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Teacher self-efficacy and teacher beliefs play salient roles in science and math education with in-service teachers. This study seeks to understand the relationship between teacher knowledge, beliefs, and self-efficacy about science and math education in prekindergarten and kindergarten classrooms. The Prekindergarten and Kindergarten Science and Math Standards and Self-Efficacy Surveys were created to measure teacher knowledge of curriculum standards, beliefs of teaching skills, level of self-efficacy, and frequency of activities in classrooms for science and math, respectively. The self-report surveys were completed by 53 prekindergarten and 30 kindergarten teachers to examine the relationship that their knowledge of science and math standards, beliefs of science and math teaching skills, and level of science and math self-efficacy have on the frequency of science and math activities conducted in their classrooms. Beliefs of science and math teaching skills were related significantly to the reported frequency of science and math activities in prekindergarten and for science activities in kindergarten. Years of teaching prekindergarten was associated significantly with increased science and math activities. Teacher education was not associated with frequency of science or math activities. Findings revealed the more prekindergarten teachers enjoyed their science classes and math workshops the more they reported conducting science and math activities in the classroom. Both prekindergarten and kindergarten teachers reported that the less they enjoyed their previous math classes, the more time they spent on math activities in their classrooms. Results from this study have implications for professional development regarding science and math pedagogy and content knowledge.

Keywords: teacher beliefs, teacher self-efficacy, science and math education, prekindergarten, kindergarten

TEACHERS' KNOWLEDGE, BELIEFS, SELF-EFFICACY, AND IMPLEMENTATION OF EARLY CHILDHOOD LEARNING STANDARDS IN SCIENCE AND MATH IN PREKINDERGARTEN AND KINDERGARTEN

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Rebekah Chace Pierro

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Committee Chair

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This thesis written by REBEKAH CHACE PIERRO has been approved by the following committee of the Faculty of The Graduate School at The University of North Carolina at Greensboro.

Committee Chair ________________________________

Committee Members ________________________________

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CHAPTER I

INTRODUCTION

Multiple studies over the last 20 years have focused on the relationship between the beliefs and practices of teachers in the classroom, but little attention has been given to the connection between teachers' beliefs and specific subject areas of science and math (Ginsberg & Golbeck, 2004). A belief may be defined as "information that a person accepts to be true" (Koballa & Crawley, 1985, p. 223), and teacher beliefs may influence teacher behaviors in the classroom (La Paro, Siepak, & Scott-Little, 2009). A definition of teacher self-efficacy is the belief that a teacher has in his or her capacity to influence student learning, performance, and motivation (Guskey & Passaro, 1994; Tschannen-Moran, Hoy, & Hoy, 1998). To understand how self-concept, self-efficacy, and self-belief fit together, self-belief is defined as a combination of both self-concept and self-efficacy (Pajares & Schnuck, 2002). An example of how beliefs might drive practice is that teachers who have the belief that they lack skills in teaching science and or math in the classroom may develop a dislike for science and or math teaching, which, in turn, leads teachers to avoid teaching science and math if possible (Riggs & Enoch, 1990).

In a study done by Torquati, Cutler, Gilkerson, and Sarver (2013), the authors reported results that measured both professional teacher and student teacher confidence on practices regarding activities related to math and science education, and math and science ranked fourth and fifth out of five items, respectively. Neither preservice teachers, which are students training to be teachers, nor in-service teachers, which are professional educators currently teaching in classrooms, feel much comfort in terms of math and science instruction. Yet, early childhood, specifically prekindergarten and kindergarten is a time of unending curiosity and wonder for children. They are constantly asking, “Why?”. Developmental research indicates that long before entering elementary school, children begin gaining reasoning skills similar to the basics of scientific thinking, which are related to the foundations of physics, chemistry, psychology, and biology (Duschl, Schweingruber, & Shouse, 2007; Brenneman, 2011).

Children learn best when learning through discovery and hands-on activities, which drives cognitive and language development, and this method of teaching may be easily transferred to science and math education (French, 2004). Children’s science, math, and language skills are strengthened when students are given opportunities to experience activities that encourage them to make observations and predictions and provide descriptions and explanations on results (Peterson & French, 2008). Science and math learning also are important in how they assist children to process information in nonlinear paths and develop critical thinking and problem solving skills, which are life skills.

Children’s learning is impacted by their self-belief systems of self-concept and self-efficacy (Pajares & Schunk, 2002). Parents and teachers play a critical role in the development of self-belief in children, and this self-belief affects children’s learning by either supporting or marginalizing their ability to understand new concepts and ideas.

Difficulties arise when parents and teachers have limited self-belief, or even anxiety, related to specific academic disciplines. Examples of such subjects are science and math, which have distinctive vocabularies and may involve specific theoretical concepts that defy simple explanation. If parents or teachers have had negative previous experiences with science and or math, it may negatively influence their perceived self-efficacy about teaching, or even answering questions, about science and or math.

In terms of teaching science and math to prekindergarten and kindergarten students, previous studies indicate issues of confidence for teachers (Copley, 2004; Ginsburg, Lee, & Boyd, 2008). In previous studies, early childhood teachers are described as being "phobic of mathematics, viewing it as only 'counting, adding, subtracting, and knowing shapes,' and have little or knowledge about the mathematics standards" (Copley, 2004, p. 402). Ginsburg et al. (2008) go one step further, stating that from their personal experience "many prospective and current preschool teachers do not like mathematics, are afraid of it, and do not want to teach it" (p. 10). This may be directly related to teacher self-efficacy and beliefs, which can affect teacher confidence.

Although some research exists about teacher self-efficacy, teacher beliefs, and science and math education in early childhood classrooms, there is a dearth of data on this topic in prekindergarten and kindergarten classrooms. The purpose of this study is to provide information on the beliefs of teachers and how those beliefs influence classroom practices in the subject areas of science and math, specifically in the early childhood setting. This paper will examine the self-efficacy and beliefs of in-service teachers concerning classroom practices in relation to knowledge of science and math curriculum standards as well as teacher education, years of teaching experience, and past science- and math-related experiences.

Curriculum is defined as “all the experiences children have under the guidance of teachers” (Caswell & Campbell, 1935, p. 69). Standards are used to stipulate what knowledge and abilities children of a certain age should have (Kagan & Scott-Little, 2004). In this document, the phrase “curriculum standards” will be used to discuss the standards developed in North Carolina for prekindergarten and kindergarten in the domain areas of science and math.

The theories discussed in the next chapter will assist in focusing the concepts of self-efficacy and beliefs that were introduced in this chapter. The work of Bronfenbrenner outlined in his bioecological theory and the theoretical keystones of Bandura summarized in his findings on self-efficacy are used as a framework for this study and provided guidance in the method and analyses. Together, these theories give both global and individual perspectives to the pathways in which teacher beliefs and instructional self-efficacy develop.

CHAPTER II

THEORY

In this chapter, there will be a discussion of the theories that provided guidance in this study on teachers' self-efficacy and beliefs about their own science and math instruction. The first theory is Bronfenbrenner's bioecological theory, which was used to provide a global perspective of the potential influence of the environment on teachers' beliefs and skills in teaching science and math. In addition, Bandura's work on self-efficacy and self-belief, which provides context in understanding how teachers' concept of self in terms of capabilities and beliefs affect their classroom and instructional practices, offers an opportunity to explore teachers' self-efficacy. Each of these theories will be used as frameworks for the literature review and the research questions posed in this study.

Bronfenbrenner's Bioecological Theory

Bronfenbrenner posits that an individual's background and biological features impact the interactions that occur in their immediate environment. It is these interactions or proximal processes that he believes are the drivers of development (Bronfenbrenner & Morris, 2006). The bioecological theory of Bronfenbrenner (2000, 2001) is used in this study to focus on the influence teachers' background (including both education and experience) plays in creating individual experiences that may be associated with how teachers approach science and math instruction. The process-person-context-time (PPCT) model was developed by Bronfenbrenner (2001) to establish a means of testing his bioecological theory of systems. The first letter "P" represents proximal processes. Proximal processes are "mechanisms that produce development" (Bronfenbrenner, 2000, p. 129). In other words, teacher-child interactions, teacher education (preservice and in-service), and the continuous engagement in various learning activities, either in or out of the classroom or other environments, that may increase in complexity over time (Bronfenbrenner, 2000). Influential proximal processes may also include an individual teacher's education prior to college education and teacher training (service and preservice). Previous research has revealed that self-reported science teaching self-efficacy was related negative science experiences in high school, yet with a supportive learning environment, these negative reports of science self-efficacy were improved (Watters & Ginns, 1995). With this study, Watters and Ginns found that improvements to outcomes also occurred when teachers successfully implemented teaching practices to their young students (1995).

The second "P" in PPCT is for "person," which is described by Bronfenbrenner (2001) as the product of "the form, power, content, and direction of the proximal processes" (p. 6965), including genetic components. In the case of this study, the teacher is the person in the PPCT model. This is especially relevant in this study as the experiences that teachers had as students in the subjects of science and math may shape how they now approach science and math in classroom instructional situations. If teachers feel confident in their abilities to understand scientific concepts and mathematical problem solving as both students and after, then that confidence may be evident in how they approach teaching scientific concepts and mathematical problem solving as teachers of young children. This concept aligns closely with work done by Bronfenbrenner and Morris (2006) on the three person characteristics: force (or disposition), resource, and demand characteristics. Resource characteristics are those that encourage interactions with proximal processes such as knowledge, experience, skill, and ability (Bronfenbrenner & Morris, 2006). In this study, teachers' resource characteristics are part of what is being measured through the survey, and their experiences may drive how teachers interact with children due to past science and math experiences.

The next component of the theory is context. Context in the PPCT model in Bronfenbrenner's theory is the close and distant environment in which proximal processes are interacting (2000). A nested model providing context for development, Bronfenbrenner's systems theory requires consideration beginning with the innermost level and working outward. Specifically, the levels to the ecological systems theory are: microsystems, mesosystems, exosystems, macrosystems, and chronosystems (Bronfenbrenner). Context includes the microsystems, mesosystems, exosystems, and macrosystems in which teachers develop from children and into adulthood. In this study the microsystems of interest are the teacher's immediate environs, which include interactions with their work setting and earlier college environment. Mesosystems are the connections between different microsystems, such as family happenings and school happenings. In this study, survey questions about teachers' previous experiences related to science and math classes and workshops attempt to elicit information from the respondents on the timing of science and math classes and workshops and if the respondents enjoyed them. These questions were included to potentially connect participants' past science and math educational experiences, or their previous mesosystems, to participants' current science and math teaching practices.

The next level in the systems theory is exosystems. Exosystems are the links between experiences associated with social settings in which the individual (teacher) have no active role but are impacted by the immediate environment. An example of this may be how public and private funding situations change (i.e., salary cuts, job stress, changes in center or school administration), which may impact teachers' abilities to provide thoughtful instruction or engage classes in a new cognitive area due to a lack of funding, specifically to science and math content areas and activities. A particular exosystem issue for prekindergarten and kindergarten teachers that would affect the amount of time on science and or math activities is the emphasis on literacy by local program directors and school administrators. With only so many hours in the day, teachers may feel pressure to focus on literacy from forces outside of their classrooms.

Encompassing exosystems, mesosystems, and microsystems, macrosystems are the culture that individuals live in, such as poverty, religion, ethnicity, or democracy. For teachers, macrosystems may assist in defining them over the course of their personal history within the context of their community. An example of how a changing macrosystem might impact teachers is, again, the pressure to teach language and literacy that is driven by national or state policy, which may equate to less time for science and math for learning opportunities in classrooms (Greenfield et al., 2009; Saçkes, Trundle, Bell, & O'Connell, 2011). This is different from the exosystem example of pressure by program directors and school administrators to teach literacy because the pressure has two different origins; the macrosystem pressure is a larger scale (i.e., state or national changes in curriculum standards or teaching requirements) than the exosystem drivers.

The final system discussed by Bronfenbrenner is chronosystems. Chronosystems are the patterning of environmental events over the course of a teacher's life, which may include impacts created by time or critical developmental periods (Bronfenbrenner, 2000, 2001). In the case of this study, it is important to consider the development of the state level standards as a specific area that would impact teachers and their classroom practices. Another important aspect to consider is the change over time with the increased emphasis on accountability of teachers through assessment of children's learning. In this paper, context is influenced by the confluence of teachers' knowledge of standards, belief in their teaching skills, and level of self-efficacy, which are all person variables, and the implementation of *Foundations* standards, Essential Standards and Common Core standards within the classroom and outdoor environments. Again, the implementation of standards may influence teachers at both the exosystem level, through program directors and school administrators, and the macrosystem level, through state and or national policy changes concerning curriculum standards or teacher education requirements.

Time is the historic period of the person's life. Bronfenbrenner and Morris (2006) discussed the importance of regularity in the PPCT model, specifically in interactions. This is the microsystem in which development takes place, from interactions in the home and classroom. In terms of this study, the microsystem interactions that teachers have had over time regarding science and math may directly affect the manner in which they teach science and math. The mesosystem is critical to consider as well. Bronfenbrenner and Morris (2006) pointed out that an escalating effect is expected when there is instability in the microsystem because "at this higher level of environmental structure, similarly disruptive characteristics of interconnected microsystems tend to reinforce each other" (p. 820). Thus, if there are issues related to science and math education in the microsystem, then they are amplified in the mesosystem. Finally, the macro-level system dynamic is also salient when considering teachers and science and math education and instruction. Macrosystems involve the cultural environment in which individuals live (Bronfenbrenner, 2000). If there is a culture accepting of science and math educational excellence, then this will play a role in how teachers approached science and math as students.

In the context of this paper, time also is considered salient due to changes in instructional practices and attitudes concerning science and math. It is also important to consider the presence of state level standards during this period. These standards will affect teachers' classroom practices, and potentially impact children's outcomes. Changes to standards will influence how teachers must address science and math instruction in both prekindergarten and kindergarten classrooms. In general, the systems theory provides the architecture for examining what has influenced teachers and their classroom practices. To not consider systems theory essentially minimizes the classroom experiences of teachers when they were students. As teachers' previous educational experiences influence their self-efficacy, it seems reasonable to consider the Bronfenbrenner's bioecological theory and his PPCT model in this study.

Bandura's Theory of Self-Efficacy

Another important piece in the puzzle of early childhood science and math instruction is teacher self-efficacy. The theoretical foundations of self-efficacy were driven by the ideas of Bandura (1981), who defined self-efficacy as the perceived ability that one possesses the competence to organize social, motor, and cognitive skills into a course of action to accomplish tasks or face obstacles. Research conducted by Bandura on self-efficacy indicated that the greater the perceived self-efficacy, the more adaptive the behavior, but that people may circumvent potentially adverse situations that they believe exceed their abilities to cope. When individuals avoid possibly difficult situations due to a lack of perceived self-efficacy, this is in direct contradiction to circumstances where people behave with assurance when they consider themselves capable of handling situations that would otherwise be overwhelming (Bandura, 1977). Research conducted on a science teaching intervention with preservice elementary school teachers by Ginns, Watters, Tulip, & Lucas (1995) has indicated that although preservice teachers experienced positive changes in their science experiences and their beliefs about teachers improving children's science learning, the study did not find significant increases in teachers' science teaching confidence. The authors suggested that this may be due to perceived self-efficacy diminishing when faced with difficulties, then rebounding with successful science teaching experiences, then decreasing once difficulties are again encountered (Ashton & Webb, 1986, as cited in Ginns et al., 1995).

Bandura explained that the sources of efficacy are acquired through four different sources: performance experience or enactive attainments, modeling or vicarious experience, verbal or social persuasion, and emotional arousal or physiological factors. Enactive attainments are the most influential opportunities for self-efficacy information because they are based on authentic experiences (Bandura, 1981). Efficacy is raised by successful experiences, and efficacy is lowered by repeated failures (Bandura, 1981). This source of information applies to teachers if, as students, they experience multiple successes in the areas of science and math, or conversely, they experience various failures in understanding scientific concepts and mathematical applications. Vicarious experiences are based on seeing another individual succeeding, which raises our self-efficacy, yet observing another fail at an experience, decreases our self-efficacy. In general, vicarious experiences are not as strong in developing efficacy as enactive attainments. With vicarious experiences, preservice teachers may have viewed cooperating teachers having success in conveying science and math concepts, which would increase the preservice teacher's feelings of self-efficacy in science and math instruction once they are in their own classroom. If they do not have many opportunities to view this kind of success, however, they may feel discouraged in the area of science and math instruction.

Verbal persuasion is another source of information in the development of self-efficacy, and it is defined as leading an individual through verbal suggestion into thinking they can prevail over their difficulties (Bandura, 1981). It may be less likely to produce enduring results of increased efficacy with verbal persuasion, and verbal discouragement is typically more effective at minimizing an individual's self-efficacy than encouragement is at growing it. An example of how this might pertain to early childhood teachers in the subject areas of science and math is that teachers may have heard while they were growing up that they were not "good" at science or math, or both. The final source of information that is used in developing self-efficacy as outlined by Bandura is physiological factors, which are defined as the emotions elicited by stressful situations that may debilitate an individual's performance (Bandura, 1981). When these debilitating emotions, such as fear and anxiety, reach elevated levels of distress and feelings of ineptitude are rampant, then the fear of incompetency may become a reality due to these feelings. This fear response may be triggered with science and math activities for both students and teachers.

As shown in examples in the previous paragraph, Bandura's theory of self-efficacy and its formation are easily related the subject of this study: early childhood teachers and their classroom practices in science and math education. Previous research has documented in-service and preservice prekindergarten to third grade teachers expressed lack of confidence and increased anxiety related to teaching in the scientific domain (Copley & Padrón, 1999; National Science Board, 1999; Torquati et al., 2013). Several other reasons have been suggested for this anxiety, specifically teachers' limited content knowledge in science and math and pressure to focus teaching efforts on language and literacy (Greenfield et al., 2009; Saçkes et al., 2011; Tu, 2006).

In conclusion, the theories posited by Bronfenbrenner and Bandura assist in understanding the development of an individual that occurs over time with experience, both on the macro and micro levels. Bronfenbrenner's bioecological theory, and the PPCT model he devised to test the theory, provide an overarching perspective on how teachers develop their beliefs and the beginnings of self-concept. Bandura's theory on self-efficacy postulated on teachers' convictions regarding personal abilities to do more than teach a specific subject matter, but also maintain an environment conducive to learning, use resources effectively, and assist parents in helping their children learn (Bandura, 1997; Friedman & Kass, 2002). This theory provides the backbone of this study by illustrating the importance of teachers' self-efficacy in terms of providing a positive learning environment for all students, but specifically in this case, prekindergarten- and kindergarten-age children. In the context of teachers of young children, the theories of Bronfenbrenner and Bandura provide the theoretical support necessary to guide the content and research questions asked in this study.

CHAPTER III

LITERATURE REVIEW

Guided by the theoretical work of Bronfenbrenner and Bandura, this literature review will outline the work completed in the area of teacher self-efficacy and beliefs. It will also provide information on the data collected in the areas of prekindergarten and kindergarten science and math instruction. Four measures used in the areas of teachers' self-efficacy and beliefs for science and math instruction are also introduced.

Self-Efficacy and Beliefs

Self-belief systems are comprised of both self-concept and self-efficacy (Pajares & Schnuck, 2002). Self-efficacy is defined as the strength or capacity to complete what one has set out to accomplish (Bandura, 1977), and as a construct, it does not include confidence, which is considered a commonplace word that implies the strength of a belief but not the assertion of capability or agency on which the belief is centered (Bandura, 1997). Self-belief is defined as the sense of "self" (Pajares & Schnuk, 2002), which is described as an individual's ability to contemplate on how he or she is being assessed by others in society (White & Klein, 2002). The "self" is rooted in the objective and subjective, which is otherwise known as the "I" and the "Me." Theoretically, the behavior of an individual (I) matches the sense of self (Me) that is obtained from interacting with others (LaRossa & Reitzes, 1993). Beliefs are defined as information that one has related to a specific object (Fishbein & Ajzen, 1975; Koballa, 1988; Maier, Greenfield, & Bulotsky-Shearer, 2013). Typically, individuals consider beliefs to be true, even if they are not accurate (Maier et al., 2013). This is relevant because the beliefs that occupy individuals' minds become the guidelines that govern their behavior, either positively or negatively. For children, these beliefs are shaped by interactions with parents and teachers. If teachers lack self-efficacy and self-belief in terms of their competency with science and math, then they may not feel like they have the competence to spend much time on those subjects in the classroom (Brown, 2005; Pajares, 1992; Maier et al., 2013).

Self-efficacy and beliefs are closely linked. If an individual has a belief that they can accomplish a formidable task, that individual has the expectation and confidence that the task will be completed (Bandura, 1977). The individual has high self-efficacy. The relationship between self-efficacy and teaching determines teachers' persistence when facing difficulty and resilience when dealing with setbacks. For teachers, greater self-efficacy has been linked to less critical interactions with students over errors and greater enthusiasm for, and commitment to, teaching (Tschannen-Moran, Hoy, & Hoy, 1998). This finding connects the theoretical concept of higher self-efficacy, which typically leads to greater confidence in a subject area, and the ability to better regulate teacher–child interactions.

Beliefs are challenging to change once established and practiced; thus, the longer a belief has been entrenched in an individual's belief structure, the more resistant it is to change (Pajares, 1992). Theoretically, beliefs are considered critical because they influence the behaviors of teachers in the classroom (Maier et al., 2013; Pajares, 1992). Specifically in relation to teacher education programs, it has been suggested that preexisting beliefs are so entrenched that attempts to develop or change ideas on teaching practices will be ineffectual unless prior beliefs are managed (O'Loughlin, 1988; Scott-Little, La Paro, & Weisner, 2006). In order to influence change on teachers' beliefs, it seems that strong and immediate evidence for improved outcomes for students is required (Pajares, 1992). These improved outcomes may play a role in not only changing teachers' beliefs but also their instructional practices and pedagogy.

Pedagogical Science Knowledge

In terms of the pedagogy of teaching young children, it has been postulated that to best teach young children science, early care and education teachers must have Pedagogical Science Knowledge (PSK; Chalufour, 2010). PSK is described by Chalufour (2010) as the comprehension of science content, expertise of how children acquire new knowledge, and the abilities required to facilitate and support children's opportunities to learn new knowledge in science through inquiry and conceptual development. This type of pedagogy allows teachers to offer science curriculum that aligns with children's natural curiosity of the world around them and focuses their early science skills, which is the path to science literacy and the beginning of critical thinking (Chalufour, 2010). Without changes in beliefs of teachers who may have had negative experiences with science and math in the past, teachers will not change their beliefs or attitudes concerning the best ways to interact, instruct, or involve their students because their beliefs are entrenched, perhaps from their time as students, years prior to teaching.

Shifts toward new curriculum or teaching methods in the areas of science and math may not have the desired effect if there is no belief change in teachers. Thus, it is critical, in order to effect change in how science and math are taught in the early care and education classroom, to understand the beliefs of teachers and their opinions of their self-efficacy with science and math while also supporting them through their expansion of PSK and the math equivalent. The impacts of self-efficacy and beliefs on teaching practices in science and math are specifically addressed in the next section. Some strategies for science and math instruction are also presented.

Teaching Science and Math: Practices and Strategies

Although there has recently been a deluge of research on the importance of science and math instruction in early care and education settings, there remains a lack of time spent teaching science and math in the preschool classroom. More time is spent in the domains of language and literacy, art, and social studies than in science and math instruction (Early et al., 2010; Maier et al., 2013; Tu, 2006). Some of the reasons for this may be a lack of content knowledge (Cho, Kim, & Choi, 2003), limited understanding of science concepts and increased discomfort in teaching science (Garbett, 2003; Saçkes et al., 2011), confidence issues in using science equipment, and pressure to teach language and literacy and minimal time for science (Greenfield et al., 2009; Saçkes et al., 2011).

In terms of math instruction in the early care and education classroom, it has been suggested that the teachers' beliefs about the importance of math content for preschoolers is not universal (Brown, 2005). In the study, Brown assessed preschool teachers' efficacy, beliefs, and math instructional practices and the results showed a weak correlation between higher reported teacher efficacy and teacher beliefs about math instruction. This research suggested that the lack of suitable knowledge and preparation might cause both preservice and in-service teachers to not prioritize math as critical for young children, which may impact teacher self-confidence (Brown, 2005). Although it is recommended by NAEYC that teachers challenge and scaffold children's math abilities, in this study, these practices were rarely observed (Brown, 2005).

There is evidence that suggests, "teachers often teach the content of a course according to the values held of the content itself" (Pajares, 1992, p. 309-310). Teacher self-efficacy is a critical piece in terms of understanding why teachers may not want to engage their students in science and math hands-on activities. Prekindergarten and kindergarten students, as well as older children, need to be permitted to create their own knowledge through methods that encourage and support inquiry, otherwise known as scaffolding interactions between teacher and child (DeJarnette, 2012). Instead, students often learn about theory and scientific concepts through didactic instruction, which minimizes opportunities for the students to develop their self-efficacy in autonomy and limits the occasions available for students to engage in hands-on learning through interactions with teachers, peers, and materials. Both Bronfenbrenner and Bandura's theories indicate the necessity of moving away from this type of teaching and instead focusing on providing children with an environment rich in objects and materials to explore and measure and observe with sensitive, responsive teachers who are knowledgeable in how to encourage children's self-efficacy through autonomy development. The corollary of this is often seen in many prekindergarten and kindergarten classrooms and results in students then relying on the knowledge and conclusions of others and missing the opportunity to experience new learning and knowledge acquisition themselves (DeJarnette, 2012). In a study completed by Early et al. (2010), early childhood classrooms were observed for teacher-child interactions, and the results indicated that teaching interactions were over three times more likely to be didactic rather than scaffolded. There are at least two reasons why this may have occurred. Scaffolding interactions may require greater instructional skill from the teacher, and the implementation of didactic instruction is easier for larger groups (Early et al.).

Scaffolding interactions through conversations during actual science and math activities are not the only opportunities for children to grow knowledge and skill. Besides talking about their observations and ideas, prekindergarteners and kindergarteners can create science and or math journals in which students may catalog science and math concepts through drawing (Riley-Ayers, Stevenson-Garcia, Frede, & Brenneman, 2011). These journals or notebooks are useful in keeping a record of scientific explorations and observations and investigations, specifically students' questions and notes (Novakowski, 2010). Drawing and discussing new scientific and math-related ideas allows children to reflect and absorb new knowledge, while developing language and critical thinking skills. Talking with children about their journals or notebooks affords teachers with the opportunity to informally assess children's development in science, math, and language (Brenneman & Louro, 2008). Discussions about science or math learning relate back to Bronfenbrenner's bioecological theory by providing children with the occasion to explore scientific and or mathematical concepts in the context of a supportive educational environment. These teaching practices offer science- and or math-rich proximal processes for children that may increase interest and enthusiasm for science and or math activities, assist in developing critical thinking skills, and potentially encourage science or math employment opportunities in the future. It is important to measure teachers' beliefs on science and math education for young children in order to understand and ultimately support the development of teacher self-efficacy in science and math instruction. The amount of teaching experience and years of education may impact teachers' beliefs, and thus, their self-efficacy.

Teacher Education and Years of Teaching Experience

In addition to content knowledge and time issues in the early care and education classroom, the important elements of teacher education and years of teaching experience may impact the self-efficacy and beliefs of teachers on science and math instruction. It is necessary to remember that teacher education and years of teaching experience are part of the second "P," or "person" in Bronfenbrenner's PPCT model. The "person," or teacher, brings education and experience acquired through preservice and in-service opportunities into the classroom. These "person" characteristics, acquired by teachers through interacting in their environment, provide knowledge and other resources to be used like tools from their tool kit to assist them in educating young children. Research in teacher education has suggested that teachers with less education are typically less sensitive and more authoritarian in the classroom (Arnett, 1989). The corollary has also been found:

teacher education has been positively associated with quality teacher-child interactions (Kelley & Camilli, 2007; La Paro et al., 2009) and linked to increased teacher sensitivity and higher quality teacher-child interactions (Mashburn et al., 2008). Research in professional development for teachers in science has shown that increasing amounts of professional development were significantly related to more use of inquiry-based teaching practices and increased levels of investigative classroom culture (Supovitz & Turner, 2000), both of these constructs are related to inquiry-oriented science teaching that involves investigative experiences.

Teaching experience has not been incorporated into as much work, yet research does suggest that it influences in children's outcomes (Hindman, Skibbe, Miller, & Zimmerman, 2010). A study by Supovitz and Turner (2000) on professional development of primary and middle school teachers found that teaching experience was negatively correlated with inquiry-oriented science teaching. Another study considering the relationships between teachers' beliefs on teaching science, learning science and the nature of science found that secondary school science teachers in Taiwan with more years of experience were more traditional and less constructivist in their views of science teaching (Tsai, 2002). Yet another study found that the years of teaching experience was associated with teachers experiencing reduced self-efficacy (Brousseau, Book, & Byers, 1988). This information suggests that both teacher education and years of teaching experience may require exploration and consideration when looking at self-efficacy in early care and education classrooms.

Previously Used Measures to Assess Teachers' Beliefs on Science and Math Instruction

As discussed in earlier sections, teacher self-efficacy and beliefs are critical in understanding teaching practices. To gain further understanding into how teachers perceive their capabilities at science and math instruction, researchers have been working on measures to capture teachers' perceived self-efficacy and beliefs related to science and math teaching. Four measures that have been developed to assess science and or math teacher perceived self-efficacy are briefly discussed here. The measures are The Early Childhood Teachers' Attitude toward Science Teaching (Cho et al., 2003), Science Teaching and Environment Ration Scale (STERS; Chalufour, Worth, & Clark-Chiarelli, 2006), Preschool Rating Instrument for Science and Mathematics (PRISM; Stevenson-Garcia, Brenneman, Frede, & Weber, 2010), and Preschool Teachers' Attitudes and Behaviors towards Science (P-TABS; Maier, Greenfield, & Bulotsky-Shearer, 2013).

The first measure introduced is The Early Childhood Teachers' Attitude toward Science Teaching is a 22-item survey that assesses teachers' attitudes toward science teaching. It was adapted from Thompson and Shrigley's (1986) "Revised Science Attitudes Scale," which was created to measure attitudes toward science teaching from pre-service elementary teachers (Cho et al., 2003). The second measure is STERS, which was created to assess the effectiveness of a professional development workshop intended to increase the quality of classroom science instruction. The measure was developed by Chalufour, Worth, and Clark-Chiarelli (2006, as cited in Brenneman, 2011), and uses teacher interview and classroom observation to rate the teachers on eight items using a 4-

point rubric (Brenneman, 2011). The third measure is PRISM, a 16-item instrument designed to assess the presence of classroom materials and the teaching interactions that are associated with science and math learning (Brenneman, 2011). PRISM involves a variety of science items are evaluated including biological and nonbiological science; reading and writing about science; explorations and investigations in science; and recording in scientific journals (Brenneman, 2011), and items related to measurement and classification involve both science and math domains. The final measure is P-TABS. Developed by researchers from the University of Miami, it is a 35-item measurement of preschool educators' beliefs and attitudes concerning science (Maier et al., 2013).

All of these measures provide either opportunities for the participants to respond regarding science teaching attitudes and beliefs, or provide quality assessments of teacher-child interactions in instructional settings in both science and math. Yet, none of these measures consider the importance and impact of curriculum standards on teachers' self-efficacy and beliefs in terms of science and math instructional practices in the classroom. The importance of curriculum standards is four-fold: 1) strengthening teachers' understanding of child development; 2) developing a roadmap of potential classroom plans for implementing curriculum; 3) promoting goals for children's learning and development to be shared throughout any and all programs and services; and 4) informing families on developmentally appropriate learning expectations (North Carolina Foundations Task Force, 2013). These curriculum standards provide integral references against which teachers may compare their classroom practices. By not including the standards, the measures fail to consider all of the concepts to be covered in the classroom in the subject areas of science and math and do not assess teachers' beliefs and practices related to these specific concepts. Thus, a measure that considers teachers' knowledge of curriculum standards in science and math, beliefs about their skills at implementing activities addressing science and math curriculum standards, level of self-efficacy in science and math, and the frequency that science and math standards-related work is being done in classrooms is needed to examine how teachers' knowledge, beliefs, and self-efficacy are related to classroom practices in the subject areas of science and math.

Curriculum Standards

In order to provide a more complete picture of teachers' knowledge base for science and math in prekindergarten and kindergarten classrooms, curriculum standards were used as a framework in the surveys, the Prekindergarten and Kindergarten Science and Math Standards and Self-Efficacy Surveys, created for this study. Curriculum standards provide specific information that teachers may use as guides for their instructional plans. By using the curriculum standards in the surveys, teachers are prompted to consider their knowledge of the standards, beliefs in their skills at implementing learning activities, and level of self-efficacy in relation to science and math against their frequency of working on these standards. Reading and reflecting on their knowledge, beliefs, and self-efficacy gives teachers the opportunity to ruminate on their classroom practices from multiple perspectives, providing a more thorough, and perhaps more thoughtful, self-reported assessment. This level of detail is lacking from the other measures that were previously introduced.

For prekindergarten science and math, the standards used were *Foundations: Early Learning Standards for North Carolina Preschoolers and Strategies for Guiding Their Success* (North Carolina Foundations Task Force, 2013). The standards for science in kindergarten were taken from the 2009 Essential Standards (Standard Course of Study) established by the Department of Public Instruction, Public Schools of North Carolina State Board of Education (North Carolina Department of Public Instruction, 2009). The math standards for kindergarten were taken from the Common Core State Standards for Mathematics from the North Carolina Department of Public Instruction (North Carolina Department of Public Instruction, 2009).

The new measures, the Prekindergarten and Kindergarten Science and Math Standards and Self-Efficacy Surveys, were developed to incorporate teachers' classroom experiences with implementing science and math activities and the frequency of the implementation of those activities, as well as their knowledge of science and math content and standards, into one questionnaire that is situated on the framework of the curriculum for prekindergarten and kindergarten. They also include questions on teacher education and years of teaching experience. The self-efficacy questions inquire as to the level of enjoyment, confidence, and effectiveness that the teachers feel they have teaching science and math. There are also a few questions concerning the last science and math classes taken and if they enjoyed them. These questions are intended to explore the feelings teachers had for science and math prior to becoming professionals. These feelings assist in creating a more complete portrait of teachers and their self-efficacy with science and math instruction.

Purpose of this Study

Research supports the importance of teacher self-efficacy in the classroom (Friedman & Kass, 2002). Research also supports the impact that teachers' beliefs and knowledge have on their behavior in the classroom, specifically in the scientific domain (Maier et al., 2013). A few measures have been created to gain information on teacher-related factors with regards to science and math, but only one has been validated (P-TABS) and none of the measures include questions concerning science and math curriculum standards. To gain additional understanding on science and math teaching practices in early childhood classrooms, this research study seeks to examine the relationship between teachers' knowledge of science and math standards, their beliefs regarding their skills at implementing activities in science and math, and their level of self-efficacy regarding science and math and teachers' science and math teaching practices, specifically the frequency science and math standards are worked on in prekindergarten and kindergarten classrooms. This study was conducted to provide basic information on science and math teaching practices in prekindergarten and kindergarten. Using both the theoretical perspectives and the current literature, the research questions, exploratory research questions, and corresponding hypotheses are listed in the next chapter.

CHAPTER IV

RESEARCH QUESTIONS AND HYPOTHESES

The theoretical framework and literature review for this study indicate that questions related to teachers' knowledge of science and math standards, their self-reported beliefs of their science and math teaching skills, and their level of science and math self-efficacy may affect the amount of time teachers spend on science and math learning activities in the classroom. More specifically, this study looks to investigate three major questions and two exploratory questions.

Research Question 1

How does teachers' knowledge of science standards, beliefs of their science teaching skills, and level of science self-efficacy relate to science teaching practices in prekindergarten and kindergarten classrooms?

Hypothesis 1. Teachers who self-report greater knowledge of science standards, more positive beliefs of their science teaching skills, and greater level of science self-efficacy with their teaching also will report more frequent science activities that relate to science standards.

Research Question 2

How does teachers' knowledge of math standards, beliefs of their math teaching skills, and level of math self-efficacy relate to math teaching practices in prekindergarten and kindergarten classrooms?

Hypothesis 2. Teachers who self-report greater knowledge of math standards, more positive beliefs of their math teaching skills, and greater level of math self-efficacy with their teaching also will report more frequent math activities that relate to math standards.

Research Question 3

What influence do teacher education and the years of teaching experience have on the relationship between knowledge of standards, beliefs of teaching skills, and level of self-efficacy with the frequency of learning activities for science and math?

Hypothesis 3a. Teachers with more education, more years of teaching experience, greater knowledge of science standards, more positive beliefs of their science teaching skills, and greater level of science self-efficacy will report more frequent science activities that relate to science standards.

Hypothesis 3b. Teachers with more education, more years of teaching experience, greater knowledge of math standards, more positive beliefs of their math teaching skills, and greater level of math self-efficacy will report more frequent math activities that relate to math standards.

Exploratory questions related to the context teachers experience both prior to becoming a professional teacher and while working as a professional teacher are investigated. These questions are associated with teachers' previous science and math experiences, and are in the surveys to provide information on how teachers' past learning experiences in both classes (preservice educational experiences) and workshops (in-service educational experiences) may affect their current teaching practices.

Exploratory Research Question 4

Is there a relationship between the timing of when science classes and workshops were taken and the amount of enjoyment derived from taking those classes and workshops, and the frequency of science activities related to standards taught in prekindergarten and kindergarten classrooms?

Hypothesis 4. Teachers with more recent science classes and workshops who experienced more enjoyment while taking these classes and workshops will report teaching more frequent science activities relating to science standards.

Exploratory Research Question 5

Is there a relationship between the timing of when math classes and workshops were taken and the amount of enjoyment derived from taking those classes and workshops, and the frequency of math activities related to standards taught in prekindergarten and kindergarten classrooms?

Hypothesis 5. Teachers with more recent math classes and workshops who experienced more enjoyment while taking these classes and or workshops will report teaching more frequent math activities relating to math standards.

The method for data collection and plan of analysis in order to answer the questions of the study are discussed in the next chapter.

CHAPTER V

METHOD

Research Design

To determine the associations between teachers' curriculum standards knowledge for science and math, beliefs of skills implementing science and math activities, and level of science and math self-efficacy and teaching practices involving science and math, an exploratory descriptive study was conducted. The survey developed by the author was designed to quantify teachers' self-report of the following independent variables: (a) knowledge of science standards in prekindergarten and kindergarten classrooms, (b) beliefs about skills implementing activities using science standards, (c) level of self-efficacy with science instruction, (d) knowledge of math standards in prekindergarten and kindergarten classrooms, (e) beliefs about skills implementing activities with math standards, and (f) level of self-efficacy with math instruction. The dependent variable was the self-reported frequency of activities related to science and math curriculum standards in prekindergarten and kindergarten classrooms. Although self-report is a potential limitation in terms of teachers having personal bias as to the happenings in their classrooms, it also is important to understand what the teachers believe their classroom practices to be currently. In this study teacher education and years of teaching experience were examined in relation to the dependent variable. To provide information on how teachers' classroom practices might be effected by their past experiences in science and math, the context of both prekindergarten and kindergarten teachers' science and math learning were explored on the surveys. These learning context questions on the surveys asked teachers when they took their last science class and how much they enjoyed it, as well as when they took their last science workshop and how much they enjoyed it. The same questions were asked of the teachers in the math section of the surveys. The impetus for this line of analysis was Bronfenbrenner's PPCT model, and the questions in the survey were written to cover both preservice experiences (science and math classes) and in-service experiences (science and math workshops).

Procedure

The pools of potential participants for this study were prekindergarten and kindergarten teachers in the Piedmont Triad area of North Carolina. Recruitment efforts specifically targeted prekindergarten teachers from Davidson, Forsyth, Guilford, and Rockingham counties and kindergarten teachers from Forsyth and Rockingham Counties.

To gain permission to survey prekindergarten and kindergarten teachers in Davidson, Forsyth, Guilford, Randolph, and Rockingham Counties, two different methods were required due to the different governing bodies of each group of teachers. For prekindergarten teachers, the DCDEE provided support and information as to the best method to invite teachers to participate in the study, which involved attending Professional Leadership Community meetings in order to administer the Prekindergarten Science and Math Standards and Self-Efficacy Survey to the participants. To gain access to kindergarten teachers in the selected counties, applications were completed and submitted to the Department of Research & Evaluation (or some variant thereof) for each county. Two counties, Forsyth and Rockingham, agreed to take part in the study, and the kindergarten teachers in those counties were emailed information about the survey and a link to the Kindergarten Science and Math Standards and Self-Efficacy Survey on Qualtrics.

Two different types of sample recruitment occurred in this study. Prekindergarten data collection consisted of visiting meetings of the aforementioned Professional Leadership Communities (PLCs) attended by NC Pre-K teachers. PLCs are voluntary monthly meetings led by a mentor/educator that assist prekindergarten teachers with developing their professional skills in educating young children. While visiting these meetings, the study was introduced and explained and the teachers were invited to complete a printed copy of the prekindergarten survey, which took approximately 10 to 15 minutes. Consent information was provided prior to the surveys being presented to the teachers, and forms for providing personal contact information were passed out if the participants who consented were interested in entering a drawing to receive three $200 Target gift cards. Data collection for kindergarten consisted of emailing the surveys to kindergarten teachers from Forsyth and Rockingham counties. Informed consent was obtained by participants as part of the online completion process, and kindergarten participants were given the opportunity to provide contact information for the Target gift card drawings via a separate online portal. Data was collected in the fall of 2014 for kindergarten and spring of 2015 for prekindergarten.

Participants

Participants invited to complete the surveys totaled 56 prekindergarten and 271 kindergarten teachers. The total participants who completed the survey included 53 prekindergarten teachers and 30 kindergarten teachers. This represents a 25% response rate, which is within range for academic research as reported by Lefever, Dal, and Matthíasdóttir (2007). The teachers from both grades/age-levels varied in terms of experience and education (see Table 1 for prekindergarten teacher descriptive statistics and Table 2 for kindergarten teacher descriptive statistics).

Measures

The Prekindergarten and Kindergarten Science and Math Standards and Self-Efficacy Surveys were 23-item scales developed by the author to assess teacher self-efficacy and beliefs through the lens of curriculum standards knowledge. The survey asked teachers to respond to questions regarding their knowledge of prekindergarten and kindergarten standards for science and math. For prekindergarten science and math, the standards used were *Foundations: Early Learning Standards for North Carolina Preschoolers and Strategies for Guiding Their Success* (North Carolina Foundations Task Force, 2013). The standards for science in kindergarten were taken from the 2009 Essential Standards (Standard Course of Study) established by the Department of Public Instruction, Public Schools of North Carolina State Board of Education (North Carolina Department of Public Instruction, 2009). The math standards for kindergarten were taken from the Common Core State Standards for Mathematics from the North Carolina Department of Public Instruction (North Carolina Department of Public Instruction, 2009). Although there is no direct reliability or validity data for the Prekindergarten and Kindergarten Science and Math Standards and Self-Efficacy Surveys, the items were reviewed by experts in this content area to assure initial validity of items (Hamre et al., 2012). A pilot study of the measure was conducted in fall 2014, and involved a total of 10 teachers, five teachers from prekindergarten and five from kindergarten. These teachers completed the survey and then were interviewed to address inconsistencies regarding readability. Cronbach's α values were calculated for the subscales of knowledge of science standards, knowledge of math standards, skill at implementing science activities related to standards, skill at implementing math activities related to standards, level of self-efficacy related to science standards, and level of self-efficacy related to math standards in order to establish a baseline of reliability for each subscale (see Tables 1 and 2). These values suggest initial evidence of reliability of this new measure.

Also, on both the prekindergarten and kindergarten surveys, respondents were asked to respond to questions related to teachers' enjoyment, confidence, and perceived effectiveness such as "How much do you enjoy teaching science to your class" and items related to self-efficacy such as "How confident do you feel teaching science to your class" and "How would you rate your effectiveness in teaching science concepts?" Items were rated on a Likert-type response scale from 1 (*hardly ever*) to 5 (*a great deal*). The survey also inquired about the teachers' past learning experiences related to science and math education through questions such as, "When was your last science class that focused specifically on science concepts and methods (e.g., biology, physics, chemistry, preschool and kindergarten science curriculum course, etc.)", rated on a response scale using a range of years (e.g., 0-2 years, 3-5 years, 6-10 years, 11-15 years, 16-20 years, and more than 20 years) and "How much did you enjoy this science class?", rated from 1 (*not very much*) to 5 (*a great deal*). These questions were posed for math as well. Demographic questions concerning years of experience and level of education also are included on the surveys. These questions included a range of years for experience (e.g., 0-3 years, 4-6 years, 7-10 years, 11-20 years, and more than 20 years) and a range for level of education (e.g., "Did not complete high school" to "Graduate degree"). There were also questions as to how the respondents used curriculum standards to guide their planning and implementation. To explore the context of teachers' past learning experiences and how those experiences might influence their teaching practices, the survey also asked the timing of teachers' last science or math class or workshop and how much they enjoyed that science or math class or workshop.

Ethical Consideration

The Institutional Review Board (IRB) approval for this study was granted in the fall of 2014. Guidelines related to electronic data collection were followed. All identifying data were de-identified prior to data analysis. All data were secured during work on the study, and after the required amount of time has passed, data will be destroyed.

CHAPTER VI

RESULTS

Preliminary Analyses

Preliminary data analyses were conducted to examine the variables for normality and to determine if any outliers existed. The normal distribution was assessed for the following variables: each of the four variables for years of teaching, two variables that relate to using standards for planning; knowledge of curriculum standards (independent variable), skills for implementing activities (independent variable), self-efficacy (independent variable), and frequency of activities (dependent variable) for addressing standards in both science and math for prekindergarten and kindergarten; and highest level of teacher education. The results showed no outliers for any of the data variables. The skewness for all data fell within -2 to 2, which suggests that all variables were normally distributed. The ranges also were appropriate for each of the variables with the full range of responses used for prekindergarten science and most of prekindergarten math. Kindergarten teachers' responses were nearly the full range for science, but were much more limited for math, which may reflect the extensive training on Common Core Math for kindergarten teachers. Imputed values were used in place of missing data in the averages (Graham, Olchowski, & Gilreath, 2007). A total of 29 values were missing from various areas of the prekindergarten data and 10 values were missing from various areas of the kindergarten data. All analyses, with the exception of the multiple linear regression for the exploratory research questions, were conducted using the IBM Statistical Package for the Social Sciences (SPSS), versions 22 and 23. The multiple linear regression for the exploratory research questions was completed in Statistical Analysis System (SAS), version 9.4.

Descriptive Analyses

Descriptive statistics on the data on the demographics section of the surveys were analyzed in order to describe the years of experience, teacher education, and use of standards in planning. The mean, standard deviation, and range for each these variables for prekindergarten is shown in Table 1, and for kindergarten the results for the same variables are shown in Table 2. For the prekindergarten survey results, the mean, standard deviation, range, and Cronbach's α for the independent variables of the averages of knowledge, skills at implementing activities, and self-efficacy, and for the dependent variable of the frequency of activities in the classroom for both science and math are all shown in Table 3. On average the years of teaching experience for prekindergarten teachers is 7-10 years, which is also approximately the same for the average of intentionally teaching math. For intentionally teaching science on average it is a little less at 4-6 years. The prekindergarten teachers reported an average education of a "four-year degree in a field related to early childhood or child development, such as elementary education or psychology," and ranged from "one-year community college diploma" to a "graduate degree." Prekindergarten teachers self-reported the average frequency of science activities in their classrooms to be 3.73 out of 5.00 (or daily), which corresponds to more than bi-monthly but less than weekly on the survey. They also self-reported an average frequency of 4.24 out of 5.00 (or daily) of math activities, which corresponds to more than weekly but less than daily on the survey. Teachers reported relatively lower knowledge of science standards than math standards, relatively lower beliefs of science teaching skills than math teaching skills, and relatively lower levels of science self-efficacy than math self-efficacy. The mean for the knowledge of science standards was 3.86 with a range of 1-5, while the mean for knowledge for math standards was 4.30 with a range of 1-5. The mean for beliefs of science skills was 4.05 with a range of 1-5, while the mean for beliefs of math skills was 4.32 with a range of 1-5. The mean for levels of science self-efficacy was 3.98 with a range of 1-5, while the mean for levels of math self-efficacy was 4.32 with a range of 3-5. For frequency of science activities, the mean was 3.73 with a range of 1-5, and the mean frequency of math activities was 4.24 with a range of 1-5.

Mean, standard deviation, range, and Cronbach's α for the kindergarten survey results including knowledge, skills at implementing activities, self-efficacy, and frequency of activities in the classroom for both science and math are all shown in Table 4. Kindergarten teachers reported an average of approximately 4-10 years of experience teaching kindergarten, and an average of 7-10 years teaching overall. For intentionally teaching math, the average is 7-10 years, which is the same for intentionally teaching science. All of the kindergarten teachers reported having at least a four-year degree in either early childhood or child development, a related field such as elementary education or psychology, or in another field unrelated to child development. The average of self-reported frequency of science activities in kindergarten was 3.29 out of 5.00 (or daily), which corresponds to slightly more than bi-monthly on the survey. The average of self-reported frequency of math activities was 4.25 out of 5.00 (or daily), which corresponds to more than weekly but less than daily. In terms of knowledge of standards, beliefs of skills, and levels of self-efficacy, kindergarten teachers' self-reported higher average values for math than science, with much more limited ranges in math. The mean for the knowledge of science standards was 3.75 with a range of 1-5, while the mean for knowledge for math standards was 4.52 with a range of 2-5. The mean for beliefs of science skills was 3.75 with a range of 1-5, while the mean for beliefs of math skills was 4.42 with a range of 3-5. The mean for levels of science self-efficacy was 3.92 with a range of 2-5, while the mean for levels of math self-efficacy was 4.52 with a range of 2-5. For frequency of science activities, the mean was 3.29 with a range of 1-5, and the mean frequency of math activities was 4.25 with a range of 2-5.

Main Effect Analyses

Research Question 1. To answer the first research question concerning how teachers' knowledge of science standards (independent variable), beliefs of their science teaching skills (independent variable), and level of self-efficacy teaching science (independent variable) are related to science teaching practices (i.e., frequency of activities addressing science standards, which is the dependent variable), Pearson correlations were completed to assess the relationships between the three independent variables and one dependent variable in this study. In the prekindergarten classroom, the science teaching practices were significantly, positively correlated with years of teaching preschool, r = .317, p = .021, and average of beliefs of science teaching skill, r = .340, p =

.014, but not knowledge of science standards or reported science efficacy. Other correlation data concerning prekindergarten science are presented in Table 5.

In the kindergarten classroom, the frequency of science teaching practices were significantly, positively correlated with average of teachers' knowledge of science standards, r = .444, *p* = .014; average teachers' beliefs of science teaching skills, r = .470, *p* = .009; and average level of science self-efficacy, r = .450, *p* = .012, but not years of teaching kindergarten. Other correlation data concerning kindergarten science are presented in Table 6. Teachers' experience and education were not significantly related to kindergarten teachers' self-reported knowledge of science standards, beliefs of science teaching skills, level of science self-efficacy, or frequency of science activities conducted in kindergarten classrooms.

Research Question 2. To answer the second question on how teachers' knowledge of math standards (independent variable), beliefs of their math teaching skills (independent variable), and level of self-efficacy teaching math (independent variable) are related to frequency of math teaching practices, Pearson correlations were computed. In the prekindergarten classroom, the frequency of math teaching practices were significantly, positively correlated with years of teaching preschool, r = .332, *p* = .015; years of intentionally teaching math, r = .333, *p* = .015; average of teachers' knowledge of math standards, r = .363, *p* = .008; average teachers' beliefs of math teaching skills, r = .603, *p* = .000; and average level of math self-efficacy, r = .359, *p* = .009. Other correlation data concerning prekindergarten math are presented in Table 7. In the kindergarten classroom, the math teaching practices were not significantly correlated with any of independent variables. Other correlation data concerning kindergarten math are presented in Table 8.

Multiple Linear Regressions

Research Question 3. The third research question examines the influence that teacher education and years of teaching experience have on the relationships between knowledge of science and math standards, beliefs of science and math teaching skills, and levels of science and math self-efficacy and the frequency of science and math activities in classrooms. Based on the hypotheses, the multiple linear regression analyses included the variables for teacher education, years of teaching experience, and any of the independent variables (i.e., knowledge of science or math standards, beliefs of science or math teaching skills, and level of science or math self-efficacy) that were correlated with the dependent variable of frequency of science or math activities conducted in classrooms. The independent variable with the stronger association was used if independent variables were highly correlated ($\geq .60$) with each other. The multiple linear regressions are shown in multiple models so as to indicate what the strongest predictors were in each model. Model 1 only includes teacher education for each regression, while model 2 includes teacher education and the years of experience either teaching preschool or teaching kindergarten. Model 3, if present, includes teacher education, years of teaching experience, and beliefs of science or math teaching skills, and model 4, if present, includes teacher education, years of teaching experience, beliefs of science or math teaching skills, and level of science or math self-efficacy.

The results of the regressions are displayed in Tables 9 and 10. For prekindergarten science, a significant regression equation was found for model 3. Model 3 includes the variables teacher education, years teaching preschool, and beliefs of science teaching skills variables. The regression equation for model 3 is (F(3,45) = 3.488, p = .023), with an R^2 of .189. The R^2 of .189 suggests that 18.9% of the variance of frequency of science activities is explained by the three variables. The R^2 change suggests that years teaching preschool is the strongest predictor, followed by beliefs of science teaching skills, for the frequency of science activities in prekindergarten. For kindergarten science, a significant regression equation was calculated in model 4 for the frequency of science activities in kindergarten classrooms based on teacher education, years of experience teaching kindergarten, average of beliefs of science teaching skills, and average level of science teaching self-efficacy. Knowledge of science standards and beliefs of science teaching skills were strongly correlated (.708), and beliefs of science teaching skills was included in the multiple linear regression analysis because it had the stronger association with the frequency of science activities. This equation is (F(4,25) = 3.094, p = .034), with an R^2 of .331. The R^2 of .331 suggests that 33.1% of the variance of frequency of science activities is explained by the four variables (see Tables 11 and 12). The R^2 change suggests that beliefs of science teaching skills is the strongest predictor, followed by level of science self-efficacy, for the frequency of science activities in kindergarten.

A multiple linear regression also was completed to predict the frequency of math activities in prekindergarten classrooms based on teacher education, years of experience teaching preschool, average of beliefs of math teaching skills, and level of math self-efficacy. A significant regression equation was found for model 3 ($F(3,46) = 11.806$, $p = .000$), with an R^2 of .435 for model 3. The R^2 of .435 suggests that 43.5% of the variance of frequency of math activities is explained by the three variables of teacher education, years of teaching preschool, and beliefs of math teaching skills. The R^2 change suggests that beliefs of math skills is the strongest predictor, followed by years of teaching preschool, for the frequency of math activities (see Tables 13 and 14). For kindergarten math although no significant correlations were found, a multiple linear regression was still conducted to maintain analytical consistency and no significant regression equations were found (see Tables 15 and 16).

Exploratory Questions

The exploratory questions associated within the context of the teachers' previous science and math learning experiences were considered in an effort to provide information on how teachers' past experiences might drive their current teaching practices. The questions on the surveys asked when teachers took their last science class (implying a preservice educational experience) and how much they enjoyed it, as well as when they took their last science workshop (implying an in-service educational experience) and how much they enjoyed it. The same questions were asked of the teachers in the math section of the surveys. Of the teachers who participated in the surveys, the percentages of those who had taken a science and or math class and or workshop was quite high, ranging from 87% to 98% for science and 83% to 100% for math. In terms of the exploratory research questions, Exploratory Research Question 4 examines if there is a relationship between the timing of when science classes and/or workshops were taken, and the amount of enjoyment derived from taking those classes and workshops, and the frequency of science activities taught in prekindergarten and kindergarten classrooms. Exploratory Research Question 5 asks if there is a relationship between the timing of when math classes and workshops were taken, and the amount of enjoyment derived from taking those classes and workshops, and the frequency of math activities related to standards taught in prekindergarten and kindergarten classrooms.

The descriptive statistics for the exploratory questions, which variables are years since last science or math class or workshop and enjoyment of last science or math class or workshop (See Table 1 and Table 2). In an effort to consider how preservice and in-service teachers' experiences might influence their classroom practices (measured in this study as the frequency of science and math activities in the classroom), Pearson correlations and multiple linear regressions, in both the prekindergarten and kindergarten data sets, were conducted separately for preservice and in-service learning experiences.

Exploratory Research Question 4. Results from the Pearson correlations conducted to answer this research question indicate that there was a trend toward an association between teachers liking their last science class (preservice) and the frequency of science activities in prekindergarten classrooms, r = .229, p = .099. This finding is supported by a mean rating of enjoyment of 3.83, which corresponds to between "3" for "Somewhat" to "4," for the prekindergarten teachers who had a science class approximately 3-5 years ago (98% of the sample). There were no significant relationships between enjoying in-service science educational experiences, or science workshops, and frequency of science activities in their prekindergarten classrooms. In addition, there were no significant relationships between enjoying preservice science education experiences and frequency of science activities for kindergarten teachers. Lastly, kindergarten teachers' enjoyment of in-service science education experiences were not related significantly to the frequency of science activities in kindergarten classrooms (see Tables 17 and 18). The multiple linear regressions conducted using the prekindergarten and kindergarten science variables also showed no significant predictors.

Exploratory Research Question 5. From the Pearson correlations conducted to examine the relationships between when math classes and workshops were taken and the frequency of math activities in prekindergarten and kindergarten classrooms, two trends were indicated. One of the trends showed a relationship between the prekindergarten teachers liking their last math workshop (in-service) and the frequency of math activities in their classrooms, r = .245, p = .077. This finding is supported by a mean rating of enjoyment of 3.74, which corresponds to between "3" for "Somewhat" to "4," for the prekindergarten teachers who had a math workshop approximately 3-5 years ago (87% of the sample). The other trend found was negative and between kindergarten teachers liking their last math class (preservice) and the frequency of math activities in their classrooms, r = -.337, p = .068 (see Tables 19 and 20). This finding is supported by a mean rating of enjoyment of 3.53, which corresponds to between "3" for "Somewhat" to "4," for the kindergarten teachers who had a math class approximately 3-5 years ago (100% of the sample).

Among all the regressions, there were only two found to be significant and both were from the prekindergarten data set and were related to math (see Table 21). The results for teachers' self-reported enjoyment of their last math class taken (b = -.219, $p < .05$) indicated that the less the enjoyment of the class, the greater the frequency of math activities in the prekindergarten classroom. For the second variable found to be significant, teachers' self-reported enjoyment of the last math workshop taken (b = .358), the effect was positive and significant ($p < .01$), indicating that the greater the enjoyment of the workshop, the higher the frequency of math activities in the prekindergarten classroom.

CHAPTER VII

DISCUSSION

Using Bronfenbrenner's bioecological theory and Bandura's theory on self-efficacy as a framework, this study examined the relationship between prekindergarten and kindergarten teachers' self-reported knowledge of standards, beliefs of teaching skills, and level of self-efficacy for science and math and teachers' self-reported frequency of science and math activities in their classrooms. Science and math education activities provide opportunities for children to learn to think critically and observe their surroundings while also improving important language skills (Brenneman & Louro, 2008), and should be considered an essential component to early childhood classrooms in both programs, family childcare homes, and public and private schools. For teachers to teach young children about science and math effectively, they need to possess knowledge of science and math concepts and processes, and understand children's developmental learning progressions or how children construct knowledge in science (Chalufour, 2010) and math (Ryan, Whitebook, & Cassidy, 2014).

The findings for this study show teachers' beliefs of their teaching skills to be a strong predictor of providing science and math activities in prekindergarten. No significant relationships were found in kindergarten math, which may be related to the homogeneous nature of the sample and sample size or due to the degree requirements and Common Core training needed to teach kindergarten. Years of teaching prekindergarten was significant in both science and math, but no significant relationships were found between years of experience and kindergarten teaching for either subject area. Teacher education was not significantly related to either grade level or subject area. In terms of the exploratory questions, both prekindergarten and kindergarten teachers reported that the less they enjoyed previous math classes, the more time they spent on math activities in their classrooms. Prekindergarten teachers also reported that the more they enjoyed science classes, the more science activities were conducted in their classrooms. This suggests a link between enjoyment of preservice education experiences and classrooms practices for science in prekindergarten. For math, prekindergarten teachers also reported a positive relationship between enjoying previous math workshops and more math activities conducted in their classrooms, which suggests a link between enjoyment of in-service educational experiences and classroom practices for math in prekindergarten.

Science

Results addressing the first research question concerning prekindergarten and kindergarten science indicated that teachers' self-reported beliefs of science teaching skills was significantly related to more science activities for both grade levels. Multiple linear regression of both prekindergarten and kindergarten provided evidence that teachers' beliefs about their science skills was a strong predictor of the frequency of science activities conducted in classrooms. This outcome supports Hypothesis 1 for both prekindergarten and kindergarten by providing evidence that teachers' beliefs are potentially important when considering classroom practices. These findings seem relatively logical and straightforward in that teachers, regardless of grade, who have more positive beliefs in their skills at implementing science activities will spend more time on those science activities than teachers who have less positive beliefs in their science skills. This also is supported by research that suggests that teacher beliefs play a large role in determining how teachers engage in classroom practices (Pajares, 1992; Brown, 2005). A study by Wilkins (2008) compared teachers' content knowledge, attitudes, and beliefs, and found teacher beliefs to have the strongest relationship to the classroom practices of elementary (kindergarten through 5^{th} grade) teachers. Children's learning also may be affected by beliefs through teacher-child interactions influenced by teacher beliefs (Stipek, Givvin, Salmon, & MacGyvers, 2001). Stipek and colleagues (2001) found that with the 4th through 6th grade teachers in their study the more traditional the teachers' beliefs (i.e., math as an ability that some people possess and others do not and learning math is extrinsically motivated), the more traditional the teachers' practices (i.e., focusing on performance, or the right answer, and speed rather than understanding and learning; less autonomy and more high risk in terms of mistakes rather than more autonomy and less social risk in terms of making mistakes). Also, teachers with more traditional beliefs from this study were found to enjoy math less and exhibit less enthusiasm in their classrooms (Stipek et al., 2001), which is a finding that could be closely linked to Bronfenbrenner's theory on resource characteristics as well as Bandura's work on self-efficacy. The teachers with more traditional beliefs have had experiences with proximal processes that have cemented those beliefs of focusing on performance rather than learning (among other previously noted differences) (Bronfenbrenner & Morris, 2006), which has influenced how those teachers see their abilities in teaching math to their students (Bandura, 1981). Their self-efficacy has been affected by their developmental experiences, perhaps a reason for reduced enjoyment and enthusiasm, which has affected their classroom practices.

Additional evidence was found supporting Hypothesis 1. Kindergarten teachers who self-reported having greater knowledge of science standards and greater levels of self-efficacy with their science teaching spent more time on science related learning experiences. The relationships between knowledge of science standards and level of science self-efficacy and frequency of science activities were significant for kindergarten but not prekindergarten. These two findings may be related to the differences in educational requirements for prekindergarten and kindergarten teachers (Hyson, Tomlinson, & Morris, 2009). Kindergarten teachers must have a four-year degree to teach, but this level of education is not required for prekindergarten teachers in many states (Early & Winton, 2001). It is possible that prekindergarten teachers are not as familiar with science standards as kindergarten teachers are due to the knowledge and experience a more advanced degree may offer kindergarten teachers relative to prekindergarten teachers. Additional research is required to determine how educational requirements for prekindergarten and kindergarten teachers might influence their knowledge of standards for science.

This finding may also have to do with materials in prekindergarten classrooms that are used in science learning and the lack of quality science materials that provide children with multiple opportunities to engage in rich exploration of their environment. Nayfield, Brenneman, and Gelman (2011) found that even if quality science materials abound in preschool classrooms, which is relatively rare, teachers and students often do not use them. Thus, children are not interacting with the science tools and objects nor are they interacting with teachers in guided learning situations with science tools and objects. The authors explained that much of the reason that children are not engaging with these science tools and objects is because these items are less self-explanatory or used less often by teachers than other items in the classroom such as blocks, markers, dress up items, etc., and that science tools and objects might require demonstrations and practice for children to use by themselves (Nayfield et al., 2011). Future work focusing on science materials is required to further understand these mechanisms of demonstration and practice and their importance in prekindergarten.

Math

Results for prekindergarten math indicated that teachers' self-reported knowledge of math standards, beliefs of math teaching skills, and math self-efficacy was positively and significantly related to teachers' self-reported frequency of math activities conducted in the classroom. These results support Hypothesis 2 for prekindergarten that teachers who have greater knowledge of math standards, more positive beliefs about their math skills, and greater level of math self-efficacy reported spending more time on math activities than teachers who have less knowledge of math standards. These findings suggest that these three independent variables significantly, and positively, may affect the frequency of math activities conducted in the classroom with prekindergarteners. From the multiple linear regression analysis, the strongest predictor of the frequency of math activities for prekindergarten math was the self-reported beliefs of math teaching skills.

In kindergarten, no significance was found between teachers' self-reported knowledge of math standards, beliefs of math teaching skills, and level of math self-efficacy and the frequency of math activities.

The lack of relationships between the independent variables and the dependent variable for kindergarten math may be due to the sample of kindergarten teachers who participated in this study. These are highly experienced, highly educated kindergarten teachers who self-reported high knowledge of math standards, math teaching skills, math self-efficacy, and frequency of math activities. The limited variability in this relatively small sample may have led to the lack of findings with the kindergarten math data. A potential cause for the limited variability could be the amount of training that kindergarten teachers received for teaching Common Core Math to their students. The type and amount of training and the accountability associated with the adoption of Common Core may have influenced how kindergarten teachers reported their knowledge of standards, beliefs of their math teaching skills, and their level of math self-efficacy. Since all the kindergarten teachers in the state received this training, it likely led to high levels of knowledge of the standards and high expectations for implementing math activities, and thus there was limited variability and statistical power in the analyses. A larger sample with a greater range of responses in knowledge, skills, and self-efficacy related to the math standards may better differentiate which teachers plan and carry out more math lessons and which predictive variables are the most salient in these relationships. Furthermore, directly asking teachers about their specific training on the

Common Core or Prekindergarten standards may shed additional light on these relationships.

Education and Experience

The results related to teacher education and years of teaching experience suggest that years of teaching prekindergarten has a positive and significant relationship with the frequency of both science and math activities conducted in prekindergarten classrooms. This finding partially supports Hypotheses 3a and 3b in that prekindergarten teachers with more years of teaching prekindergarten reported more frequent science and math experiences that relate to science and math standards. No significant relationships were found between education and frequency of science or math activities in prekindergarten. Also, no significant relationships were found for years of teaching experience and education for kindergarten. Although one might suggest from these findings that prekindergarten years of teaching experience is more important than kindergarten years of experience in relation to the amount of time teachers spend on activities on science and or math standards, another possibility is that the sample of kindergarten teachers is too small and too similar to find significant relationships among these variables. Another factor supported by research (Early et al., 2006) is the educational requirement to teach kindergarten is at least a four-year degree, which limits the educational variability for kindergarten teachers. Again, the lower degree of variability in the kindergarten sample likely decreased the statistical power of the data.

Teacher education has been shown to be associated positively with quality teacher-child interactions (Kelley & Camilli, 2007; La Paro et al., 2009) and related to classroom quality and children's outcomes (Early et al., 2007; LoCasale-Crouch et al., 2007), but there were no significant associations, either positive or negative, found in this study between teacher education and any of the study variables. One reason for this finding might the limited range of education in both the prekindergarten and kindergarten data sets and the lack of specificity on the types of educational experiences that teachers encountered in their programs of study. Studies linking teachers' education and classroom quality are not always congruent with each other, and other factors may be influencing quality besides a global measure of teacher education. A broader education sample with more details on the types of educational experiences teachers received might assist in teasing out these relationships.

Another reason for the lack of significance among the averaged subscale items might be the specific subjects of science and math examined in this study. One of the strongest predictors of later achievement in school has been reported to be early math skills (Duncan et al., 2007). Also evident from research is that teachers' math proficiency drives young children's performance in math (Sarama & DiBiase, 2004). Yet, it is uncommon for four-year early childhood teacher preparations programs to provide classes specifically on teaching science or math to young children (Isenberg, 2000). Compare this to the literacy classes that many four-year early childhood teacher preparation programs have as part of their required coursework for teacher education (Brenneman, Stevenson-Boyd, & Frede, 2009; Isenberg, 2000). The lack of opportunities for preservice early care and education teachers to sharpen their skills in how to engage young children in learning science and math may influence their self-efficacy and decrease their willingness and readiness to introduce science and math activities and language in their classes (Chen, McCray, Adams, & Leow, 2014; Copley, 2004; Ginns, Watters, & Tulip, 1995).

Previous Math and Science Experiences

The exploratory questions associated with the context of the teachers' previous science and math experiences were considered in an effort to provide information on how teachers' past experiences might drive their current teaching practices. The questions on the surveys related to past experiences asked teachers when they took their last science class (implying a preservice educational experience) and how much they enjoyed it, as well as when they took their last science workshop (implying an in-service educational experience) and how much they enjoyed it. The same questions were asked of the teachers in the math section of the surveys.

Results suggest a trend that supports Hypothesis 4. Although there were not many significant findings for the science-specific questions among the contextual variables, this outcome suggested that perhaps the more science classes are enjoyed, the more likely science activities will be completed in classrooms in the future. Among prekindergarten teachers, a trend finding lends partial support to Hypothesis 5 in that the higher the level of prekindergarten teachers' enjoyment in the last math workshop taken, the more frequent math activities were reportedly conducted in prekindergarten classrooms. One surprising finding was that the less prekindergarten and kindergarten teachers' enjoyed their last math class, the more frequent math activities are conducted in their classrooms. These results indicate that when teachers do not seem to enjoy their previous math classes, that dissatisfaction may motivate them to plan more math activities in classrooms. In contrast, more enjoyment with math workshops does seem to lead to more math activities in prekindergarten classrooms. These findings are interesting in that the math class (preservice experience) relationship is negative, but the math workshop (in-service experience) relationship is positive. This finding may have implications for the types of math classes teachers are taking at the preservice level and how the information learned in these courses connects to teaching strategies in the classroom. It also is interesting to generally note that prekindergarten teachers reported enjoying science and math classes and science workshops, and kindergarten teachers rated math workshops higher in enjoyment.

These findings may be important to consider in preservice and in-service development, and present an interesting difference between science and math. For science, the only positive finding was for science classes, while the findings for math classes were all negative. Math workshops were calculated to be positive and significant for more prekindergarten math activities, while nothing was found in the investigation of relationships of science workshops and frequency of science activities. This is rather surprising as 94% of prekindergarten teachers reported attending a science workshop relatively recently (mean timing of the science workshops was approximately 3-5 years ago), and enjoying it (mean enjoyment rating is 4.00, making it the highest rated science or math learning experience). As teachers reported relatively high values for knowledge of standards, beliefs of skills, and level of self-efficacy, it seems that using their confidence in teaching young children might be an effective way to encourage new activities related to science and math. It is likely that when teachers try new activity plans and experience children's excitement with science and math knowledge acquisition then they are more prone to acquire more personal science and math knowledge to potentially share with their classes (Chen & McCray, 2012).

Knowledge, Beliefs, and Self-Efficacy

In terms of how previous experiences might influence teaching practices, research has found that the previous experiences of preservice elementary teachers in science (Tosun, 2000) and math (Brady & Bowd, 2005) greatly outweigh any recent achievements in both subjects. Moreover, Tosun found that participants described their science class experiences as students from elementary school to college overwhelmingly negatively with a ratio of 40:7 in terms of the negative to positive descriptors. The author suggests that these negative feelings surpass science achievement that may be experienced by the preservice teachers, which would negatively affect teachers' science teaching self-efficacy. As Bronfenbrenner and Morris (2006) have theorized, this suggests a strong connection between a person's resource characteristics involving less self-perceived ability and skill, wrapped up in a negative experience, and preservice teaching of science. These ideas of past negative science experiences also align with Bandura's theory involving enactive attainments, which suggests that successful experiences raise efficacy and unsuccessful experiences lower it (1981). A study conducted by Stevens and Wenner (1996) of the content knowledge and beliefs regarding science and math of elementary preservice teachers showed that the preservice teachers' knowledge of both subjects was "suspect" (p. 6), yet the participants' beliefs that they will be effective at teaching science and math to elementary students seemed overly optimistic and somewhat naïve to the authors. "Results from this study would suggest that these preservice teachers enjoy a relatively positive self-concept regarding general ability to teach regardless of their lack of in-depth understanding of subject matter or perceived ability to implement science and mathematics instruction using a process, conceptual, or problem-solving approach" (Stevens & Wenner, 1996, p. 8).

In general, participants from both prekindergarten and kindergarten self-reported relatively high on knowledge of standards, beliefs of teaching skills, and level of self-efficacy in science and math. The means were slightly lower for the frequency of science activities for kindergarten than for prekindergarten, but the means for frequency for math were quite similar across the grades. These means correspond consistently with how teachers in this study viewed their previous experiences in science and math classes and workshops, which ranged from 3.37 for kindergarten teachers' enjoyment of science workshops to 4.00 for prekindergarten teachers' enjoyment of science workshops. These relatively constant ratings of enjoyment support the work by Bandura in that the teachers highly rated their enjoyment and their self-efficacy and their self-belief in their skills, which indicates they feel they teach science and math well to the young children in their classrooms. Consequently, the participants in this study may mirror the preservice teachers in the Stevens and Wenner study in their optimistic feelings about their knowledge and skills related to science and math standards and instruction. Future work which investigates teachers' knowledge, beliefs, and skills in relation to observed teaching practices would further strengthen the understanding of the relationships between these variables and may better inform how preservice and in-service educational experiences might best improve classroom practices.

In considering self-efficacy for prekindergarten and kindergarten teachers and how they teach science and math, it would be interesting to see how these results might compare with classroom observation and interviews. As a reminder, Bandura explicated the sources of self-efficacy as being from four sources, specifically enactive attainments, modeling, verbal persuasion, and physiological factors (1981). Using Bandura's ideas on the sources of self-efficacy, it would seem that future work in science and math self-efficacy would need to focus on interviewing in-service teachers about their experiences to learn what has worked best in the past, and then encompassing those best practices into science- and math-specific learning opportunities for preservice teachers and in-service teachers.

Limitations

Although this study provides an important look at the relationships between knowledge, skills, self-efficacy and frequency of math and science classroom practices for prekindergarten and kindergarten teachers, there are some limitations. The small sample size for both sets of teachers decreased the statistical power for the analyses, which may contribute to more difficulty in finding significant relationships between and among variables and did not allow a factor analysis to be conducted to assess the surveys for content and interpretation of the questions by respondents. A factor analysis would allow for an analysis for how the survey questions would hold together in terms of participant responses. This would provide information on the constructs within the scale and on how to improve the surveys' validity.

Teacher education level and years of teaching experience variables lack variability due to the Likert scale groupings. The options for respondents were as follows for both prekindergarten and kindergarten for years of teaching experience: 0-3 years, 4-6 years, 7-10 years, 11-20 years, and More than 20 years. The ideas behind offering these five choices was to provide answers that would correspond readily with new teachers, teachers with some experience, teachers who were well-experienced, and seasoned professional educators. Perhaps if the years were further separated into more than five groups or recorded as a continuous rather than a categorical variable the greater variability would lead to more direct findings. The minimum requirements for teaching kindergarten in North Carolina include undergraduate coursework and a professional educator's license. This minimum requirement led to limited variability in the teacher education variable of the kindergarten sample. The respondents had 12 options for highest teacher education level on both surveys but these are still categorical data with limited ability to differentiate the type of education participants received and did not address variables such as the specific types of coursework, practicum experiences, and mentoring within the areas of science and math.

Another limitation was the potential for bias of the prekindergarten teacher sample. The prekindergarten teachers were participating in a professional development program, called Professional Leadership Communities, a coordinator-led, voluntary program for prekindergarten teachers in North Carolina who would like to learn classroom best practices from a well-trained group leader and each other. The voluntary nature of the communities implies a likely selection bias as this prekindergarten teacher sample may not be indicative of the prekindergarten teacher population in general. The mean of the years of experience for the prekindergarten teacher sample was 3.23, which corresponds to over 7-10 years on the survey. This indicates that the prekindergarten teachers who participated in this survey were relatively experienced and familiar with importance of science and math instruction for young children. The relatively high means for knowledge of science (3.86) and math (4.30) standards, beliefs in science (4.05) and math (4.32) teaching skills, and level of science (3.98) and math (4.32) self-efficacy also support this idea.

Surveys requiring teachers to self-report information are a double-edged sword in that they are more cost effective than observations, interviews, and teacher logs, but one wonders about the reliability and validity of teachers reporting on their teaching practices (Supovitz & Turner, 2000). In an effort to validate survey data, Burstein et al. (1995) collected information via interviews, teacher logs, observations, and classroom artifacts from teachers, and discovered that surveys were a valid option for collecting data on content covered in classrooms and strategies related to instructional practices. The researchers found, however, that it was problematic and difficult to accurately collect information on instructional goals using survey data (Burstein et al., 1995). To truly establish the validity of the self-report of teachers and the surveys, classroom observations and teacher interviews are required.

Future Work

This study is the foundation for a series of questions to be asked in regard to science and math learning in early care and education environments. Next steps for examining the relationships between teachers' knowledge of standards, beliefs of teaching skills, and level of self-efficacy and the frequency of activities for science and math would be observing teachers in their classrooms and comparing those findings with the self-reported survey findings from this study. In the observations, it would be interesting to go beyond frequency of science and math activities to consider teacher and children's use of science and math language, child engagement, and depth of quality of the science and math instruction. Past research has indicated that early childhood teachers lack confidence in teaching science (Watters & Ginns, 1995) and math (Copley, 2004). In this study, however, both prekindergarten and kindergarten teachers reported mean scores as average to above average in their knowledge of science and math standards, beliefs of science and math teaching skills, and level of science and math self-efficacy. The concern when considering this finding is that teachers believe early science and math requires little real knowledge of either subject to teach them to young children (Chen et al., 2014). The reason they may believe this is the case is that concepts related to science and math that are taught to young children are often more simple than those taught to older children. Another possible answer is that teachers' feelings of confidence might stem from their knowledge of children and how they learn, and not necessarily from their knowledge of science and math or lack thereof (Chen et al., 2014). Teachers may feel more efficacious in this area due to strong beliefs in their abilities to provide high quality, highly engaged science and math instruction at a depth that is developmentally appropriate for the individual children in their classrooms. This aspect is important to tease apart because research has also indicated that teachers' confidence in their math abilities can influence children's attitudes of math (Chen et al., 2014). Interested in the affect that teachers' math anxiety had on children, Beilock, Gunderson, Ramirez, and Levine (2009) measured children's anxiety related to math at the beginning and end of first grade and found a significance related to gender. Girls who had teachers with math anxiety developed increased math anxiety themselves by the end of the academic year, which also influenced their learning outcomes (Beilock et al., 2009). In general, the higher the math anxiety for the teacher, the lower the math achievement for the girls in the class (Chen et al., 2014). In contrast, teachers' confidence in their personal math skills is reported to positively affect children's math learning (Stipek et al., 2001). Thus, studying prekindergarten and kindergarten child outcomes in relation to teaching practices would be a worthwhile pursuit in this line of research.

Another line of research needs to inquire with teachers what type of science teaching tasks causes them the most concern or anxiety. Chen et al. (2014) examined teachers' self-reported abilities on specific math abilities as part of a larger study. Their results indicated that the majority of teachers felt confident in what math to teach to children and their ability to teach it, but they were less confident in the math knowledge that children bring to school upon entry, how best to assess children's math knowledge, and turning the assessment results into teaching plans for their class. Their findings suggest that teacher confidence is dependent on the type of math knowledge and teaching ability (Chen et al., 2014). This type of information would be useful in both science and math for creating professional development targeted to the teachers' needs.

Conclusion

Science and math education for young children is critical. Learning these subjects assists in developing skills related to problem solving and analytical thinking, language and literacy (Gelman & Brenneman, 2004; Ginsburg et al., 2008). Research suggests that early math skills and understanding is a strong contributor to later school achievement (Duncan et al., 2007). Teachers' knowledge of science and math standards, beliefs of science and math teaching skills, and level of science and math self-efficacy are all important to consider when trying to understand teachers' classroom practices. Moreover, for children to acquire new knowledge and understanding of science and math, teachers must have the knowledge, self-belief, and self-efficacy in their abilities to teach science and math and be proficient in those subjects (Ginsburg et al., 2008; Sarama & DiBiase, 2004; Watters & Ginns, 1995).

This study investigated how teachers' knowledge of standards, beliefs of teaching skills, and level of self-efficacy in science and math influenced their teaching practices in terms of how often they were working on science and math activities related to their grade's curriculum standards. The findings indicate that beliefs of science and math teaching skills play a major role in how teachers implement science and math activities, and this is supported by past work (Pajares, 1992). The use of curriculum standards in this study offers an opportunity to examine how teachers view their teaching skills and feelings of self-efficacy in relation to these standards. As growing pressure is put on teachers to guide young children's development in the areas of math and science, it is increasingly important that teachers gain the knowledge, skills, and confidence to implement developmentally appropriate activities in these areas throughout preschool and kindergarten. Since all young children deserve the chance to develop strong foundational skills and knowledge in math and science, this area of research is worthy of continued pursuit.

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APPENDIX A

TABLES

Table 1. Years of Experience, Teacher Education, Use of Standards for Planning, Years Since Last Science or Math Class or Workshop, and Enjoyment of Last Science or Math Class or Workshop for Prekindergarten Teachers.

	Mean	Standard Deviation	Range
Years teaching prekindergarten (n = 53)	3.23	1.40	1-5
Total years of teaching (n = 53)	3.49	1.30	1-5
Years of intentionally teaching science (n = 51)	2.84	1.30	1-5
Years of intentionally teaching math (n = 53)	3.15	1.46	1-5
Highest level of teacher education (n = 50)	9.48	1.50	5-12
Use of standards in planning for prekindergarten (n = 52)	4.31	.883	1-5
Years since last science class (n = 53)	2.47	1.53	1-7
Enjoyment of last science class (n = 53)	3.83	1.12	1-5
Years since last science workshop (n = 53)	2.15	1.73	1-7
Enjoyment of last science workshop (n = 53)	4.00	1.11	1-5
Years since last math class (n = 53)	2.55	1.59	1-7
Enjoyment of last math class (n = 53)	3.60	1.25	1-5
Years since last math workshop (n = 53)	2.62	2.17	1-7
Enjoyment of last math workshop (n = 53)	3.74	1.00	2-5

Table 2. Years of Experience, Teacher Education, Use of Standards for Planning, Years Since Last Science or Math Class or Workshop, and Enjoyment of Last Science or Math Class or Workshop for Kindergarten Teachers (n = 30).

	Mean	Standard Deviation	Range
Years teaching kindergarten	2.90	1.56	1-5
Total years of teaching	3.47	1.50	1-5
Years of intentionally teaching science	3.23	1.41	1-5
Years of intentionally teaching math	3.43	1.50	1-5
Highest level of teacher education	10.30	1.64	8-12
Use of standards in planning for kindergarten	4.67	.758	2-5
Years since last science class	3.10	1.94	1-7
Enjoyment of last science class	3.37	.999	1-5
Years since last science workshop	2.73	2.17	1-7
Enjoyment of last science workshop	3.37	1.33	1-5
Years since last math class	2.60	1.85	1-6
Enjoyment of last math class	3.53	1.11	1-5
Years since last math workshop	1.70	1.21	1-7
Enjoyment of last math workshop	3.87	1.04	1-5

Table 3. Descriptive Statistics for Knowledge, Skill in Implementing Activities, Self-Efficacy, and Frequency of Activities in the Classroom for Prekindergarten Teachers in Science and Math.

	Mean (SD)	Range	Cronbach's α
	Science		
Average of prekindergarten teachers' knowledge of science standards	3.86 (.70)	1-5	.93
Average of prekindergarten teachers' skill at implementing activities around science standards	4.05 (.58)	1-5	.91
Average of prekindergarten teachers' science teaching self-efficacy	3.98 (.81)	1-5	.87
Average frequency of prekindergarten science activities	3.73 (.59)	1-5	.81
	Math		
Average of prekindergarten teachers' knowledge of math standards	4.30 (.64)	1-5	.97
Average of prekindergarten teachers' skill at implementing activities around math standards	4.32 (.65)	1-5	.97
Average of prekindergarten teachers' math teaching self-efficacy	4.32 (.58)	3-5	.88
Average frequency of prekindergarten math activities	4.24 (.61)	1-5	.96

Table 4. Descriptive Statistics for Knowledge, Skill in Implementing Activities, Self-Efficacy, and Frequency of Activities in the Classroom for Kindergarten Teachers in Science and Math.

	Mean (SD)	Range	Cronbach's α
	Science		
Average of kindergarten teachers' knowledge of science standards	3.75 (.67)	1-5	.81
Average of kindergarten teachers' skill at implementing activities around science standards	3.75 (.73)	1-5	.82
Average of kindergarten teachers' science teaching self-efficacy	3.92 (.75)	2-5	.84
Average frequency of kindergarten science activities	3.29 (.77)	1-5	.68
	Math		
Average of kindergarten teachers' knowledge of math standards	4.52 (.60)	2-5	.97
Average of kindergarten teachers' skill at implementing activities around math standards	4.42 (.57)	3-5	.95
Average of kindergarten teachers' math teaching self-efficacy	4.52 (.47)	2-5	.83
Average frequency of kindergarten math activities	4.25 (.59)	2-5	.92

Table 5. Correlations between Teacher Education, Teacher Experience, Averages of Teachers' Knowledge, Skill, Self-Efficacy, and Frequency of Science Activities in Prekindergarten Classrooms.

	1	2	3	4	5	6	7	8
1. Highest teacher education level	1	.137	.099	.086	.306*	.226	-.047	.043
2. Years teaching preschool	.137	1	.874**	.806**	.147	.261	.198	.317*
3. Years teaching total	.099	.874**	1	.709**	.126	.197	.047	.221
4. Years teaching science	.086	.806**	.709**	1	.175	.306*	.244	.221
5. Average knowledge of science standards	.306*	.147	.126	.175	1	.636**	.277*	.100
6. Average belief of science teaching skills	.226	.261	.197	.306*	.636**	1	.198	.340*
7. Average level science self-efficacy	-.047	.198	.047	.244	.277*	.198	1	.212
8. Average frequency of science activities	.043	.317*	.221	.221	.100	.340*	.212	1

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 6. Correlations between Teacher Education, Teacher Experience, Averages of Teachers' Knowledge, Skill, Self-Efficacy, and Frequency of Science Activities in Kindergarten Classrooms.

	1	2	3	4	5	6	7	8
1. Highest teacher education level	1	-.055	.025	.073	-.134	-.222	-.308	-.078
2. Years teaching kindergarten	-.055	1	.844**	.749**	.307	.446*	.181	.032
3. Years teaching total	.025	.844**	1	.860**	.353	.432*	.228	.161
4. Years teaching science	.073	.749**	.860**	1	.432*	.461*	.335	.166
5. Average knowledge of science standards	-.134	.307	.353	.432*	1	.708**	.566**	.444*
6. Average belief of science teaching skills	-.222	.446*	.432*	.461*	.708**	1	.479**	.470**
7. Average level science self-efficacy	-.308	.181	.228	.335	.566**	.479**	1	.450*
8. Average frequency of science activities	-.078	.032	.161	.166	.444*	.470**	.450*	1

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 7. Correlations between Teacher Education, Teacher Experience, Averages of Teachers' Knowledge, Skill, Self-Efficacy, and Frequency of Math Activities in Prekindergarten Classrooms.

	1	2	3	4	5	6	7	8
1. Highest teacher education level	1	.137	.099	.186	.034	.072	.092	-.001
2. Years teaching preschool	.137	1	.874**	.842**	.018	.195	.281*	.332*
3. Years teaching total	.099	.874**	1	.855**	.084	.177	.193	.254
4. Years teaching math	.186	.842**	.855**	1	.149	.294*	.268	.333*
5. Average knowledge of math standards	.034	.018	.084	.149	1	.643**	.231	.363**
6. Average belief of math teaching skills	.072	.195	.177	.294*	.643**	1	.525**	.603**
7. Average level math self-efficacy	.092	.281*	.193	.268	.231	.525**	1	.359**
8. Average frequency of math activities	-.001	.332*	.254	.333*	.363**	.603**	.359**	1

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 8. Correlations between Teacher Education, Teacher Experience, Averages of Teachers' Knowledge, Skill, Self-Efficacy, and Frequency of Math Activities in Kindergarten Classrooms.

	1	2	3	4	5	6	7	8
1. Highest teacher education level	1	-.055	.025	.169	-.027	-.054	-.076	-.107
2. Years teaching kindergarten	-.055	1	.844**	.872**	.293	.269	.294	-.097
3. Years teaching total	.025	.844**	1	.901**	.286	.263	.311	-.193
4. Years teaching math	.169	.872**	.901**	1	.383*	.361	.386*	-.175
5. Average knowledge of math standards	-.027	.293	.286	.383*	1	.732**	.374*	.007
6. Average belief of math teaching skills	-.054	.269	.263	.361	.732**	1	.576**	-.015
7. Average level math self-efficacy	-.076	.294	.311	.386*	.374*	.576**	1	-.057
8. Average frequency of math activities	-.107	-.097	-.193	-.175	.007	-.015	-.057	1

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 9. Multiple Linear Regression Model Summary of Teacher Education, Teacher Experience, and Beliefs of Science Teaching Skills for Prekindergarten Teachers.

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.080[a]	.006	-.015	.59417	.006	.304	1	47	.584
2	.341[b]	.116	.078	.56648	.110	5.707	1	46	.021
3	.434[c]	.189	.135	.54872	.073	4.025	1	45	.051

a. Predictors: (Constant), highest teacher education level
b. Predictors: (Constant), highest teacher education level, years teaching preschool
c. Predictors: (Constant), highest teacher education level, years teaching preschool, average of beliefs of science teaching skills

Table 10. ANOVA for Multiple Linear Regression of Teacher Education, Teacher Experience, and Beliefs of Science Teaching Skills for Prekindergarten Teachers.

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.107	1	.107	.304	.584[a]
	Residual	16.593	47	.353		
	Total	16.700	48			
2	Regression	1.939	2	.969	3.021	.059[b]
	Residual	14.761	46	.321		
	Total	16.700	48			
3	Regression	3.151	3	1.050	3.488	.023[c]
	Residual	13.549	45	.301		
	Total	16.700	48			

Dependent Variable: average of teacher's frequency of science activities
a. Predictors: (Constant), highest teacher education level
b. Predictors: (Constant), highest teacher education level, years teaching preschool
c. Predictors: (Constant), highest teacher education level, years teaching preschool, average of beliefs of science teaching skills

Table 11. Multiple Linear Regression Model Summary of Teacher Education, Teacher Experience, Knowledge of Science Standards, Beliefs of Science Teaching Skills, and Level of Science Self-Efficacy for Kindergarten Teachers.

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.078[a]	.006	-.029	.78273	.006	.172	1	28	.681
2	.083[b]	.007	-.067	.79678	.001	.021	1	27	.885
3	.511[c]	.261	.176	.70021	.255	8.961	1	26	.006
4	.575[d]	.331	.224	.67955	.070	2.605	1	25	.119

a. Predictors: (Constant), highest teacher education level

b. Predictors: (Constant), highest teacher education level, years teaching K

c. Predictors: (Constant), highest teacher education level, years teaching K, average of beliefs of science teaching skills

d. Predictors: (Constant), highest teacher education level, years teaching K, average of beliefs of science teaching skills, average of level of science self-efficacy

Table 12. ANOVA for Multiple Linear Regression of Teacher Education, Teacher Experience, Knowledge of Science Standards, Beliefs of Science Teaching Skills, and Level of Science Self-Efficacy for Kindergarten Teachers.

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.106	1	.106	.172	.681[a]
	Residual	17.155	28	.613		
	Total	17.260	29			
2	Regression	.119	2	.060	.094	.911[b]
	Residual	17.141	27	.635		
	Total	17.260	29			
3	Regression	4.513	3	1.504	3.068	.045[c]
	Residual	12.748	26	.490		
	Total	17.260	29			
4	Regression	5.716	4	1.429	3.094	.034[d]
	Residual	11.545	25	.462		
	Total	17.260	29			

Dependent Variable: average of teacher's frequency of science activities
a. Predictors: (Constant), highest teacher education level
b. Predictors: (Constant), highest teacher education level, years teaching kindergarten
c. Predictors: (Constant), highest teacher education level, years teaching kindergarten, average of beliefs of science teaching skills
d. Predictors: (Constant), highest teacher education level, years teaching kindergarten, average of beliefs of science teaching skills, average of level of science self-efficacy

Table 13. Multiple Linear Regression Model Summary of Teacher Education, Teacher Experience, Beliefs of Math Teaching Skills, and Level of Math Self-Efficacy for Prekindergarten Teachers.

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.001[a]	.000	-.021	.61465	.000	.000	1	48	.996
2	.338[b]	.114	-.077	.58461	.114	6.060	1	47	.018
3	.660[c]	.435	.398	.47195	.321	26.118	1	46	.000
4	.660[d]	.435	.385	.47706	.000	.019	1	45	.891

a. Predictors: (Constant), highest teacher education level
b. Predictors: (Constant), highest teacher education level, years teaching preschool
c. Predictors: (Constant), highest teacher education level, years teaching preschool, average of teacher's skill at implementing activities and math standards
d. Predictors: (Constant), highest teacher education level, years teaching preschool, average of beliefs of math teaching skills, average of level of math self-efficacy

Table 14. ANOVA for Multiple Linear Regression of Teacher Education, Teacher Experience, Beliefs of Math Teaching Skills, and Level of Math Self-Efficacy for Prekindergarten Teachers.

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.000	1	.000	.000	.996[a]
	Residual	18.134	48	.378		
	Total	18.134	49			
2	Regression	2.071	2	1.036	3.030	.058[b]
	Residual	16.063	47	.342		
	Total	18.134	49			
3	Regression	7.889	3	2.630	11.806	.000[c]
	Residual	10.246	46	.223		
	Total	18.134	49			
4	Regression	7.893	4	1.973	8.670	.000[d]
	Residual	10.242	45	.228		
	Total	18.134	49			

Dependent Variable: average of teacher's frequency of math activities
a. Predictors: (Constant), highest teacher education level
b. Predictors: (Constant), highest teacher education level, years teaching preschool
c. Predictors: (Constant), highest teacher education level, years teaching preschool, average of beliefs of math teaching skills
d. Predictors: (Constant), highest teacher education level, years teaching preschool, average of beliefs of math teaching skills, average of level of math self-efficacy

Table 15. Multiple Linear Regression Model Summary of Teacher Education and Teacher Experience for Math and Kindergarten Teachers.

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.107[a]	.011	-.024	.59366	.011	.325	1	28	.573
2	.148[b]	.022	-.050	.60132	.011	.291	1	27	.594

a. Predictors: (Constant), highest teacher education level
b. Predictors: (Constant), highest teacher education level, years teaching kindergarten

Table 16. ANOVA for Multiple Linear Regression of Teacher Education and Teacher Experience for Math and Kindergarten Teachers.

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.115	1	.115	.325	.573[a]
	Residual	9.868	28	.352		
	Total	9.983	29			
2	Regression	.220	2	.110	.304	.740[b]
	Residual	9.763	27	.362		
	Total	9.983	29			

Dependent Variable: average of teacher's frequency of math activities
a. Predictors: (Constant), highest teacher education level
b. Predictors: (Constant), highest teacher education level, years teaching kindergarten

Table 17. Correlations of Years Since Last Science Class, Enjoyment of Last Science Class, Years Since Last Science Workshop, Enjoyment of Last Science Workshop, and Frequency of Science Activities in Prekindergarten Classrooms.

	1	2	3	4	5
1. Years since last science class	1	-.166	.221	.034	-.085
2. Enjoyment of last science class	-.166	1	-.414**	.664**	.229+
3. Years since last science workshop	.221	-.414**	1	-.111	-.168
4. Enjoyment of last science workshop	.034	.664**	-.111	1	.217
5. Average frequency of science activities	-.085	.229+	-.168	.217	1

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
+ Correlation is significant at the 0.10 level (2-tailed).

Table 18. Correlations of Years Since Last Science Class, Enjoyment of Last Science Class, Years Since Last Science Workshop, Enjoyment of Last Science Workshop, and Frequency of Science Activities in Kindergarten Classrooms.

	1	2	3	4	5
1. Years since last science class	1	.070	.419*	.267	.101
2. Enjoyment of last science class	.070	1	.211	.754**	.013
3. Years since last science workshop	.419*	.211	1	.343	.028
4. Enjoyment of last science workshop	.267	.754**	.343	1	.153
5. Average frequency of science activities	.101	.013	.028	.153	1

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 19. Correlations of Years Since Last Math Class, Enjoyment of Last Math Class, Years Since Last Math Workshop, Enjoyment of Last Math Workshop, and Frequency of Math Activities in Prekindergarten Classrooms.

	1	2	3	4	5
1. Years since last math class	1	-.277*	.486**	-.270	.094
2. Enjoyment of last math class	-.277*	1	-.370**	.700**	-.063
3. Years since last math workshop	.486**	-.370**	1	-.418**	.070
4. Enjoyment of last math workshop	-.270	.700**	-.418**	1	.245+
5. Average frequency of math activities	.094	-.063	.070	.245+	1

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
+ Correlation is significant at the 0.10 level (2-tailed).

Table 20. Correlations of Years Since Last Math Class, Enjoyment of Last Math Class, Years Since Last Math Workshop, Enjoyment of Last Math Workshop, and Frequency of Math Activities in Kindergarten Classrooms.

	1	2	3	4	5
1. Years since last math class	1	-.027	.114	.061	.127
2. Enjoyment of last math class	-.027	1	-.108	.722**	-.337+
3. Years since last math workshop	.114	-.108	1	.159	.032
4. Enjoyment of last math workshop	.061	.722**	.159	1	-.213
5. Average frequency of math activities	.127	-.337+	.032	-.213	1

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
+ Correlation is significant at the 0.10 level (2-tailed).

Table 21. Multiple Linear Regression Coefficients from Years Since Last Science or Math Class, Enjoyment of Last Science or Math Class, Years Since Last Science or Math Workshop, and Enjoyment of Last Science or Math Workshop in Prekindergarten and Kindergarten Classrooms.

	B	SE B	p
Prekindergarten Science			
Years since last science class	.017	.120	.885
Enjoyment of last science class	-.018	.059	.755
Years since last science workshop	-.028	.054	.606
Enjoyment of last science workshop	.088	.109	.417
Kindergarten Science			
Years since last science class	.027	.089	.761
Enjoyment of last science class	-.163	.251	.515
Years since last science workshop	.011	.088	.901
Enjoyment of last science workshop	.158	.201	.432
Prekindergarten Math			
Years since last math class	.019	.063	.765
Enjoyment of last math class	-.219*	.102	.033
Years since last math workshop	.006	.052	.903
Enjoyment of last math workshop	.358**	.137	.009
Kindergarten Math			
Years since last math class	.037	.063	.559
Enjoyment of last math class	-.185	.156	.237
Years since last math workshop	-.007	.097	.943
Enjoyment of last math workshop	.021	.168	.901

** Significant at the 0.01 level (2-tailed).

* Significant at the 0.05 level (2-tailed).