacher reflection), and “I remember someone in my methods class who demonstrated rotating group activities…[and] I spent time researching how others have taught [this]…” (week 7, student teacher reflection), further related familiarity with feeling more confident about teaching.

Sharon frequently searched through her memory bank for similar science experiences or familiarized herself with the design of a similar lesson to frame how she designed her lesson. In conjunction with being familiar with elements of her lessons, my domain analysis of Sharon’s data indicated that content knowledge was another contributor to her efficacy.

Content knowledge. At the beginning of Phase I, Sharon shared:

I would say I have a solid understanding of science content. What I learned, I retained….Some more so than others, like I think I know more life science than physical science, but I know enough in all. I know having a strong content base knowledge [in science] is what makes me feel secure about teaching it— but that
makes sense because you have to understand what you’re about to teach. (Phase I, Questionnaire 1)

Sharon linked knowing science to feeling secure about teaching it and rationalized that relationship to the fact that “you have to understand what you’re about to teach.”

During her student teaching midterm reflection, Sharon shared:

It’s obvious to me now - I have confidence because what I know in science. I have learned a lot of science facts and how to think science in my k-12 years and in my college classes as well as many ways to teach them in my education courses. Knowing the content and being able to totally see how I should be teaching has played a big part in my confidence to teach inquiry science!

Toward the end of student teaching, Sharon wrote, “It feels great to be able to engage students in the application of the topic and higher order thinking…. and I know I can do this only because I know the content well” (week 11, student teacher reflection).

In her lesson reflections, Sharon often credited her knowledge of the content to her ability to teach inquiry lessons. For Sharon, content knowledge, relationship with science, and familiarity with science teaching practices and resources, were identified as her contributors of efficacy and was the foundation for her high level of science teaching self-efficacy.

Development of Sharon’s Professional Self

Sharon was assigned to a third grade class located at the school in the southwestern region of the school district during student teaching. The week 5 Student Teaching Summary of Sharon included three observations and three of Sharon’s reflections of those observed lessons during weeks 2 through 5. The observations evidenced that
Sharon demonstrated, “Great command of class…. effective questioning strategies…. and good scaffold of a content rich lesson! How can you modify handing out materials and grouping so the lesson flows better?” (week 3, supervisor observation notes). Sharon’s first lesson observation complimented teaching practices in all three STEs, and stated that she showed the ability to manage her students, engage them in inquiry learning, and teach a content rich lesson. Suggestions about Sharon’s teaching were present to encourage her to refine her practices for an efficient lesson.

Sharon’s reflection of this lesson read:

I need to figure a better way to do the small things like handing out their notebooks and assignments so the lesson flows better for student learning. I have ideas like…. But I want to observe my CT for what she does and how it influences the students learning environment….” (week 3, student teacher reflection)

In her reflection, Sharon noted a practice to improve, offered ideas on how to improve it, and identified a resource to help her improve. An excerpt from the following week’s reflection exemplified Sharon’s awareness of a learning environment when she wrote, “I also want to ask less, but better questions. By thinking up a few purposeful questions, I think I can facilitate a more discussion based learning environment for the students” (week 4, student teacher reflection). This indicated that early on, Sharon was proficient and reflective in her inquiry science teaching with respect to all three areas of the STEs.

The week 10 Student Teaching Summary of Sharon included two observations and two of Sharon’s reflections on those lessons during weeks 6 through 10. Because of her primary cooperating teacher’s track break, Sharon moved from her third grade class to a
fourth grade class during week 6 and no observations were scheduled during that week. However, by the next week, Sharon had taken over 100% of her new class.

Even with only one week to adjust to a new class of students, observation notes during this time continued to complement Sharon’s execution of inquiry and content rich lessons. During her first full week in her new class, observation notes said:

There was a clear purpose for this lesson and the class was focused the whole time. You started the lesson with a great connection to prior knowledge (even though you pretty much just met this class!) and you reinforced prior knowledge and other content throughout the lesson. Also, good cuing to what they’ll need to know! Your questions and design of lesson encouraged discussions where students had to apply what they were learning. (week 7, supervisor observation notes)

Observation comments throughout weeks 6 to 10 were similar to this example, and indicated that Sharon was successful in executing inquiry teaching practices in science in all three areas of the STEs. In week 8, observation notes added, “Great set up for what they are doing in the next lesson!” (week 8, supervisor observation notes). Progress in her teaching practice was demonstrated as Sharon developed from a narrow focus on one lesson at a time as seen during the first 5 weeks of instruction to successfully preparing students for learning throughout one themed unit.

By week 10, Sharon’s reflections demonstrated thought on how to teach with future lessons in mind as evidenced by her comment:

I liked how the discussion flowed in this lesson, but now I’m thinking what can I do to set them up for the next few lessons… this will certainly help them connect
the dots! My CT is very overt with telling them that they’ll “need to know that” [later], but I wonder if there’s something less, “boom, in your face.” I guess she does that because she’s training them to see how lessons are all connected. (week 7, student teacher reflection)

Sharon also started thinking about how she could refine personal teaching nuances as demonstrated by her thoughts in the following reflection:

I’ve been wondering if I prefer a particular group, gender, or person when I ask different questions or assign different tasks. Do I ask the hard questions to a certain person or group? Do I limit some students to the easy questions? Do I give all students the opportunity to engage in all levels of our activities? If so, then I am putting some of my students at a disadvantage! Can you come by tomorrow and tally who I talk to? Maybe I’ll make a tally chart with like all the students down one side, and things like hard question, easy question….across the top…

(week 8, student teacher reflection)

Sharon’s reflection demonstrated her interest in evidence-based practices. Her reflections at this time also demonstrated thought toward whole unit learning and the refinement of her personal teaching habits, both with the goal of improved learning for her students.

Sharon’s last Student Teaching Summary at week 15 included two observations and two of Sharon’s reflections on those lessons during weeks 11 and 12. During week 13, Sharon had completed the student teacher observation requirements and returned to her original fourth grade class. By this time, Sharon was directing her observations by identifying what she wanted me to observe, and this final summary consisted of follow up comments to Sharon’s questions. As her supervisor, I continued to observe Sharon for
other areas to improve, but Sharon was accurately identifying what science teaching practices she could refine for more inquiry based lessons. I wrote:

You asked me to observe how you set the stage for the rest of the unit and if you were clear about the writing standards for their journals. It was obvious that the application questions cued student to what you’ll be doing in the next lessons…sometimes you even asked them, “what do you think you’re going to use this for” and that was great!....You reinforced the writing standards by…[and] asking them to repeat it – way to have them explain! (week 11, supervisor observation notes)

In my week 12 observation note I commented, “ok, we need to take a look at that tally chart. I want you to look it over and make notes and I’ll do the same. Email me when you’re free to meet and discuss our findings!”

My observations notes were guided by Sharon’s inquiries. This indicated two important characteristics of Sharon. First, it suggested that she was acutely aware of what practices she could refine for maximum efficiency and learning. Second, it demonstrated her desire to improve.

By week 15, Sharon’s reflections analyzed the influences her teaching practices had on her students learning as evidenced by her week 11 reflection:

Knowing what I expect enables my students to focus on learning. My CT lays her expectations right out there. I want to make sure I do that because it is my job to create an environment free of mental clutter…. My carefully crafted questions help my students build their knowledge base for use later in the unit. You can’t ask them to apply their knowledge if they don’t understand the information. It is
my role to guide them toward this understanding. (week 11, student teacher reflection)

Sharon also wrote:

I’ve been wondering what I do to help develop problem-solving and reasoning skills….I want my students to be able to evaluate, justify, reason, and explain….I know we do these things in science, but I need to outwardly think what I can I do to make sure I am teaching them how…” (week 12, student teacher reflection)

Sharon’s reflections had matured to a level where she entertained teaching practices that addressed not only content, but also reasoning, evaluating, and problem-solving skills. Not only did Sharon address all three areas of STEs independently, but also she demonstrated comprehension in how all three areas, classroom management, teaching practices, and age and appropriate lessons interact to create the most influential learning community for her students.

Profile of Sharon

Sharon started the year-long study having the second highest amount of efficacy in her ability to teach science. Sharon experienced a steady increase of efficacy with a slightly higher science methods course efficacy raw gain (+11) than her student teaching efficacy raw gain (+8). In contrast to the dramatic changes in efficacy scores seen from participants thus far, Sharon’s changes were more stable. One factor that may account for Sharon’s stable changes in efficacy was the possible ceiling effect (Roberts, Henson, Tharp, & Moreno, 2001). The concept of the ceiling effect suggests that because the STEBI-B cannot measure beyond its own highest score, it does not have the capability of measuring efficacy gains if participants score high on initial efficacy measures. Although
Sharon’s efficacy scores showed a raw gain during each phase of the study, her scores had less of a range to increase than those who initially scored lower. However, this study focused on the trends in the efficacy changes and the characterization each level of efficacy through qualitative data, and not the comparison or meaning of actual STEBI-B PSTE scores.

For Sharon, the categories relationship with science; familiarity with science content, teaching practices, and resources; and content knowledge overtly contributed to her initial high level of efficacy. Although Sharon did not overtly identify experiences or observations that increased her efficacy during her methods class, Sharon credited mastery (Bandura, 1986) sources of efficacy when she recalled her science learning experiences.

During the first 5 weeks of her student teaching semester, Sharon demonstrated control of her class and science inquiry teaching skills in a content rich lesson. At this time, Sharon evaluated the influence of both her own and her cooperating teacher’s teaching practices on student learning. Her reflections addressed all the STEs. Vastly different from all the participants before her, Sharon started her student teaching semester evaluating the impact of her teaching on student outcomes and was representative of a “Maturing Efficacy” (Putney & Broughton, 2010, p. 17) because she was able to see herself as the teacher in relation to the classroom learning community.

Sharon continued to show progress in her teaching as evidenced by her lesson observations during weeks 6 through 10, even with a move to a new grade level with new students. It was evident that Sharon’s teaching practices and reflections had matured because they shifted from a focus of one lesson to a focus of a themed unit (week 7 and 8,
supervisor observation notes and student teacher reflections). Both her teaching and her reflections addressed all three areas of STEs in reference to themed units.

During the last 5 weeks of the semester, Sharon’s teaching practices demonstrated mastery of science inquiry teaching in management, teaching practice, and in a content rich lesson. At this point Sharon was leading her progress by guiding me as to what teaching practices to observe. Sharon’s reflections evaluated her teaching practices for content and in reasoning, evaluating, and problem-solving skills for student learning, which addressed all three areas of STEs with depth.

Sharon started the study with the second highest level of science teaching self-efficacy and steadily increased in her level of efficacy throughout the study. Setting her apart from all the participants before her, Sharon’s characteristics represented her high level of efficacy. Sharon continually showed increased effort and persistence (Hoy & Spero, 2005). She also created a classroom climate with “academic rigor and intellectual challenge” (Pajares & Schunk, 2001) and advocated teaching practices that are in line with inquiry science (Czerniak & shriver, 1994).

Sharon maintained her high level of efficacy and development in her teaching practice because her initial perspective of herself as the teacher who influenced student learning. Understanding that she was responsible for her students’ learning, coupled with the support of her science content knowledge and positive relationship with science, Sharon’s self-regulatory (Zimmerman, 2000) disposition strengthened her capability to learn.

Ann

Based on Ann’s Phase I pre STEBI-B PSTE score of 52 out of 65, she started the study with the highest level of science teaching self-efficacy. Like all the participants in
this study, Ann’s scores showed an increase in efficacy from the beginning to the end of the study (see Table 9).

Table 9

*Ann’s STEBI-B, PSTE Scores*

<table>
<thead>
<tr>
<th></th>
<th>Score</th>
<th>Raw Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline (Phase I, pre STEBI-B PSTE)</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>Phase I post STEBI-B PSTE</td>
<td>54</td>
<td>+2</td>
</tr>
<tr>
<td>Phase II pre STEBI-B PSTE</td>
<td>51</td>
<td>-3</td>
</tr>
<tr>
<td>Final (Phase II, post STEBI-B PSTE)</td>
<td>58</td>
<td>+7</td>
</tr>
<tr>
<td>Baseline to Final</td>
<td></td>
<td>+6</td>
</tr>
</tbody>
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Note: Raw Gain = difference between scores, + = efficacy increase, - = efficacy decrease

Although Ann’s self-efficacy score indicated an overall increase in efficacy, a slight decrease (-3) in her scores was found between the end of Phase I and the beginning of Phase II. Similar to all the participants in this study, Ann shared, “I’m a little nervous about taking over the whole class for an extended period, but I think it will be a wonderful learning experience” (Phase II, Questionnaire I), which suggested that teaching full time tested her science teaching self-efficacy. Regardless of the decrease, Ann’s student teaching raw gain (+7) was more than three times as much as her science methods class raw gain (+2). To contextualize Ann’s scores, the analysis of the qualitative data is reported next.
**Contributors to Ann’s Self-Efficacy**

For Ann, efficacy stems such as “I am more able,” “I am unable,” or “I feel more confident about,” had connecting ideas that were most frequently identified by the following categories: relationship with science, experience teaching science, and content knowledge. Each of these is fleshed out below.

*Relationship with science.* It was apparent that Ann’s relationship with science contributed to her high level of efficacy in excerpts such as, “I was surrounded by the love of science from an early age... it’s just a natural part of me...” (Phase I, Questionnaire 1). This “natural part” of Ann was portrayed as a history of positive influences in science as she talked about family members, “my mom was a science teacher and I remember helping her with experiments and setting up for her class...my sister is a biologist...[and] my uncle is an engineer...” (Phase I, Questionnaire 1).

Enriching school experiences also created Ann’s relationship with science as evidenced by her account:

> My most vivid memory was from my fourth grade when my class hatched baby ducks…. another favorite memory is from the third grade when I conducted a science experiment to find out the percentage of fruit that consisted of water…

(Phase I, Questionnaire 1)

Ann enthusiastically described her family stories and her school projects and commented:

> Science was always a challenging yet enjoyable process. What science has been for me is what I want to create for my students. I have a wonderful connection with science and it’s because of that I believe I can do well teaching science.

(Phase I, Questionnaire 1)
At the end of her methods class, Ann wrote:

I’ve learned so much in this class…I think I am able to teach inquiry science because I was able to relate how to teach it to how I learned…. At the beginning of the semester I connected my history with science to my confidence to teach it. Now I’m certain that my confidence comes from this bond I have with science.

(Phase I, Questionnaire 2)

Ann also reminisced about her relationship with science during student teaching and shared, “All I know is how I fell in love with learning science…what I wanted to learn, what I enjoyed… and that drives how I teach my class” (week 4, student teacher reflection). At the end of student teaching, Ann shared:

After all it sounds like everyone has been through, and after all I have learned this semester, I genuinely feel blessed that I have a combination of a strong background and a love for science, for both have made me feel competent as a science teacher. (Phase II, Questionnaire 2)

In addition to Ann’s relationship with science, experiences in teaching science also influenced her feelings toward her ability to teach science.

Experience teaching science. Although Ann measured having the highest level of self-efficacy, she stated that she had “high knowledge but some confidence” (Phase I, Questionnaire 1) regarding her ability to teach earth and life science and “some knowledge and some confidence” (Phase I, Questionnaire 1) regarding her ability to teach physical science. These personal descriptions of her confidence in teaching science ended with “because I did not have to the opportunity to teach science during my practicum experiences and that concerns me” (Phase I, Questionnaire 1). In these
excerpts, Ann described herself as having “some confidence” regardless of the amount of knowledge she reported. This indicated that for Ann, having experience in teaching had more influence than the amount of her content knowledge.

For Ann, she used her lack of science teaching experiences to frame what she needed to learn in methods class as exemplified in her questionnaire:

   Discussions of the new requirement that students must now pass a science portion of the proficiency exam in order to graduate has made me more aware of my responsibility to be an effective teacher of science at the elementary level, yet I have no experience at this stage… I would like to equip myself with a variety of research-based teaching strategies that have been proven to improve the performance of students in science. (Phase I, Questionnaire 1)

Ann also wrote, “An area of particular concern for me is how to assess my students in order to collect valid and useful information about their understanding of science concepts” (Phase I, Questionnaire 1). Ann sought out reform based teaching strategies and methods of assessment to make up for her lack of science teaching experiences and to ensure classroom readiness.

At the end of her science methods class, Ann reported:

   Knowing science does not guarantee I will be an effective teacher of science. To make up for my lack in teaching science, I paid particular attention to how to design lessons and how to create the classroom conditions that facilitate student learning. I also observed the variety of lessons for each grade level that target the different science content strands. I applied what I observed and what was discussed in class to creating and teaching a lesson using the strategies. These
experiences, combined with my knowledge of science make me feel I am a competent teacher of science. (Phase I, Questionnaire 2)

For Ann, a lack of experience did not make her feel less able to teach science, it informed her with what she needed to learn.

*Content knowledge.* Like all the participants in this study, Ann indicated that content knowledge was a strong contributor to her efficacy when she wrote, “I have high content knowledge in earth and life science because of the numerous classes I have taken and the retention of what I learned. I believe this will help my ability to design a challenging and meaningful lesson” (Phase II, Questionnaire 2).

Ann also cited her level of science knowledge as a factor for her efficacy throughout student teaching as evidenced in her teaching reflections:

My strength in this lesson was my questioning skills and I attribute that to knowing their prior knowledge, what I wanted them to learn, and my expectations on how they were going to apply their knowledge. This overall picture was possible because I understand the material. (week 3, student teacher reflection)

Crediting content knowledge for her ability to teach inquiry science was also evident in her student teaching midterm reflection when she wrote:

I know I create and execute lessons that are developmentally appropriate, yet challenging enough to keep them thinking about the concepts under discussion. I think this is because of the training I had in my methods class about lesson plans and my deep knowledge of the subject. One without the other would not result in the same quality of teaching. (student teaching midterm reflection)
At the end of her student teaching semester, Ann shared, “The nature of effective questioning and discussion are critical. There is no way one can ask effective questions, scaffold the content, or engage students in a meaningful discussion without mastery of the content” (end of student teaching journal). Ann’s relationship with science, experience teaching science, and content knowledge were identified as her contributors of efficacy and were the basis for her high level of science teaching self-efficacy.

Development of Ann’s Professional Self

Ann was assigned to a second grade class located at the school in the southwestern region of the school district during student teaching. The week 5 Student Teaching Summary of Ann included three observations and three of Ann’s reflections of those observed lessons during weeks 2 through 5. Observations evidenced that Ann, “has a sense of withitness [sic]. You orchestrated the lesson with links to prior knowledge, effective transitions, proper pacing, control of class, and with content rich discussions!” (week 3, supervisor observation notes). By week 3, observational comments referenced execution of teaching skills in all three STEs, which indicated that Ann was able to control her class and execute inquiry based teaching practices in a content rich environment.

In Ann’s reflection of this lesson, she wrote:

I want to learn how to manage the materials efficiently. The distribution and collection of materials interrupted the flow of the class today. I am going to observe my CT on how and when to bring the materials into student view and ask her the reason behind her designs. (week 3, student teacher reflection)
In their early lesson reflections, both Ann and Sharon commented about their management of materials and stated that they wanted to observe their cooperating teacher for ideas. In another reflection, Ann wrote, “I was particularly pleased with how the discussion went. I was able to remain focused on the objectives and guide my student’s understanding in a student-centered environment” (week 4, student teacher reflection). Ann’s lessons reflections indicated that she was reflective of the impact of her teaching practices on student learning.

The week 10 Student Teaching Summary of Ann included two observations and two of Ann’s reflections during weeks 6 through 10. At this time, Ann guided my observations by identifying what management, teaching practices, and content elements in her lesson design and execution to refine. My observational comments addressed Ann’s suggestions and said:

You delivered the directions well for your students. You were succinct and you asked them to repeat them at the beginning of the lesson and as the lesson progressed….yes, your students were engaged in a content rich exploration and explanation throughout the lesson – they were able to interpret their knowledge of seasons through colors and feelings in the form of a poem! Total integrated lesson without compromising science content… (week 9, supervisor observation notes)

During a meeting, I said:

You’ve based your reflections on what you can do to impact student learning and you offer ways to make your practices more efficient….You have been leading our meetings and identifying what you need assistance with….I like that you offer insightful input about your own progress. (week 6, supervisor notes)
At week 10, Ann’s reflections demonstrated being conscientious of the impact of her teaching on the long-term needs of her students. In addition to suggesting how I observe her lesson execution Ann wrote, “I met with the fourth grade teacher and asked what about seasons students will need to know. I used that to help me design my lesson” (week 8, student teacher reflection). Ann was teaching a second grade class and researched the fourth grade curriculum to ensure her students were properly prepared for the future learning. The design of her integrated lesson toward future grade level concepts indicated progress from focusing on teaching practices toward an awareness of her student’s future need.

Ann’s last Student Teaching Summary at week 15 included two observations and two of Ann’s reflections during weeks 11 through 13. Because of track break, Ann moved from her second grade class to a fourth grade class during weeks 11 and 12. Although Ann was only in her new class for 2 weeks, she taught at least 80% of the time. Ann quickly adjusted to her new grade level and class, and observational comments during week 12 read:

That was an amazing lesson! The whole flow of it – from direction giving to the orchestration of the group activity and discussion was representative of reformed, inquiry science teaching – and you just joined this class! You had them figure out how to best explore the densities of the liquids so they could figure out the mystery liquid….great scaffold of problem solving skills… and the students were guided to tie the concept of density to water pollution – great connection to authentic situations. Be prepared to talk about differences between teaching second and fourth grade in our next meeting… (week 12, supervisor observation)
Ann’s ability to facilitate a lesson that required students to address an authentic global issue (water pollution) while problem-solving about a science content (density) proved her mastery of inquiry based science teaching. In her reflection of this lesson Ann wrote:

I was nervous about a whole new class and new grade level. The nervousness made me extra cautious of my planning for this lesson. I thought adding the water pollution issue to teaching about density was going to be overwhelming, but it turned out it fit perfectly. The water pollution part gave students the opportunity to apply their knowledge to something real….My close of the lesson could be stronger. I need to learn to look at the time more so I can modify what we’re doing as we go along. I don’t want to get into a habit of a poor close to a lesson because…. I have observed veteran teachers and it seems easy to let that part of the lesson go. (week 12, student teacher reflection)

Ann’s confidence in her ability to teach science supported her ability to deem nervousness and areas to improve as learning situations and not as obstacles.

As evidenced by observation notes, and very similar to how Sharon’s progress was characterized, Ann’s teaching progressed from the polishing of individual teaching practices to the refining of teaching practices within a content rich integrated unit. Ann’s reflections also developed from a focus of refining independent teaching practices to leading her own progress toward ensuring a student centered and content rich learning environment. Both the development of her teaching and reflections addressed inquiry science teaching all three STEs.
Profile of Ann

Ann started the study with the highest level of science teaching self-efficacy. Her student teaching efficacy gain (+7) had more of an impact on her efficacy than her methods class efficacy gain (+2). Similar to Sharon’s case, one factor that may account for the minor changes in Ann’s efficacy scores was the possible ceiling effect (Roberts, Henson, Tharp, & Moreno, 2001). Because Ann started the study with a very high level of efficacy, her scores had less of a range to increase than those who initially scored lower.

The contributors of efficacy that characterized Ann were her relationship with science, her experience teaching science, and science content knowledge. Although Ann did not overtly identify experiences or observations that increased her efficacy during her methods class, like Sharon, Ann credited mastery (Bandura, 1986) sources of efficacy when she recalled her science learning experiences.

During the first 5 weeks of her student teaching semester, Ann’s teaching practices were described as, “You orchestrated the lesson with links to prior knowledge, effective transitions, proper pacing, control of class, and with content rich discussions!” (week 3, supervisor observation notes). Early on, Ann demonstrated control of her class and science inquiry teaching skills in a content rich lesson. At this time, Ann evaluated the influence of both her own and her cooperating teacher’s teaching practices on student learning. Like Sharon, Ann demonstrated mastery in inquiry science teaching and depth in her reflections in all three areas of the STEs (management, teaching practices, content rich lessons). Also like Sharon, Ann started her student teaching semester evaluating the
impact of her teaching on student outcomes and was representative of “Maturing Efficacy” (Putney & Broughton, 2010, p. 17).

Ann continued to show progress in her teaching as evidenced by her lesson observations during weeks 6 through 10. By this time, Ann progressed from successfully teaching single subject lessons to demonstrating mastery of teaching integrated lessons (week 9, supervisor observation). During this time, Ann’s reflections addressed the future needs of her students for proper design of her present lessons (week 8, student teacher reflection). In other words, Ann researched the learning expectations of subsequent grade levels to ensure she was properly preparing her students for their future. Ann’s teaching practices and reflections addressed all three STEs focusing on the needs of her grade level. Ann’s reflections during these weeks were clearly continuing to develop in the “Maturing Efficacy” (Putney & Broughton, 2010, p. 17) stage.

Ann moved from her second grade class to a new fourth grade class during weeks 11 and 12. Despite the move, Ann demonstrated mastery of science inquiry teaching in a content rich lesson during the last 5 weeks of the semester. In her new class, Ann “address[ed] an authentic global issue (water pollution) while problem-solving about a science content (density)” (week 12, supervisor observation notes), which illustrated her mastery of inquiry based science teaching. Like Sharon, Ann’s reflections evaluated her teaching practices in content and in reasoning, evaluating, and problem-solving skills for student learning. Even in her new class, Ann demonstrated mastery inquiry science teaching and reflections in all three areas of the STEs.

Ann started the study with the highest level of science teaching self-efficacy, and her characteristics epitomize her high level of efficacy. Exemplary of high levels of efficacy,
Ann continually showed increased effort and persistence (Hoy & Spero, 2005) as indicated in her student teacher reflections. Ann also created a classroom climate with “academic rigor and intellectual challenge” (Pajares & Schunk, 2001) and advocated teaching practices that are in line with inquiry science (Czerniak & Shriver, 1994) as evidenced by her lesson observations. Also, as shown in her week 12 student teacher reflection, Ann deemed nervousness and areas to improve as learning situations and not as threats to her confidence (Pajares & Schunk, 2001).

Like Sharon, what maintained Ann’s high efficacy and development in her teaching practice was her initial perspective of herself as the teacher who influenced student learning. Understanding she was responsible for her students’ learning, combined with the support of her science content knowledge and positive relationship with science, Ann’s self-regulatory (Zimmerman, 2000) disposition strengthened her capability to learn.

**Brief Characterization of High Levels of Efficacy**

The domain analyses for the telling cases representing the high level of efficacy indicated that experience teaching science and familiarity with teaching practices, relationship with science, and content knowledge, were categories of contributors of their efficacy. Unique to Sharon and Ann were their fond recollections of science learning experiences, their high levels of content knowledge, and their responses to challenges solely as learning experiences and not as threats to their confidence.

Also unique to the participants with high levels of efficacy was their initial teaching practices. They started their student teaching semester teaching inquiry science in a content rich environment, which validated mastery of teaching in all three STEs
(classroom management, teaching practices, content rich lessons). Regarding the quality of their reflections, the participants with the high level of efficacy started their student teaching semester in the “Maturing Efficacy” stage (Putney & Broughton, 2010, p. 17) and reflected about the impact of their teaching practices on their students’ learning.

Next, a cross-case analysis summarizing the similarities and differences between levels of efficacy concludes this chapter. To accentuate the differences between levels of efficacy, and because telling cases identified as having medium levels of efficacy behaved comparable to those with low levels of efficacy, analysis between high (the top two telling cases) and low levels (the bottom four telling cases) of efficacy are discussed in the cross case analysis.

**Cross Case Analysis**

My componential analysis of the data indicated that all telling cases were unique in their explanations of what contributed to their science teaching self-efficacy, in their areas of science teaching progress, and in their rate of progress. However, as evident in the data, similarities and differences were found in categorized contributors of efficacy and the development of their professional selves found within and across the different levels of efficacy. First, the trends over all the participants’ STEBI-B (Enochs & Riggs, 1990) science teaching self-efficacy score are discussed. Second, the similarities and differences between cases are discussed.

**Trends in All Cases**

Although many differences in the telling cases were shared, some stark similarities appeared. The most obvious similarity between all cases was the fact that regardless of
initial level of efficacy, all participants measured an increase in efficacy and
demonstrated an improvement of their professional selves. Although a measured increase
and a demonstrated improvement were shown, the degree of development differed. The
degrees of development are discussed later in the characterization of each case. The
common trends found in the self-efficacy scores during the year-long study are discussed
first. The contributors to efficacy found common among all participants are discussed
second.

_Trends in Scores_

A glance at the STEBI-B (Enochs & Riggs, 1990) raw scores over the duration of the
year-long study clearly illustrate a similarity between all cases regarding a trend in scores
(see Figure 9).
Regardless of initial score, the upward slope of the first line segment (P1 pre to P1 post) revealed that all participants increased in efficacy from the beginning of Phase I (science methods class) to the end of Phase I. This supports findings in the current literature that assert that elementary methods class is an intervention that has been found to increase efficacy (Howitt, 2007; Schunk, 1991). In the Phase I, Questionnaire 2 document, participants shared that experiences such as observing their peers teach,
experiencing teaching, and learning content assisted in helping them feel more capable of teaching science.

The downward slope of the second line segment (P1 post to P2 pre) showed that all participants declined in efficacy between the end of Phase I (science methods class) and the beginning of Phase II (student teaching). The time between the two phases was a 3 week holiday break that separated their science methods class and student teaching. Although this decline was not statistically significant, all the participants shared varying levels of anxiety in their Phase II, Questionnaire 1 about the authenticity of student teaching.

The transition between methods class and student teaching is pivotal. Current literature suggests that although efficacy is believed to increase during elementary science methods class (Bleicher, 2007; Jarrett, 1999), pre-service elementary education student’s science teaching self-efficacy declines during student teaching (Tschannen-Moran, Hoy, & Hoy, 1998; Utley, Bryant, & Moseley, 2005), and ineffective teaching practices are employed during student teaching (Plourde, 2002). This is detrimental because student teaching marks the end of their pre-service education and the beginning of their first year of teaching.

However, in this study, as seen in the upward slope of the last line segment (P2 pre to P2 post), all participants contradicted the findings in the current literature and measured an increase in efficacy during student teaching. Although the increase in scores contradicted current literature, the concern remains in the fact that, with the exception of Nancy, the development of professional self during student teaching was not representative of the goal of inquiry science teaching for the participants with lower
levels of efficacy. Although student teaching experiences impacted each participant differently, in their Phase II, Questionnaire 2, all participants expressed that being immersed in a situation that resembled an authentic situation helped them feel better prepared for teaching science. As seen in Figure 9, the last trend in scores was that all participants measured an increase level of efficacy from the beginning of the study (P1 pre) to the end of the study (P2 post), and collectively their measured increase was statistically significant.

**Characterization of Contributors to Self-Efficacy**

In addition to trends in scores across all cases, similar categories of contributors to self-efficacy were found across all telling cases. Although similarities were found in categories, differences occurred in how those categories characterized participants with different levels of efficacy. The identified categories of contributors to science teaching self-efficacy that were common to all participants were content knowledge and experience. How those contributors characterized different levels of efficacy are discussed next.

**Content Knowledge**

Content knowledge was a contributor of efficacy identified in all six of the participants. Regardless of level of efficacy, all participants connected the need for content knowledge to the ability to ask purposeful questions and engage students in content rich activities and discussions. The connection that all participants made validated that all participants were aware that content knowledge was needed for inquiry science teaching.
When addressing content knowledge throughout student teaching, participants commented on how knowing a topic enabled them to engage in meaningful discussions or how not knowing enough of a topic impeded their ability to challenge students. For all participants, the struggle with or ease of teaching a lesson was often associated with their perceived level of content knowledge. Although content knowledge was a common category of a contributor of efficacy across all six participants, what differed was the characterization of how participants with low and high levels of efficacy viewed the purpose of content knowledge and responded to a lack of content knowledge.

**Low levels of efficacy.** The participants with lower levels of efficacy defined the purpose of content knowledge in the same manner and reported similar reactions to the lack of content knowledge. Nancy, Sandy, Whitney, and Karen shared that having content knowledge allowed them to ask purposeful questions and enabled them to field student questions, suggesting that they conceptualized the value of content knowledge as a means to ask questions and address student answers. They indicated that they needed to know just a little more science content than their students. By implying that they need to know just a little more than their students, Nancy, Sandy, Whitney, and Karen’s belief about content knowledge support research that asserts that teachers with low levels of efficacy teach less content (Jones & Carter, 2006).

Not only did Nancy, Sandy, Whitney, and Karen cite comparable purposes of content knowledge, but they also responded to a lack of content knowledge similarly. For all the participants who ranged from low to medium levels of efficacy, their lack of knowledge in any given content area was directly associated to their doubts about their ability to teach that content. All of these participants stated that they had low content knowledge in
physical science, and Sandy and Karen also stated they had low content knowledge in both earth and life sciences.

The reported level of content knowledge of the telling cases representing the lower levels of efficacy and how they responded to the lack of content knowledge was a detriment to their ability to teach a content rich science lesson. Their disposition regarding their level of content knowledge and how it impacted them support current literature that characterize pre-service teachers with low levels of efficacy as teaching less content (Jones & Carter, 2006), teaching as a disperser of facts (Tilgner, 1990), and seeing challenges as threats (Pajares & Schunk, 2001).

High levels of efficacy. The two participants with high levels of efficacy defined the purpose of content knowledge in a manner that was contrary to the participants with medium to low levels of efficacy. Sharon and Ann shared in the belief that the purpose of content knowledge was to create rigorous, content rich science experiences for their students. Far beyond how participants with lower levels of efficacy viewed the need for content knowledge, Sharon and Ann also deemed content knowledge necessary to scaffold their student’s content learning and thinking skills for future lessons and grade levels.

Sharon and Ann never questioned their confidence in their ability to teach science because of their uncertainty about their content knowledge. However, Sharon and Ann both started the program with a history of positive experiences in learning science and they both implied that their histories contributed to their high content knowledge in science in general. Any implication of uncertainty for Sharon and Ann was seen as an opportunity to improve, and not as a threat to their confidence.
The participants with high levels of efficacy operationalized content knowledge as a means to scaffold student learning in content rich whole units with grade level accomplishments in mind. Pre-service teachers with high levels of efficacy are characterized as individuals who have “academic rigor and intellectual challenge” (Pajares & Schunk, 2001, p. 13) and more effective classrooms (Dembo & Gibson, 1985). In addition to content knowledge being a contributor of self-efficacy for all participants, experience was also an identified contributor that all participants referenced.

Experience

Regardless of level of efficacy, all participants expressed an assortment of science experiences as contributors to their efficacy. For all six participants, when they shared about experiences during their science methods class, they referenced what they had observed and practiced and how these experiences made them feel.

The numerous entries were representative of vicarious and mastery sources of efficacy that influenced their affective state (Bandura, 1986) and unanimously made the participants feel more prepared to teach science. All six participants shared that they observed and practiced science teaching techniques during their science methods class. Participants cited practice in making lessons plans and teaching in front of their peers, and opportunities they were afforded to observe each other and their instructors. The finding that all participants increased in efficacy during their methods class and that all participants cited observing and practicing science teaching skills as a contributor to their efficacy affirm the value of methods class experiences on increasing science teaching self-efficacy (Bleicher, 2007; Brand & Wilkins, 2007; Howitt, 2007; Jarret 1999; Yoon et al, 2006).
All six participants also shared descriptions about their prior experiences in learning science. Emergent from my study were the distinguishing vast differences in the accounts of the experiences and influences of the experiences between the low and high levels of efficacy.

**Prior experience and low levels of efficacy.** Nancy, Sandy, Whitney, and Karen’s personal feelings about prior experiences in learning science can be summed up with the descriptors indifferent, disdain, and avoidance, and their descriptions about their experiences in learning science had words such as monotonous, lacking, and uninspiring. Their descriptors suggest that they have a weak understanding of science (David, Pettish, & Smithey, 2006). Throughout student teaching, these participants continued to recall their ill memories of learning science as reasons for their struggles in teaching, which suggest that prior experiences have a stronghold on them. For participants with lower levels of efficacy, their weak understanding of science was a major contributor to their struggles in teaching science.

**Prior experience and high levels of efficacy.** On the other hand, the participants with high efficacy reported fond and enriching experiences in science that they spoke about as their relationship and connection to science. Sharon relished memories of being a science explorer and Ann recalled being surrounded by the love of science, and for both participants, their positive histories and relationship with science framed their vision of teaching. Sharon and Ann related their confidence to teach science to their positive prior learning experiences and tapped into the memories of how they were taught to help refine their teaching practices during student teaching.
In addition to prior experiences, all participants’ referenced challenging experiences they faced in learning science, learning how to teach science, and teaching science during student teaching. However, participants with lower levels of efficacy viewed their challenges differently than participants with higher levels of efficacy.

*Challenges for low levels of efficacy.* Participants with lower levels of efficacy encountered challenges ranging from not succeeding in learning science content to teacher centered and traditional science teaching practices during student teaching. Challenges differed between participants. However, common among all participants with lower levels of efficacy was their reference to how their lack of authentic science teaching experiences prior to student teaching contributed to their struggles during student teaching. Although research found that science methods classes increased efficacy, it appeared that authentic science teaching experiences were an element participants with lower levels of efficacy needed to sustain their efficacy through student teaching.

Another similarity between three of the four participants with lower levels of efficacy was how their challenges impacted them. Nancy was the anomaly in this situation. Nancy was identified as having the lowest level of efficacy at the beginning of the study, but she responded differently to her challenges than the three other participants with lower levels of efficacy. Nancy is discussed last.

Sandy, Whitney, and Karen all struggled with classroom management until the end of student teaching, and for all three participants their challenges caused serious doubt in their ability to teach. Sandy struggled with classroom management, but shrugged it off with stating all she needed was experience. Karen’s struggle in classroom management
was compounded by the fact that she reported a very low science content knowledge. For Whitney, although she had a strong grasp of science content, she did not know how to manage her class or teach the concepts. All three participants were limited in their ability to demonstrate inquiry teaching skills in science because of the classroom management issues they faced.

All three participants with lower levels of efficacy also shared their difficulties in learning science. However, regardless of their struggles, the common factor among all three participants with lower levels of efficacy was their perspective in regard to the challenges they faced. All three participants viewed challenges as an obstacle to inquiry science teaching and as a reason to doubt their confidence in their ability to teach science. In other words, if participants with lower levels of efficacy expressed struggle in any area, then they felt they could not succeed in teaching it. Sandy, Whitney, and Karen blamed external factors for their inability to teach, which deflected their responsibility to change. Also common between Sandy and Karen was the fact that each of them responded to their challenges with a simple solution. For example, Sandy and Karen often blamed their inability to implement inquiry science teaching practices on the fact that they have never done it before. Their response to significant challenges indicated that they did not take ownership for it, did not recognize the severity of their issues, and they believed that their issues would somehow disappear.

Nancy was the one participant who was identified as having a low level of efficacy and had some of the same challenges as the other participants. However, Nancy did not have the same response to her challenges. Nancy’s responses to her challenges were similar to the participants with high levels of efficacy. Although Nancy’s behavior
contradicted what current literature reports about pre-service teachers with low levels of efficacy, her response was not surprising. In her Phase I, Questionnaire document, Nancy wrote the following unprompted statement, “Thank you. I am participating in your study because I feel it will benefit me to increase my knowledge and confidence in teaching science.” It was evident that increasing her knowledge and confidence to teach science was her goal and Nancy demonstrated dedication toward her goal. The dispositional difference between Nancy and the other three participants was that the other three participants blamed external factors (their prior histories, not having experience) for their struggles whereas Nancy used her challenges to focus on what she needed to do to improve. This suggested that for Nancy and Karen, attitudes supersede typical behaviors related levels of efficacy.

Challenges for high levels of efficacy. For Sharon and Ann, a challenging experience resembled an area in their teaching they planned to refine and not one that made them question their ability. Regardless of the perceived severity of their challenges, both participants took responsibility and identified where in their planning or execution they could improve. For Sharon and Ann, and like Nancy, a challenge was an indicator of what needed to improve and what could be learned. For them, challenges were opportunities to evaluate how to improve and not a cause for doubt in their confidence to succeed.

Although their challenges seemed few, both participants and Nancy confidently identified some teaching practices as needing refining for maximum effectiveness in the classroom. The crucial difference between the participants with high efficacy and Nancy and the participants with low efficacy was that the participants with high efficacy took
responsibility for their challenges, articulated the impact of their challenges on teaching effectiveness, and suggested ways to improve.

In sum, dispositions regarding responses to challenges were related to levels of efficacy. The participants with high levels of efficacy, and Nancy, deemed challenges as opportunities to learn and the challenges had no detrimental adverse effect on their confidence. The participants with low levels of efficacy found blame for their challenges, did not articulate the impact of their actions on classroom effectiveness, and offered quick-fix solutions. The most significant difference for participants with low levels of efficacy was that challenges decreased their confidence. Nancy was an anomaly regarding her response to challenges and her uniqueness was attributed to her attitude. Her science methods efficacy gain (+11) and beginning to end efficacy gain (+17) was the highest among all six participants, and it was her disposition that was the foundation of her confidence.

Content knowledge and experience were what all participants referenced as sources of their science teaching self-efficacy. Each participant also discussed prior experiences and challenges. Constant with previous work in the field, my findings indicated that the lack of content knowledge and that negative science experiences resulted in decreased efficacy (Appleton, 2006; Davis, Petish & Smithey, 2006). What this study added was the elucidation of unique perspectives to challenges and dispositions despite negative backgrounds in science, like with Nancy.

**Personal Enjoyment**

Personal enjoyment was the one category of contributor to efficacy that was overtly addressed by the cases with low levels of efficacy, but not the high level of efficacy. How
each level was influenced by their enjoyment of a science topic or experience is discussed next.

*Low levels of efficacy.* All four participants who ranged in the medium to low levels of efficacy referenced personal enjoyment as a contributor to their self-efficacy. Not only did they discuss personal enjoyment as a contributor to their efficacy, but also personal enjoyment was the filter to all other influences on their confidence. In other words, regardless of their previous science experiences, if they felt particular interest in the experience, then they deemed themselves able to teach it. For Nancy, despite her lack of her earth science teaching experience, her interest in it made her feel confident to teach it. Karen claimed insufficient content knowledge and no life science teaching experience yet stated being confident about teaching life science because she enjoyed life science. Sandy shared that she failed a science project in high school yet her recollections of how fun the project was enabled her to feel able to teach it.

Not only did the participants with low levels of efficacy linked their personal enjoyment and interest in a topic to their ability to teach it, but also they related a lack of interest in a topic to their inability to teach it. For the participants with low levels of efficacy, their personal enjoyment preceded the influence of an unsuccessful experience and the influence of no experience. Personal enjoyment of a subject matter was imperative for the participants with lower levels of efficacy because it was the one factor that increased their efficacy and deemed them able to teach successfully regardless of achievement in that area. For these participants, their affective state (Bandura, 1986) was the filter to all other influences on their efficacy.
**High levels of efficacy.** Sharon and Ann shared fond anecdotes about the many science learning experiences that created their relationship with science. However, for them, the mention of personal interest or enjoyment of science experiences had no direct relationship to their ability to teach that subject. Enjoying a particular subject related to the pleasure of teaching that subject, but not the effectiveness of it. The participants with high levels of efficacy tended to remain more practical when identifying factors related to inquiry science teaching. For example, although Ann shared enjoying projects as a learner and indicated that she would like to engage her students in projects, she stated needed to learn inquiry science teaching methods to successfully teach her students. Ann was clearly aware that enjoying projects alone did not deem her able to engage her students in projects, but learning teaching methods would.

Although each participant referenced how content knowledge, experience, challenges, and personal enjoyment influenced their efficacy, the participants with low levels of efficacy responded to these factors differently than participants with high levels of efficacy. The contrast in the responses to the contributors of efficacy demonstrated obvious differences in their disposition about science and differences in their development in teaching science. In other words, participants with lower levels of efficacy and participants with higher levels of efficacy each had different views about what science teaching entailed, which influenced the progress of their science teaching practices.

**Science Teaching Practices**

As evidenced by their reported science experiences and responses to science experiences, a distinct difference exists between the disposition of participants with low
and high levels of efficacy toward science teaching between. Also vastly different between these groups of participants was the development of professional self. Current literature states that pre-service elementary teachers with low levels of science teaching self-efficacy use more teacher centered teaching strategies (Appleton, 2006), which are more traditional teaching than inquiry. They also teach less content (Jones & Carter, 2006) and engage in low risk activities (Davis, Petish, & Smithey, 2006), which imply low level learning. Current literature also assert that individuals with higher levels of efficacy are more amenable to the implementation of reform efforts (Ghaith & Yaghi, 1997) and create a learning environment rich with content (Dembo & Gibson, 1985), which imply inquiry based science teaching.

The findings shared next support current literature in terms of the initial characterization of teaching practices for low and high levels of efficacy. More importantly, the findings of this study add to the literature by addressing more than a static characterization of low and high levels of efficacy. Next, the differences between how the participants with low and high levels of efficacy’s professional self developed are discussed. In this discussion, how their conceptualization of science teaching and contributors of efficacy influenced their development of their science teaching practices is also addressed.

**Development of Professional Self in Low Levels of Efficacy**

As evidenced in their raw gains, Sandy, Whitney, and Karen’s efficacy increased substantially more during their science methods class (+13, +13, +18 respectively) than during their student teaching experiences (+1, +6, +4 respectively). Data discussed will show how the deceleration of their efficacy scores seen during student teaching was
validated by how their struggles challenged their efficacy throughout the semester.

Nancy’s continuum of development was not similar to their experiences and is discussed separately.

Sandy, Whitney, and Karen’s early issues with classroom management prevented them from executing inquiry science teaching practices early in the semester, and they continued to struggle with classroom management for most of the semester. In their reflections, they were only able to identify the basis of their struggle and they blamed their inability to teach an inquiry science lesson on external factors such as their lack of experience and content knowledge. This disposition common to all three participants prevented them from taking responsibility for their weaknesses, which grossly limited their ability to develop. At this time, their reflections were indicative of Putney and Broughton’s (2010) “Efficacy Onset” (p. 13) stage.

Of the three, Karen had the highest level of efficacy, but appeared the most unconcerned about overcoming her weakness. She was nonchalant about not being prepared and not taking the time to create an effective lesson, which slowed her progress more than the participants with lower levels of efficacy. This supported my finding that disposition played a large role in the rate of progress in the development of professional self.

Despite their initial low levels of efficacy and dispositions that restricted progress, Sandy, Whitney, and Karen demonstrated development in their teaching practices. By mid-semester, Sandy, Whitney, and Karen had intermittent control of their class and were able to demonstrate science teaching practices. Sandy and Whitney were able to demonstrate the potential to teach inquiry science when their students were focused, but
Karen’s lack of content knowledge limited her to low level, teacher centered, traditional teaching methods.

At this point, Sandy, Whitney, and Karen started to address the basic relationship between their lesson designs, the flow of their lessons, and their student’s behavior. Although Sandy, Whitney, and Karen continued to blame their struggles on external factors, their reflections were representative of progress because they started to address the connectivity between their teaching practices and student behavior which was representative of Putney and Broughton’s (2010) “Developing Efficacy” (p. 14) stage. They became responsible for their students’ behaviors by making the relationship between their actions and their students’ behaviors.

By the end of their student teaching experience, Sandy, Whitney, and Karen demonstrated improved control of their class and demonstrated more inquiry based teaching. However, their lack of control in the classroom continued to limit their ability to teach a complete science inquiry and content rich lesson. Improvement in their teaching practices was noted because all three participants were able to control their class for longer periods of time and demonstrated teaching practices indicative of science inquiry. Karen was the participant whose teaching practices least resembled inquiry teaching because her lack of content knowledge grossly limited her ability to interact with her students in the manner inquiry teaching and learning requires.

Sandy, Whitney, and Karen blamed their struggles on external factors throughout student teaching. Sandy continued to use the lack of experience as a reason for her struggles, Whitney continued to report she did not know what to do, and Karen heavily cited her lack of content knowledge. Despite their inclination to blame outside sources,
their final reflections were indicative of development because they had shifted from a basic identification of their challenges to the implications of their teaching practices on student behavior. Their thinking still reflected Putney and Broughton’s (2010) “Developing Efficacy” (p. 14) stage.

Their initial struggles with classroom management and poor quality of science teaching practices align with findings in the literature that offer a static characterization of those with low levels of efficacy (Jones & Carter, 2006). However, what we now know is how the combination of how their disposition, struggles, and reflections influenced their efficacy and development of teaching practices over the course of student teaching. Understanding the complete continuum of development for pre-service elementary teachers with low levels of science teaching self-efficacy is vital to understanding how to create the most valuable and supportive environment for learning how to teach science. Creating this learning environment is essential because it is believed that a connection exists between teacher self-efficacy, teacher performance, and student achievement (Ashton & Webb, 1986; Gibson & Dembo, 1984).

In my study, Nancy was an anomaly. Although Nancy started the study with the lowest level of science teaching self-efficacy, she did not have the same struggles nor did she develop in the same manner as those with lower levels of efficacy. Also opposite from the participants with lower levels was the fact that Nancy’s efficacy gain increased more during student teaching (+11) than methods class (+7). This supports that although Nancy had challenges during student teaching, she, like the participants with higher levels of efficacy, deemed her challenges as opportunities to learn and not as threats to her confidence. Nancy did not struggle with classroom management and her challenges
were more about continuity and connectivity of activities and interactions in a lesson. Although Nancy initially demonstrated haphazard classroom interactions, she quickly progressed toward multitasking in a fluid lesson. Nancy’s progress and behavior were, again, comparable to participants with higher levels of efficacy and are discussed more in the next section.

Development of Professional Self in High Levels of Efficacy

Sharon and Ann started their student teaching experiences with a solid grasp of classroom management. Their lessons were content rich and they engaged their students in explorations and discussions. At the beginning of the semester, they were simply fine-tuning teaching practices for maximum efficiency and were at Putney and Broughton’s (2010) “Maturing Efficacy” (p. 17) stage.

Although faced with minimal struggles in teaching science, Sharon and Ann’s reflections accurately evaluated what teaching practices they could improve for a refined inquiry science lesson. Clearly evident in their reflections, Sharon and Ann evaluated their experiences in terms of the effectiveness of their practices, impact of their practices on student learning, and preparation for the future. Their reflections included methods to improve to ensure quality science teaching practices. Sharon and Ann expressed a heightened awareness of their own progress in their reflections. Needing only the guidance of their cooperating teacher and supervisor, Sharon and Ann were in control of their progress early on in the semester.

Nancy started her student teaching experience with a command of classroom management, but initially struggled with the cohesiveness of her lesson. Unlike her counterparts with lower levels of efficacy, Nancy’s struggles did not impede her
development in science teaching practices. Nancy did not blame external sources for her weaknesses, but like Sharon and Ann, Nancy accurately identified what she needed to modify, planned how to refine her practices, and put forth effort in improving.

Sharon and Ann’s science teaching practices and reflections were indicative of progress because they shifted their practices from a focus on a single lesson to a focus on themed units and future lessons, always with student learning in mind. Nancy’s progression happened along the same continuum with a rapid acceleration toward successfully inquiry science teaching in lessons that prepared student for future lessons. One difference between Sharon, Ann, and Nancy was that regarding reflections, Sharon and Ann started the semester where Nancy was by mid-semester. The important similarity between Nancy, Sharon, and Ann was their disposition in how they viewed their weaknesses and how that propelled their development of their teaching practices.

My findings support the characterization that pre-service elementary teachers with high levels of science teaching self-efficacy use the types of instructional strategies promoted in science education, are not threatened by challenges, and have classrooms conducive to academic excellence (Pajares & Schunk, 2001). My findings add how their dispositions and reflections advanced the development of their teaching practices over the course of student teaching. Teasing out differences between low and high levels of efficacy is imperative because behaviors associated with pre-service teachers with high levels of efficacy have a direct impact on their student’s learning (Brophy, 1979; Gibson & Dembo, 1984; Tschannen-Moran, Hoy, & Hoy, 1998). How my findings expanded the field of science teaching self-efficacy is addressed in the next chapter.
CHAPTER 5
DISCUSSING LEARNING TO TEACH SCIENCE

The purpose of my study was to examine contributors to pre-service elementary teachers’ science teaching self-efficacy and science teaching techniques across different levels of self-efficacy to better understand what is needed to the break the cycle of ineffective science teaching methods. In researching the questions that guided my study, 1] What science experiences influence science teaching self-efficacy in pre-service elementary teachers and 2] How are science teaching practices depicted across different levels of efficacy during student teaching, my findings both confirmed what researchers in the field have concluded and expanded the direction of this field.

Blazing New Paths in Science Teaching Self-Efficacy

Research on pre-service elementary teachers’ science teaching has informed the field in many ways about the needs and tendencies of those with different levels of efficacy. But, as articulated in the following paragraphs, many questions and issues relating to methodology and our understanding about the effects of developing efficacy on science teaching practices remained unanswered and were addressed by this study.

Two of the most common suggestions for research in the area of pre-service elementary science teaching self-efficacy called for longitudinal studies and for science teaching observations (Bleicher, 2004; Brand & Wilkins, 2007; Posnanski, 2002; Utley & Bryant, 2005). Woolfolk Hoy & Burke Spero (2005) state, “longitudinal studies across teacher preparation programs and the first several years in the field could begin to map the development of efficacy beliefs” (p. 346). I addressed this gap in the literature by
conducting a year-long study, which supported the shift in the perception of efficacy from a static view to a developmental view. This shift expanded our knowledge of how developing efficacy influenced developing science teaching practices.

My research design yielded findings that pointed to the fact that efficacy is not necessarily as static as constructed in the literature. Rather, efficacy is a developmental process that influences the progress of teaching practices. Research has extracted Bandura’s (1986) sources of efficacy from his SCT to characterize different levels of efficacy, which limits the perception of efficacy to a static portrayal of individuals. What has yet to be done is to view developing efficacy as an influence in Bandura’s (1977) triad as a way to understand the meaning of the characterizations. The new view provided by my research allows for an individual’s developing efficacy needs to be met and for an understanding of the effects efficacy development has on teaching development instead of focusing on fixing efficacy as an end product.

The dual-phase nature of my study’s design afforded me the new view and allowed me to trace my participants’ developing efficacy. I found that the participants with lower levels of efficacy started the student teaching semester discussing the success of their cooperating teachers (Putney & Broughton, 2010; see Appendix M). This implied that their views of teaching were focused only on their cooperating teachers. By the middle of the semester, their discussions shifted to focusing on the design and execution of their technical teaching practices (Putney & Broughton, 2010), indicating development of their efficacy through their shift in focus from other to self. Sandy, Whitney, and Karen’s developing efficacy stopped at this stage and they failed to see the direct influence of their teaching practices on student learning. Through comparing reflections and teaching
observations, I found that the development of Sandy, Whitney and Karen’s teaching practices were limited by their perceptions of teaching. Their development stopped at the improvement of the technical execution of a practice because they viewed refining teaching practices as a means to improve the technical aspect of that particular teaching practice instead of creating an effective learning environment. This study showed that their teaching practices also fell short of this connection because they did not develop a relationship between their teaching and student learning.

On the other hand, although Sharon and Ann started the study with high levels of efficacy, demonstrated inquiry science teaching, and focused on student learning in their reflections, they continued to show development in their science teaching and reflections. Through the examination of their feelings of confidence, lessons of teaching, and lesson self-reflections over time, I found that in acknowledging the relationship between their practices and student learning that they, and Nancy, continually refined their teaching practices for improved student learning. Although Nancy started her student teaching semester in “Efficacy Onset” by viewing only her cooperating teacher’s successes (Putney & Broughton, 2010), she quickly developed through to “Maturing Efficacy” where she articulated the influences of her practices on the classroom community. By reaching “Maturing Efficacy” (Putney & Broughton, 2010), Nancy, Sharon, and Ann successfully refined their inquiry science teaching practices as a means to create an effective learning environment.

The second call was for the inclusion of teaching observations in the research design. In current studies, data sources relied heavily on questionnaires, teaching artifacts, and surveys. This limited our knowledge about how participants were thinking related to what
they were doing. However, in my study, student teachers were observed in teaching entire science lessons in their classrooms and their self-reflections on those lessons were collected over the course of their 16-week student teaching semester. The dual-phase design and observations of authentic teaching addressed the limitations of current literature by affording me the opportunity to trace evidence of efficacy, science teaching practices, and reflections over time. My study not only mapped the development of efficacy beliefs, but as discussed next, it also illustrated the interplay and development of levels of efficacy, contributors to efficacy, reflections, and science teaching practices.

Consistent with the literature, my findings confirmed that participants with lower levels of science teaching self-efficacy reported poor science experiences and low content knowledge, while the participants with higher levels of efficacy reported a positive relationship with science and a higher level of content knowledge (Jarret, 1999). My participants described how experiences such as practicing and observing teaching techniques increased their efficacy (Bandura, 1986; Palmer, 2002) and how the realities of student teaching challenged their efficacy (Utley, Bryant, & Moseley, 2005).

The design of my study, highlighting the relationship among the levels of efficacy, contributors to efficacy, reflections, and science teaching practices, contributed to understanding the development of science teaching practices through self-efficacy. This design facilitated the extension of our understanding that not only is science experience critical, but also an individual’s personal interest in a particular topic provided a filter for their efficacy, as I saw in Sandy, Whitney, and Karen. This motivated their persistence to learn.
Also evident in their descriptions of their confidence, lesson observations, and lesson self-reflections, pre-service teachers with lower levels of efficacy possessed accountability, but lacked ownership of their science teaching practices. Where accountability is the limitation to choosing the right teacher action to implement, ownership is the ability to evaluate how to modify and shape inquiry teaching practices as a means for student learning. Accountability is doing teacher practices, such as selecting the right teacher action to implement while ownership is the internalizing of how teacher practices influences student learning, such as evaluating how to modify and shape inquiry teaching practices as a means for student learning.

Sandy, Whitney, and Karen demonstrated accountability because they were doing what they have been taught to do and what they have observed from their cooperating teacher, and they acted like teachers. They viewed their cooperating teachers and recalled experiences for teaching practices that they could mirror for a desired outcome such as better control of students. In this sense, they were expressing accountability for doing correct teacher acts.

What was missing from Sandy, Whitney, and Karen’s articulation of their practices was ownership of their teaching practices in the form of assessing and modifying the science teaching practices they were adopting for student learning. In their teaching reflections, they suggested only on how to refine the technical execution of their teaching practices and they demonstrated a modified execution of their teaching practice. With a lack of ownership and a narrow focus in their reflections, they lacked the understanding of the classroom as a dynamic relationship. This lack of ownership subsequently limited
their control in their ability to refine their practices with student learning as the focus, and the development of their teaching practices suffered.

On the other hand, Nancy, Sharon, and Ann owned their science teaching practices because they analyzed how their actions resembled inquiry teaching and influenced student learning. Ownership toward student learning was clearly evident in their language because they constantly assessed their teaching practices in terms of its effectiveness of inquiry science teaching with student learning as their focus, and from this, they continued to refine their practices.

The “X” Factor

The X factor in the study refers to the ribbon that ties efficacy back into the SCT (Bandura, 1986) and propels an individual’s development beyond refinement of a technical task. Ownership is the X factor that accounted for an understanding of the hows and whys of the refinement of technical tasks for student learning, and not just for the improvement of the task itself. I found that ownership of teaching actions on students’ learning was the factor that separated the participants who demonstrated inquiry based science teaching by the end of the their student teaching experiences and those who did not.

Accountability and responsibility are expected from every level of teacher education, including the teacher (Cochran-Smith & Fries, 2001; Hammerness et al., 2005; Loughran, 2006b). Examples such as scripted curriculum communicates to teachers that mimicking prescribed teaching actions rather than the ownership of practices are best for student learning. Scripted curriculum also supports accountability of teaching practices but
deemphasizes the need for ownership of practices toward student learning. The concept of accountability and scripted curriculum communicates an assumption about what we think about preparing future teachers. Is teacher education shaping pre-service teachers to enact technical teaching techniques, or are we shaping their understanding of the process of it?

Teacher education programs, and the actions of teacher educators and supervisors, are responsible for shaping future teachers (Cochran-Smith & Fries, 2001; Darling-Hammond & Cobb, 1996; Feiman-Nemser, 2001). Pre-service teachers are also accountable for their learning (Loughran, 2006b; Putnam & Borko, 2000). Looking at the sources of efficacy and the levels of efficacy the way researchers have been limits what we have been able to learn. The emphasis has been on what pre-service teachers do and not how they think about what they do. If research only examines what the sources of efficacy are, then research fails to ascertain this key piece. This limits our view not only in how pre-service teachers are implementing their practices, but also how they are interpreting it in and for practice. This grossly limits our view of how their practices are developing. In my study, the observations and the reflections on those observed lessons allowed me to see this in the research.

What hampered Sandy, Whitney, and Karen’s development in their science inquiry teaching practices was the fact that they continually blamed external factors on their challenges in teaching and that their reflections stopped at addressing the impact of their teaching practices on their students’ behaviors and classroom actions (Larrivee, 2006). Sandy, Whitney, and Karen connected their inability to maintain classroom management to their inability to teach inquiry science. They also made suggestions on what teaching
strategies to modify to improve classroom interactions. In their statements, they expressed accountability and responsibility for their actions by making the connection between their actions and what was happening in the classroom, but they failed to make the connection to student learning.

What Sandy, Whitney, and Karen needed was guidance on how to interpret their recollections of learning to teach science and their observations of their cooperating teacher. Asking pre-service teachers to reflect, discuss, and explain, suggests that they are asked to assess their teaching practices. However, the participants with lower levels of efficacy were limited to assessing which practices to employ. Ownership is more than reflection, and for some, ownership of teaching practices toward student learning must be taught.

Loughran (2006b) states how reflection, when combined with experience, helps students value what they are learning and are significant to the development of professional learning. My study showed that professional growth occurred when there was ownership of the influences of their science teaching practices on student learning. Sandy, Whitney, and Karen communicated accountability for their teaching by reflecting on the technical aspects of teaching, but failed to own student learning. By just thinking about accountability, the blame of their weaknesses on external factors never changed, and without ownership they failed to express their responsibility for their students’ learning. On the other hand, Nancy, Sharon and Ann continually expressed ownership of the influence of their practices on student learning. Their ownership propelled them to refine their inquiry science teaching practices for student learning.
Nancy started the study with the lowest level of efficacy and had the same contributors to her efficacy as the participants with lower levels of efficacy, but she was an anomaly. By the end of student teaching, Nancy demonstrated inquiry science teaching. What propelled her forward in her development of her science teaching practices and confidence? Like the participants with higher levels of efficacy, and vastly different than the participants with lower levels of efficacy, Nancy had the X factor. Nancy evaluated her weakness in her teaching practices (instead of blaming external factors) and articulated the connections between her teaching practices, the characteristics of inquiry learning, and her students’ learning, which was indicative of Maturing Efficacy (Putney & Broughton, 2010). In recognizing these connections, Nancy, and the participants with high levels of efficacy, took ownership of their actions and shaped their science inquiry teaching practices with student learning in mind.

Dewey (1964) stated,

[T]he work of the expert or supervisor should be directed to getting the student to judge his own work critically, to find out for himself in what respects he has succeeded and in what failed, and to find the probable reasons for both failure and success, rather than to criticizing him too definitely and specifically upon special features of his work (pp. 334-335).

Teacher education must move beyond accountability and responsibility and emphasize ownership of actions. Pre-service elementary teachers with lower levels of science teaching self-efficacy lack ownership and I assert that teacher educators and supervisors must continually and overtly shape their sense of ownership in the development of their teaching practices toward student learning. This demands that teacher educators and
student teacher supervisors purposefully shape pre-service teachers’ thinking to shift to ownership under which accountability and responsibility are subsumed. We start the shift to ownership by first examining the implications of the language and expectations used in teaching pre-service teachers.

In addition to identifying the X factor that separated the pre-service elementary student teachers who demonstrated science inquiry teaching and those who did not, my study connected to and continued the work of Bandura’s (1986) sources of efficacy and revealed contributors to efficacy and pre-service elementary science teaching practices during student teaching.

The “X” Factor as it Relates to Efficacy

Just because a person reports he or she is efficacious does not mean he or she has ownership. For example, Karen scored and claimed she had more confidence in her ability to teach science than three of the six participants, yet she was one of the three who failed to demonstrate inquiry science teaching and articulate ownership of her practices toward student learning. How, then, does ownership tie to efficacy?

Studies that used Bandura’s (1986) sources of efficacy as a framework identified how those sources influenced efficacy, assuming that efficacy influenced the learning of teaching. For example, some found that mastery experiences during student teaching challenged efficacy, therefore learning of teaching practices were minimal (Plourde, 2002; Utley, Bryant, & Moseley, 2005). Other studies found relationships between mastery and vicarious experiences during science methods courses and an increased level of efficacy to teach (Brand & Wilkins, 2007; Howitt, 2007).
Current literature has limited our view of the sources of efficacy and resulted in a checklist of what pre-service teachers should be exposed to in order to increase their efficacy. From current literature, we know that mastery, vicarious, verbal persuasion, and affective states (Bandura, 1986) experiences increase efficacy, but we do not know in what ways they shape teaching practices, thus limiting what we have learned from Bandura’s (1986) construct of efficacy. In my study, exploring the sources of efficacy and science teaching practices over time revealed a gap in the literature where the sources limit what we can actually see about the teachers.

The connection between ownership and efficacy is that ownership is the factor that propels individuals with any levels of efficacy toward internalizing what they are learning. Current literature establishes accepted characterizations of levels of efficacy, but ownership is the factor that separates those who learn about a task to improve performance in that task and those who learn the task as a integral part of a whole, regardless of level of efficacy.

My study revealed how participants with and without ownership used their sources of efficacy to shape their thinking and teaching practices. For example, those who lacked ownership of practices toward student learning (Sandy, Whitney, and Karen) used their mastery and vicarious sources of efficacy to cultivate their mirroring of teaching practices. Verbal persuasion and affective states sources of efficacy (Bandura, 1986) also supported mirroring of teacher acts. Those with ownership (Nancy, Sharon, and Ann) discussed how mastery and vicarious experiences were implemented in practice. In turn, those experiences were interpreted and implemented in their own practice.
Learned from my study was the fact that the four sources of efficacy alone does not foster ownership, which was imperative to the development of inquiry teaching practices for student learning. This view shifted the focus of learning to teach on the presence of ownership and not on level of efficacy, thus level of efficacy became a guide as to how to support each participant’s development. In looking at their sources and teaching practices over time, I saw how the interpretations of sources limited or supported the development of inquiry science teaching practices.

New Meanings for Science Teacher Education

My study showed that not all pre-service teachers in this study taught reform-minded science. The factor that differentiated between the participants who demonstrated science inquiry teaching and those who did not was ownership of the relationship between teaching practices and student learning. This has implications for pre-service teacher education design and practice.

(Re)Shaping Elementary Science Teachers Through Ownership

With the exception of Nancy, those with lower levels of efficacy lacked ownership. It was evident that the participants with lower levels of efficacy continued to blame external factors and reflected for the refinement of the technical execution of practices (Hammerness et al., 2005). This strongly suggests that to prepare teachers with lower levels of efficacy to teach then teacher education must move beyond accountability in executing particular teaching practices. All key players in teacher education must take an active role in changing how pre-service teachers view their role by planting the seed of
ownership in the relationship between teaching practices and student learning. This shaping of the mind must be infused overtly throughout pre-service experiences.

Ownership of teaching practices was one finding that clearly differentiated those who succeeded in developing toward science inquiry teaching and those who did not. The other difference that clearly impeded progress in reformed science teaching was level of content knowledge (Schoon & Boone, 1998). Although level of content knowledge was self-reported, those who reported lower levels of content knowledge taught rote memorization of science facts through teacher lecture (Jones & Carter, 2006). Those who reported higher levels of content knowledge were able to scaffold their students’ learning and engage their students in content rich inquiry lessons (Pajares & Schunk, 2001). In assessing only teaching practices over time, it was clear that no matter how much progress a participant demonstrated in teaching or how far along they were in their 16-week semester, content knowledge was a factor that prevented inquiry teaching. This finding has crucial implications on education.

In order to achieve science literacy, kindergarten through college experiences must teach content through scientific habits of mind (NRC, 1996). College science content classes must also be aware of the general characterization of pre-service elementary teachers in regard to learning science and what they claim they need to feel able to teach science. In addition to their need for content understanding, participants with lower levels efficacy’s cry for authentic experiences included being immersed in learning science in the same way they are expected to teach science (Ginns & Watters, 1999). This implies that university science content courses must model science reformed based inquiry
teaching (Loughran, 2006a). In line with shaping ownership, science education must also
play a part in guiding the thought process of students.

Pre-service teachers’ cry for authentic experiences also implies that teacher education
must mandate more authentic science teaching experiences prior to student teaching.
Authentic science teaching experiences must be required and monitored during practicum
experiences, but can also happen through science tutoring or involvement in science field
trips or school science projects. Authentic science teaching experiences coupled with the
proper molding of the ownership of the influences of their teaching practices on student
learning can propel pre-service elementary teachers with low levels of efficacy toward
developing their inquiry science teaching practices by giving the practice and vision of
inquiry science and the support needed to evaluate their practices toward student learning
(Dewey, 1964; Loughran, 2006b; Putnam & Borko, 2000).

Efficacy as a Gauge

With efficacy being deeply rooted in personal science histories, it is difficult to change
(Jarrett, 1999). Knowing this, I propose a shift in the focus of efficacy from viewing
efficacy as an identifier of predicted behaviors to using efficacy as a gauge for how to
approach learning to teach. By modifying teacher education approaches to what efficacy
gauges indicate, teacher educators become focused on teaching science teaching practices
guided by levels of efficacy instead of focused on changing the levels of efficacy. This
suggests that instead only providing sources of efficacy known to increase pre-service
teachers’ levels of efficacy, teacher educators combine exposure to sources of efficacy
with shaping ownership of their practices when teaching science teaching practices. In
this model, levels of efficacy serves as a gauge as to the kinds of exposure and the kinds of guidance needed toward ownership needed in learning to teach.

*The Role of the Cooperating Teacher*

A common element found in all my participants was that they referenced their cooperating teacher throughout their student teaching experiences. This supports how influential the role of the cooperating teacher is for student teachers (Guyton & McIntyre, 1990). This finding confirms several aspects that we already know about the relationship between cooperating teachers and student teachers, such as the varied types of relationships and their outcomes (Wang & Odell, 2007). Also, cooperating teachers must be carefully selected for they serve as the professional compass for our student teachers (Guyton & McIntyre, 1990), and student teachers must be guided on how to observe and evaluate their cooperating teacher’s actions and decisions when negotiating their own progress (Huling-Austin, 1992). Last, pre-service programs must devote time to fostering the cooperating teacher and student teacher relationships (Wang & Odell, 2007). However, my findings helps us think about the cooperating teacher and student teacher relationship differently because of the relationships found between student teaching practices, references to their cooperating teachers, levels of efficacy, and presence of ownership.

Although all the participants viewed their cooperating teachers as a model, their efficacy levels gauged why they viewed their cooperating teacher and the presence of ownership determined how they viewed their cooperating teacher. Sandy, Whitney, and Karen looked to their cooperating teachers for the modeling of the technical execution of science teaching practices for the sole purpose of improving the execution of that
practice, and failed to make a connection between the impacts of their teaching practices on student learning. This suggests that the onus was on the cooperating teacher to model the right execution. This also suggests that cooperating teachers must also know how to shape their student teachers’ thinking for ownership of their practices toward student learning.

Nancy, Sharon, and Ann referenced their cooperating teachers as resources to help refine their ideas of teaching. Nancy, Sharon, and Ann clearly exemplified ownership of their actions in their interaction with their cooperating teachers. This supports the need for pre-service education programs to shape lower levels students’ reflection for the ownership of the influences of teaching practices on student learning (Loughran, 2006b).

New Directions in Elementary Science Education

This study not only strengthened but also extended findings in the field of pre-service elementary science teaching and self-efficacy. It is important not only to make transparent the limitations of this particular study but also to focus on what new questions and directions for research are needed.

Limitation of Study

As described, the lesson observations and reflections collected over time provided a more thorough picture of the development of science teaching practices during student teaching and how self-efficacy supported and challenged shifts from traditional science teaching to reform based inquiry science teaching. However, as in every research, this study had its limitations. In addition to the limitations addressed in Chapter 2, I recognize one other limitation to my study. Because the construct of self-efficacy embedded in the
Social Cognitive Theory (Bandura, 1986) encompasses an immense array of interconnected personal, environmental, and behavioral factors that influence learning, a limitation to my study was that I isolated my focus to the influences of levels of efficacy on science teaching practices observed during student teaching. However, because of the endless possible interactions in SCT (Bandura, 1986), it is impractical to consider all facets in one study. To better understand the underpinnings of SCT (Bandura, 1986) is it important to contribute data that can be pieced together with other studies. My study expanded the views of current literature and contributed an understanding of what supports and inhibits continued learning, especially for those with lower levels of efficacy. In analyzing and comparing each participant, suggestions for new research in science education were revealed.

New Research

In order to blaze new paths and address new meanings in elementary science education, research in the field must take new directions. Understanding how to move pre-service elementary students with low levels of science teaching self-efficacy sufficiently along the continuum of progress so they demonstrate the ability to teach inquiry science upon completion of student teaching is my impetus in suggesting new directions.

First, Smolleck, Zembal-Saul, and Yoder (2006) raise the issue that the current widely used measure for pre-service elementary teachers’ science teaching self-efficacy measures for science teaching efficacy, but not in regard to science inquiry teaching. The vernacular used in the STEBI-B (Enochs & Riggs, 1990) does not address efficacy toward inquiry science teaching (Smolleck, Zembal-Saul, & Yoder, 2006), but pre-
service teachers are expected to learn inquiry science teaching practices. Since the direction of science education leans heavily toward teaching science inquiry and science literacy, measures that test for understanding of, efficacy in, and perspectives on, must be newly tailored to specific inquiry and science literacy goals.

The research on the link between efficacy and inquiry science teaching will be strengthened when the measure of efficacy is designed specifically for inquiry teaching. Smolleck, Zembal-Saul, and Yoder (2006) validated their Teaching Science as Inquiry (TSI) measure of pre-service teachers’ inquiry science teaching efficacy. However, it has not yet been widely tested. Future research must be applied to developing efficacy instruments that align with the goals of reformed science education.

Second, to extend the findings of my study, I suggest that future research follow my study design to highlight the relationship among teaching observations, reflections, and evidence of efficacy over time with an instrument that measures efficacy in the teaching practices we are fostering. Current studies explicitly stated that longitudinal studies and science teaching observations were a must for the advancement of the understanding of the effects of efficacy on teaching practices (Bleicher, 2004; Brand & Wilkins, 2007). Future studies must continue collecting science teaching observations and reflections over time. Through the examination of science teaching observations, reflections, and efficacy together over time, I mapped the interactions and track the development of all three. More studies are needed to find patterns in how pre-service teachers think and teach to get closer to answering how to move pre-service elementary students sufficiently along the continuum of progress so they demonstrate the ability to teach inquiry science upon completion of student teaching.
Third, I suggest that research on the relationship between authentic teaching experiences and the development of inquiry science teaching practices continue. In Usher and Pajares’ (2008) critical review of sources of self-efficacy, they address “cognitive self-modeling” and “imaginal experiences” (p. 783) as valuable vicarious sources for pre-service teachers because they offer pre-service teachers the opportunity to visualize their role in teaching (Palmer, 2006). The participants with lower levels of efficacy in my study stated they wanted more authentic teaching experiences for those very reasons. Future studies must assess the value and purpose of authentic teaching experiences and design the exposure to these experiences with the participants needs in mind. Not only is exposure to authentic experiences necessary, but also the guidance on how to process the experiences is imperative.

Lastly, the factor that was overtly missing from those who failed to progress toward inquiry science teaching was the ownership in their teaching for student learning. Future studies must carefully assess the language pre-service teachers use in their reflections and in their validation and reasoning behind their teacher practices to differentiate between accountability and ownership. Reviewing reflections guided by Putney and Broughton’s (2010) developing efficacy continuum is one way of assessing for ownership of practices. I encourage future studies to not only explore the influence of ownership on reflections and teaching practices, but to also explore how teacher education shapes pre-service teachers’ thinking toward ownership. Given the findings of my study, I believe that without ownership of teaching practices toward student learning, development of teaching practices remains limited to mirroring prior experiences and cooperating teachers. With ownership, the development of teaching practices is a conscious
refinement of teaching toward student learning. Although this chapter concludes this study, it serves as a springboard for continued work in the understanding of what pre-service elementary education students need to support them along the continuum of progress so they demonstrate ability to teach inquiry science upon completion of student teaching, and the implication of those needs on teacher education, science education, and future research.
APPENDIX A: STEBI-B SURVEY

Please mark the box that most closely matches the degree of your agreement with each of the statements that follow.

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

13. Increased effort in science teaching produces little change in students’ science achievement.  

14. The teacher is generally responsible for the achievement of students in science.  

15. Students’ achievement in science is directly related to their teacher’s effectiveness in science teaching.  

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.  

17. I will find it difficult to explain to students why science experiments work.  

18. I will typically be able to answer students’ science questions.  

19. I wonder if I will have the necessary skills to teach science.  

20. Given a choice, I will not invite the principal to evaluate my science teaching.  

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.  

22. When teaching science, I will usually welcome student questions.  

23. I do not know what to do to turn students on to science.  

Date:

Name: ____________________

1] Describe 3 – 5 school science memories that summarize your overall elementary school science experience. If you would like to add any additional information, please feel free to do so.

2] How many science classes (list the classes if you can) do you recall taking in high school?

3] Describe 3 – 5 school science memories that summarize your overall high school science experience. If you would like to add any additional information, please feel free to do so.

4] List the college science classes you have taken.

5] Describe 3 – 5 school science memories that summarize your overall college science experience. If you would like to add any additional information, please feel free to do so.

6] If you had to effectively teach an earth, life, or physical elementary science class today, how would you rate your level of confidence?
Briefly explain WHY you selected a particular LEVEL OF CONFIDENCE for:

EARTH:

PHYSICAL:

LIFE:

7] Rate your level of science content knowledge for each area:

<table>
<thead>
<tr>
<th></th>
<th>5 Very High Knowledge</th>
<th>4 High Knowledge</th>
<th>3 Some Knowledge</th>
<th>2 Low Knowledge</th>
<th>1 Very Low Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Life</td>
<td></td>
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</tbody>
</table>

Briefly explain WHY you selected a particular LEVEL OF SCIENCE CONTENT KNOWLEDGE for:

EARTH:

PHYSICAL:

LIFE:

8] Describe any factors that may have had an influence on your confidence to effectively teach an elementary science lesson today.
APPENDIX C: PHASE I JOURNAL PROMPT

Journal Prompt _____

NAME: ____________________________

Date: ______________________________

If any, identify and describe which experiences in your elementary science methods class have *increased* influenced your efficacy (confidence in ability) to teach science. Be as specific as you can about the description of the experiences. Ex: what you may have observed, actually did, discussed in class, teacher demeanor…

If any, identify and describe which experiences in your elementary science methods class have *decreased* your efficacy (confidence in ability) to teach science. Be as specific as you can about the description of the experiences. Ex: what you may have observed, actually did, discussed in class, teacher demeanor…

If you don’t feel any more or less confident to teach science than when the class started, please summarize the experiences in your methods class so far and explain why they have had no impact on your confidence.
APPENDIX D: PHASE I METHODS CLASS QUESTIONNAIRE 2

Date: __________________________

Name: __________________________

1] How do you feel about your level of understanding in science content? Has it increased, decreased, or stayed the same since the beginning of the semester? Please explain what contributed to your change in science content knowledge.

2] Describe positive or negative experiences OTHER than the experiences in your science methods class (ex: practicum, tutoring, science classes…), that have influenced your confidence to teach elementary science.

3] If you had to create a complete lesson for and effectively teach an earth, life, or physical elementary science class today, how would you describe your level of confidence and why?

<table>
<thead>
<tr>
<th></th>
<th>5 Very High Confidence</th>
<th>4 High Confidence</th>
<th>3 Some Confidence</th>
<th>2 Low Confidence</th>
<th>1 Very Low Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life</td>
<td></td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

Briefly explain WHY you selected a particular LEVEL OF CONFIDENCE for:

EARTH:

PHYSICAL:

LIFE:

4] Describe teaching characteristics that influence your motivation and confidence to learn to teach science.
5] Did you have a choice as to how many science lessons you could teach during your practicum? Explain situation:

6] How many science lessons did you teach during your practicum? Please describe your experiences in teaching science to elementary students.
APPENDIX E: PHASE II STUDENT QUESTIONNAIRE 1

Name: _________________________________  Date: _______________________________

Supervisor:

Cooperating Teacher:

Grade level:    School:

1] What experiences, if any, from your science methods class experience do you believe will support your student teaching experience? In what ways?

2] Check which box describes you best for each subject:

<table>
<thead>
<tr>
<th></th>
<th>I Will Enjoy Teaching This Subject</th>
<th>I Am Indifferent About Teaching This Subject</th>
<th>I Will Not Enjoy Teaching Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Studies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>This Subject Will Be Easy To Teach</th>
<th>This Subject Will Take Effort To Teach</th>
<th>This Subject Will Be Very Difficult To Teach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Social Studies</td>
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</tr>
<tr>
<td>Science</td>
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<tr>
<td>Math</td>
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</tbody>
</table>

Please explain the reason for your selection of that description for each subject.
### WEEKLY JOURNAL

<table>
<thead>
<tr>
<th>NAME:</th>
<th>DATE:</th>
<th>Week #:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>YAY!</strong></th>
<th><strong>NOT SO YAY.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Describe an event that happened in your class</td>
<td></td>
</tr>
<tr>
<td>What were your feelings about this event?</td>
<td></td>
</tr>
<tr>
<td>What were your actions during this event?</td>
<td></td>
</tr>
<tr>
<td>What did you learn about yourself as a teacher?</td>
<td></td>
</tr>
<tr>
<td>What did you learn about students as learners?</td>
<td></td>
</tr>
<tr>
<td>Questions, comments, concerns?</td>
<td></td>
</tr>
<tr>
<td>What about your pre-service experiences influenced how you acted during/responded to/felt about this situation?</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX G: REVISED JOURNAL PROMPT

WEEKLY JOURNAL
NAME:     DATE:     Week #:  

<table>
<thead>
<tr>
<th>YAY!</th>
<th>NOT SO YAY.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Think of a specific part of a <strong>math, science or SS</strong> lesson that demonstrated a teaching practice (questions, timing, flow, wrap up, transitions, instructions…) you executed and describe what you did:</td>
<td></td>
</tr>
<tr>
<td>Describe how the preparation of your lesson contributed to what you did</td>
<td></td>
</tr>
<tr>
<td>By reflecting on what you did, what about that teaching practice can you learn?</td>
<td></td>
</tr>
<tr>
<td>Regarding what you did, what can you learn about students as learners?</td>
<td></td>
</tr>
<tr>
<td>What steps will you take to further refine what you did?</td>
<td></td>
</tr>
<tr>
<td>How did your methods class influence (help or hinder) what you did?</td>
<td></td>
</tr>
<tr>
<td>Additional info that contributed to what you did? (CT, supervisor, resources, have done this before, each other…)</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX H: MIDTERM REFLECTION

Name:
Date:
Grade Teaching:
How often do you get to teach science?

Mid-Term Reflection about Teaching Science

1. Describe as many science teaching practices that are executed throughout a science lesson. List these in chronological order from beginning of lesson to end of lesson. BE SPECIFIC.

   Beginning:     Middle:   End:

2. Which of the ones listed above do you feel you need to work on and what about it do you need to improve? BE SPECIFIC.

3. How has your science methods class HELPED in preparing you for (lesson plans) and executing (teaching) an effective science lesson? BE SPECIFIC.

4. Looking back, what more could your science methods class have done to better prepare you to effectively teach science? N/A

5. How has your cooperating teacher HELPED in preparing you for (lesson plans) and executing (teaching) an effective science lesson?

6. What have you learned through your experiences thus far in teaching science?

7. How would you describe your level of confidence in teaching science AND to what do you attribute your confidence?

8. Any additional comments about your ability to effectively teach science?
## APPENDIX I: TEACHING EVALUATION

**Field Experience Performance Evaluation**

<table>
<thead>
<tr>
<th>Student:</th>
<th>Cooperating Teacher:</th>
</tr>
</thead>
<tbody>
<tr>
<td>School:</td>
<td>Grade: Room:</td>
</tr>
<tr>
<td>UNLV Supervisor:</td>
<td>Semester</td>
</tr>
<tr>
<td>Subject:</td>
<td>Observation #</td>
</tr>
<tr>
<td>Check all that apply: Integrated Lesson: Midterm Grade: Final Grade:</td>
<td></td>
</tr>
</tbody>
</table>

### Planning and Preparation

<table>
<thead>
<tr>
<th>UNLV Rating</th>
<th>Comments and Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goals/Objectives Written</td>
<td></td>
</tr>
<tr>
<td>Based on Print Knowledge</td>
<td></td>
</tr>
<tr>
<td>Materials/Equipment</td>
<td></td>
</tr>
<tr>
<td>Differentiated Instruction</td>
<td></td>
</tr>
<tr>
<td>Procedures and Activities</td>
<td></td>
</tr>
<tr>
<td>Assessment Component</td>
<td></td>
</tr>
</tbody>
</table>

### Learning Environment

<table>
<thead>
<tr>
<th>UNLV Rating</th>
<th>Comments and Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classroom Expectations</td>
<td></td>
</tr>
<tr>
<td>Efficient Activities and Routines</td>
<td></td>
</tr>
<tr>
<td>Classroom Management/Monitors Student Behavior</td>
<td></td>
</tr>
<tr>
<td>Builds Positive Self Concept</td>
<td></td>
</tr>
<tr>
<td>Proactive Discipline</td>
<td></td>
</tr>
<tr>
<td>Interactions with Students</td>
<td></td>
</tr>
<tr>
<td>Cultural Diversity</td>
<td></td>
</tr>
</tbody>
</table>

### Instruction

<table>
<thead>
<tr>
<th>UNLV Rating</th>
<th>Comments and Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduces Lesson and States Objectives</td>
<td></td>
</tr>
<tr>
<td>Content Knowledge</td>
<td></td>
</tr>
<tr>
<td>Directions and Explanations</td>
<td></td>
</tr>
<tr>
<td>Procedures and Activities</td>
<td></td>
</tr>
<tr>
<td>Use of Materials/Equipment</td>
<td></td>
</tr>
<tr>
<td>Student Involvement</td>
<td></td>
</tr>
<tr>
<td>Effective Pacing</td>
<td></td>
</tr>
<tr>
<td>Smooth Transitions</td>
<td></td>
</tr>
<tr>
<td>Ongoing Assessment</td>
<td></td>
</tr>
<tr>
<td>Accommodates Individual Needs</td>
<td></td>
</tr>
<tr>
<td>Evaluation of Lesson</td>
<td></td>
</tr>
</tbody>
</table>

### Professional Dispositions

<table>
<thead>
<tr>
<th>UNLV Rating</th>
<th>Comments and Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional Appearance</td>
<td></td>
</tr>
<tr>
<td>Punctuality/Attendance</td>
<td></td>
</tr>
<tr>
<td>Self-Initiative/Independence</td>
<td></td>
</tr>
<tr>
<td>Reliability/Dependability</td>
<td></td>
</tr>
<tr>
<td>Collegiality</td>
<td></td>
</tr>
<tr>
<td>Receptive to Feedback</td>
<td></td>
</tr>
<tr>
<td>Ability to Reflect on Performance</td>
<td></td>
</tr>
<tr>
<td>Interpersonal Skills</td>
<td></td>
</tr>
<tr>
<td>Tact/Judgment</td>
<td></td>
</tr>
<tr>
<td>Written Expression</td>
<td></td>
</tr>
<tr>
<td>Oral Expression</td>
<td></td>
</tr>
</tbody>
</table>

### Rating Scale

<table>
<thead>
<tr>
<th>Rating</th>
<th>UNLV</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 or 5</td>
<td></td>
<td>Exceeds Expectations</td>
</tr>
<tr>
<td>4 or 3</td>
<td></td>
<td>Meets Expectations</td>
</tr>
<tr>
<td>2 or 1</td>
<td></td>
<td>Does Not Meet Expectations</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>Not Evident</td>
</tr>
<tr>
<td>NA</td>
<td></td>
<td>Not Applicable</td>
</tr>
</tbody>
</table>

**APPENDIX J: PRE AND POST SCIENCE LESSON SELF EVALUATION**

242
Name: _______________________________      Date of Lesson: _________________

Grade level: ________________

Objective of lesson: _____________________________________________________

*(please attach lesson plan)*

**PRE-LESSON REFLECTION:**

1] How do you feel about teaching this lesson? Why?

2] What do you think will be *your science teaching* strengths in teaching this lesson? Why?

3] What do you think will be *your science teaching* weaknesses in teaching this lesson? Why?

4] What science teaching strategies and techniques do you plan to use in this lesson?

5] In your own words, describe how this lesson is representative of scientific reform practices.

Name: _______________________________      Date of Lesson: _________________

Grade level: ________________
Objective of lesson: _____________________________________________________

POST LESSON REFLECTION:

1] How do you feel about the lesson you taught?

2] Look at your pre-lesson reflection # 4. Describe the execution of the science teaching strategies you used.

3] Describe the effectiveness of the science teaching strategies you used.

4] Describe a strength you experienced while teaching this lesson.

5] What, if any, aspects of your elementary science methods class shaped your teaching practice for this lesson?

6] Describe a weakness you experienced while teaching this lesson.

7] How did you overcome your weakness?

8] How do you think your elementary science methods class could have better prepared you to deal with the difficulties with this lesson?

9] If you could teach this same science content tomorrow, what would you change about your lesson, how would you change it, and why would you change it?

10] Additional comments about how you feel?

APPENDIX K: PHASE II STUDENT TEACHING QUESTIONNAIRE 2
NAME: ____________________________

1. Describe your overall elementary science student teaching experiences.

2. Describe how your student teaching experiences have influenced your confidence to teach elementary science.

3. Describe some challenges you faced when teaching science. Describe how you met those challenges.

4. Identify specifically how you feel your science methods class prepared you for the challenges you faced when teaching science.

5. Identify specifically how you feel your science methods class failed to prepare you for the challenges you faced when teaching science.

6. As a soon to be first year teacher, how prepared do you feel you are to teach elementary science?

7. What was the existing approach to teaching science in the classroom you were placed in? How did that approach influence your science teaching experience?

APPENDIX L: LEVEL 1 ANALYSIS
Participant:
Grade Teaching:

<table>
<thead>
<tr>
<th>SE SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre – methods efficacy:</td>
</tr>
<tr>
<td>Post – methods efficacy:</td>
</tr>
<tr>
<td>Pre – student teaching efficacy:</td>
</tr>
<tr>
<td>Post – student teaching efficacy:</td>
</tr>
<tr>
<td>Beginning to end:</td>
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</table>

PHASE 1 QUESTIONNAIRE 1: 9/2/08

1 – 5] School memories:

<table>
<thead>
<tr>
<th>Elementary</th>
<th>High</th>
<th>College</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

6 – 7] Describe level of confidence to create a complete lesson for and effectively teach an earth, life, or physical elementary science class today (1-5 with 1 very low)

<table>
<thead>
<tr>
<th>Earth</th>
<th>Physical</th>
<th>Life</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Content knowledge:

<table>
<thead>
<tr>
<th>Earth</th>
<th>Physical</th>
<th>Life</th>
</tr>
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<tbody>
<tr>
<td></td>
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</table>

8] ADDITIONAL INFORMATION:
N/A

PHASE I JOURNALS:

<table>
<thead>
<tr>
<th>1 9/15/08</th>
<th>2 10/21/08</th>
<th>3 11/25/08</th>
</tr>
</thead>
<tbody>
<tr>
<td>describe how experiences in your elementary science methods class have increased your efficacy to teach science.</td>
<td>describe how experiences in your elementary science methods class have increased your efficacy (confidence in ability) to teach science, and decreased</td>
<td>describe how experiences in your elementary science methods class have increased your efficacy (confidence in ability) to teach science, and decreased</td>
</tr>
</tbody>
</table>
### PHASE II QUESTIONNAIRE 1: 1/15/09

1] What experiences from methods class will support your student teaching experiences?

2] Rate each subject as “will enjoy teaching” “am indifferent” or “will not enjoy” and “will be easy” “will take effort” and “will be difficult” and explain your answers.

<table>
<thead>
<tr>
<th>Reading</th>
<th>SS</th>
<th>Science</th>
<th>Math</th>
</tr>
</thead>
</table>

### Summary of Student Teaching Semester:

<table>
<thead>
<tr>
<th>IO/FO Obs</th>
<th>My eval of LP</th>
<th>Execution</th>
<th>Her Post Lesson</th>
<th>comments</th>
</tr>
</thead>
</table>
## Midterm summary (journal prompt at midterm):

How often taught science:

2] What do you need to work on and what about it do you need to improve?

3] How has your science methods class HELPED in preparing you for (lesson plan) and executing (teaching) an effective science lesson? BE SPECIFIC.

4] Looking back, what more could your science methods class have done to better prepare you to effectively teach science?

6] What have you learned thus far?

7] Describe level of confidence and what attributed to this?

<table>
<thead>
<tr>
<th>Week</th>
<th>IO/FO Obs</th>
<th>My eval of LP</th>
<th>Execution</th>
<th>Post Lesson</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wk 8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>Week</td>
<td>Notes</td>
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<tr>
<td>3/ 2-6</td>
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<td>FT</td>
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<tr>
<td>Wk 9</td>
<td></td>
<td></td>
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<tr>
<td>3/ 9-13</td>
<td></td>
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<tr>
<td>Wk 10</td>
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<td>3/ 16-20</td>
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<td>Wk 11</td>
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<tr>
<td>3/ 23-27</td>
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<tr>
<td>Wk 12</td>
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<tr>
<td>3/ 30-3</td>
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<tr>
<td>SP BRK</td>
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<tr>
<td>Wk 13</td>
<td></td>
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<tr>
<td>4/ 13-17</td>
<td></td>
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<tr>
<td>75%</td>
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<tr>
<td>Wk 14</td>
<td></td>
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<tr>
<td>4/ 20-24</td>
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<td></td>
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<tr>
<td>Wk 15</td>
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<td></td>
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<tr>
<td>4/ 27-1</td>
<td></td>
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</tbody>
</table>

**Final Journal:**

**Questionnaire II summary:**
APPENDIX M: LOW LEVELS OF EFFICACY


<table>
<thead>
<tr>
<th>Focus</th>
<th>Efficacy Onset</th>
<th>Efficacy Developing</th>
<th>Efficacy Maturing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mentor Teacher</td>
<td>Mentor Teacher’s Relationship to Students</td>
<td>Curriculum</td>
<td>Self as Teacher</td>
</tr>
<tr>
<td></td>
<td>Self as Within</td>
<td></td>
<td>Community With</td>
</tr>
<tr>
<td></td>
<td>Heightened Student</td>
<td></td>
<td>Learning Focus</td>
</tr>
</tbody>
</table>

Start of Student Teaching to 1st 5 Weeks of Student Teaching

* Struggled with classroom management
* Teaching strategies resembled traditional teaching
* Reflections were about the execution of technical teaching practices on student behavior

LOW LEVEL

2nd 5 Weeks of Student Teaching to End of Student Teaching

* More control of classroom management for longer periods of time
* Evidence of inquiry based teaching, but still heavily traditional teaching
* Reflections were about the execution of technical teaching practices on student behavior
APPENDIX N: PHASE I IRB APPROVAL

UNLV UNIVERSITY OF NEVADA LAS VEGAS

Social/Behavioral IRB – Expedited Review Approval Notice

NOTICE TO ALL RESEARCHERS:
Please be aware that a protocol violation (e.g., failure to submit a modification for any change) of an IRB approved protocol may result in mandatory remedial education, additional audits, re-consenting subjects, researcher probation suspension of any research protocol at issue, suspension of additional existing research protocols, invalidation of all research conducted under the research protocol at issue, and further appropriate consequences as determined by the IRB and the Institutional Official.

DATE: October 10, 2008
TO: Dr. Carl Klecka, Curriculum and Instruction
FROM: Office for the Protection of Research Subjects
RE: Notification of IRB Action by Dr. J. Michael Stitt, Chair
Protocol Title: Evaluation of Science Teaching Self-Efficacy in Pre-Service Elementary Teachers
Protocol #: 0808-2829

This memorandum is notification that the project referenced above has been reviewed by the UNLV Social/Behavioral Institutional Review Board (IRB) as indicated in Federal regulatory statutes 45 CFR 46. The protocol has been reviewed and approved.

The protocol is approved for a period of one year from the date of IRB approval. The expiration date of this protocol is October 5, 2009. Work on the project may begin as soon as you receive written notification from the Office for the Protection of Research Subjects (OPRS).

PLEASE NOTE:
Attached to this approval notice is the official Informed Consent/Assent (IC/IA) Form for this study. The IC/IA contains an official approval stamp. Only copies of this official IC/IA form may be used when obtaining consent. Please keep the original for your records.

Should there be any change to the protocol, it will be necessary to submit a Modification Form through OPRS. No changes may be made to the existing protocol until modifications have been approved by the IRB.

Should the use of human subjects described in this protocol continue beyond October 5, 2009, it would be necessary to submit a Continuing Review Request Form 60 days before the expiration date.

If you have questions or require any assistance, please contact the Office for the Protection of Research Subjects at OPRSHumanSubjects@unlv.edu or call 895-2794.

Office for the Protection of Research Subjects
4305 Maryland Parkway • Box 451047 • Las Vegas, Nevada 89154-4047
(702) 895-2794 • FAX (702) 895-0860

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APPENDIX O: PHASE II IRB APPROVAL

Social/Behavioral IRB – Expedited Review
Approval Notice

NOTICE TO ALL RESEARCHERS:
Please be aware that a protocol violation (e.g., failure to submit a modification for any change) of an IRB approved protocol may result in mandatory remedial education, additional audits, re-consenting subjects, researcher probation, suspension of any research protocol at issue, suspension of additional existing research protocols, invalidation of all research conducted under the research protocol at issue, and further appropriate consequences as determined by the IRB and the Institutional Office.

DATE: February 3, 2009
TO: Dr. Cari Klecka, Curriculum and Instruction
FROM: Office for the Protection of Research Subjects
RE: Notification of IRB Action by Dr. J. Michael Stitt, Chair
Protocol Title: How Self-Efficacy Continues to Shape Science Teaching Practices During Student Teaching
Protocol #: 0812-2948

This memorandum is notification that the project referenced above has been reviewed by the UNLV Social/Behavioral Institutional Review Board (IRB) as indicated in Federal regulatory statutes 45 CFR 46. The protocol has been reviewed and approved.

The protocol is approved for a period of one year from the date of IRB approval. The expiration date of this protocol is February 2, 2010. Work on the project may begin as soon as you receive written notification from the Office for the Protection of Research Subjects (OPRS).

PLEASE NOTE:
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Office for the Protection of Research Subjects
4505 Maryland Parkway • Box 451645 • Las Vegas, Nevada 89154-4147
(702) 895-2794 • FAX: (702) 895-0805

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REFERENCES


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University of Nevada, Las Vegas
Cheryl Ramirez Sangueza

Degrees:
Bachelors of Arts, Secondary Education, General and Earth Science, 1995
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Master of Arts, Secondary Science Education, 1997
Teachers College, Columbia University

Publications:

Presentations:


Dissertation Committee:
Chairperson, Cari Klecka, Ph.D
Committee Member, Sandra Odell, Ph.D
Committee Member, Janelle Bailey, Ph.D
Committee Member, LeAnn Putney, Ph.D