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EFFECTIVENESS OF PEER COACHING TO ENHANCE PRE-SERVICE TEACHERS' SELF-EFFICACY TOWARD SCIENCE INSTRUCTION AND PEDAGOGICAL CONTENT KNOWLEDGE

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EFFECTIVENESS OF PEER COACHING TO ENHANCE PRE-SERVICE TEACHERS' SELF-EFFICACY TOWARD SCIENCE INSTRUCTION AND PEDAGOGICAL CONTENT KNOWLEDGE

A DISSERTATION APPROVED FOR THE
DEPARTMENT OF INSTRUCTIONAL LEADERSHIP AND ACADEMIC CURRICULUM

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DEDICATION

"Families are the compass that guides us. They are the inspiration to reach great heights, and our comfort when we occasionally falter." —*Brad Henry*

To my incredible family

Steve, Dakota, Ty, Rachel, Mom, and Dad

I love you!

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PROLOGUE

This dissertation adheres to a journal-ready format. Three journal articles prepared for submission to refereed journals comprise the first part of the dissertation. Manuscript I, The Growth of Pedagogical Content Knowledge in Pre-service Teachers: Integration of the Social Cognitive Theory and Constructivism is prepared for the *Journal of Teacher Education*. Manuscript II, Effectiveness of Peer Coaching to Enhance Pre-service Teachers' Self-efficacy toward Science Instruction and Pedagogical Content Knowledge is prepared for the journal *Teaching and Teacher Education*. Manuscript III, Empowering Pre-service Science Teachers through Peer Coaching is prepared for the *Journal of College Science Teaching*.

Dissertation Abstract

Peer coaching, specifically its role in influencing pedagogical content knowledge and self-efficacy of pre-service teachers (PSTs) regarding teaching science in early education is examined. First, this study proposes a theory to increase pre-service teachers' pedagogical content knowledge by merging the constructivist theory of cognitive development (Piaget, 1952; Vygotsky, 1978), with Bandura's (1997) self-efficacy theory. Combining the two theories broadens the construct and enriches the preparation of pre-service teachers. Incorporating a peer coaching model as a tool to understand the importance of building the pre-service teachers' science self-efficacy together with the construction of knowledge plays a critical role in developing the pedagogical content knowledge of pre-service teachers. Second, a mixed methods phenomenological study utilized observations, reflective journals, recorded post-conferences, class discussions, and a field notebook to gather qualitative data, and the Science Teaching Efficacy Belief Instrument-Pre-service (STEBI-B) was administered to gather quantitative data (Enochs & Riggs, 1990). Participants included 26 PSTs enrolled in a university primary science methods course and a 60-hour primary practicum in fall 2017. The fall 2016 course was completed by 19 PSTs that served as the comparison group for this research. This study found peer coaching to be an effective tool to increase PSTs' self-efficacy and pedagogical content knowledge. Third, this dissertation provided practical strategies for implementing one model of peer coaching in teacher education methods courses.

MANUSCRIPT I

The Growth of Pedagogical Content Knowledge in Pre-service Teachers:

Integration of the Social Cognitive Theory and Constructivism

This manuscript is prepared for submission to the peer-reviewed *Journal of Teacher Education* and is the first of three manuscripts prepared for a journal-ready doctoral dissertation.

Abstract

Recognizing that pre-service teachers (PSTs) thrive in the teaching field when they are knowledgeable, confident, and supported leads to combining the constructivist theory articulated by Piaget (1952) and Vygotsky (1978), which describes how knowledge is constructed, with Bandura's (1987) social cognitive theory, which defines methods of support and building self-efficacy in PSTs. The constructivist theory states that people are better equipped and more inclined to comprehend information that is the result of their own cognition or self-constructed knowledge. Bandura's (1997) social cognitive theory states people's self-efficacy or belief in their ability to accomplish a task, meet a goal, perform a function, etc. has a positive effect on their actual ability. Personal views of one's efficacy influence how one thinks, feels, acts, and motivates one's self.

The growth of (Pedagogical Content Knowledge) PCK represents the integral components needed to support PSTs toward becoming effective educators. Understanding the importance of building the PSTs' self-efficacy together with the construction of knowledge through peer coaching plays a critical role in developing the PCK of PSTs.

Keywords: pre-service teachers, constructivist theory, Bandura's self-efficacy theory, pedagogical content knowledge, peer coaching

The Growth of Pedagogical Content Knowledge in Pre-service Teachers:

Integration of the Social Cognitive Theory and Constructivism

Preparing pre-service teachers (PSTs) to become effective educators, metaphorically, resembles the construction of a house. By the time PSTs arrive at college, the brick and mortar structure of their architectural design has been built. The foundation exists in the form of early schooling; the structural frame represents gained knowledge, talent, and skills; and the electrical wiring symbolizes the connection of previous experiences that affect critical decision-making. PSTs do not enter their professional preparation empty-handed. Thanks to the apprenticeship of observation (Lortie, 1975), these individuals bring with them images and understandings of teaching that will shape their nascent practices. This understanding of the teaching profession represents a solid exterior of the house that signifies a college student who is eager and willing to embrace a complex profession. Teaching requires a unique combination of patience, commitment, and specialized application of knowledge.

The next phase of construction involves designing the interior floor plan and imagining life in a new space. In this metaphor, teacher preparation programs lay the groundwork for PSTs to develop a plan to become effective educators and help them envision how that plan integrates into their individual teaching style. Groundwork often comes in the form of content classes, methods courses, observations and practicums in actual classrooms. Through these experiences, PSTs learn how to lead instructionally productive discussions, write lesson plans with specific learning goals, tailor the curriculum to fit detailed standards, and analyze students' comprehension of the lesson to determine effectiveness of their teaching (Hanford, 2015). Nevertheless, understanding how to become an effective educator and being an effective educator differ just as understanding math and being able to teach math remain two different skills. Both skills are equally important just as a solid foundation and a sturdy framework remain necessary to ensure a quality home. The goal of this article is to highlight how the utilization of peer coaching serves as a tool to build PSTs' self-efficacy along with pedagogical content knowledge (PCK) to become effective educators.

Although PSTs can choose a variety of educational floor plans (preparation programs), certain common program elements help prepare them to become successful teachers. First, PSTs need the opportunity to develop their personal method of teaching content, which is PCK. PCK considers the method in which teachers relate their knowledge about teaching to their content knowledge or what they know about the subject they teach (Cochran, 1997). Among the three core knowledge categories—content, pedagogical content, and curricular knowledge—defined by Shulman (1987), PCK "identifies the distinctive bodies of knowledge for teaching" (p. 9). Specifically, PCK means knowing the content in pedagogically practical ways and having the ability to explain that knowledge clearly to students. Despite varying definitions, research has identified two key aspects of PCK: knowledge of PST's content understanding and knowledge of instructional strategies (Berry, Friedrichsen, & Loughran, 2015; Borko, 2004; Jüttner, Boone, Park, & Neuhaus, 2013; Magnusson, Krajcik, & Borko, 1999; Park & Oliver, 2008). Successful application of PCK remains a continuous, intentional process in which teachers share content in meaningful ways to increase student learning.

Second, PSTs need to believe they are capable of being effective while teaching young children; that is, they must possess a positive self-efficacy toward teaching. Bandura (1997) observed that the performance of teachers, and particularly novice teachers, depended to a great degree on their levels of self-efficacy. Self-efficacy is independent of any objective measured ability. The effect is strong enough that a confident person who should not be able to succeed at a task can essentially outperform a person who is qualified at that task but does not believe in her ability (Bandura, 1987). Thus, a PST who is uncertain or nervous about her ability to do the job may benefit greatly from support and mentoring to obtain self-efficacy. Recognizing that PSTs thrive in the teaching field when they are knowledgeable, confident, and supported leads to combining the constructivist theory, which describes how knowledge is constructed, with Bandura's social cognitive theory that defines methods of support and building self-efficacy in PSTs.

Constructivist Theory

The constructivist theory exists as a learning philosophy grounded in psychology that describes how people may acquire knowledge, grow in comprehension, and interact with and interpret new ideas and events (Maclellan & Soden, 2004). Constructivists such as Dewey, Piaget, Vygotsky, and Bruner have posited that learning occurs as an active, constructive process. Therefore, the constructivist theory has a direct application to education and gaining of knowledge. Vygotsky (1981) maintained "development does not proceed toward socialization but toward the conversion of social relations into mental functions" (p. 162). He insisted that the relationship between learning and one's social and cultural worlds remain the important constant. Kamii, Manning, and Manning (1991) asserted “individuals bring past experiences and beliefs, as well as their cultural histories and world views, into the process of learning” (p. 91) when they construct knowledge internally by interacting with their environment. Thus, learning is the process of adjusting mental models (schemas) to accommodate new experiences.

Vygotsky (1978) referred to the construction of understanding or learning as a social advancement that involves language, memory, real-life situations, collaboration among learners, and *scaffolding* of knowledge. Scaffolding of knowledge involves giving more support when a person struggles with a particular task and, as time passes, less support as the individual makes progress (Wood, Bruner, & Ross, 1976). A construct fundamental for scaffolding instruction includes the concept of the *zone of proximal development* (*ZPD*). Vygotsky (1978) described ZPD as “the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving … in collaboration with more capable peers” (p. 86). ZPD is a challenging level of growth reached through social interaction.

The constructivist theory states that people are better equipped and more inclined to comprehend information that is the result of their own cognition or self-constructed knowledge (Piaget & Inhelder, 1958). Piaget’s theory of constructivism emphasizes the process of one’s education and correlates with his personal theory of cognitive development. His cognitive developmental stages serve as a blueprint that portrays the steps of typical intellectual development from infancy through adulthood. These progressive stages occur sequentially and continuously from the simplest form of thinking to abstract reflective rationale. Piaget's theory of constructivism emphasizes previous experiences along with an individual's progression through the cognitive developmental stages are dependent on maturity and environmental stimuli. Piaget (1952) believed the mind constructs schemas that allow a person to adapt to her environment through selection, analysis, and reorganization of information with regard to existing conceptual configurations. When the environmental knowledge does not fit or connect with the existing structure, *disequilibration* occurs. Disequilibration refers to learners receiving new information incapable of conforming to existing schema, which initiates an imbalance in one's equilibrium or mental stasis.

To restore equilibrium, Piaget's (1952) cognitive theory considers two key components: *assimilation* or *accommodation*. Assimilation occurs when an individual integrates new experiences into her previous experiences by causing an individual to develop different viewpoints, reconsider what were once misunderstandings, and assess information that prevails as significant, which eventually adjusts her perceptions. Accommodation adapts the new experience into the conceptual capacity already present. In accordance with Piaget's theory, cognitive development is a reiterative process between assimilation or accommodation identified as equilibration. Figure 1 represents the upward spiral of the constructivist theory. Each twist of the spiral leads to greater understanding and elevation of knowledge through real-life situations, scaffolding of knowledge, interaction among learners, disequilibrium, application of prior knowledge, assimilation or accommodation, and equilibration which results in the construction of meaning. Once equilibration has been reached, knowledge increases. The spiral moves upward as a PST continues to learn and apply this gained knowledge to her teaching.

Figure 1 represents the reiterative process of constructing knowledge and understanding as suggested by the constructivist theory.

Figure 1.1

Symbolically, Piaget's cognitive theory and restoration of equilibrium resemble rearranging of a room. A new piece of furniture generates disorder in a particular space. Through movement and positioning, eventually the homeowner arranges the furniture to incorporate the new piece and finds functionality of the area. Restoration of a comfortable balance creates a clear path for traffic flow and a new perception of the living space.

Social Cognitive Theory

Bandura's (1987) social cognitive theory states that people's self-efficacy— or belief in their ability to accomplish a task, meet a goal, perform a function, etc.— affects their actual ability to do so. Personal views of one's efficacy influence how one thinks, feels, acts, and motivates self. Self-efficacy remains a personal judgment of capability; however, four main sources of influence can improve people's belief concerning their efficacy. Bandura (1997) identified the sources of influences as *mastery experiences*, *vicarious experiences*, *social persuasion*, and *physiological arousal*. Figure 2 symbolizes the four influences that build self-efficacy.

Figure 1.2

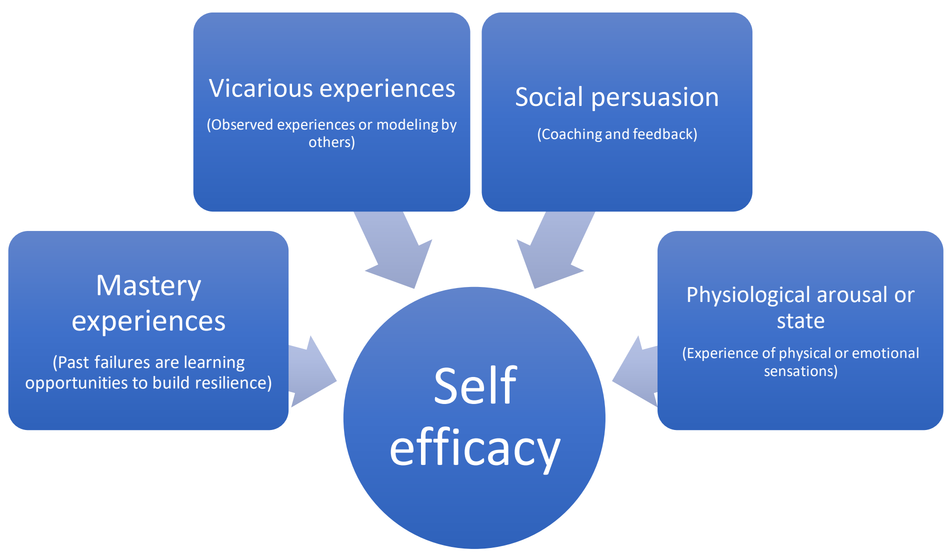

Figure 2 symbolizes the four influences of self-efficacy stated in Bandura's social cognitive theory. Bandura described the most prominent influence as *mastery experiences*.

Bandura (1997) described the most prominent influence as mastery experiences. Mastery experiences relate to achieving the results of success through dedicated efforts and to reaching realistic, but challenging goals. When describing mastery experiences, Bandura indicated these experiences "provide the most authentic evidence of whether one can muster whatever it takes to succeed" (p. 3). Mastery experiences influence self-efficacy in two ways: 1) people who master a difficult task realize their potential and 2) people who consider failure as a learning opportunity build resilience and gain competence by using a different approach.

Second, vicarious experiences arise from the observation of success through the persistent effort of others who are role models, peers, or people similar to themselves (Bandura, 1997). Perceived similarity to role models strongly stimulates the influence of vicarious experiences on the beliefs of self-efficacy. The greater the presumed similarities, the more influence a role model's successes and failures will have. Competent role models transmit knowledge, effective skills, and management strategies through their behavior and expressed ways of thinking. Observing similar peers cope with challenging obstacles may be more empowering to individuals than the particular skills being demonstrated. Vicarious experiences serve as a powerful influence toward building self-efficacy when similar others are able to succeed at difficult tasks.

Third, social persuasion refers to an influential person in one's life who can strengthen the belief that one has the ability to succeed (Bandura, 1997). Persuasive encouragement in perceived self-efficacy leads people to try harder to succeed; these self-affirming beliefs promote the development of skills and a sense of personal efficacy. Bandura's final component for building self-esteem involves the physiological arousal of a person. An individual's state of being may influence the judgment of one's self-efficacy. For example, depression can reduce confidence in abilities while positive emotions may boost confidence in skills.

Bandura's (1997) later work with self-efficacy focused on teachers and has become a viable and popular perspective by which to understand why some teachers succeed and others fail. He stated that educational administrators should focus on ways to help teachers increase their self-efficacy. Good teachers can be made great ones and poor teachers adequate or better simply by increasing their belief in their ability to do the job. Levels of self-efficacy greatly alter the effectiveness of teachers.

Growth of Pedagogical Content Knowledge

Scholars building on the constructivist theory emphasize the importance of each person being an intellectual explorer who makes her own discoveries and constructs knowledge (Piaget & Inhelder, 1958). Researchers who concentrate on the self-efficacy component of Bandura's social cognitive theory stress the relationship of one's sense of self-efficacy and the major role that belief plays in how one approaches goals, tasks, and challenges (Hendricks, 2015; Kazempour, 2014). Yet, when recognizing factors related to effective educators such as organization, presentation strategies, communication with students, and classroom management (Kretlow & Bartholomew, 2010), the two constructs are inseparable components that scaffold PSTs' abilities as they seek to achieve a higher level of expertise. Merging the constructivist theory of cognitive development with Bandura's (1997) self-efficacy theory broadens the construct and enriches (or elevates) the preparation of PSTs. Hence, understanding the importance of building the PSTs' self-efficacy together with the construction of knowledge through pedagogical methods, mastery and vicarious experiences, content classes, social persuasion, scaffolding of knowledge, and collaboration between peers play a critical role in developing the PCK of PSTs. Equivalent to building a house, constructing an effective PST requires the combination of knowledge and self-efficacy as the structural integrity of a home requires a foundation built to last.

Figure 3 allows the visualization of the growth of PCK by representing the integral components needed to support PSTs' toward becoming effective educators. The center column represents the constructivist theory as a reiterative process between assimilation or accommodation to construct new knowledge. Each spiral up the column leads to greater understanding and elevation of PCK due to language and real-life situations, scaffolding of knowledge, interaction among learners, disequilibrium, application of prior knowledge and understanding, assimilation or accommodation, and finally, equilibration or the construction of meaning. The spiral moves upward as a PST continues to learn and apply this gained knowledge to her teaching.

Figure 1.3

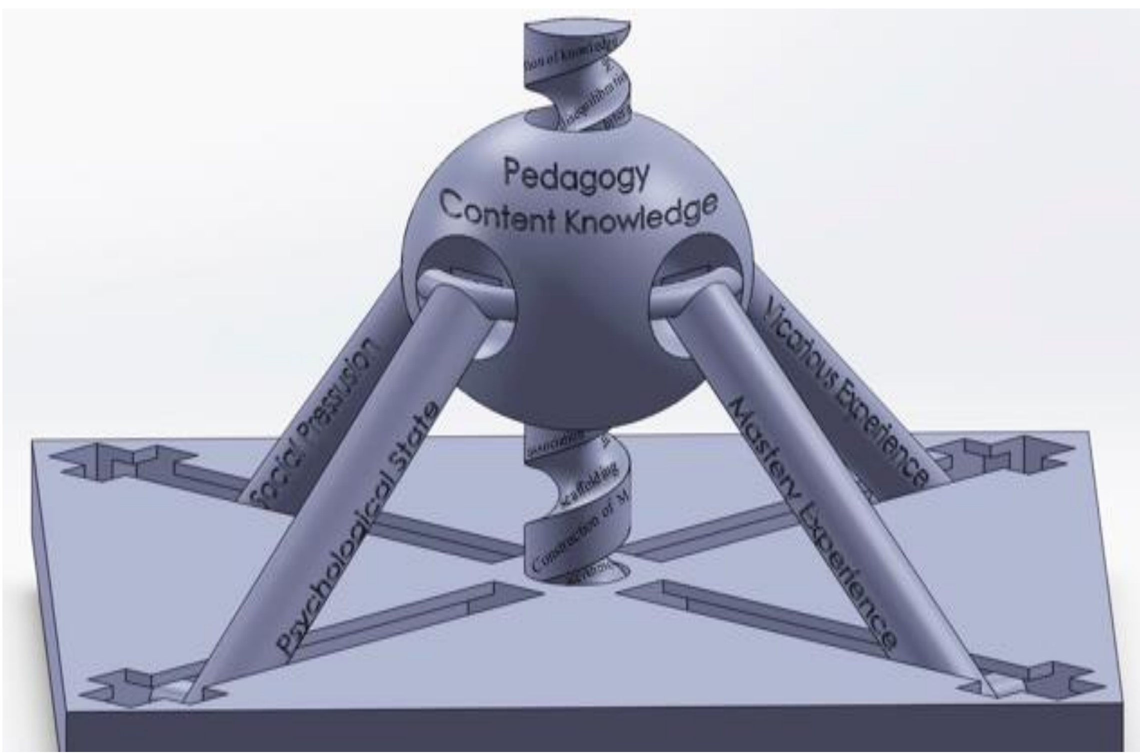

Figure 3 symbolizes the constructivist theory linked with Bandura's self-efficacy theory to represent the growth of PCK.

The supporting beams represent Bandura's (1997) four influences of self-efficacy that scaffold and secure PSTs' PCK to a higher level of expertise. The mastery experiences beam represents the most prominent of the influences. Nevertheless, all four influences boost PSTs' confidence in their ability to manage classroom behavior, explain content thoroughly, and present strategies that will help facilitate student comprehension. Self-efficacy allows PSTs to optimistically believe their chances of being successful in the classroom are favorable.

As PSTs experience teaching, they develop their style of PCK by building new schemas to help understand the classroom environment as they continually move between phases of cognitive disequilibrium and equilibrium. Equilibration for PSTs occurs when they assimilate familiar information and accommodate unfamiliar stimuli. Constructivist theory suggests that PSTs will operate better and more efficiently when they have played an active role in creating the pedagogical practices they will use. Comparable to a designer decorating a home, PSTs bring personal flair, style, and strategies from existing experiences to their teaching. Likewise, teachers are classroom facilitators who use methods of their own creation and accepted practices to manage, plan, organize, guide, and provide directions to learners (Howes, Lim, & Campos, 2008). Thus, gaining pedagogical knowledge allows better planning and curriculum creation by PSTs.

The relevance of Bandura's (1987) theory is that PSTs need support and mentoring in addition to training. This encouragement should include raising PSTs levels of self-efficacy by using peer interaction. Peer interaction consists of PSTs with similar levels of knowledge who are willing to actively collaborate to plan, teach, and reflect. Active collaboration, which results in vicarious experiences, helps PSTs recognize effectiveness in the classroom and assist peers to reach a challenging level of growth through scaffolding. By practicing Vygotsky's ZPD, peer's strengths (i.e. classroom management, making content relevant, connecting to students, etc.), which often differ from observing peer's strengths, become learning opportunities through social interaction and support.

Bandura's (1987) theory suggests that teachers who believe in their own abilities will be more effective simply because of that belief. This theory suggests that teachers (novice or otherwise) will function best in an environment in which they have the opportunity to construct their own knowledge through the teaching of content material. PSTs' acquisition of pedagogy and content knowledge while using active collaboration and scaffolding links PSTs' self-efficacy to teaching and supports the growth of PCK.

Active collaboration encompasses higher-level communication, social skills, and problem solving as it facilitates a change in behavior (Romagnano, 1994). Hardre, Davis, and Sullivan (2008) stressed the importance of teachers' learning collaboration to model these skills. By using a combination of construction of meaning and collaboration, the individual can apply prior knowledge, understanding, and self-determination with received feedback to become a more effective teacher. In return, teachers who become analytic about their own practice through reflective collaboration with supportive peers are more likely to apply new knowledge, techniques, and strategies in their own classrooms (Lyons & Pinnell, 2001). Once more, the PST functions as the interior decorator of their own teaching by deciding the design, style, and contents through their effort, collaboration, and reflection.

Peer Coaching

More specific to education, Walpole and McKenna (2013) explained colleague collaboration or peer coaching as “a strategy for implementing a professional support system for teachers” (p. 1). Wynn and Kromery (1999) described peer coaching as "a training method in which a pair of practicum students, student teachers, or classroom teachers observe each other and provide consultative assistance in correctly applying teaching skills and proposing alternative solutions to recognized instructional needs" (p. 22). This support system may include theory, demonstration, practice, or feedback. Coaching allows peers opportunities for pre-observation conversations, observations, and post-observation reflective sessions (Vidmar, 2006). The process creates a supportive, nonthreatening professional relationship; allows teachers to gain experience and improve teaching practices; and promotes long-term change, which in return fosters the four influences of self-efficacy along with strengthening pedagogy and content knowledge. Bowman and McCormick’s (2001) use of peer coaching with PSTs demonstrates that, regardless of the subject area, grade level, or number of years of experience, peer coaching equips teachers to become collaborators, which helps develop a higher quality of instruction. Comparable to home builders who hire contractors to provide services to construct a well-built home, peer coaching stands as a method to create an environment of supportive professionals who seek to make a positive impact on student achievement.

Peer coaching is a process by which similarly experienced individuals mentor each other to help build new skills, share ideas, teach one another, or solve problems in their teaching environments. How active the peer is in this manner depends on the individual arrangement, but the assistance offered can include helping with planning overall curricula, preparing materials, lesson assistance, and in-class observation and feedback (Abel, 2015). Fundamental to the process of peer coaching is creating a relationship that remains non-threatening while encouraging open conversation and collaboration between partners (Latz, Speirs Neumeister, Adams, & Pierce, 2008; Moss, Sloan, & Sandor, 2009; Murray, Ma, & Mazur, 2009; Shulman, 1987). Individual sessions remain effective when peers go into the classroom to assist rather than critique one another. Guidance and mentoring are a collaborative effort in which peers self-direct partners in learning. Conversations are directed toward articulating intentions before observations and followed by reflections after the lesson (Vidmar, 2006). As PSTs reflect upon their experience teaching with a peer, they realize significant insight about the intended results in comparison with the actual lesson. Accomplishments as well as frustrations are shared and discussed between the pair. By making the reciprocal conversations part of the process, PSTs have the opportunity to build upon everyday classroom experiences and complement class time with the conversations before and after teaching. Early in peer coaching, PSTs learn to be intentional in the classroom by developing discernment that accompanies their actions (Shulman, 1987). By making self-reflection a continuous practice, PSTs ultimately develop the ability to self-monitor and address weaknesses in their teaching.

In a review of peer coaching studies, Lu's (2010) findings illustrate benefits as well as obstacles of peer coaching. Benefits related to peer coaching included improvement of professionalism, increased focus on student learning, and an overall feeling of comfort and confidence while teaching in front of peers. Peer coaching also was reported to have contributed to PSTs' openness to accept constructive feedback or criticism of their teaching (Hasbrouck, 1997). Kim and Tan (2012) stated that peer coaching "increases reflective practice, aids implementation of teaching models and instructional strategies, and enhances classroom management and the development of pedagogical content knowledge" (p. 108). Ovens (2004) found PSTs demonstrated more accountability and commitment when involved in peer coaching and that a mutual sense of trust, honesty, and equality developed among peers during the process.

Although many merits were discussed in these studies, some obstacles were also identified. One reason peer coaching has not been comprehensively implemented may be due to teacher educators' additional deliberation, organization, and action required to incorporate peer coaching in undergraduate courses (Lu, 2010). Peer coaching takes time and training into an already packed program. Ovens (2004) described an increased workload for PSTs, time constraints, and lack of knowledge among PSTs to analyze lessons during the study. Two additional challenges included scheduling difficulty for peer coaching and lack of skills to provide feedback (Kurtts & Levin, 2000). Bowman and McCormick (2000) found emotional support felt during peer coaching can be replaced by other campus efforts. The outcome of the study suggests that as long as PSTs receive sufficient theoretical and practical knowledge regarding teacher behavior, classroom support, and weekly-integrated seminars on teaching skills, PSTs will develop collegial reinforcement needed for teaching.

The growth of PCK provides an interesting perspective on peer coaching. A PST who collaborates with another PST will be active in the creation of the work environment in which she ultimately operates. Constructing meaning of particular pedagogy or content presentation through experiences in the classroom while being encouraged by a supportive peer increases PCK and self-efficacy. Goos, Gailbraith, and Renshaw (2002) stated that the collaborative environment works best when each collaborator brings something different to the discussion. The growth of PCK suggests that such collaboration may be more than the sum of its parts and underscores the value of peer coaching.

Exponential Power of Peer Coaching

Peer coaching utilized as an instrument to unite the construction of knowledge with building self-efficacy may enable teacher preparation programs to scaffold PSTs' ability to become more effective educators. Certainly, peer coaching has been found to increase reflective practice, solve instructional problems, and improve teacher quality (Britton & Anderson, 2010; Yee, 2016). Furthermore, McDermott (2011) reported that the technique expands the knowledge base of PSTs in the areas of academic content, formative assessment, classroom management, and learning strategies. Peer coaching enhances PSTs' competency to analyze, self-evaluate, and reflect on their practices while having a positive and significant linear impact on their effectiveness (McKenna & Walpole, 2008; Teemant, Wink, & Tyra, 2011). Moreover, a positive correlation can be seen between the number of peer coaching experiences and the impact on PCK, which increases exponentially as more experiences occur due to the cumulative benefits. Therefore, the exponential power lies in the relational nature of peer coaching.

The essential core of the peer coaching strategy rests heavily on mutual respect and trust. The supportive relationship minimizes the impression that one person is dominating the other. Peer accountability heightens self-awareness, develops critical thinking skills, sharpens relational abilities, energizes partners, and creates a desire for more connection (Parker, Kram, & Hall, 2014). This bidirectional relationship is a constant between the peer being observed and the observing peer. (Represented in Figure 3 in metallic to reflect the bidirectional growth of PCK). As PSTs plan, teach, and reflect, the peer partner is listening, observing, collaborating, and constructing meaning for herself through the entire process and vice versa. The process directly applies to each peer during both roles and affects at least three of the four influences of self-efficacy.

Initially, a PST who successfully presents a lesson encounters a mastery experience. The successful experience alone provides the PST with the authentic evidence that she has the ability to succeed in teaching, at least this individual lesson. Thus, the presenting PST's self-efficacy has been positively influenced while also constructing her personal PCK. Meanwhile, the peer observing is influenced by a vicarious experience. Watching a similar person with the same skill-set allows the observing peer to recognize that she can likewise be successful. The observed peers' successes and failures are more influential the greater the presumed similarities between the partners. Therefore, when a peer successfully manages challenging obstacles, the observing peer may become more empowered by the similar peer's ability (Bandura 1997). In return, the observing peer's self-efficacy has been positively influenced. Accordingly, if an observing peer witnesses another peer's success but her lesson transpires as less effective, the observing peer who has encountered a vicarious experience may treat this particular failure as a learning opportunity to build resilience and, upon reflection, use a different approach (mastery experience).

Moreover, structured feedback serves as a consistent feature of peer coaching. The reciprocity of learning between peers continues to increase as PSTs clarify, elaborate, justify, and analyze their own or their partner's reasoning through authentic dialogue and social persuasion. Successful peer partner conferencing includes these important characteristics but also requires each partner to reflect on her own personal teaching practices. The partnership between committed peers increases the process of learning through persuasive encouragement. Sincere encouragement from peers that directs attention to the positive attributes of the lesson or the peer's strengths increase self-efficacy and may lead recipients to try more diligently to succeed. Hence, the exponential power of peer coaching is collective, bidirectional, and continuous.

Conclusion

Figuratively, the building of a hypothetical house in this paper symbolized the development of PSTs experience striving to reach the desired destination of the teaching profession. First, PSTs arrive at college with their architectural design set. Their foundation poured and the structural frame supported. Previous experiences created the electrical wiring of critical decision-making while the completed exterior signified the PSTs' readiness for the next phase of construction. With the guidance of teacher preparation programs, PSTs started the groundwork and interior design to build an effective educator. One viable technique, peer coaching, aided the architectural progression in building an effective educator through the growth of PCK (Jenkins & Veal, 2002).

The use of peer coaching as a tool for teacher preparation programs is not novel to teacher educators. However, the exponential power of peer coaching through the interconnecting and complimenting features of the constructivist theory merged with the self-efficacy component of Bandura's (1987) social cognitive theory to form the growth of PCK may be relevant to PSTs' learning. By implementing a peer coaching model for PSTs to practice active collaboration, teacher preparation programs support and encourage a deeper level of communication, problem-solving, and social skills. This low cost, high impact resource is self-renewing and easy for teacher preparation programs to implement and sustain. Peer coaching enriches PSTs' teaching through a reiterative process that allows pedagogy and content knowledge to grow while increased self-efficacy scaffolds PCK to a higher level of expertise. Respectfully, through the construction of knowledge and expansion of self-efficacy, the growth of PCK advances PSTs toward becoming effective educators.

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MANUSCRIPT II

Effectiveness of Peer Coaching to Enhance Pre-service Teachers' Self-efficacy toward Science Instruction and Pedagogical Content Knowledge

This manuscript is prepared for submission to the peer-reviewed journal, *Teaching and Teacher Education*, and is the second of three manuscripts prepared for a journal-ready doctoral dissertation.

Abstract

The need for US citizens to acquire better science proficiency has been demonstrated as the nation continues to lag behind many countries in this subject (Organisation for Economic Co-operation and Development [OECD], 2016). The foundation starts with early childhood education; however, science is not emphasized at that level in lieu of literacy teaching. Some educators may be reluctant to teach the subject due to their lack of self-efficacy in science education. Thus, the preparation of pre-service teachers (PSTs) to teach science is critical. The purpose of this study was to examine the influence peer coaching and mentoring may have on the self-efficacy of PSTs regarding teaching science in early education. This phenomenological study employed a mixed-methods approach. Observations, reflective journals, recorded post-conferences, class discussions, and a field notebook were utilized to gather qualitative data and the Science Teaching Efficacy Belief Instrument-Pre-service (STEBI-B) was administered to gather quantitative data (Enochs & Riggs, 1990). Participants included 26 PSTs enrolled in a university primary science methods course and a 60-hour primary practicum in the fall semester of 2017. The fall courses of 2016 were completed by 19 PSTs that served as the comparison group for this research. In preparation to teach science in early education, this study found peer coaching to be an effective tool to increase PSTs' self-efficacy and pedagogical content knowledge (PCK). Furthermore, the results of this study has implications for PSTs preparation for implementing one model of peer coaching in teacher education methods courses.

Keywords: pre-service teachers, science self-efficacy, pedagogical content knowledge

Effectiveness of Peer Coaching to Enhance Pre-service Teachers' Self-efficacy toward Science Instruction and Pedagogical Content Knowledge

In the United States, many individuals have not been grounded in science in their elementary and secondary educations. As a result, few are proficient in the field of science, and many lack even basic science knowledge (National Research Council, 2012). While universities require several general science courses for early childhood and elementary undergraduate degrees, pre-service teachers (PSTs) frequently do not relate the challenging content to their future early childhood classrooms. In addition, most early childhood teacher preparation programs require only one science methods course that is commonly merged with other subjects. Often, early childhood educators feel underprepared to teach the new standards reflected in the Oklahoma Academic Standards for Science (OAS-Science) (Oklahoma State Department of Education, 2018).

The lack of science in early childhood and elementary classrooms impedes students' development of scientific thinking (Trundle, 2009); therefore, it is imperative to prepare PSTs to incorporate science into their curriculum. Research has proposed that high-quality science undergraduate coursework in teacher preparation programs has the potential to cultivate PSTs' science self-efficacy beliefs (Menon & Sadler, 2017). Furthermore, PSTs who increase pedagogical content knowledge (PCK) in science may increase their future students' ability to complete scientific practices successfully (Kazempour, 2014). Teacher preparation programs need to seek ways to educate and empower PSTs to become confident in teaching science along with all other subjects. Collaborative research and engagement in equal meaningful learning communities have been shown to be extremely valuable in this area for PSTs (Abel, 2015). Peer coaching represents a form of collaborative action research that can exist as a viable tool to improve teaching (Moss, Sloan, & Sandors, 2009).

The purpose of this mixed-methods phenomenological study was to understand the influence peer coaching had on PCK and the self-efficacy of PSTs concerning teaching science in early education. Two questions guided this research: does the experience of peer coaching predict growth in PSTs self-efficacy toward science and PCK? and do peer-coaching and instructional feedback differ in predicting PSTs growth in self-efficacy toward science?

Theoretical Framework

The theoretical underpinnings that link PSTs' self-efficacy toward science instruction and their PCK include the constructivist theory articulated by Piaget (1952) and Vygotsky (1978), and Bandura's (1987) social cognitive theory. The constructivist theory states that people are better equipped and thus more inclined to comprehend information that is the result of their own cognition or self-constructed knowledge (Piaget & Inhelder, 1969). Essentially, constructivism advocates that people generate knowledge and meaning through active learning and involvement.

Vygotsky (1978) referred to the construction of understanding or learning as a social advancement that involves language, real-life situations, interaction among learners, and scaffolding of knowledge. A construct fundamental for scaffolding instruction includes the concept of the zone of proximal development (ZPD). Vygotsky (1978) described the ZPD as "the distance between the actual developmental level as determined by independent problem-solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers" (p. 86). The ZPD is a challenging level of growth reached through social interaction. PSTs' acquisition of effective science pedagogy while using peer interaction allows the application of constructivism.

Hardre, Davis, and Sullivan (2008) stressed the importance of teachers' learning collaboration in order to model these skills for students. Collaboration encompasses higher-level communication, social skills, and problem-solving as it facilitates a change in behavior (Romagnano, 1994). By using a combination of construction of meaning and collaboration, the individual can apply prior knowledge, understanding, and self-determination with received feedback to become a more effective teacher. In return, teachers who become analytic about their own practice through reflective collaboration with supportive peers are more likely to apply new knowledge, techniques, and strategies in their classrooms (Lyons & Pinnell, 2001).

Bandura's (1987) social cognitive theory states people's self-efficacy or belief in their ability to accomplish a task, meet a goal, perform a function, etc. has a positive effect on their actual ability to do so. Self-efficacy is independent of any objectively measured ability. The effect is strong enough that people who, objectively, should not be able to succeed at a task can essentially outperform a person who is qualified at that task but does not believe in their ability to do so (Bandura, 1987).

The relevance of Bandura's (1997) theory to the present study was that PSTs need encouragement and mentoring in addition to training. This encouragement should include raising their levels of self-efficacy. Bandura's four influences of self-efficacy include *mastery experiences, vicarious experiences, social persuasion,* and *physiological arousal*. Mastery experiences relate to attaining the results of success through committed determination and reaching realistic but challenging goals. Vicarious experiences occur when one observes role models or people with similar ability succeed by their persistent effort. Social persuasion refers to an influential person in one's life who can strengthen the beliefs that one has the ability to achieve a goal. Physiological arousal is an individual's state of being that may influence the judgment of self-efficacy.

The constructivist theory can be considered with Bandura's (1997) self-efficacy theory to form an understanding of how PSTs develop PCK. Constructivist theory suggests teachers (novice or otherwise) will function best in an environment in which they have the opportunity to construct their own knowledge through the teaching of content material. Bandura's (1997) theory asserts teachers who believe in their own abilities will be more effective simply because of that belief. Yet, when recognizing factors related to effective educators such as organization, presentation strategies, communication with students, and classroom management (Kretlow & Bartholomew, 2010), the two constructs are inseparable components that scaffold PSTs' abilities as they seek to achieve a higher level of expertise. Merging the constructivist theory of cognitive development with Bandura's self-efficacy theory broadens the construct and enriches the preparation of PSTs. Both theories substantiate the value of peer coaching improving teaching quality for PSTs.

Review of Literature

Peer Coaching

Peer coaching is a process by which similarly experienced individuals mentor each other to help build new skills, share ideas, teach one another, or solve problems in their teaching environments. McKenna and Walpole (2008) explained peer coaching as a strategy for implementing a professional support system for teachers. Coaching allows peers opportunities for pre-observation conversations, observations, and post-observation reflective sessions (Vidmar, 2006). The process creates a non-threatening professional relationship, allows teachers to gain knowledge, improves teaching practices, and promotes long-term change. Bowman and McCormick's (2001) use of peer coaching with PSTs demonstrates that, regardless of the subject area, grade level, or number of years of experience, peer coaching equips teachers to become collaborators, which helps develop a higher quality of instruction. Peer coaching stands as a way to construct an environment of supportive professionals who seek to make a positive impact on student achievement.

Fundamental to the process of peer coaching is creating a relationship that remains non-threatening while encouraging open conversation and collaboration between partners (Shulman, 1987). The level of involvement depends on the individual arrangement, but the assistance offered can include helping with lesson plans, planning overall curricula, preparing materials, and in-class observation and feedback (Abel, 2015). Field observations are most effective when peers go into the classroom to assist rather than critique one another. In return, guidance and mentoring develop into a collaborative effort where PSTs self-direct partners in learning.

A variety of benefits that enhanced teaching quality were reported in a review of peer coaching (Lu, 2010). Benefits included improvement of professionalism, increased focus on student learning, and an overall feeling of comfort and confidence while teaching in front of peers. Peer coaching also was reported to have contributed to PSTs' openness to accept constructive feedback on their teaching (Hasbrouck, 1997). Ovens

(2004) found PSTs demonstrated more accountability and commitment when involved in peer coaching and a mutual sense of trust, honesty, and equality developed among peers during the process.

However, potential obstacles to successful peer coaching exist. Ovens (2004) described an increased workload for PSTs, poor organization of teacher preparation programs, time constraints, and lack of knowledge among PSTs to analyze lessons during the study. Additional challenges included unequal partners, reinforcing inaccurate knowledge, and scheduling difficulty for peer coaching (Kurtts & Levin, 2000).

Combined, the constructivist theory and Bandura's (1997) influences of self-efficacy provide an interesting perspective on peer coaching. A PST who collaborates with another PST will be active in the creation of the work environment in which she ultimately operates. Collaborative environments work best when each collaborator brings something different to the discussion (Goos, Galbraith, & Renshaw, 2002). Constructivist theory suggests such collaboration may be more than the sum of its parts and underscore the value of peer coaching. Subsequently, PSTs' self-efficacy remains supported through each teaching experience.

Pedagogical Content Knowledge

PCK is based on the method by which teachers relate their knowledge about teaching to their content knowledge or what they know about the subject they teach (Cochran, 1997). Among the fundamental knowledge categories defined by Shulman (1987), PCK "identifies the distinctive bodies of knowledge for teaching" (p. 8). In other words, PCK means knowing the content in pedagogically practical ways and making it clear to students. Despite varying definitions, research has identified two core aspects of

PCK: knowledge of students' understanding and knowledge of instructional strategies (Berry, Friedrichsen, & Loughran, 2015; Park & Oliver, 2008). Peer coaching may expand the knowledge base of PSTs in the areas of instructional strategies, teaching models, and classroom management (Wynn & Kromrey,1998).

Constructivist theory suggests PSTs will operate better and more efficiently when they have played an active role in creating the pedagogical practices they will use. Meanwhile, Bandura’s (1997) self-efficacy theory indicates a PST that observes a similar peer teach a lesson or handle a classroom situation can perform an equivalent task through vicarious experiences. Observing a peer succeed increases the PST’s belief that she can master comparable activities. Teachers are facilitators who use successful practices as well as methods of their own creation to administer teaching. Gaining pedagogical knowledge through observation allows better planning and curriculum creation by PSTs.

Teaching Quality

Although quality teaching is certainly important, currently, no measure of teaching quality is widely accepted (Altbach, 2015). This may be due to the subjectivity of the concept and the difficulty in objectively measuring this construct. Generally, quality teaching is described as that which leads to improved student progress (Coe, Aloisi, Higgins, & Major, 2014). Consequently, teachers are commonly evaluated on the performance of their students, which is only a rough indicator of the quality of their teaching. Core components of quality teaching include PCK, classroom management, teacher’s self-efficacy, and classroom environment (Coe et al., 2014).

The environment in which teachers operate affects the quality of their teaching. Blömeke and Klein (2013) posited the presence or absence of a supportive environment had a significant influence on the teaching quality delivered by novice mathematics teachers. Likewise, such an environment adds to teachers' self-efficacy and helps them to construct their own teaching environments as per Vygotsky (1978). The environment is often reflected in the overall classroom community and management. Along with PCK, classroom management and environment contribute to quality learning. Additionally, a teacher's belief in particular practices, theories about learning, and personal conceptual models play a role in the learning process as well as their self-efficacy in their ability.

This study is designed to support and extend the existing literature on peer coaching and self-efficacy toward science in several ways. First, the primary objective is to examine the effective peer coaching has on PSTs self-efficacy toward science and PCK. Second, the researcher wants to examine whether peer coaching incites PSTs' growth in self-efficacy toward science.

Methodology

To understand the phenomenon that peer coaching had on PSTs' science self-efficacy and PCK a mixed methods approach was utilized. Mixing qualitative and quantitative methods allowed for a richer picture of associations by revealing in detail the processes by which data were gained and analyzed. Murray, Ma, and Mazur (2009) employed a mixed methods study to research the effects of peer coaching on teachers' collaborative interactions and students' mathematics achievement scores. Statistically, peer coaching was not associated with any improvements in students' math achievement, but the qualitative survey revealed teachers found it beneficial to share ideas, techniques, and teaching strategies with peers. Likewise, this mixed methods phenomenological study allowed PSTs' perceptions, perspectives, and understandings of peer coaching to be revealed.

Participants and Location

In this study, 26 PSTs from the fall of 2017 and 19 PSTs from the fall of 2016 provided consent for the researcher to include their data in the study analysis. The 2017 sample consisted of 24 females and 2 males. The 2016 sample consisted of 18 females and 1 male. Typical of the US teacher demographics, the majority of PSTs were white, female, and middle socio-economic status. The average age of both PST samples was 20 years old. At the time of enrollment, most PSTs had completed three or four of the required courses in general physical science, general earth science, and biology before beginning their first science methods course and practicum. Pseudonyms were selected by the PSTs to protect confidentiality.

Research was conducted at a small private university in the southwestern region of the US where the researcher has been a teacher education program instructor for the past 5 years. The researcher taught both fall science courses and supervised the corresponding 60-hour practicums that placed PSTs with primary students in local schools.

Data Sources and Collection

Qualitative data used to examine PSTs' peer coaching experiences, self-efficacy, and PCK included journal entries, observations, pre and post-observation conference discussions, and a field notebook. Quantitative data utilized to examine PSTs' self-efficacy was the STEBI-B. Data triangulation provided a more detailed and balanced picture of the situation and allowed for more complexity in the study's findings (Glense, 2011).

Journals. As a requirement of the science methods and practicum courses, each PST submitted 12 journal reflections through Google Docs that were placed in individual electronic folders (Miles, Huberman, & Saldana, 2014). The initial and final journal prompts were identical to elucidate any attitude change toward teaching science, PCK, or self-efficacy. Additionally, data from all 12 journal entries informed planning class discussions, scaffolding learning, and monitoring the understanding and knowledge of PSTs (Lake, Al Otaiba, & Guidry, 2010).

Pre and post-observation conferences. PSTs were required to record pre-observation conferences and post-observation conferences. A standard set of questions were provided to prompt PSTs' thought processes about expectations before the lesson and reflections on what happened during the lesson (See appendix). All peer pre-observation conferences took place the day before the lesson. Post-conferences occurred immediately after observations in each grade level's conference room. PSTs relied upon personal phones for audio recordings and submitted a copy of weekly conversations through Google Drive.

Observations. Video observations allowed the researcher to view PSTs' teaching quality, PCK, and their ability to make a connection between the methods and content they had learned in class to classroom practice. Peer coaching dyads observed each other six times. The initial observation took place during the methods course so PSTs would have a guided opportunity to gain experience in observation techniques. The remainder of the observations took place in 26 primary grade classrooms. Although four elementary schools were used for the practicum experience, peer coaching dyads attended the same site. Each set of peer coaches had the autonomy of observing each other on the same day or taking turns every other week.

Field notebook. Reflecting in a field notebook permitted the researcher to keep notes about the study's focus and record the context of events (Bazeley, 2013). The field notebook assisted the researcher in the recollection of events, class discussions, and observations. Recorded memos documented decisions made throughout the data collection and data analysis (Lincoln & Guba, 1985).

STEBI-B. The STEBI-B is a one-page instrument that has 23 items containing statements such as "Even if I try very hard, I will not teach science as well as I will most subjects" (Enochs & Riggs, 1990). This quantitative survey allowed PSTs to indicate their level of agreement by choosing from a five-point Likert scale. The scale ranges from "strongly agree" to "strongly disagree." The PSTs' responses provided a degree of measurement of their attitudes and self-efficacy beliefs. The personal science teaching efficacy (PSTE) subscale has 13 statements that look at the teachers' belief in their ability to successfully assume the role of classroom teacher while the science teaching outcome expectancy (STOE) subscale has 10. The initial research data showed the accuracy of the STEBI-B instrument had overall internal consistency. The Cronbach's alpha for all 23 statements was .90 (Enochs & Riggs, 1990). The internal consistency of the 13 PSTE statements and the 10 STOE statements was $\alpha = .90$ and $\alpha = .76$, respectively.

Procedures

During the first weeks of the 2016 and 2017 fall semesters, PSTs were introduced to the eight scientific practices, crosscutting concepts, and discipline core ideas that science, technology, and engineering share by reading the *Framework* (National Research Center, 2012). Four class periods were spent teaching, modeling, and explaining these practices. For the remainder of the semester, PSTs engaged in weekly lessons and activities in which they assumed the role of primary age students to experience in-class investigations and have first-hand practice of doing science to increase content knowledge. After each investigation, PSTs, individually or in small groups, identified science content and practices included in the various activities and teaching methods that contributed to PCK.

Additionally, participants in this treatment group (fall 2017) attended two 90-minute seminars before beginning their primary practicum. During the first seminar, relational trust activities were incorporated to build a respected academic community. Next, the researcher introduced the concept of peer coaching and the specific model to be incorporated. In the second seminar, PSTs viewed video clips featuring teachers demonstrating teaching skills and then discussed possible strategies of implementation. After the video, PSTs were categorized into small groups according to practicum school placements and asked to select a peer coach. After the pairing, PSTs practiced conducting post-conferences as peer coaching dyads by discussing strengths and weaknesses based on the previously viewed video.

During the third week of the semester, peer coaching dyads began their practicum in early childhood classrooms. First-week practicum activities involved observations of the cooperating teacher and students while becoming comfortable with the routine. The following week, peer coaching dyads began teaching lessons and completing the peer coaching model requirements.

While observing, the peer coach sat in an unobtrusive location where s/he was able to view the PST and the students in the classroom. The observing peer maintained detailed notes for discussion during the post-conference. Each post-observation conference was audio-recorded, transcribed, and then sent to each PST for verification of content. Throughout the semester, the researcher observed one post-observation conference of each PST and afterward met individually with the observing peer to give constructive feedback on peer coaching. In addition, cooperating classroom teachers gave feedback to PST on lesson presentations and classroom management techniques. During the final observation, peer coaches video-recorded their partners' teaching a science lesson for the researcher to utilize during the analysis of data, a practice employed by Ricketts (2014). Although the focus for the PSTs' observations differed, Rickets' research recognized the importance of video observations and how they can contribute to the data.

Alongside the science methods course, PSTs attended a weekly one-hour evening class following the Wednesday practicum and discussed pedagogical skills, classroom management, and peer coaching procedures. Class discussions were recorded and used to guide the instructors' preparation for the next class's instructions, reflective journal questions, and suggestions for cooperating teachers to discuss with individual PSTs.

In both 2016 and 2017 fall classes, the STEBI-B pre-test was administered during the first class period of the science methods course and the post-test during the fifteenth week. Both the 2016 fall science methods course PSTs (comparison group) and the 2017 PSTs participated in the inquiry-based science class, Wednesday practicum, and the weekly one-hour class. All PSTs were required to teach five lessons throughout the 10-

week practicum and complete reflective journals. Cooperating classroom teachers provided feedback on lesson presentations and classroom management. Twice the 2016 PSTs received instructor's written and verbal feedback after being observed. The 2017 PSTs participated in peer coaching and received continuous feedback from their peers.

Data Analysis

Qualitative Analysis

The first level of coding, or *starter codes*, assisted the researcher to work through sources of data. Provisional starter codes allowed the researcher to categorize segments of data based on responses, participants, and interactions that emerged as significant during the first round of coding. The audio recordings of the pre/post-observation conference discussions and journal reflections were transcribed and uploaded into Dedoose 8.0.35 (2018), a software program used for analyzing qualitative and mixed methods research. Reading and coding in Dedoose assisted the researcher in becoming familiar with the data.

The second round of coding involved reexamining, recoding, and refining of the data into categories and subcategories while looking for themes (Bazeley, 2013). Highlighted excerpts were reviewed and recoded; then, memos were added to give context to participants' comments. Themes, found through multiple reoccurrences of specific codes, were identified and placed in an analytical cluster diagram. Next, all excerpts were separated into individual code categories and then reviewed to distinguish details of the data.

Bazeley (2013) encouraged qualitative researchers to participate in a constant comparative process to generate interesting information, enrich description, and to provide data to report. The constant comparative method became more intensive as the study progressed and the entire data set was collected. Miles et al. (2014) believed comparisons could be used to further explore and describe data along with using them as a tool for explaining and predicting.

Quantitative Analysis

Quantitative methods focus on objective measurements and the statistical, mathematical, or numerical analysis of data gathered through surveys, questionnaires and polls, or by manipulating pre-existing statistical data using computational techniques (Babbie, 2010). Quantitative research concentrates on gathering numerical data and generalizing that information across collections of people or explaining a particular phenomenon. The utilization of the pre and post-STEBI-B allowed for the identification of changes in PSTs' self-efficacy.

For the quantitative portion of this research, a Wilcoxon signed-rank test was used to compare the pre and post-survey answers for each set of PSTs in the 2016 and 2017 courses. This test was used due to the small sample size and because the data were not necessarily normally distributed. In the STEBI-B, a combination of thirteen questions created the personal science teaching efficacy (PSTE) subscale. The overall PSTE for the 2016 PSTs' showed a significant difference between the pre and post-survey results indicating an increase in PSTs self-efficacy at a 0.05 significance level. In examining the individual questions for the 2016 PSTs, questions 5, 6, 8, 12, 17, 18, 21, and 23 were significant at a 0.005 level. The smaller significance level was used on the individual questions to compensate for the number of tests.

The overall PSTE for the 2017 PSTs who participated in peer coaching also yielded a significant difference between the pre and post-survey scores, which indicated an increase in PSTs' self-efficacy at a 0.05 significance level. In examining the individual questions for the peer coaching PSTs, questions 5, 12, 18, 19, and 23 were significant at a 0.005 level. Once again, the smaller significance level was used on the individual questions to compensate for the number of tests.

Before presenting the findings of this study, the researcher considered criteria to determine quality in mixed methods research. Teddlie and Tashakkori (2009) recommended the term *inference quality* to refer to issues that would be termed internal validity in quantitative terms or trustworthiness in qualitative terms. Quantitative researchers employ the constructs of reliability and validity to substantiate their research. The strategies for ensuring trustworthiness or validity will depend on the nature and purpose of individual projects (Maxwell, 2013).

This study had multiple purposes and questions that justified the use of a mixed method design. The initial question aimed to examine the effectiveness of peer coaching to enhance PSTs' growth in science instruction and PCK. To adhere to the criteria that defined quality for the qualitative portion of this study, the researcher participated in persistent observation, peer debriefing, member checks, and triangulation of final data. In addition, the researcher provided an audit trail for transparency and documentation to address authenticity and transformative criteria.

Limitations

The assumptions for this study assumed participants were forthright and honest in their answers during the qualitative data collection phase and they accurately reported during the quantitative phase. Although the researcher had no way to verify this, all participants were briefed prior to the study's commencement on its purpose, goals, and procedures. Because they will all be professionals, PSTs had no reason to misrepresent information.

Nonetheless, a limitation of the study was the sample consisted of relatively homogenous in age, race, and stage in their professional development. However, this is typical as the majority of early childhood and elementary educators are white, middle-class females (Drudy, 2008; National Center for Education Studies, 2014). Additionally, the competing roles, researcher and instructor, could be considered a conflict in interest when in both roles of truth-finding and truth-telling. The relatively small sample size exposed the study to mathematical variations in the quantitative phase. Therefore, this cannot be any finalized or definitive research and the need for further study will doubtless be manifest, regardless of the direction of the results.

Findings and Discussion

Preliminary Science Self-Efficacy

PSTs' initial journal entries allowed the researcher to examine preliminary self-efficacy toward teaching science before the required practicum and peer coaching began. The question, "How do you feel about teaching science to young students?" served as the journal prompt. The entries revealed that 25 out of 26 PSTs shared a predominant theme of anxiety toward teaching science in the upcoming practicum. Typical explanations identified for the anxiety included three reoccurring patterns: 1) attitudes and beliefs, 2) uncertainty of classroom management skills, and 3) lack of science content knowledge.

Attitudes and beliefs. Beliefs exist as internal feelings that something is true. Attitudes are defined by the way a person expresses or applies their beliefs. Bryan (2003) described how teachers' beliefs about a subject such as science have been shaped by personal experiences. Consequentially, PSTs' with pre-existing negative beliefs toward science may develop an adverse stance in their teaching practices that impede the implementation of the subject (Kelly, 2000).

Negativity or a dislike toward an academic subject often increases anxiety on one's ability to teach the topic (Trundle, 2009). In the PSTs' initial journal, science was commonly described with words or phrases such as "not my favorite subject," "I hate science," "bad experience," or "I'm nervous." Annie succinctly described her feelings toward science. She stated,

> I did not love science in school. In fact, I hated it, and to be honest, I still feel pretty much the same way. We sat in a classroom and did worksheets every day. I was taught to memorize everything, which meant that I didn't really comprehend what I was learning.

Many of the PSTs had experienced science through a traditional, teacher-centered classroom that involved memorization of facts, terms, and completing worksheets. Table 1 displays additional comments associated with negative attitudes and beliefs toward science.

Table 2.1

Attitudes and Beliefs

Pre-Service Teachers	Journal excerpts describing negative attitudes and beliefs
Mary	"It kind of makes me nervous thinking about teaching science."
Maria	"When I think about teaching science, it makes me feel nervous right off the bat because science has never been my favorite or strongest subject."

Ruth	"Science has never been a subject that I liked very much."
Paige	"Teaching science honestly makes me feel nervous."
Harriet	"Additionally, I had a bad experience with a science teacher and it completely ruined me from ever liking science."

Classroom management. Effective classroom management creates a path for teachers to involve students in critical thinking and learning (Oliver & Reschly, 2007). Difficulties with controlling classroom behavior often lead to the teacher being ineffective in the classroom. PSTs often express fears about lacking effective classroom management techniques to control disruptive or disorderly behavior of students (Browers & Tomic, 2000).

Understandably, the second description of anxiety manifested in the form of doubt in classroom management skills. Teaching science often involves experiments with hands-on manipulatives and materials, which added to PSTs' uncertainty of classroom management. Many PSTs voiced their concerns about not being able to control a large class while teaching science. Harriet candidly wrote, "Being in charge of a classroom all alone honestly makes me scared to death."

In a similar manner, Table 2 displays a sampling of comments that revealed PSTs' initial uncertainty in classroom management skills while teaching science.

Table 2.2

Classroom Management Insecurities

Pre-Service Teachers	Journal excerpts describing uncertainty in classroom management
Nikki	"I doubt my ability to retain control of the classroom and keep students interested in the lesson."

Anastasia	"I think my concern comes from the fact that I will be teaching science, managing a classroom, and being evaluated by my cooperating teacher all at the same time."
Tina	"I'm nervous that since this is a classroom with more than 20 students that it is going to be hard to keep control of the class while I am teaching science."
Kristi	"Although I have observed and watched others teach, I have never had a leading role in the classroom. I know classrooms are unpredictable and I cannot really guess what the students will say or do."

Lack of science content knowledge. The National Research Center (2012) stated that a teacher's knowledge about science influences the quality of instruction she provides and has an effect on students' success. In other words, to teach science effectively, the teacher must first understand the subject. Worth and Grollman (2003) emphasized the teacher's role is critical to students' science learning. Teachers guide students' scientific inquiry by their explicit personal understanding of the underlying concepts and their importance. This guidance and facilitation is based on each teacher's knowledge and enables her to direct students' attention to crucial aspects of the phenomenon they are exploring.

Characteristic of the nation's current scientific knowledge, PSTs identified the third source of anxiety as a lack of science content knowledge. Fear of losing credibility in front of primary students was evident as PSTs repeatedly stated their doubt in their ability to answer science questions. One PST transparently shared her fear of teaching science and the reason for her anxiety. Lori wrote,

> It makes me nervous to think that students will be coming to me with science questions. I do not feel like I am qualified in that subject. I am scared that a student will ask a question that I do not know the answer to [*sic*]. I do not want them to think I am dumb!

Anecdotally, comments dealing with the fear of being asked science questions appeared in the first journal multiple times. Table 3 presents a few PSTs' initial comments dealing with their lack of science content knowledge.

Table 2.3

Lack of Science Content Knowledge

Pre-Service Teachers	Journal excerpts describing science content knowledge
Laura	"It makes me a little worried that students will ask me a question that I don't know the answer."
Audrey	"Teaching science makes me feel like I need to read and learn A LOT more to be a great resource to my students."
Mandy	"My hope is that when students come to me with science questions that they will be simple questions."
Macy	"When it comes to having my own class that will be coming to ask me science questions, I get a little freaked out."
Ali	"One of my main fears is what if one day when I am a teacher I can't answer a child's question they ask me."

Although 25 out of 26 PSTs voiced concerns related to anxiety, two PSTs made comments in their journals that were positive toward science. Nikki previously voiced concerns about classroom management but added, "However, when it comes to science, I cannot wait because I want to learn alongside my students." Anastasia also expressed apprehension toward managing a classroom yet stated: "I really love science and am thrilled to get to instill that same love into the students I meet." Hattie was the only student who did not voice any anxiety about teaching science. She wrote, "Science is the subject that I look forward to teaching the most." Hattie was an outlier in this study but clearly represented the diminutive population of PSTs who desire to teach science.

Recognition of the specific origins of anxiety among the majority of the PSTs allowed the researcher to tailor peer coaching instructions toward increasing self-efficacy while teaching science. Classroom management techniques were researched, demonstrated, and discussed among peer dyads in the Wednesday evening classes. Additionally, peer coaches were encouraged to reduce partners' fears by focusing on the positive aspects of each lesson observed and providing specific feedback to their peer about their teaching. As with the previous year, emphasis in the science methods course centered on the content and learning together through inquiry rather than the traditional teacher-centered instructional methods (Blank, 2012).

Post Science Self-Efficacy

By the end of the semester and final analysis of data, the researcher identified two relevant themes (Bazeley, 2013). The themes were organized into categories: self-efficacy expansion and development of PCK. Each category consisted of several subcategories.

Self-Efficacy Expansion

As evident from the multiple sources of data, PSTs' self-efficacy expanded over the duration of the semester. PSTs articulated their growth in confidence to teach science, manage a classroom, and deal with unexpected events that occurred with primary students. Explanations of self-efficacy aligned with Bandura's (1987) suggested sources of influence. PSTs wrote, demonstrated, or verbally described their confidence through mastery experiences, vicarious experiences, verbal persuasion, and physiological arousal.

Mastery experiences. Straightaway into the semester, PSTs plunged into writing plans and teaching 30-minute lessons in front of their cooperating teacher, peer coach, and an average of 24 primary students. These realistic but challenging experiences immediately provided authentic evidence for the PSTs to examine whether they possessed the committed determination to succeed. Each successful performance allowed PSTs to expand their self-efficacy. Benita described one example of a successful experience.

> After giving my science lesson in my practicum, I feel much more confident in teaching science than at the beginning of the semester. I will definitely continue to use science in my classroom, and I will do that through integration based on science.

Immediately after the presentation of their first lesson, it was apparent that most PSTs began to realize their capabilities. Table 4 presents evidence that PSTs were broadening their self-efficacy through mastery experiences.

Table 2.4

Mastery Experiences

Pre-Service Teachers	Journal Excerpts describing mastery experiences
Claire	"You don't know how to teach until you've experienced teaching. I feel like I can teach anything now."
Audrey	"Being able to actually teach full lessons in a real classroom with 25 children and not completely losing control of them or myself has definitely strengthened my belief that I can be a good teacher.
Macy	"Actually being able to teach on my own and getting feedback from my peer has helped me so much in seeing my strengths and using them."
Brooke	"A teaching skill that has grown over the semester would be my confidence. This has really grown within myself. I know I can teach and have a positive effect on the students. I also have confidence knowing that if I am struggling with a certain aspect of teaching that I will be able to master it and continue to grow throughout my teaching career."

Vicarious experiences. Throughout Bandura's (1987, 1997) self-efficacy research, he regarded mastery experiences as the most influential source of self-efficacy. Undeniably, the lesson plan preparation, active teaching, and management of a class strongly influenced PSTs during this study. However, PSTs communicated more often in their journals that vicarious experiences immensely influenced their teaching. Observing peers allowed a transfer of competencies and provided PSTs with a point of reference for social comparison (Hendricks, 2015). Some PSTs voiced emulation of peers' positive practices or routines while others specified teaching errors or oversights they would definitely avoid. Ruth demonstrated examples of both in one of her journal entries. She wrote,

> The first thing that I observed that made me a better teacher and will continue to make me a better teacher was a lack of confidence in my peer. This inspired me to do two things, first was to build her up and second was to not let my nerves get the best of me while I was teaching. The second thing my peer demonstrated that helped me become a better teacher was preparation. My peer coach spent every Tuesday night going over her lesson, reading the book several times, and double checking to make sure she had everything she needed. My peer coach inspired me to spend a little more time in preparation before I taught each lesson.

Vicarious experiences proved to be extremely influential while PSTs participated in peer coaching. Weekly, PSTs articulated how or what they learned by observing their peers. Table 5 displays a small sample of vicarious experiences expressed throughout the semester.

Table 2.5

Vicarious Experiences

Pre-Service Teachers	Journal excerpts describing vicarious experiences
Mary	"While watching my peer coach teach I was able to observe her using classroom management strategies we learned in class. It is one thing to

	hear my professors talk about classroom management, but to be able to see and hear my peer coach applying her knowledge helped me as well.”
Cheryl	“While my peer coach was patient and attentive sometimes she struggled with having control of the classroom. One thing I realized I was good at was classroom management.”
Laura	“Watching my peer coach teach definitely helped me become a better teacher. My first lesson I spoke very quietly and softly and it was not at all effective. I walked into [sic] watch my peer’s lesson and immediately noticed the difference in the level and tone of our voices. I tried to mirror that in my next lesson.”

Social or verbal persuasion. Bandura’s (1987) third source of influence on self-efficacy involves social persuasion or encouragement from an influential person who can strengthen the beliefs that one can succeed. During this study, verbal persuasion became equally as important as vicarious experiences as seen throughout the documentation between peer coaches. Video observations captured open body language, reassuring smiles, and eye contact between the teaching peer and the recording peer. Additionally, discussions transcribed from the Wednesday evening classes recorded multiple words of encouragement. Anastasia expressed the influence of verbal persuasion clearly when she wrote,

> Peer coaching helped me grow as a teacher in numerous ways. I think the biggest way that it helped me grow was in my confidence. I was incredibly unsure of myself at the beginning of the semester. All I could see in myself was what I was bad at and what I could do better. Having a peer coach tell me all of the things that I did right was incredibly encouraging and helped build my confidence tremendously.

Encouragement or persuasion from a peer increased PSTs’ self-efficacy by focusing on the positive aspects of lesson plans, lessons observed, classroom management skills, and/or content knowledge. Journal entries, class discussions, and post-conference data detailed various forms of verbal persuasion between peers. Table 6 exhibits a few instances of recorded verbal persuasions between peers.

Table 2.6

Social or Verbal Persuasion

Pre-Service Teachers	Journal excerpts describing social persuasion
Cheryl	"I loved peer coaching because normally I would feel bad saying things that I felt I was better at than my peer coach, but these were things that we discussed all the time! We would often talk about each other's' skills and our own weaknesses. We would give each other feedback as to how to be more effective. I feel like this is the whole point of peer coaching-to learn from one another."
Ali	"Peer coaching helped give me confidence that I was going to do well in front of my students. Having the time immediately after teaching to debrief was also extremely beneficial to me. I loved having that time to talk about everything, from what went well to what went terribly. There were times that my peer coach had to assure me that I had actually taught well and that I was being too hard on myself. This did wonders for my teacher efficacy. Had I not had these discussions with my peer coach, I would not be as confident teaching in front of a classroom as I am now."
Annie	"The most important part of peer coaching for me has been the affirmation directly after my lesson. I usually feel nervous about how my lesson went, but Harriet is there to calm me down and assure me that it went better than I think. She also is very intentional about telling me the strengths of my lesson plans, which is great because I know what to emphasize and also what to work on."

Physiological state or arousal. Broadly defined, physiological state or arousal can be described as an emotional sensation involving a response, a subjective feeling, or a behavioral reaction (Hockenbury & Hockenbury, 2010). Also, physiological arousal can be helpful for motivation and communication (Izard, 2013). Bandura (1987) deemed physiological arousal as one of the four influencers of self-efficacy. Depending on the physiological state of a PST, this source may serve as a positive or negative influence on self-efficacy.

During the semester, PSTs demonstrated both spectrums of physiological arousal. For example, one PST's negative physiological state influenced her self-efficacy as she taught a lesson to her assigned first-grade classroom. Harriet wrote,

> I didn't sleep at all last night and I started getting really nervous about two hours before I taught my lesson. I was fearful that I would throw up, pass out, or both. I knew that I was prepared, but that did not help to calm me. When it came time for my lesson I was a nervous wreck. After the video finished I was more at ease, but still a bit of a hot mess. I am very thankful that I had my lesson plan to refer to because I totally forgot my thought process several times. The fact that the students were staring at me as well as my cooperating teacher and peer coach made me feel uneasy, but I tried to not think about that too much. During one point in the lesson I called the students to the floor so I could read them a book. Two boys started fighting. When it came time for the partner work, I was not too sure how it would go because the students do not often share ideas with one another. The children got a little loud. At the end, the noise level was too high. I have a lot of room for improvement.

Fear was the physiological arousal that caused this PST to experience sleep deprivation, forgetfulness, and the sensation of being physically ill. Harriet stated she was well prepared; however, her emotional state completely dominated her performance and served as a negative influence on her self-efficacy.

On the other hand, Macy's journal entry depicts a totally opposite physiological state and in return, a very successful lesson. She wrote

> I didn't like teaching science, I loved it! I taught my science lesson over solids, liquids, and gases and did a fun experiment with vinegar and baking soda. There was a lot of build-up to this lesson for me because I planned it two weeks in advance. I was so excited to teach this lesson, so I went into it very prepared. The lesson overall went just as I had planned, which I was so happy about! At the point of the lesson where I had the class observe the experiment, it was so uplifting to see how engaged and excited my students were about what I was teaching. They loved the experiment just as much as I did, if not more! And that brought me a lot of joy! As I said previously, science is fun, and it is something

> that students do not get taught very often. My goal is that I will make time to teach science more often in my future classroom!

Although this journal entry could also be coded as a mastery experience, Macy's positive physiological state exhibited her excitement for teaching science and remained most prominent throughout her writing. Later, when she entered the Wednesday evening class, the influence of her positive physiological arousal remained steadfast as she enthusiastically described the science teaching experience to the other PSTs.

Embedded throughout every data source, PSTs unintentionally revealed specific incidents of how their self-efficacy expanded. An attitudinal shift also transpired over the semester as PSTs sensed an increase in their ability to be successful in their chosen profession.

Development of PCK

Evident in the initial journal entries, the lack of science content knowledge created anxiety among most PSTs in this study. Many PSTs reported past experiences involving worksheets of memorized laws, theories, or facts were ineffective in preparing them to understand or explain the actual workings of the natural world. The National Science Research Council (1996) referred to science as a path that leads to diverse ways in which scientists study the world and propose explanations based on evidence. Although comparable, science remains defined differently by different people. Duschl, Schweingruber, and Shouse (2007) stated that,

> Science is both a body of knowledge that represents current understanding of natural systems and the process whereby that body of knowledge has been established and is continually extended, refined, and revised. Both elements are essential: one cannot make progress in science without an understanding of both the body of knowledge and the process by which this knowledge is established, extended, refined, and revised. (p. 26)

Similar to the above definition, effective early childhood science teaching requires two elements: an understanding of science concepts and the skill to guide students through the process of inquiry to gain science knowledge. Thus, preparing PSTs in methods of effective pedagogy as well as science content knowledge remained the utmost focus during both fall science methods courses.

Science content knowledge. Pairing peer coaching with a science methods course to increase PSTs' science content knowledge aligned with Piaget (1952) and Vygotsky's (1978) view of the constructivist theory. The acquisition of content knowledge during the science methods course remained a developmental progression by incorporating hands-on experiments and activities consistent with scientific principles. Additionally, PSTs scaffold their knowledge through coursework, peer collaboration, reciprocal feedback, and teaching science to primary students. This aggregation of experiences guided PSTs to greater construction of meaning and knowledge.

Near the end of the semester, PSTs were asked: "How do you feel about teaching science at this point in the semester?" Most PSTs acknowledged an increase in their science content knowledge and their comfort to teach science. For example, Laura wrote

> I feel so much more excited, interested, and confident in teaching science after taking this course. The more I learn about how to teach science, the more I wish my elementary teachers would have known this information. I am now confident that I have the tools necessary to teach science and that it is okay not to have every single answer.

Annie shared her gained insight by stating,

> I don't actually feel nervous about teaching science anymore. I have grown so much in my knowledge of science and how things happen in science this year. I know that my knowledge will continue to grow. I even want kids to ask science questions because I've learned that science is so much fun! I want my students to share that love. I can remember nearly breaking out into tears the first lesson I taught. I couldn't manage the class, I barely knew my material, and I don't think

> the kids understood the lesson very well. Now, I feel confident when going to the front of the class. I know that the kids respect me a lot more and they understand my lessons very well. I also know that they are learning because this is evident in the pre and post-assessments that they have taken.

Another PST, Mary, pointed out a few positive aspects about teaching science; however, she verbalized some doubt in her knowledge of science content. She wrote,

> I feel better about teaching science after this course. I learned that when science is hands-on, it is more fun for both the student and the teacher. There are some science concepts I still am fuzzy on. However, I know that if I watch someone else teach the concept, then I will have a better understanding of how to do so myself.

Mary confessed that she still had uncertainty in some areas of her science content knowledge, but her response about watching someone else teach indirectly affirmed that her involvement in peer coaching enabled her to gain understanding and scaffold her content knowledge. This journal excerpt established that Mary had traveled through the peer coaching process to a position of conscious competence (Parker, Kram, & Hall, 2014). Throughout the data, PSTs who internalized competent relational skills modeled effective reflective learning with others.

Pedagogy knowledge. Researchers have emphasized the distinction between teacher content knowledge and knowledge that becomes relevant in practice (Kersting, Givvin, Sotelo, & Stigler, 2010). Pedagogy refers to the discipline that addresses the theory and practice of teaching and how these influence student learning (Loughran, 2006). Pedagogy informs teaching strategies, actions, judgments, and expectations. Furthermore, educational pedagogy includes the social and intellectual interaction the teacher seeks to establish in the classroom environment.

Pedagogical skills mentioned by PSTs in journal entries or conference discussions included topics such as organization, time management, and methods of teaching.

Additionally, PSTs reflected on the attention span of primary students, classroom management skills, and egocentric tendencies of young students in social settings. As might be expected, some PSTs learned the importance of pedagogical skills while teaching young students through trial and error. For example, Laura wrote the following about her kindergarten lesson:

> I definitely wasn't pleased at the end of my lesson. I had a PowerPoint that had pictures of patterns in everyday life and pictures of examples of certain types of patterns. Next, I read a book about patterns. Towards the end of carpet time, I realized I had expected them to sit too long. I was starting to lose their attention and panicked a little bit. Then, I forgot to give specific instructions for the project we were going to make. I gave them their materials and sent them on their way. I quickly realized I had made a big mistake. My control was gone and they were going crazy with their beads. They threw them all over the room. This just spiraled into a bigger and bigger mess. I didn’t know how to regain control or how to end the lesson. I was repeatedly trying callbacks but was not successful. My voice wasn't loud enough and even if I did get their attention I didn't really know what to say at this point. I didn’t know what to tell them to do next when they were finishing and it felt very chaotic and overwhelming. I think that is why I cried when I got to the teacher’s workroom. I just felt really overwhelmed.

Although Laura’s teaching session materialized as a negative experience, the event allowed her peer coach to identify some positive aspects of her lesson. She addressed the meaningful connection made with students’ lives as well as the development of language through open-ended questions. The peer coach spoke about the critical thinking time that allowed students to collaborate. Eventually, the conversation between the two peers unfolded as an analysis of developmental characteristics of 5-year olds and effective classroom practices with kindergarteners.

Clearly, Laura’s sixth journal entry reflected a different level of awareness and growth in her pedagogical skills. She wrote,

> I look back at the first lesson I taught and cringe. My classroom management was nonexistent. When planning my lesson, I didn't plan out the directions that I was going to give the students. I thought I would just know what to say when I was up

> there. I kind of laugh at that now, because it was not at all what happened. Thankfully, I feel like I have been improving each week since then. I am much better at planning my lessons now. I think about exactly how I want it to go, how it could go wrong, and how I can prevent these potential issues. I consider exactly what directions I need to give in order for my students to understand and so my lesson will go smoothly. Overall, I feel that my biggest improvement has been my voice and classroom management skills. I have felt more confident each time. This has also led to my classroom management being much better. After the first week, I was feeling very discouraged and doubtful of my ability. These past few weeks have been so encouraging and have given me so much hope that since I have improved a lot after just a few times, I will continue to improve the more I get up and teach.

Initial journals conveyed insecurities, reservations, and disappointments in pedagogical skills while the concluding journals communicated PSTs' progress in classroom management, time-saving strategies, and awareness of child development. Momentum continued to build in pedagogical skills over the semester as PSTs reflected upon their experiences and applied this analysis to develop teaching techniques such as modeling, questioning, giving instructions, and managing a classroom.

Pedagogy and content knowledge integration. Effective teachers possess content knowledge and pedagogical skills to connect subject matter and student learning (Dewey, 1939). Shulman (1987) labeled the integration of these distinct categories of teacher knowledge as PCK. Naturally, PSTs are expected to gain pedagogical skills to present critical scientific ideas and concepts in a manner that makes the information understandable to students. So, successful delivery of PCK remained a continuous, mindful process for PSTs throughout this study. One student articulated the importance of presenting science content in a manner understandable to young students. She wrote,

> Students are born with a strong sense of curiosity. They like to ask what something is or why it looks the way it does. As a teacher, I have a choice to either stunt that curiosity, or to funnel it into a real interest. As a teacher, it is my responsibility to build my students' thirst for knowledge. In order to feed that thirst effectively, I need to teach science in a way that truly informs while

> continuing to grow their curiosity and make them interested in what they are learning. Students are not motivated by listening to a teacher talk about a topic, and then completing a writing assignment. Science is all about asking questions and conducting experiments to find answers to those questions. We perform experiments every day and do not even realize it. We might ask if the milk in our refrigerator has expired, or if it is still drinkable. To answer our question, we first look at the expiration date. Then we smell the milk. If it still smells normal, we may drink a small sip of the milk to make sure that it is still safe to drink. By asking those questions and going through a process to answer those questions, we conduct multiple experiments every day. Science is all about using the scientific method to discover new ideas. By teaching students the process of the scientific method, we teach them how to think for themselves and explore their surroundings instead of simply looking for an answer online.

This journal entry was written during the eighth week of practicum and exists as an example of Hattie's developing PCK. She addressed pedagogical knowledge by mentioning characteristics of young students, relevance of lesson, and motivation. Furthermore, she acknowledged how content should be delivered and the importance of the scientific method. She gave a simple, but practical, explanation of how the scientific method is used in everyday life and finally, she addressed her goal for her primary students to apply this knowledge to their surroundings and be able to think critically on their own.

Combining a student-teaching practicum, peer coaching, and a science methods course appeared to promote growth in self-efficacy and PCK. The practicum allowed PSTs opportunities to practice their PCK in real-world situations. Additionally, the teaching experience gave PSTs occasions to apply theory to practice while peer coaching allowed them an added opportunity to view a peer and learn from their successes and mistakes. In the primary classroom, PSTs learned how the knowledge of students, environmental contexts, methods and their personal content knowledge had a continual influence on their lessons. Although PSTs progressed at their own rate, the reciprocal process of constructing meaning, gaining experience, receiving peer feedback, and scaffolding knowledge allowed exponential growth in PCK through the reiterative progress and practicum timeline.

To address the lead question, the findings indicated that peer coaching enhanced PSTs self-efficacy toward science instruction and PCK. Regarding self-efficacy, the researcher remained aware that many factors might contribute to its development, for example, previous mastery experiences or natural classroom with-it-ness. Some PSTs appeared to have a natural ability to teach. However, all PSTs communicated development of reflective skills, benefits gained through peer coaching, and an increase in their confidence. PCK development proved to be an on-going process that required deliberate attention. Although overall growth was noted, PSTs reflections indicated an uneven amount of focus on pedagogical knowledge rather than content knowledge. This might be related to the primary level curriculum or the need to focus on classroom management with primary students. Still, once PSTs felt comfortable with their pedagogical skills they appeared to become more intentional teaching content.

Quantitative Findings

The second research question sought to reveal whether peer-coaching and instructional feedback incited growth in predicting PST's growth in self-efficacy toward science. Although the sample size was too small for generalizability, the criteria that defined quality and fidelity for the quantitative portion of this study guided the researcher. Analysis of the STEBI-B pre and post-tests indicated a favorable increase in self-efficacy beliefs by most of the PSTs regarding their ability to teach science in both the 2016 (instructor feedback) science methods course and the 2017 (peer coaching) science methods course. Supportive of Bowman and McCormick (2000) findings, PSTs who felt emotionally supported and received sufficient theoretical and practical instructions through peer coaching or instructor feedback reported no significant difference in collegiality among peers. The significance in this finding remains the importance of supportive feedback to PSTs.

Conclusion

Peer coaching proved to be much more powerful than expected. PSTs increased their self-efficacy, pedagogy, and science content knowledge. The experience created a professional connection that allowed PSTs to gain knowledge, improve teaching practices, and promoted long-term change (Vidmar, 2006). The process of building a nonthreatening, collaborative relationship had exponential power due to the bidirectional, reiterative activity that pushed PSTs to be intentional in their planning, preparation, and teaching. Both the peer coaching group and instructor feedback group indicated a significant increase in science teaching self-efficacy. However, PSTs that participated in peer coaching continued to independently organize and participate in the endeavor the following semester without assistance or intervention from the instructor. The experience showed to be so powerful that it caused PSTs to change their behavior. Peer coaching served as the mechanism that continuously elevated PSTs to a new level in the construction of meaning while being supported through Banduras' sources of self-efficacy (1987).

Furthermore, the use of peer coaching with PSTs demonstrated an influence on current perceptions of science teaching and increased the application of methods taught in the science methods course. Embedded in Vygotsky's ZPD (1978) is an understanding that teachers must distinguish between students' possession of science knowledge and moving them to a more meaningful application of this knowledge. This study demonstrated that combining an inquiry-based science methods course, practicum, and peer coaching helped reduce PSTs' anxiety related to teaching science.

PSTs who enthusiastically shared science with young students provided a great significance to many components of a child's development (Eshach & Fried, 2005). Quality teaching, affected positively by peer coaching, resulted in increased student learning. Confident science PSTs provided opportunities for primary students to take advantage of their natural curiosity and wonder that allowed growth toward their full potential, which may lead to finding interest in science careers later in life.

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Appendix

Pre and Post-Conference Questions

Pre-conference questions (discussed the day before peer observation)

- What objective do you want your students to accomplish by the end of the lesson?
- What higher order questions are you asking students to consider?
- How can I, as your peer coach, help you?
- Is there a particular student you would like for me to observe?
- Is there something specific you want me to observe? (ex. behavior, engagement, understanding, etc.)

Post-conference questions (discussed immediately following the lesson)

- On a scale from 1-5, five being the best, how do you think the lesson went?
- What do you think were the strengths of this lesson?
- If you could teach the same lesson again, what would you do differently?
- What teaching strategies do you feel worked well with your students?
- How does this lesson compare with the last lesson you taught?
- Do you think your students understood the objective of this lesson? If yes, what did you see students doing that made you feel they understood? If no, what could you do differently to help your students comprehend your lesson?

MANUSCRIPT III

Empowering Pre-service Science Teachers through Peer Coaching

This manuscript is prepared for submission to the peer-reviewed journal, *Journal of College Science Teaching*, and is the third of three manuscripts prepared for a journal-ready doctoral dissertation.

Abstract

Science education starts in early childhood classrooms; however, science is not emphasized at that level in lieu of mathematics and literacy teaching (Organisation for Economic Co-operation and Development [OECD], 2016). Some educators may be reluctant to teach the subject due to their lack of self-efficacy in science education. Thus, the preparation of pre-service teachers (PSTs) to teach science has been critical. This article shares the influence peer coaching may have on the self-efficacy of PSTs regarding teaching science in early education. This phenomenological study employed a mixed-methods approach. Observations, reflective journals, recorded post-conferences, and class discussions were utilized to gather qualitative data; the Science Teaching Efficacy Belief Instrument-Pre-service was administered to gather quantitative data (Enochs & Riggs, 1990). Participants included 26 PSTs enrolled in a university primary science methods course and a 60-hour primary practicum. In preparation to teach science in early education, this study found peer coaching to be an effective tool to increase PSTs' self-efficacy and pedagogical content knowledge. Furthermore, this particular study provided strategies for implementing one model of peer coaching in teacher education methods courses.

Keywords: pre-service teachers, science self-efficacy, pedagogical content knowledge, peer coaching

Empowering Pre-service Science Teachers through Peer Coaching

Active participation in quality science instruction in early childhood classrooms helps young children develop positive attitudes towards science (Blank, 2012). Yet, research indicates that science instructional time is decreasing in elementary schools. Recently, Cafarella, McCulloch, and Bell (2017) reported that only 20% of students in K-3 and 35% of students in grades 4-6 have access to daily science instruction. Furthermore, the study found that in some parts of the country teachers allocate an hour or less per week to science due to the concentration on math and reading curriculum. Another explanation for science receiving a disproportionately small allotment of classroom instruction is teachers' negative attitudes and low self-efficacy in their ability toward teaching the subject (Seung, Park, & Narayan, 2010; Sinatra, Broughton, & Lombardi, 2014).

Research corroborates that pre-service teachers (PSTs) who have a negative outlook about science do not effectively engage inquiry-based teaching methods (Appleton & Kindt, 1999; Kazempour, 2014). If PSTs perceive science education negatively, they may avoid making the effort to become fully prepared in the subject. However, the good news is that PSTs who experience success in their teacher preparation programs are more likely to embrace teaching science in their future classrooms. Naturally, PSTs gravitate toward imparting the knowledge they feel competent in presenting. Hence, teacher preparation programs in colleges and universities should focus on building PSTs' content knowledge along with their self-efficacy to promote positive attitudes toward incorporating science into early childhood classrooms.

Peer Coaching

Peer coaching is one way to increase teachers' self-efficacy and improve attitudes toward teaching science. It is a process by which similar experienced colleagues mentor each other to help build new skills, share ideas, teach one another, or solve problems in their teaching environments (Vidmar, 2006). This support system may include theory, demonstration, practice, and advice. Coaching allows peers opportunities to develop open dialogue and give instant feedback through pre and post conferences. The process allows PSTs to gain knowledge, improves teaching practices, and promotes long-term change. Importantly, this collegial relationship creates a non-threatening environment while encouraging open conversation and collaboration between partners (Shulman, 1987). Collaboration may include assisting with lesson plans, planning overall curriculum, preparing materials, and giving specific feedback. Individual peer coaching sessions remain effective when peers go into the classroom to assist, rather than critique one another.

In a pilot study at a small university in the southwest, PSTs participated in peer coaching during their combined science methods course and a 60-hour primary practicum. PSTs attended two 90-min peer coaching seminars prior to beginning the primary practicum. The first seminar session focused on how each PST would play a supportive role in coaching rather than a traditional evaluative one. Peer encouragement included identifying strengths, ensuring clear and specific communication, and listening while acknowledging partner's personal views about teaching. Explicit attention was given to how peers delivered constructive feedback. For instance, PSTs were advised to give concrete examples such as, "You called on eight girls and two boys during your lesson.” rather than “You call on girls the most.” By stating specific and concrete evidence, peer coaches remained objective. Also, PSTs were encouraged to paraphrase while responding to a peer (“Let me see if I understand what you are saying …” and “I think you are saying…”). Paraphrasing insured clear communication between peers and removed assumptions. Imperatively, all communication was deemed personal and confidential in order to build trust among peer dyads.

During the second seminar session, PSTs chose a peer partner for the practicum and viewed videotaped clips featuring experienced teachers demonstrating effective pedagogical skills such as questioning, thinking out loud, classroom management techniques, etc. Coaching dyads took turns offering hypothetical feedback based on the videotaped lessons. Peers gained insight by practicing objective feedback while examining strengths and weaknesses of the videotaped lesson and by discussing improvements.

While participating in the peer coaching study, PSTs were responsible for five peer coaching sessions. Each session included a 20-minute pre-observation conference, a 30-45-minute observation that transpired during practicum hours, and a 30-minute post-conference. The peer coach focused on encouragement and reassurance during these conferences to provide a safe venue for their peer to share concerns, anxieties, or triumphs.

Pre-observation Conference

The pre-observation conference occurred the day before the lesson was to be taught. PSTs answered questions about their lesson expectations, classroom management techniques, and specific ways the observing peer could be of assistance. Furthermore, the pair discussed classroom arrangement for transitions between activities, expected noise level, and anticipated teaching routine or agenda. (See Appendix A for pre- and post-observation questions).

Observations

During observations, coaches discreetly sat in the back of the room and took notes while their peer taught. They gathered information in several ways. Some drew a map of the peer's assigned classroom; divided the map into fourths; and kept tallies of events, questions, interactions, and movement among the quadrants. Others wrote anecdotal records describing events of the lesson or documented selective verbatim records between the PST and students for post-conference discussions.

Post-conference

After the lesson, post-conferences served as reflective sessions that permitted the observed peers to analyze whether their lesson expectations met reality. The observing peer coaches served as active listeners and encouragers while providing non-threatening audiences for the partners. After the observed peers shared reflective views and discussed their lessons, the observing coaches shared their perspectives of what they saw and provided specific and concrete constructive feedback.

Primary Methods Practicum

The primary objective of the practicum was to offer PSTs authentic hands-on experience in a K-3 classroom before student teaching. This required course provided practical training under the supervision of veteran classroom teachers. The PSTs practiced using manipulatives, problem solving techniques, and hands-on science activities. Moreover, PSTs gained an understanding of primary students and classroom management.

While providing a safe and structured environment, the practicum allowed PSTs to become comfortable with being observed, participating in peer coaching, and receiving constructive feedback. The course required PSTs to spend six hours every Wednesday in a primary-age classroom for ten consecutive weeks. First-week activities involved observations of the classroom routine and getting acquainted with the cooperating teacher and students. The following nine weeks, PSTs fulfilled practicum responsibilities by teaching five 30-minute lessons, assisting the cooperating teacher in classroom duties, and interacting with primary-age students.

During the pilot study, practicum hours presented PSTs opportunities for observations and post-observation reflective sessions. Each observing peer kept notes about specific classroom management techniques, demonstrations of teaching skills, and students' behavior. After examining initial observation notes, PSTs used a form to gather specific observation information (See Appendix B for observation notes).

Peers used observation notes to guide the post-conferences immediately after each lesson. Additionally, cooperating classroom teachers provided feedback on lesson plans, presentations, and classroom management techniques.

Science Methods Course

At the beginning of the semester, most PSTs were unfamiliar with the eight scientific practices, crosscutting concepts, and discipline core ideas that science, technology, and engineering share based on the Oklahoma Academic Standards for Science (OAS-Science) (Oklahoma State Department of Education, 2018). Two weeks of class were spent getting familiar with the standards and learning to write 5E lesson plans (lesson plan that includes Engage, Explore, Explain, Elaborate, and Evaluate) (Chen, Mineweaser, Accetta, & Noonan, 2018). For the remainder of the course, PSTs engaged in weekly inquiry-based lessons and activities in which they learned methods of teaching primary grade-level standards and practiced doing science firsthand to increase content knowledge.

PSTs wrote 5E lesson plans that engaged primary students in science practices. Peer coaching dyads completed the first lesson plan together in order to share ideas and communicate. The final science lesson plan was written by the PST who was then video-recorded teaching the lesson. Both the lesson plan and a copy of the video-recording were turned into the instructor for evaluation. (See Appendix C for an example of the required 5E lesson plan completed by PSTs.)

PSTs' Reflections of Peer Coaching

In addition to standard course assessments (See Appendix D), PSTs completed 10 weekly journal reflections. In these journal reflections, PSTs answered questions that evaluated their level of confidence in teaching science, attitudes toward peer coaching, and changes in classroom management skills. A few journal questions included "How would you describe your relationship with your peer coach?", "What do you believe are strengths or weaknesses of peer coaching?", "How has this experience strengthened your belief that you can be an effective teacher?", and "Describe how you feel about teaching science to young children?" These questions helped to determine attitudinal shifts toward teaching science and opinions about peer coaching.

PSTs' first journal entry examined their initial self-efficacy toward teaching science before starting the required practicum and implementing the peer coaching model. The question, "How do you feel about teaching science to young children?" served as the journal prompt. Most PSTs reported being nervous in anticipation of teaching science. One PST stated, "It kind of makes me nervous thinking about teaching science and maintaining control of a classroom." Another student candidly wrote, "I do not feel like I am qualified in that subject. I am scared that a student will ask a question that I do not know the answer to [*sic*]. I do not want them to think I am dumb!" Collectively, PSTs voiced some type of anxiety prior to the first day of practicum.

By the end of the semester, PSTs articulated their growth in confidence to teach science, manage a classroom, and deal with unexpected events that may occur with primary students. After delivering a successful science lesson, one PST wrote, "After giving my science lesson in my practicum, I feel much more confident in teaching science than at the beginning of the semester." Another PST stated, "A teaching skill that has grown over the semester would be my confidence. I know I can teach and have a positive effect on students." Through peer support, gaining content knowledge, and having the experience of a practicum, not only did PSTs' self-efficacy grow, but also their attitudes toward teaching science shifted monumentally. An additional comment made by a PST on the final exam demonstrated her attitudinal shift. She wrote, "I can't wait to teach science in my future classroom. I am going to start with science and integrate all the other subjects." Overall, PSTs' enthusiasm to share science in their future early childhood classrooms revealed an optimistic view of the subject.

Once again, journal reflections conveyed positive sentiments toward peer coaching. PSTs stated evidence of support, mutual trust, and feelings of being more effective due to observing an equal peer. One PST described how she learned by watching her peer. She wrote, “Watching my partner teach helped me become a better teacher. My first lesson I spoke very quietly. I watched my peer’s lesson and immediately noticed the difference in the level and tone of our voices. I tried to mirror that in my next lesson.” Peer coaching enriched both the peer being observed and the coach observing.

Combining a primary methods practicum, peer coaching, and a science methods course appeared to stimulate growth in self-efficacy and promote positive attitudes toward incorporating science into early childhood classrooms. The practicum allowed PSTs opportunities to practice their teaching methods and skills in real-world situations. Additionally, the teaching experience gave PSTs occasions to apply theory to practice while peer coaching allowed them an added opportunity to view the lessons of a peer and learn from their successes and mistakes. Although PSTs progressed at their own rate, the reciprocal process of constructing meaning, gaining experience, receiving peer feedback, and scaffolding knowledge allowed exponential growth in self-efficacy through the reiterative progress and practicum timeline.

All PSTs communicated development of reflective skills, benefits gained through peer coaching, and an increase in their confidence. The only drawback mentioned by a few PSTs involved the occasional difficulty of scheduling the pre-conference. However, most PSTs stated that the pre-conference had become so critical to their effectiveness that they made it a priority every Tuesday.

Benefits

PSTs continuously benefit from practicum experiences in the classroom and informal interactions with peers. One advantage gained from peer coaching during a practicum is the opportunity to share perspectives. Recognizing a peer's perspective aids in deepening the working relationship and contributes to a feeling of accountability toward a partner. Another advantage PSTs receive from this situation is the acceleration of learning. Learning accelerates forward exponentially when peers observe, practice, and receive quick, reliable feedback. Lastly, peer coaching builds camaraderie among PSTs. Peer coaching has a positive influence that encourages responsibility, teamwork, and competence. By empowering PSTs with the knowledge of how to participate in peer coaching, they learn techniques of effective teaching in a nonthreatening and professional manner. Moreover, science enthusiastically shared with young children provides a great significance to many components of a child's development (Eshach & Fried, 2005). Most importantly, providing opportunities for young children to take advantage of their natural curiosity and wonder allows growth toward their full potential, which may lead to more students finding interest in science careers later in life.

This pilot study may contribute to the development of science methods courses within early childhood and elementary teacher preparation programs. Utilizing peer coaching with PSTs has the potential to influence current perceptions of science teaching and may improve course instruction in the science methods course. PSTs benefit from a program that combines science methods course, practicum, and peer coaching. Furthermore, PSTs with increased content knowledge, improved teaching strategies, and strengthened self-efficacy are more likely to be effective science educators.

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Appendix A

Pre and Post-Conference Questions

Pre-conference questions discussed the day before peer observation

- What objective do you want your students to accomplish by the end of the lesson?
- What higher order questions are you asking students to consider?
- How can I, as your peer coach, help you?
- Is there a particular student you would like for me to observe?
- Is there something specific you want me to observe? (ex. behavior, engagement, understanding, etc.)

Post-conference questions discussed immediately after the lesson

- On a scale from 1-5 with 5 being the best, how do you think the lesson went?
- What do you think were the strengths of this lesson?
- If you could teach the same lesson again, what would you do differently?
- What teaching strategies do you feel worked well with your students?
- How does this lesson compare with the last lesson you taught?
- Do you think your students understood the objective of this lesson? If yes, what did you see students doing that made you feel they understood? If no, what could you do differently to help your students comprehend your lesson?

Appendix B

Observation Notes

PST being observed: ____________________ PST observing: _____________________
Observation Date and Time: ____________________________________
Please use this form to jot down specific details to discuss during post-conference.
****

Classroom Management Techniques:
Beginning of lesson-

Middle-

End-

Specific expectations and directions given to students:

Assessment of students:
Beginning of lesson-

Middle-

End-

Demeanor, attentiveness, & connections made with students:

Examples of student engagement:

5E Progression

Engage-

Explore-

Explain-

Elaborate-

Evaluate-

Verbal flow:
Class Traffic:
Duration of tasks:
Event count:

Please use back for selective verbatim or additional notes.

Appendix C

5E Model Lesson Plan Format

SUBJECT MATTER
Science: Solids and Liquids (Oobleck Experiment)

Instructional Time/Period of the Day 10:00-10:45 **DATE** 10-28

Material Needed:
-PowerPoint: Learning about Solids and Liquids
-Cornstarch ,Water, Food Coloring, Baggies, Newspaper, Containers with solids and liquids, w
wipes

ENGAGE: (Motivation or hook to get students excited about learning.)
Boys and girls,
Earlier we wrote in our journals what we think a scientist is. Would anyone like to shar what he or she thinks a scientist is? (Have a few students share what they think a scienti might be and then share the great news with them.) I have great news for each of you! Guess what, each and every one of you are scientists! Today, I will need everyone to w your scientist hat (pretend to put hat on my head). Are you ready to do some exploring and experimenting? How do you think a scientist acts when he or she is working? Do y think they follow the rules? Do you think they give their full participation? Do you thin they have fun but are respectful as they work? Great! So, get ready scientist, today we a going to learn about solids and liquids!

EXPLORE: (Hands-on experiences that help build concepts and developing skills.)
Ask students to find one thing in their desk that they think is a solid and raise it up in th air. Ask students to raise their hand if they think they know a liquid that is in the classroom. Let them share their answers.
Pass out containers with solids and liquids. Allow time for groups to sort containers int categories.

EXPLAIN: (Students share knowledge and teacher helps fill in any gaps.)
Ask for students to share in their groups what makes something a liquid or a solid. Ask for volunteers to share their answers.
Show PowerPoint with examples of solids and liquids. Ask if anyone could give examp of a solid or liquid. I will also have different objects to show solids or liquids that they could pass around.
In the power point, I have the definition for both solid and liquids.

I have a smartboard activity for the students to do. It has different pictures of solids and liquids. Students drag the picture under the correct category: solid or liquid.

ELABORATE: (An extension or activity that reinforces the objective.)

Earlier we talked about how we think scientists act. We agreed that scientists follow the rules and get along with each other. Before we begin our fun part of our science lesson we have to make sure everyone clearly understands the rules.
Rules:

1. We will open the plastic bag when we are asked to do so.
2. We will leave the corn starch in the bag and we will keep our plastic bag over the newspaper.
3. We will listen carefully for instructions about what we are supposed to do.
4. We will stay in our groups unless asked to do otherwise.
5. We will have fun and challenge our thinking.
6. After we are finished with the experiment please help clean up the area.

Pass out the plastic bags that already have cornstarch in them. Each student will get a bag. Students will write down what they think will happen to the cornstarch once water is added. Ask if they think it will be a solid or liquid. Once students have finished writing their prediction, they will add water to their plastic bag. I will MODEL the procedure but will not give away the results. They will each have their own little cup of water. After students have their water in their bags, I will pass out food coloring for them to put two drops into their bags. Once students have water and food coloring, they need to zip their baggies back up. When the baggies are completely sealed tell them to mix everything together. Give students the time to figure out if they think it is a solid or a liquid. Let students open their bags and feel the mixture. Have them write down what they think it is and then have a few share their answer and why they answered the question that way. After the discussion of whether it is a solid or liquid explain that is it both!

EVALUATE: Independent Practice: (This could also provide an assessment – Evidence that intended learning has occurred.)

The paper students are writing their predictions, observations and conclusions on will be turned in but also I will ask them to write their definitions of a solid and liquid.

Closure – Placing lesson in context to ensure connectedness to long term objective(s) and/or relevancy

Please turn to your neighbor and tell them what the difference is between a solid and liquid.
Can anyone define a solid? What are some examples of a solid? (Get several answers.)
Can anyone define a liquid? What are some examples of a liquid? (Get several answers.)
Why are we all scientists? (Because we are always exploring and experimenting!)
Scientist, please see what solids and liquids are at your house tonight. We will talk about your discoveries tomorrow morning during our morning meetings.

Appendix D

Assignments Required in Science Methods Course

Individual Requirements

- 5E lesson plan
- Midterm exam
- Final exam
- Science activity presentation
- Science article review

Peer Coach Dyad Requirements

- 5E lesson plan
- Peer presentation

Assignments required in Primary Practicum

Individual Requirements

- Write five lesson plans
- Teach five lessons in primary grade
- 60 hours of attendance (10 Wednesdays)

Peer Coach Team Requirements

- Complete five pre and post-conferences
- Video record partner teaching science
- Observe peer teach 5 times and fulfill peer coaching duties

APPENDIX A: PROSPECTUS

PROSPECTUS

UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

EFFECTIVENESS OF PEER COACHING TO ENHANCE PRE-SERVICE TEACHERS' SELF-EFFICACY TOWARD SCIENCE INSTRUCTION AND PEDAGOGICAL CONTENT KNOWLEDGE

A PROSPECTUS

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

Degree of

DOCTOR OF PHILOSOPHY

By

KELLI PROVENCE-DUDLEY
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EFFECTIVENESS OF PEER COACHING TO ENHANCE PRE-SERVICE

TEACHERS' SELF-EFFICACY TOWARD SCIENCE INSTRUCTION AND

PEDAGOGICAL CONTENT KNOWLEDGE

A DISSERTATION APPROVED FOR THE
DEPARTMENT OF INSTRUCTIONAL LEADERSHIP AND ACADEMIC CURRICULUM

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Abstract

There is a demonstrated need for U.S. citizens to acquire better science proficiency, as the country begins to lag behind many countries in that area. The foundation starts with early childhood education; however, science is not emphasized at that level, in lieu of mathematics and literacy teaching. The role of pre-service teachers (PSTs) in this area is critical. Reluctance to teach the subject may be due to their lack of self-efficacy in science education. The purpose of this study is to examine the influence that peer coaching and mentoring could have on the self-efficacy of PSTs in terms of teaching science in early education. This phenomenological study will employ a mixed-methods approach. Observations, focus group interviews, reflective journals, and lesson plans will be the qualitative data employed; the Science Teaching Efficacy Belief Instrument-Pre-service (STEBI- B) will be used to gather quantitative data. Participants will be 26 PSTs, who enroll in a university primary science methods course in the fall semester. It is hoped by the researcher that the findings of the study could provide a better understanding of the role that peer coaching could have in the preparation of PSTs to teach science in early education.

Effectiveness of Peer Coaching to Enhance Pre-service Teachers' Self-Efficacy toward Science Instruction and Pedagogical Content Knowledge

The need for school children to receive a thorough education in the sciences is manifest. However, in the United States, many individuals have not been grounded in science in their elementary and secondary educations and, as a result, few are proficient in the field of science, and many of them lack even the basic science knowledge (National Research Council, 2012). Pre-service teachers (PSTs) who comprehend the importance of teaching science practices may increase students' ability to successfully complete scientific tasks. The problem that is the focus of the current study is that PSTs in the U.S. often do not receive the foundational education that they need in order to become proficient science educators. As a result, they do not spend much of their classroom time engaged in planned or spontaneous science activities (Tu, 2006).

Peer coaching has been recognized as a way that PSTs can be trained to deliver science content and pedagogy (Yee, 2016). However, the effect of peer coaching in improving science efficacy of early education teachers is not well known. This study will enable the researcher to determine if peer coaching could have an impact on the development of early education science teachers. The consequence of the problem, should it remain unaddressed, is a continuing lag in the science education and literacy of the U.S. population. The benefits of addressing the problem could include better-trained and more effective early education science teachers and resultant improvement in the science education and literacy of the American people.

The power of children's early thinking and learning reinforce a growing recognition and understanding that science may be an exceptionally important domain in early childhood, assisting not only to form a foundation for future scientific understanding but also to construct essential skills and attitudes for learning (Worth & Grollman, 2003). Therefore, science shared with young children provides a great advantage to various facets of their development and child experts suggest that science education should begin in the earliest years of schooling (Eshach & Fried, 2005; Watters, Diezmann, Grieshaber, & Davis, 2000). Nevertheless, even though the United States recognizes the value of academic achievement, more and more early childhood and elementary educators focus on teaching literacy and mathematics rather than science, which receives a disproportionately small allocation of teaching efforts (Pizzolongo & Snow, 2015). Since the lack of science in early childhood and elementary classrooms impedes children's development of scientific thinking (Trundle, 2009), the importance of preparing PSTs to incorporate science into their lesson plans is imperative. Teacher preparation programs need to seek ways to educate and empower pre-service teachers (PSTs) to become confident in teaching science, along with all other subjects. Collaborative research and engagement in meaningful learning communities have been shown to be extremely valuable in this area for PSTs (Abel, 2015). Research stresses the significance of social constructivism in the PST's educational experience and recommends that teacher preparation programs implement collaborative action research as an essential component to their programs. Moss, Sloan, and Sandors (2009) reported on how the establishment of peer coaching represents a form of collaborative action research that can exist as a viable tool to improve teaching. McDermott (2011) defined peer coaching as "a powerful process for enabling two or more people, who share common interests or goals, to collaborate in helping one another become more successful in their work or personal lives" (p. 1).

More specific to education, McKenna and Walpole (2008) explained peer coaching as a strategy for implementing a professional support system for teachers. This support system could include theory, demonstration, practice, and feedback. Coaching allows peers opportunities for pre-observation conversations, observations, and post-observation reflective sessions (Vidmar, 2006). The process creates a nonthreatening professional relationship, allows teachers to gain knowledge and improve teaching practices, and promotes long-term change. Furthermore, Wynn and Kromery (1999) add to the definition by explaining peer coaching as "a training method in which a pair of practicum students, student teachers, or classroom teachers observe each other and provide consultative assistance in correctly applying teaching skills and proposing alternative solutions to recognized instructional needs" (p. 22). Bowman and McCormick's (2001) use of peer coaching with PSTs demonstrates that, regardless of the subject area, grade level, or number of years of experience, peer coaching equips teachers to become collaborators, and collaboration provides students with a higher quality of instruction. Peer coaching stands as a way to construct an environment of supportive professionals seeking to make a positive impact on student achievement.

Purpose of the Study

The purpose of this mixed-methods phenomenological study is to understand the influence that peer coaching and mentoring could have on the self-efficacy of PSTs in terms of teaching science in early education. A sample of such teachers will be interviewed as well as administered a survey, to gather both qualitative and quantitative data. The data will consist of focus group interviews, reflective journals, observations, and lesson plans. The data will be analyzed with the goal of answering the following research questions.

Research Questions

In accordance with the study problem and the researcher's chosen methodological approach, the following research questions will be employed:

RQ1. To what extent, if any, does the experience of peer coaching predict growth in pre-service teachers' (PSTs) self-efficacy toward science and pedagogical content knowledge?

RQ2. To what extent, if any, do peer-coaching and instructional feedback differ in predicting PST growth in self-efficacy toward science?

Theoretical Framework

The theoretical framework that will underpin this study is constructivist theory as articulated by Piaget and Vygotsky. The theory states that people are better equipped and, thus, more inclined to comprehend information that is the result of their own cognition, i.e., self-constructed (Piaget & Inhelder, 1958). Piaget and Vygotsky's theories on the concepts of development support the constructivist approach, which emphasizes that each child is an intellectual explorer who makes his own discoveries and constructs knowledge (Frost, Wortham, & Reifel, 2012). In constructivist classrooms, the teacher accepts the role of a facilitator who plans, organizes, guides, and provides directions to the learner (Howes, Lim, & Campos, 2008). Constructivism maintains that human beings generate knowledge and meaning from active learning or doing. Active children who are involved in collaboration with their experiences and their ideas construct new meaning. This theory applies to collaborating PSTs.

Vygotsky (1978) referred to learning as a social advancement that involves language, real life situations, interaction among learners, and *scaffolding* of knowledge. Scaffolding of knowledge involves giving more support when an individual struggles with a particular task and, as time passes, less support as the individual makes progress (Wood, Bruner, & Ross, 1976). A construct fundamental for scaffolding instruction includes the concept of the *zone of proximal development* (ZPD). Vygotsky (1978) described the *ZPD* as "…the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (p. 86). ZPD is a challenging level of growth reached through social interaction. Pre-service teachers' acquisition of how to effectively teach science while using peer interaction allows the application of constructivism. According to Goos, Galbraith, and Renshaw (2002),

> Applied to educational settings, this view of the ZPD suggests there is learning potential in peer groups where [partners] have incomplete but relatively equal expertise- each partner possessing some knowledge and skill but requiring the others' contribution in order to make progress. (p. 195)

The authors continue by stating that "Clarification, elaboration, justification, and critique of one's own or one's partner's reasoning" identifies characteristics of the "collaborative ZPD" (Goos et al., p. 199). Successful peer partner conferencing includes these important characteristics, but also requires each partner to reflect on their personal teaching practices.

Collaboration encompasses higher-level communication, social skills, and problem solving as it facilitates a change in behavior (Romagnano, 1994). By using a combination of construction of meaning and collaboration, the individual can apply prior knowledge, understanding, and determination with received feedback to become a more effective teacher. Hardre, Davis, and Sullivan (2008) stress the importance of teachers' learning collaboration in order to model these skills for students. In return, teachers who become analytic about their own practice through reflective collaboration with supportive peers are more likely to apply new knowledge, techniques, and strategies in their classrooms (Lyons & Pinnell, 2001).

Review of Literature

Peer Coaching

Peer coaching is a process by which similar experienced individuals mentor each other to help build new skills, share ideas, teach one another, or solve problems in their teaching environments. How active the peer is in this manner depends on the individual arrangement, but the assistance offered can include helping with lesson plans, planning overall curricula, preparing materials, in-class assistance, and in-class observation and feedback (Abel, 2015). Fundamental to the process of peer coaching is creating a relationship that remains non-threatening while encouraging open conversation and collaboration between partners (Shulman, 1987). Individual sessions remain effective when peers go into the classroom to *assist* rather than *evaluate* one another. Peer relationships become collegial. Guidance and mentoring is a collaborative effort where peers self-direct partners in learning. Conversations are directed toward articulating intentions before observations, followed by reflections after the lesson (Vidmar, 2006).

As PSTs reflect upon their experience teaching with a peer, they realize significant information about the intended results in comparison with the actual lesson. Accomplishments and frustrations are shared. By making the reciprocal conversations part of the process, PSTs build upon the everyday classroom experiences, complementing class time with the conversations before and after teaching. Early in peer coaching, PSTs learn to be intentional in the classroom, using the discernment that accompanies the performance to manage their actions (Shulman, 1987). By continuous practice of addressing and self-monitoring their teaching, ultimately learning and critical reflection upon their experiences occur.

In a review of peer coaching studies, Lu's (2010) findings illustrate benefits as well as disadvantages of peer coaching. Benefits related to peer coaching include improvement of professionalism, increased focus on student learning, and an overall feeling of comfort and confidence while teaching in front of peers. Peer coaching also was reported to have contributed to PSTs openness to accept constructive feedback or criticism of their teaching (Hasbrouck, 1997). Owens (2004) found PSTs demonstrated more accountability and commitment when involved in peer coaching and that a mutual sense of trust, honesty, and equality developed among peers during the process.

Although many merits were discussed in these studies, some disadvantages were identified. Owens (2004) described an increase workload for PSTs, poor organization of teacher preparation programs, time restraints, and lack of knowledge among PSTs to analyze lessons during the study. Three additional challenges included scheduling difficulty for peer coaching, unequal partners, and lack of skills to provide feedback (Kurtts & Levin, 2000). Bowman and McCormick (2000) found the emotional support felt during peer coaching could be replaced by other campus efforts. In their experimental study, university supervisors provided feedback to the control group while the experimental group peer coached each other in pairs. The researchers reported no significant difference in collegiality among peers. The outcome of the study suggests that as long as PSTs receive sufficient theoretical and practical knowledge regarding teacher behavior, classroom support, and weekly-integrated seminars on teaching skills, PSTs will develop collegial reinforcement needed for teaching.

Constructivist theory provides an interesting perspective on peer coaching. A novice teacher (PST) who collaborates with another PST will be active in the creation of the work environment in which she ultimately operates. Goos et al. (2002) mentioned that the collaborative environment works best when each collaborator brings something different to the discussion. Constructivist theory suggests that such collaboration may be more than the sum of its parts, underscoring the value of peer coaching.

Pedagogical Content Knowledge

Pedagogical content knowledge is based on the method in which teachers relate their knowledge about teaching (pedagogical knowledge) to their content knowledge or what they know about the subject they teach (Cochran, 1997). Among the three core knowledge categories defined by Shulman (1987), pedagogical content knowledge (PCK) “identifies the distinctive bodies of knowledge for teaching” (p. 8). In other words, PCK means knowing the content in pedagogically practical ways and making it clear to students. Despite varying definitions, research has identified two core aspects of PCK: knowledge of students' understanding and knowledge of instructional strategies (Berry, Friedrichsen, & Loughran, 2015; Borko, 2004; Jüttner, Boone, Park, & Neuhaus, 2013;

Magnusson, Krajcik, & Borko, 1999; Park & Oliver, 2008). In teacher preparation programs, peer coaching has been found to increase reflective practice and solve instructional problems. It may expand the knowledge base of PSTs in the areas of instructional strategies, teaching models, and classroom management (Wynn & Kromrey,1998). Großschedl, Harms, Kleickmann, and Glowinski (2015) confirmed that science-specific findings on pre-service and in-service teachers' PCK are still scarce. To date, research on professional knowledge focuses on paper-pencil assessments (Anderson & Krathwohl, 2001). Written assessments allow for measuring knowledge but fail to fulfill the quest to recognize the connection between pedagogical knowledge and content.

Constructivist theory suggests that PSTs will operate better and more efficiently when they have played an active role in creating the pedagogical practices they will use. The teacher is a facilitator who uses accepted practices as well as methods of her own creation to administer teaching. Gaining pedagogical knowledge allows better planning and curriculum creation by PSTs.

Teaching Quality

Although quality teaching is certainly important, currently, there is no accepted measure of teaching quality (Altbach, 2015). This may be due to the subjectivity of the concept and the difficulty in objectively measuring this construct. Quality teaching is described as that which leads to improved student progress (Coe, Aloisi, Higgins, & Major, 2014). Teachers are commonly evaluated on the performance of their students, which is only a rough indicator of the quality of their teaching. Coe et al. (2014) suggest PCK, classroom management, teacher's self-efficacy, and classroom environment as core components of quality teaching.

The environment in which a teacher operates has an effect on the quality of her teaching. Blömeke and Klein (2013) posited that the presence or absence of a supportive environment had a major influence on the teaching quality delivered by novice mathematics teachers. It is likely, as well, that such an environment adds to teachers' self-efficacy and helps them to construct their own teaching environments, as per Vygotsky. The classroom environment includes quality of interactions between teachers and students, and teacher expectations (Coe et al., 2014). Teacher expectations should embrace rigor while recognizing and reaffirming students' self-worth. Quality teacher communication involves accrediting student achievement to effort rather than ability and valuing resilience to failure. The environment is often reflected in the overall classroom community and management.

A teacher's ability to coordinate effective use of class time, classroom resources/space, and manage students' behavior maximizes the learning that takes place (Coe et al., 2014). Along with PCK, classroom management and environment contribute to quality learning. Additionally, a teacher's belief in particular practices, theories about learning, and personal conceptual models play a role in the learning process as well as their self-efficacy in their ability.

Self-efficacy

Bandura's (1977) theory of self-efficacy states that a person's belief in her ability to accomplish a task, meet a goal, perform a function, etc… has a positive effect on her actual ability to do so. Self-efficacy is independent of any objective measured ability. The effect is strong enough that a person who, objectively, should not be able to succeed at a task can essentially outperform a person who is qualified at that task, but does not believe in her ability to do so (Bandura, 1977). Bandura's later self-efficacy work focused on teachers and has become a viable and popular perspective by which to understand why some teachers succeed and others fail. He stated that educational administrators should focus on ways to help teachers increase their self-efficacy. A good teacher can be made a great one, or a poor one adequate or better, simply by increasing her belief in her ability to do the job.

The relevance of Bandura's (1997) theory to the present study is that PSTs, in addition to training, need reassurance and mentoring. This encouragement should include raising their levels of self-efficacy; a novice teacher may be uncertain or nervous about her ability to do the job and thus, benefit greatly from support and mentoring. Bandura (1977; 1997) noted that the performance of teachers, and particularly novice teachers, depended to a great degree on their levels of self-efficacy.

Vygotsky's (1978) constructivist theory can be combined with Bandura's self-efficacy theory to form an understanding of how teachers operate. Constructivist theory suggests that teachers (novice or otherwise) will function best in an environment in which they have the opportunity to construct their own knowledge through the teaching of content material. Self-efficacy theory suggests that a teacher who believes in her own abilities will be more effective simply because of that belief. Peer coaching can raise novice teachers' self-efficacy (Bandura, 1997). Support will be provided for the PSTs by scaffolding the construction of their knowledge through peer coaching. Therefore, both theories support the value of peer coaching improving teaching quality for PSTs.

This study is designed to support and extend the existing literature on peer coaching and self-efficacy toward science in several ways. First, the primary objective is to examine what extent, if any, does the experience of peer coaching have on PSTs self-efficacy toward science and pedagogical content knowledge. Secondly, the researcher wants to examine if peer coaching and instructional feedback differ in predicting PSTs growth in self-efficacy toward science.

Methodology

Research Design

This mixed-methods study will be conducted through a phenomenological research approach. A phenomenological study attempts to recognize people's perceptions, perspectives, and understandings of a particular situation (Merriam & Tisdell, 2016). Mixing qualitative and quantitative methods will allow for a richer picture of associations by revealing in detail the processes by which data are gained and analyzed. Creswell (2012) dedicates a chapter in his book that discusses the details of mixed methods and the value gained by using this type of method when different types of knowledge are desirable. Fuller, Holloway, and Liang (1996) used a mixed methods approach to examine the factors that revealed parents' decisions on childcare. The study used a national survey that disclosed parental choice and utilized a qualitative interview. The interview revealed that parents valued safety and trust in their childcare providers more than other structural or process indicators of quality. By incorporating a mixed methods approach, the study revealed the value parents placed on caregiver-parent relationships even though it was not considered a major factor while making initial decisions on a quality childcare. Another mixed methods study researched the effects of peer coaching on teachers' collaborative interactions and students' mathematics achievement scores (Murray & Mazur, 2009). Researchers implemented an open-ended survey to gather data on math teachers' perceptions of peer coaching and analyzed middle school students' mathematics achievement pre-post tests using a multiple regression analysis. Statistically, peer coaching was not associated with any improvements in students' math achievement, but surveys revealed that teachers found it helpful to share ideas, techniques, and teaching strategies with peers. Additionally, teachers identified scheduling as a major barrier of peer coaching.

In this experimental study, early childhood and elementary PSTs who enroll in their initial primary science methods course will be assigned to a peer coaching practicum experience. The group will receive the same science instructional training as the previous year PSTs received --they will have the same professor, instruction, text, and assignments. The only difference will be the current PSTs will be trained and will participate in peer coaching. The previous year PSTs or control group, received only instructor feedback.

Qualitative methods will be used to examine and richly describe PSTs' peer coaching experiences, pedagogical content knowledge, and teaching quality. Quantitative methods will be used to analyze the pre- and post-test scores of the Science Teaching Efficacy Belief Instrument-Pre-Service (STEBI-B; Enochs & Riggs, 1990) of both the experimental and control groups as well as explore the relationship between peer coaching and PSTs self-efficacy.

Possible Participants and Location

In this study, 26 participants, 13 early childhood (certification to teach age 3 to grade 3) and 13 elementary (certification to teach grade 1 to grade 8) PSTs have the opportunity to provide consent for the researcher to include their data in the study analysis. The sample has the potential of consisting of 25 females and 1 male, with the average age of the PSTs being 20 years old (Hacker & Fister, 2014). All participants will be full-time students and classified as juniors or seniors at the time of the study. Most students will have completed three or four of the required courses in general physical science, general earth science, and biology before beginning their first science methods course and practicum. To protect confidentiality, pseudonyms will be assigned to or selected by the PSTs.

Research will be conducted at a small private Midwest university in the United States where the researcher has been an instructor in a teacher education program for the past five years. The researcher will be the instructor of the two current sections of the required science methods courses for all early childhood and elementary majors and the supervisor of a corresponding 60-hour practicum with primary children in a public school setting.

Data Sources and Collection Procedures

Several types of data will be used for this research study including journal entries, observations, focus group interviews, documentation as well as a pre- and post-test of the Science Teaching Efficacy Belief Instrument-Pre-Service (STEBI-B, Enochs & Riggs, 1990). Glense (2011) communicated that the more sources that contribute to a study, the richer the data and the more complex the findings. While the perception of data is universally associated with scientific research, an enormous range of organizations and institutions collect data. Data are the portions of evidence composed to help answer questions (Castle, 2012).

Qualitative Data

For the qualitative component that will examine PSTs' peer coaching experiences, pedagogical content knowledge, and teaching quality, multiple journal entries, video observations, and a university checklist will be used to assess the qualitative dimensions of PSTs' self-efficacy. PSTs will reflect on teaching science before the lesson and afterwards during the post observation.

Journals. Reflective journals are personal records of learning experiences (Yin, 2009). They are often included so the researcher can monitor the understanding and knowledge of students. Journal writing assignments can benefit students by enhancing reflection, facilitating critical thought, expressing feelings, and writing focused arguments. PSTs will be required to record learning-related events before the learning process and just after they occur. Questions will be used to prompt students' thought processes about expectations before the lesson and reflections on what happened during the lesson. Twelve reflective journal entries by each PST will be electronically submitted during the semester. Data from these journal entries will be used to monitor the understanding and knowledge of PSTs as well as to assist in planning class discussions and scaffold learning (Lake, Al Otaiba, & Guidry, 2010). Sample journal prompts are listed in Appendix A.

Observations. Data collected from observations is an essential element in qualitative research (Yin, 2009). Observations can often provide additional details about the phenomenon being studied. Patton (2015) considered observations to be the optimum way to fully appreciate the complexities of the phenomenon of attention.

Observations will allow the researcher to view teaching quality and PCK of the PSTs and their ability to make a connection between the methods and content they have learned in class to classroom practice. Peer coaching pairs will observe each other six times. The initial observation will take place in a local, private elementary school that has very small class sizes (10-14 students) where PSTs will have the opportunity to gain experience in observation techniques. The remainder of the observations will take place in 26 pre-kindergarten to second grade public school classrooms. All peer pre-observation conferences will take place in the education tutoring rooms the day before the observations. Post conferences will occur immediately after observations in each grade-level's conference room. Although the PSTs will be attending four different elementary schools, the peer coaching pairs will be in the same location. Pairs, along with cooperating teachers, will decide times of teaching observations. Peers have the freedom of observing each other on the same day or taking turns every other week.

During the 30-minute observations, the peer will sit in an unobtrusive location where she is able to view the PST and the students in the classroom. The researcher will observe each PST with the peer once during the first six weeks of the practicum. Researcher and peer coaches will use pre-observation, observation, and post-observation checklists (Appendices B, C, D) to document conversations, observation events, and discussions. The researcher will observe the post-observation conference and afterwards will meet individually with the observing peer to give constructive feedback on peer coaching.

The final peer observation will be video-recorded for the researcher to utilize during the study. Other researchers who have incorporated video-recorded observations into their case studies include Forbes, Biggers, and Zangori (2013). They observed 45 participants teaching science practices during a three-year professional development program. Moreover, these researchers developed a science practice checklist to be employed during observations of teachers facilitating science practices. In addition, Ricketts (2014) engaged video-recorded observations of PSTs teaching a science lesson in their field experience. Although the focus for the PSTs' observations will be different in this future study, Forbes and colleagues, along with Rickets' research recognized the importance of observations and how they can contribute to the data.

Focus groups. Focus groups share several mutual features with less structured interviews, however, there is more to focus groups than accumulating related data from various participants at once (Gill, Stewart, Treasure, & Chadwick, 2008). A focus group is a discussion on a specific topic planned for research purposes. This discussion will be guided, monitored, and recorded by the researcher (Appendix E). Focus groups will be used for generating information on the PSTs' views, and the implications that lie behind their opinions. They are also beneficial in generating a rich comprehension of participants' experiences and beliefs.

The final piece of data collection of this study will be two focus group sessions held in class during the last week of the semester. Each group will consist of 13 PSTs. The focus group interviews will provide access to perceived advantages and disadvantages PSTs may make between their peer coaching experiences, as well as how they feel about teaching science. The reasoning behind the multiple types of data collection will contribute to an authentic assessment of pre- and post-course self-efficacy about science.

Field notebook. In qualitative research, field notebooks have many purposes and function as a reflective tool throughout the of data collection. A field notebook may serve as an audit trail when transparent descriptions of the research process are documented. Reflecting in a field notebook will allow the researcher to keep notes about the studies focus and record the context of events (Bazeley, 2013). Glense (2011) suggest recording descriptions, ideas, hunches, reflections, and notes in a field notebook along with assumptions, revelations, observation adjustments, and plans. In this study, the field notebook will assist the researcher to recollect the events and happenings in class discussions and the 26 observations. Memos will be recorded in order to document decisions made during the data collection and data analysis (Lincoln & Guba, 1985).

Quantitative Data

Science teacher education has several objectives, but from a PST's viewpoint, a feeling of efficacy in her ability to teach science in an early childhood or elementary classroom is a genuine concern (Scharmann & Hampton, 1995; Tilgner, 1990). Without trust in one's ability, PSTs are less likely to teach science (Seung, Park, & Narayan, 2010; Ramey-Gassert & Shroyer, 1992). Research on socioscientific issues has recently revealed that instruction can influence students' attitudes toward science (Lee & Erdogan, 2007; Yager, Lim, & Yager, 2006) contributing to additional importance being placed upon teacher's efficacy in the subject.

The Science Teaching Efficacy Belief Instrument-Pre-service (STEBI- B), developed by Enochs and Riggs (1990), is used in many studies to measure science teaching self-efficacy and outcome expectancy in pre-service early childhood and elementary teachers (Cannon & Scharmann, 1996; Morrell & Carroll, 2003; Mulholland, Dorman, & Odgers, 2004). The STEBI-B is a modification from the original instrument, STEBI-A, which measures in-service teacher's efficacy beliefs toward science (Enochs & Riggs, 1990). The modifications to the STEBI-B (Appendix G) include the use of future verb tenses to reflect the emphasis on teaching by PSTs.

STEBI- B, a one-page instrument, has 23-items containing statements such as, "Even if I try very hard, I will not teach science as well as I will most subjects." (Enochs & Riggs, 1990). PSTs will indicate their level of agreement by choosing from a 5-point Likert scale. The scale ranges from strongly agree to strongly disagree. The PSTs' responses totaled over the 23 items will provide a degree of measurement of their attitudes and self-efficacy beliefs. The personal science teaching efficacy (PSTE) subscale has 13 statements that look at the teachers' belief in their ability to assume successfully the role of classroom teacher while the science teaching outcome expectancy (STOE) subscale has 10. The initial research data showed the accuracy of the STEBI-B instrument had overall internal consistency. The Cronbach's alpha for all 23 statements was .90 (Enochs & Riggs, 1990). The internal consistency of the 13 PSTE statements and the 10 STOE statements was $\alpha = .90$ and $\alpha = .76$ respectively.

Study Procedures

The process of the study will be described to the potential participants by the chair of the School of Education at the beginning of the semester. An explanation of risks, benefits, and non-requirement of the study will be explained in detail to the potential participants. The participants will provide consent for the researcher to include their data in the study analysis by signing a consent form. These forms will be collected and stored by the chair in the school of education's vault until the semester grades are posted in December. Additionally, the STEBI-B pre-test will be administered online during class before the researcher explains course assignments and expectations (Bleicher, 2004). This Likert scale survey will receive a completion grade to encourage all PSTs to complete the data source.

During the first weeks of the semester, PSTs will be introduced to the eight scientific practices, crosscutting concepts, and the discipline core ideas that science, technology, and engineering share by reading the *Framework* (NRC, 2012). Four class periods will be spent teaching, modeling, and explaining these practices. For the remainder of the course, PSTs will be engaged in weekly lessons and activities where they assume the role of a primary age student to experience in-class investigations and have first-hand experience of *doing* science to increase content knowledge. After each investigation, PSTs, individually and in small groups, will identify science practices that will be included in the various activities and teaching methods that contribute to pedagogical knowledge.

Participants in this experimental group will attend two 90-min seminars two weeks before entering the primary classrooms. During the seminar, the researcher will simulate micro-teaching sessions incorporating a targeted skill followed by a discussion. The PSTs will role-play instances of the skill in a hypothetical teaching situation. Next, while viewing a videotape featuring teachers demonstrating the highlighted skill, they will record examples of that skill's use and discuss strategies that may be helpful. The PSTs will participate in simulated post-conferences based on the video-taped lesson at the end of each seminar, using the same questions that will be asked for post-conferences throughout the study. PSTs will practice conducting post-conferences as part of peer coaching dyads; peers will discuss strengths, weaknesses, and suggest improvements.

The week before practicum begins, PSTs will visit a private elementary school and teach a short science lesson in primary classrooms while a peer observes. The peer coaching dyad will complete a pre-conference to discuss expectations, observation, and post-conference to discuss if expectations met reality.

The third week of the semester, peer coaching teams will start their practicum in early childhood classrooms. The first week will be observation of the cooperating teacher, students, and becoming comfortable with the routine. The following week peer coaching dyads will begin teaching weekly lessons and completing the peer coaching model requirements. The observing peer will maintain notes that include entries for demonstrations of teaching skills. Peers will use the notes in the post-conferences that will be held immediately after each lesson. Peer coaching dyads will conduct five post-conferences during the practicum. In addition, cooperating classroom teachers will give feedback on lesson presentations.

Pre-service teachers will write a science lesson plan that will engage primary students in at least one of the science practices near the end of the practicum. PSTs will video-record the teaching of the last science lesson and primary students' involvement. During the 14th week of the fall semester, the instructor will administer an online post-test (STEBI-B) in class.

In addition to the science methods course attendance, PSTs will attend a weekly one-hour evening class following the Wednesday practicum to discuss pedagogical skills, classroom management, and peer coaching procedures. Class discussions will be recorded and used to guide the instructors' preparation for the next class instructions, reflective journal questions, and suggestions for cooperating teachers to discuss with individual PSTs.

The PSTs in the previous course (control group) participated in the inquiry based science course and the weekly one-hour class following the Wednesday practicum. Cooperating classroom teachers provided feedback on lesson presentations. The PSTs received instructor written and verbal feedback after two observations. PSTs were also required to teach five lessons throughout the ten-week practicum and complete reflective journals.

Data Analysis

Qualitative Analysis

Data analysis in qualitative research is an ongoing process that continuously examines journals, observations, documentations, and other information simultaneously as data collection occurs (Bazeley, 2013). Qualitative data analysis is inductive, comparative, and happens *along with* the collection of data rather than *after* the collection (Merriam & Tisdell, 2016). In fact, collection and analysis should be a *simultaneous* process since the comparison informs the next data collection. Flick (2014) defines the process of data analysis as "the classification and interpretation of linguistic (or visual) material to make statements about implicit and explicit dimensions and structures of meaning-making in the material and what is represented in it" (p. 5).

Miles, Huberman, and Saldana (2014) considered organization of data as a critical factor to successful interpretations of results. Due to the sheer volume of material in this study, the process of analysis and organization might become overwhelming, repetitious, and unfocused without constant comparison and examination (Merriam & Tisdell, 2016).

A data set that has been analyzed along with the collection is both parsimonious and illuminating. After the systematic process of collecting data, organizing data, and synthesizing it, the researcher will carefully consider searching for patterns, and making decisions about what is worthy of being reported during this study (Creswell, 2012).

The identification of *codes* or "*coding* refers to the identification of topics, issues, similarities, and differences that are revealed through the participants' narratives and interpreted by the researcher" (Sutton & Austin, 2015, p. 228). Bazeley (2013) reminds researchers that *codes* can be used to serve many purposes; codes can be descriptive, topical, or analytical. Merriam and Tisdell (2016) state, "The process of making notations next to bits of data that strike you as potentially relevant for answering your research questions is also coding." The first level of coding or *starter codes* will assist the researcher to work through sources of data. Starter codes will eventually evolve from data to description to analysis during the cyclical, or recursive, process (Miles et al., 2014). Utilization of provisional starter codes will allow the researcher to categorize segments of data based on responses, participants, settings, and interactions that emerge as significant during the first round of coding.

The video recordings, class discussions, and focus group interviews will be transcribed using *Microsoft Word* and the electronic reflections will be downloaded. The data set will be read and coded by hand using starter codes for each type of data to identify and summarize themes that emerge. Reading and coding by hand will also assist the researcher in becoming familiar with the data. Afterwards, the data will be imported into Dedoose 7.0.21 (2015), a software program used to identify patterns and themes through key word and phrase searches.

The second round of coding involves reexamining, recoding, and refining of the data into categories and subcategories and looking for themes (Bazeley, 2013). Highlighted excerpts will be reviewed, recoded, and then memos added to give context to participant's comments. Using specific codes identified by multiple reoccurrences, themes will be identified and placed in an analytical cluster diagram. Next, all excerpts will be separated into individual code categories then reviewed and used to distinguish details of the data. Miles et al. (2014) described themes as "outcome(s) of coding, categorization, and analytic reflection" (p. 13).

Bazeley (2013) encourages qualitative researchers to participate in a constant comparative process in order to generate interesting information, enrich description, and to provide data to report. The constant comparative method becomes more intensive as the study progresses and all data are collected. Miles et al. (2014) believe comparisons can be used to further explore and describe data along with using them as a tool for explaining and predicting. Possible categories for comparison include degree paths (early childhood or elementary), primary grade level assigned, and cooperating teacher's attitude toward science.

Quantitative Analysis

Quantitative methods focus on objective measurements and the statistical, mathematical, or numerical analysis of data gathered through surveys, questionnaires, and polls, or by manipulating pre-existing statistical data using computational techniques (Babbie, 2010; Mujis, 2010). Quantitative research concentrates on gathering numerical data and generalizing it across collections of people or to explain a certain phenomenon. For the quantitative portion of this research, Statistical Package for the Social Science

(SPSS) will be used. SPSS is a comprehensive system for analyzing data, a multiple-regression approach to analysis of covariance (ANCOVA) will be used to determine whether the difference in the posttest scores between the experimental and control groups are statistically significant. The dependent variable will be the posttest scores, and the covariate will be the pretest scores.

Trustworthiness

Qualitative researchers employ the constructs of reliability and validity to substantiate their research. The strategies for ensuring trustworthiness or validity will depend on the nature and purpose of individual projects (Maxwell, 2013). In other words, a qualitative researcher will concentrate on trustworthiness to "persuade his or her audiences (including self) that the findings of an inquiry are worth paying attention to" (Lincoln & Guba, 1985, p. 290). Four terms characteristically used in qualitative research to convince audiences of trustworthiness are *credibility*, *transferability*, *dependability*, and *confirmability*.

Credibility

Credibility, similar to internal validity, addresses the question of how research findings match reality (Merriam & Tisdell, 2016). When discussing credibility, Ratcliffe (1983) suggests that (1) "Data do not speak for themselves; there is always an interpreter or translator" (p.149); (2) that "one cannot observe or measure a phenomenon without changing it, even in physics where reality is no longer considered to be single-faceted"; and (3) that numbers, equations, and words, "all abstract, symbolic representation of reality, but not reality itself" (p. 150). Merriam and Tisdell (2016) describe reality as holistic, multidimensional, and ever changing and, in return, validity must be assessed in terms of something other than reality itself. Thus, triangulation is the most popular strategy to support credibility of the qualitative section of this study. Researcher triangulation occurs when multiple investigators collect and analyze data. Patton (2015) coined the term *triangulating analysts* and defined the expression as " having two or more persons independently analyze the same qualitative data and compare findings" (p. 655).

In the proposed study, credibility of qualitative data will be established by keeping an audit trail of written memos regarding decisions made during data collection and analysis (Lincoln & Guba, 1985). Triangulation will be ensured by collecting multiple sources of data (i.e. observations, pre- and posttest of the STEBI-B, pre and post reflective journals) to report the experiences of the participants. The purpose of triangulation is to obtain confirmation of findings through convergence of diverse perspectives (Kasunic, 2005). The point in which the perspectives converge is viewed to signify reality.

This data will be triangulated with an independent researcher (professor that teaches similar science methods course at separate Midwest university) coding the data separately and then by finding a mutual consensus on codes. In addition, member checking will occur shortly after each data collection.

Transferability

Transferability, similar to external validity, is concerned with the degree to which the findings of one study can be applied to other situations. In a statistical sense, generalizability cannot occur in qualitative research, however, much can be learned through rich descriptions to similar relationships in the world (Merriam & Tisdell, 2016).

Lincoln and Guba (1985) state, “the burden of proof lies less with the original investigator than with the person seeing to make an application elsewhere. The original inquirer cannot know the sites to which transferability might be sought, but the appliers can and do” (p. 298).

In the proposed study, detailed, rich descriptions of the qualitative data will be written to allow others to see similar relationships in the world (Bazeley, 2013). Thick, rich descriptions refer to a highly descriptive, detailed presentation of the setting and findings in the study (Merriam & Tisdell, 2016). These descriptions will include contextual information and significance.

Dependability and Confirmability

Patton (2015) states “trustworthiness of data is tied directly to the trustworthiness of those that collect and analyze the data - and their demonstrated competence” (p. 706). Ethical issues and dilemmas are present in all research and depend on the investigator’s own sensitivity and values. To ensure the dependability and credibility of the proposed study, the researcher will follow the guidelines of the institutional review board (IRB). The goal of this researcher is to strive for intellectual rigor and uphold a strict code of ethics while keeping an audit trail so others can see the process of how data is collected and analyzed. As discussed in the credibility section, an impartial peer will audit, analyze data separately, and share in a discussion about keeping the mutual results and discarding results that do not match. In addition, multiple sources of data (pre and post reflective journals, video recordings and in-person observations, STEBI-B, document review, class discussions, and field notes) will be used to ensure triangulation.

Importance of the Findings and Significance

Pre-service teachers continuously learn from practicum experiences in the classroom and informal interactions with peers. By empowering future teachers with the knowledge of how to participate in peer coaching, this study aims to develop the PSTs' pedagogical content knowledge of science, student learning, and ways of effective teaching in a nonthreatening and professional manner. Moreover, science enthusiastically shared with young children provides a great significance to many components of a child's development (Eshach & Fried, 2005). Embedded in Vygotsky's ZPD (1978) is an understanding that teachers must distinguish between students possessing knowledge of science and moving them to a more meaningful application of this knowledge. Providing opportunities for children to take advantage of their natural curiosity and wonder allows growth toward their full potential which could lead to more students finding interest in science careers later in life.

Furthermore, this study may be significant in contributing to the development of science methods courses within early childhood and elementary teacher preparation programs. The use of peer coaching with PSTs has the potential to influence current perceptions of science teaching and may improve course instructions in the science methods course.

Finally, this study may yield new insights due to the mixed methods design. Utilizing multiple forms of data collection and analysis, this study may provide various viewpoints from which to examine the topic of pre-service early childhood and elementary teachers' early perceptions of science teaching and learning. By utilizing peer coaching, the STEBI-B and reflective journals, the researcher may provide a more comprehensive image of the relationship between peer coaching, self-efficacy, pedagogical content knowledge, and quality teaching of PSTs.

Limitations

The assumptions for this study include that participants will be forthright and honest in their answers during the qualitative data collection phase and that they will accurately report during the quantitative phase. The researcher has no way to verify this. However, all participants will be briefed prior to the study's commencement on its purpose, goals, and procedures. Furthermore, they will all be professionals. Thus, there is no reason for them to misrepresent information.

Nonetheless, a limitation of the study is that the sample is relatively homogenous in age, race and stage in their professional development. The researcher does feel that the population and sample chosen are not atypical to PSTs. The relatively small sample size exposes the study to mathematical variations in the quantitative phase. The methodology, though the researcher has planned it carefully, may not be optimal for the examination intended. Therefore, this cannot be any type of finalized or definitive research and the need for further study will doubtless be manifest, regardless of the direction of the results.

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Appendix A

Journal Reflection Prompts

1. When you consider that in just a couple of years students will be coming to you with their science questions, how does that make you feel? Explain.
2. Tell me about a science lesson/class that you remember from your K-12 schooling. What about that lesson/class made you remember it still today?
3. Think about how you learn best. How would you apply that style of learning in a science class?
4. What do you expect your students to learn from your lesson? Explain how you will know if your expectations were met?
5. Did your teaching expectations match what occurred during your lessons? Explain how your lesson was presented and how students responded.
6. How would you describe your relationship with your peer coach?
7. What science concept have you learned during this course that you did not understand at the beginning of the semester? What helped you to learn it?
8. What do you believe are strengths of peer coaching? What do you believe are weaknesses of peer coaching? Please explain.
9. When you consider that in just a couple of years students will be coming to you with their science questions, how does that make you feel? Explain.

Appendix B

Pre-Observation Questions

Pre-service teacher: ________________________ Peer Coach:___________________________
Observation Date and Time: ____________________________________

1. What do you want your students to know or do by the end of the lesson?

2. What essential questions are you asking students to consider?

3. What are your objectives and expectations for the lesson?

4. What strategies will you use to reach your student outcomes?

5. Is there a particular student you would like for me to watch?

6. What specifically do you wish for me to observe?

7. Are you available immediately after the lesson or do you want to meet during your break?

Appendix C

Observation Notes

Pre-service teacher:_________________________ Peer Coach:____________________________ Observation Date and Time: ______________________________________

Appendix D

Post-Observation Questions

Pre-service teacher:_________________________ Peer Coach:____________________________ Observation Date and Time: _____________________________________

1. How do you think the lesson went?

2.What do you think were the strengths of this lesson?

3. How can you use the strengths in your next lesson?

4. If you could teach the same class again, what would you do differently?

5. What teaching strategies do you feel worked well with your students?

6. How does this lesson compare with what you expected would happen?

7. Do you think your students understood your lesson? If so, what did you see students doing that made you feel they understood?

8. What are you learning about yourself, your teaching, your students?

Appendix E

Focus Group Discussion Prompts

Thank you for participating in peer coaching this semester. I would like to ask you a few questions about your opinion about peer coaching and how you feel toward teaching science. If I ask any questions that you would prefer not to answer, please do not feel obligated. This discussion serves as an information gathering event and no grades are associated with this class session.

What were some of your favorite moments in practicum this semester?

How would you describe your growth in becoming a teacher this semester?

How did you feel about peer coaching?

What would you describe as strengths of peer coaching?

What did you find difficult or a weakness of peer coaching?

How long did it take to become comfortable with teaching in front of a peer?

How do you feel about teaching science now that you have had this course?

How will you incorporate science into your future classroom?

Appendix F

Science Teaching Efficacy Belief Instrument – Form B

Developed by Larry G. Enochs and Iris M. Riggs, used with permission.

Please indicate the degree to which you agree or disagree with each statement below by

circling

the appropriate letters to the right of each statement.

A = Strongly Agree B = Agree C = Uncertain D = Disagree E= Strongly Disagree

1. When a student does better than usual in science, it is often because the teacher exerted a little extra effort.	**A**	**B**	**C**	**D**	**E**
2. I will continually find better ways to teach science.	**A**	**B**	**C**	**D**	**E**
3. Even if I try very hard, I will not teach science as well as I will most subjects.	**A**	**B**	**C**	**D**	**E**
4. When the science grades of students improve, it is often due to their teacher having found a more effective teaching approach.	**A**	**B**	**C**	**D**	**E**
5. I know the steps necessary to teach science concepts effectively.	**A**	**B**	**C**	**D**	**E**
6. I will not be very effective in monitoring science experiments.	**A**	**B**	**C**	**D**	**E**
7. If students are underachieving in science, it is most likely due to ineffective science teaching.	**A**	**B**	**C**	**D**	**E**
8. I will generally teach science ineffectively.	**A**	**B**	**C**	**D**	**E**
9. The inadequacy of a student's science background can be overcome by good teaching.	**A**	**B**	**C**	**D**	**E**

10. The low science achievement of some students cannot generally be blamed on their teachers.	**A**	**B**	**C**	**D**	**E**
11. When a low-achieving child progresses in science, it is usually due to extra attention given by the teacher.	**A**	**B**	**C**	**D**	**E**
12. I understand science concepts well enough to be effective in teaching elementary science.	**A**	**B**	**C**	**D**	**E**
13. Increased effort in science teaching produces little change in some students' science achievement.	**A**	**B**	**C**	**D**	**E**
14. The teacher is generally responsible for the achievement of students in science.	**A**	**B**	**C**	**D**	**E**
15. Students' achievement in science is directly related to their teacher's effectiveness in science teaching.	**A**	**B**	**C**	**D**	**E**
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.	**A**	**B**	**C**	**D**	**E**
17. I will find it difficult to explain to students why science experiments work.	**A**	**B**	**C**	**D**	**E**
18. I will typically be able to answer students' science questions.	**A**	**B**	**C**	**D**	**E**
19. I wonder if I will have the necessary skills to teach science.	**A**	**B**	**C**	**D**	**E**
20. Given a choice, I will not invite the principal to evaluate my science teaching.	**A**	**B**	**C**	**D**	**E**

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.	**A**	**B**	**C**	**D**	**E**
22. When teaching science, I will usually welcome student questions.	**A**	**B**	**C**	**D**	**E**
23. I do not know what to do to turn students on to science.	**A**	**B**	**C**	**D**	**E**

Appendix G

Signed Consent to Participate in Research

Would you like to be involved in research at the University of Oklahoma?

I am Kelli Provence Dudley from the Instructional Leadership and Academic Curriculum Department and I invite you to participate in my research project entitled Effectiveness of Peer Coaching to Enhance Pre-Service Teacher's Self Efficacy toward Science Instruction, Knowledge, and Teaching Quality. This research is being conducted at Oklahoma Christian University. You were selected as a possible participant because you are enrolled in a primary Science Methods course. You must be at least 18 years of age to participate in this study.

Please read this document and contact me to ask any questions that you may have BEFORE agreeing to take part in my research.

What is the purpose of this research? The purpose of this research is to understand the influence that peer-coaching and mentoring could have on pre-service teachers' confidence in teaching science in the primary grades.

How many participants will be in this research? About 26 people will take part in this research. Thirteen will be early childhood majors and the other thirteen will be elementary education majors.

What will I be asked to do? There are no extra course assignments if you agree or decline to participate in this research. Due to the numerous practicum students this semester, students will be placed in peer-coaching pairs. Each pre-service teacher will participate in a pre-conference, observation, and post conference five times throughout the 60-hour practicum. During the semester, you will complete weekly journal reflections about your feelings, experiences and beliefs about teaching science. All students will complete a pre and post survey, and be videoed teaching a science lesson for a completion grade. The final week of the semester, you will attend a focus group interview during class to give feedback on your peer-coaching experience.

How long will this take? Your peer-coaching participation will take about an hour during your required 6-hour Wednesday practicum. Pre and post surveys will be completed during the first 5-10 minutes of class on the first and 14^{th} week of class. Focus group interviews will be held the last week of class during class.

What are the risks and/or benefits if I participate?

There are no risks and no benefits from being in this research.

Will I be compensated for participating? You will not be reimbursed for your time and participation in this research.

Who will see my information? In research reports, there will be no information that will make it possible to identify you. Research records will be stored securely and only approved researchers and the OU Institutional Review Board will have access to the records.

You have the right to access the research data that has been collected about you as a part of this research. However, you may not have access to this information until the entire research has completely finished and you consent to this temporary restriction.

Do I have to participate? No. If you do not participate, you will not be penalized or lose benefits or services unrelated to the research. If you decide to participate, you don't have to answer any question and can stop participating at any time.

Will my identity be anonymous or confidential? Your identity will remain anonymous. Data you provide will be retained only by your chosen pseudonym. Please check below if you agree to this option:

I agree for the researcher to use my data in future studies. ___Yes ___ No

Audio Recording of Research Activities To assist with accurate recording of your responses, focus group interviews may be recorded on an audio recording device. You have the right to refuse to allow such recording without penalty. If you do not agree to audio-recording, you may decline to participate in the focus group interview.

I consent to audio recording. ___Yes ___ No

Video Recording of Research Activities To assist with accurate recording of your peer-coaching feedback, observations may be recorded on a video recording device. If you do not agree to video-recording, you cannot participate in this research. Please select one of the following options:

I consent to video recording. ___ Yes___ No

Who do I contact with questions, concerns or complaints? If you have questions, concerns or complaints about the research or have experienced a research-related injury, contact me at 405-201-1844, kelli.dudley@oc.edu or Dr. Vickie Lake, 918-660-3984, vlake@ou.edu. You can also contact the University of Oklahoma – Norman Campus Institutional Review Board (OU-NC IRB) at 405-325-8110 or irb@ou.edu if you have questions about your rights as a research participant, concerns, or complaints about the research and wish to talk to someone other than the researcher(s) or if you cannot reach the researcher(s).

You will be given a copy of this document for your records. By providing information to the researcher(s), I am agreeing to participate in this research.

Participant Signature	Print Name	Date
Signature of Researcher Obtaining Consent	Print Name Kelli Dudley	Date
Signature of Witness (if applicable)	Print Name	Date

Projected Time-Line

Summer 2017 – Complete prospectus and obtain IRB approval from both the university supporting the researcher and the university where the research is taking place.

August 2017 - Obtain consent from early childhood and elementary students to participate in study and administer STEBI-B as pre-test to consenting students during the first weeks of the semester.

September 2017 - Begin instructing all PSTs in the science practices described in A Framework for K-12 Science Education.

September 2017 – Instruct PSTs in peer coaching pre-and post-observations, and feedback.

September 2017 - Begin instructor and peer coaching weekly observations and reflections to continue through the end of November 2017.

September 2017 - Begin qualitative analysis of interviews, observations, and reflections to determine common strands that might redirect researcher prompts.

November 2017 - Re-administer STEBI-B as post-test to quantitatively compare to pretest.

December 2017 - Complete analysis of all collected data and start writing dissertation.

Spring 2018 – Defend dissertation

Dissertation – Proposed Outline

Chapter 1 – Problem Statement

Chapter 2 – 3 publication ready articles

- Empirical research article 1 tied to research questions
- Empirical research article 2 tied to research questions
- Practitioner research article tied to research questions

Chapter 3 – Implications for the Science Education field and for future research

Potential Journals

- School Science and Mathematics
- Theory and Research in Education
- Action in Teacher Education
- Educational Theory
- Teaching and Teacher Education
- Science Education
- Journal of Science Teacher Education

APPENDIX B

Internal Review Board Study Approval Letter

Institutional Review Board for the Protection of Human Subjects **Approval of Initial Submission – Expedited Review – AP01**

Date: October 24, 2017

IRB#: 8459

Principal Investigator: Kelli Provence Dudley

Approval Date: 10/24/2017

Expiration Date: 09/30/2018

Study Title: Effectiveness of Peer Coaching to Enhance Pre-Service Teachers' Self-efficacy Towards Science Instruction and Pedagogical Content Knowledge

Expedited Category: 6 & 7

Collection/Use of PHI: No

On behalf of the Institutional Review Board (IRB), I have reviewed and granted expedited approval of the above- referenced research study. To view the documents approved for this submission, open this study from the *My Studies* option, go to *Submission History*, go to *Completed Submissions* tab and then click the *Details* icon.

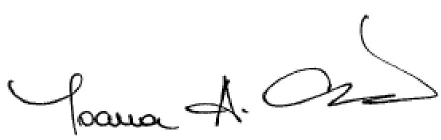
As principal investigator of this research study, you are responsible to:

- Conduct the research study in a manner consistent with the requirements of the IRB and federal regulations 45 CFR 46.
- Obtain informed consent and research privacy authorization using the currently approved, stamped forms and retain all original, signed forms, if applicable.

- Request approval from the IRB prior to implementing any/all modifications.
- Promptly report to the IRB any harm experienced by a participant that is both unanticipated and related per IRB policy.
- Maintain accurate and complete study records for evaluation by the HRPP Quality Improvement Program and, if applicable, inspection by regulatory agencies and/or the study sponsor.
- Promptly submit continuing review documents to the IRB upon notification approximately 60 days prior to the expiration date indicated above.
- Submit a final closure report at the completion of the project.

If you have questions about this notification or using iRIS, contact the IRB @ 405-325-8110 or irb@ou.edu.

Cordially,



Ioana Cionea, PhD

Vice Chair, Institutional Review Board