ABSTRACT

LUGINBUHL, SARAH CHRISTEN. A Study of Elementary Teachers’ Beliefs of Science Education and Using the Outdoors as a Setting for Teaching and Learning. (Under the direction of Dr. Sarah J. Carrier).

The goal of the present study was to examine North Carolina elementary teachers’ beliefs about science education and using the outdoors as a setting for teaching and learning. The target population were teachers who work in schools that participated in a schoolyard-focused science professional development (PD) program. Science education in elementary school can lay the foundation upon which students develop a deeper understanding of scientific issues. Outdoor education can offer benefits to students such as increased physical movement, sensory and tactile experiences, the use of problem-solving skills, the joy of discovery, and an increased interest in science. Many studies show that while teachers recognize there are benefits to using the outdoors as a setting for teaching and learning, challenges exist that inhibit them from using the outdoors for instruction. Effective PD can be an important support mechanism for teachers’ continuing development and learning, with the goal of enhancing student learning; however, if PD facilitators want teachers to implement the teachings from the PD, they must consider and account for teachers’ self-efficacy, beliefs, and instructional practices regarding science and using the outdoors as a setting for teaching and learning. This study was grounded in the framework of Bandura’s (1977) theory of self-efficacy. Self-efficacy describes the confidence one has in oneself for achieving a desired outcome from doing a certain task, with behavior affected by what one thinks, believes, and feels (Bandura, 1977; Bandura, 1997). Teachers can gain knowledge and experience through PD programs with science content, science teaching, and with new and innovative teaching and learning strategies, such as using the outdoors as a setting for teaching and learning.
In this exploratory, mixed-methods study, quantitative data is the dominant data type and qualitative data less dominant, with the qualitative data supporting and enhancing the quantitative data. The researcher developed and collected quantitative data using a survey that asked teachers at schools, where the PD occurred between 1991 and 2016, about their beliefs and instructional practices regarding science instruction and the use of the outdoors as a setting for teaching and learning. Qualitative data consisted of in-person interviews of past PD participants to better understand their beliefs of science as well as their goals, confidence, and instructional practices in science. Past PD participants’ beliefs about using the outdoors as a setting for teaching and learning, the benefits, and the challenges they face taking their students outside for teaching and learning were also discussed. Teachers’ quantitative survey responses indicated that they viewed science as an important part of the elementary school curriculum, and while they acknowledged the benefits of using the outdoors as a setting for teaching and learning, they reported barriers that deterred some of them from implementing outdoor instruction in their teaching practice. Former participants in the PD discussed benefits and challenges they saw when using the outdoors as a setting for teaching and learning. Recommendations from this study include developing outdoor PD that addresses teachers’ self-efficacy and beliefs about using the outdoors as a setting for teaching and learning so that teachers and students can benefit from outdoor education.
A Study of Elementary Teachers’ Beliefs of Science Education and Using the Outdoors as a Setting for Teaching and Learning.

by
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A dissertation submitted to the Graduate Faculty of North Carolina State University in partial fulfillment of the requirements for the degree of Doctor of Philosophy

Science Education

Raleigh, North Carolina
2019

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DEDICATION

This dissertation is dedicated to my family and friends who have supported me throughout this process.
BIOGRAPHY

Sarah Christen Luginbuhl was born and raised in Raleigh, North Carolina. She grew up playing outdoors and went camping and hiking with her family many times. She loved being out in nature as it was rejuvenating and humbling. She received a Bachelor of Science degree in Leisure Studies (better known as Parks and Recreation) from the University of North Carolina at Greensboro in 1996 and a Master of Science degree in Natural Resources, with a major in Hydrology and a minor in Soil Science, from North Carolina State University in 2004. She worked for several years as an environmental scientist, performing wetland delineations, soil surveys, and stream restorations. After starting a family, she began working in the Microbiology Department at NCSU as the Program Coordinator for the Masters of Microbial Biotechnology (MMB) program. She began working on her doctorate part-time in 2009 while working full-time at NCSU. In 2016 she began working full-time as a contractor with the federal government and will continue to work there after graduation. She is married to Colin Mathews and has two children, Grace and Miles Mathews.
ACKNOWLEDGMENTS

I would like to acknowledge my chair, Dr. Sarah Carrier, who has supported and encouraged me throughout this entire process, and my committee members Dr. Gail Jones, Dr. Meg Blanchard, and Dr. Karen McNeal for their words of encouragement. I would also like to acknowledge my parents who have given me great advice, and my husband and children who have given me moral support while I write at night and on the weekends, and sometimes during soccer games.
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CHAPTER 1: INTRODUCTION

This study was designed to examine the status of NC elementary teachers’ beliefs about elementary school science and the outdoors as a setting for teaching and learning, and how these beliefs may differ between teachers who participated in a schoolyard-focused science PD program and those that did not participate in the program. In this chapter, the researcher describes the concepts supporting this study including science and outdoor education and professional development, and an overview of the framework of Bandura’s (1977) theory of self-efficacy. This study adds to the literature by examining elementary school teachers who work in schools that participated in a schoolyard-focused, science PD program over the past 25 years, and whether any institutional memory of the program remains.

Science Education

Science education is a critical part of the elementary school curriculum, as it begins to build a solid foundation for students to develop and maintain science knowledge and interest in science and to build critical thinking skills (Banilower et al., 2013; Sandholtz & Ringstaff, 2016). Science consists of both a body of knowledge and the practices or processes through which that knowledge is established (National Research Council [NRC], 2012). Throughout K-12 science education, students gain experiences with both scientific knowledge and scientific practices, with the goal that this knowledge will help guide them in making well-informed decisions about their lives (NRC, 2012). Curriculum reform efforts over many decades have defined and redefined the goals of science education to match societal needs and advances in understanding teaching and learning.

Science education reform efforts began in response to the U.S.S.R.’s launch of Sputnik in 1957, when many curriculum reform efforts were taking place in the major content areas of
physics, biology, and chemistry, as well as earth science, physical science, and elementary science (DeBoer, 1991), and in the 1980s with the report *A Nation at Risk* (Gardner, 1983), a response to concerns about US economic competitiveness and declining US scientific production (Carey, 2000; DeBoer, 1991; NRC, 2007). In the 1990s, subject matter communities, groups consisting of subject matter experts, teachers, and curriculum developers, developed frameworks such as the *Benchmarks for Science Literacy* (American Association for the Advancement of Science [AAAS], 1993) and the *National Science Education Standards* (NRC, 1996) to guide curriculum development led by state and local authorities. The *No Child Left Behind Act* (NCLB, 2002) tied federal funding for educational improvements to specific performance goals, often resulting in more time and resources directed toward mathematics and literacy to the detriment of other subjects, including science (Marx & Harris, 2006). In the 2000s, curriculum reform efforts included the development of the *Framework for K – 12 Science Education* (NRC, 2012) and the *Next Generation Science Standards* (NGSS, 2013), which are standards based on the *Framework for K – 12 Science Education* and can be adopted by the states. By the end of 2018, 19 states and the District of Columbia had adopted the *Next Generation Science Standards* and 21 states had adopted science standards based on the *Framework for K – 12 Science Education* (https://ngss.nsta.org/About.aspx). Science education reform efforts for elementary school science include both science content and processes (NRC, 2012).

**Science Education in Elementary School**

Science education in elementary school is the foundation upon which students can develop a deeper understanding of scientific issues (AAAS, 1993; NRC, 1996, 2012; NGSS, 2013; Sandholtz & Ringstaff, 2016) and gain experience with both scientific knowledge and scientific practices, which can help students make better informed decisions about their lives.
Part of elementary science education involves learning scientific processes such as observing, measuring, and predicting (https://www.narst.org/publications/research/skill.cfm), and practices such as asking questions, planning and carrying out investigations, and analyzing and interpreting data, that emphasize open-ended discovery by the students, with the teacher as a guide (NRC, 2012). This is to establish an appreciation for scientific practices and the joy of discovery over traditional instruction of science that included rote memorization of science content with little connection to students’ lives (NRC, 2007). Despite the fact that science education is a critical part of elementary school, there is often limited time for science instruction in part due to an emphasis many schools place on mathematics and literacy (Trygstad, Smith, Banilower, & Nelson, 2013).

Federal funding for educational improvements was tied to specific performance goals usually in mathematics and literacy in the No Child Left Behind Act (2002), often resulting in more time and resources directed toward those subjects, to the detriment of other subjects, including science (Marx & Harris, 2006). End-of-grade (EOG) testing for mathematics and literacy testing usually begins in the 3rd grade, while in many states, including North Carolina, students do not take a science EOG until either the fourth or fifth grade. Teachers reported that they taught science approximately 50 minutes less per day than language arts and approximately 35 minutes less than math, with approximately 38% of teachers reporting that they do not teach science every week (Trygstad et al., 2013). With a lack of time spent teaching science, teachers’ confidence in teaching science may be limited and this can influence a teachers’ instructional practices (Thomson & Gregory, 2013).

Beginning in early elementary school, the ability to directly experience and investigate science content should be a part of science education (NRC, 2012). The outdoors has the
potential to offer students authentic experiences, opportunities to investigate topics they are learning about in the classroom, and opportunities to be more reflective of actual scientific processes and practices (NRC, 2004).

**Outdoor Education**

There is a long history of teaching and learning in the outdoors in the United States (Hammerman, Hammerman, & Hammerman, 2001). During the Great Depression of the 1930s, educators used outdoor education as a way of providing healthful living, fresh air, and sunshine, and to educate people about soil and land conservation measures. During World War II, the purpose of outdoor education was identified as an instructional setting to provide “emotional stability and well-being” for students (Hammerman et al., p. 6), as this was thought to help ameliorate some of the pressure and tension felt by the war and help people connect with the basic elements of life. During the 1970s and 1980s, the growth in environmental awareness prompted increased advocacy for learning about the outdoors, especially ecology, as part of the science-technology-society (STS) theme in science education (DeBoer, 1991).

Due to many science topics (e.g., biology, botany, and meteorology) naturally occurring in the outdoors, expanding science instruction outside of the classroom can allow students to observe and collect data in an authentic setting. In the *Framework for K – 12 Science Education* (NRC, 2012) the developers identify a goal of science to develop theories that can explain “features of the world” (p. 52).

**Using the Outdoors as a Setting for Teaching and Learning**

Using the outdoors as a setting for teaching and learning can be beneficial for student learning. The outdoors can provide an important setting for cognitive learning (Falk & Balling, 1982; Mayer, Frantz, Bruehlmae-Senecal, Dolliver, 2009; Orion, 1993), personal and social
development (Brody, Bangert, Dillon, 2008), the development of environmental stewardship (Knapp & Barrie, 2001), and has been shown to positively influence attitudes and health (Mayer, Frantz, Bruehlmb-Senecal, Dolliver, 2009). Additional benefits of using the outdoors include sensory and tactile experiences (Malone, 2008), the use of problem-solving skills, the joy of discovery, and an increased interest in science content (Hammerman et al., 2001, p. 18-20).
Learning through experience, and what one does during and after experiences, plays a central role in learning and development (Kolb, 1984). Learning happens through doing, reading, and reflecting (Darling-Hammond & McLaughlin, 1995; Kazempour & Amirshokoohi, 2014). In order to provide rich outdoor learning experiences for their students, teachers need specialized experiences in using the outdoors as a setting for teaching and learning (Simmons, 1998). Despite the many benefits of using the outdoors as a setting for teaching and learning, challenges exist that can hinder teachers from taking their students outside.

Challenges teachers cite for not utilizing outside areas include a lack of administrative and financial support, student management and safety issues, lack of time for planning, and lack of skills and knowledge about teaching outdoors (Dyment, 2005; Ernst, 2014; Waite, 2009; Waite, Bølling, & Bentsen, 2016). For teachers to provide effective instruction in the outdoors, they need preparation for how to teach in the outdoors with curricula that are designed for outdoor instruction (Meichtry & Harrell, 2002). Outdoor curricula are available, such as Project WILD (Council for Environmental Education, 2001), Project WET (Project WET Foundation, 2011), and Project Learning Tree (American Forest Foundation, 2000), which can be effective in supporting instruction in the outdoors. Effective PD that supports teacher learning about outdoor instruction and that addresses the challenges teachers cite can give them more resources, experience, and confidence in using the outdoors as a setting for teaching and learning.
Professional Development

Professional development is an important support mechanism for teachers’ continuing development and learning (Avalos, 2011; Desimone, 2009; Desimone, Porter, Garet, Yoon, & Birman, 2002; Guskey, 2003), and often refers to activities and processes that are designed to enhance teachers’ professional knowledge, skills, and attributes to improve the learning opportunities for their students (Guskey, 2003). There is a large body of research defining effective PD (Darling-Hammond, Hyler, Gardner, 2017; Desimone, 2009; Desimone et al., 2002). This has resulted in the emergence of a consensus about particular characteristics of highly effective PD. Characteristics of effective PD include (1) content focus, (2) active learning, (3) coherence, (4) duration, and (5) collective participation (Desimone et al., 2002; Desimone & Garet, 2016; Kang, Cha, & Ha; 2013). Opportunities for PD situated in the outdoors have increased over the past decade as educators see the potential of outdoor learning for student growth and achievement (Holden et al., 2011).

For outdoor PD programs to result in teachers using the outdoors as a setting for teaching and learning and seeing positive results in student learning outcomes, PD program facilitators should understand teachers’ prior science content knowledge, their beliefs and confidence in teaching science and in teaching in the outdoors, how to adapt science lessons and science standards to the outdoor environment, and the specific challenges teachers face in taking their students outside for instruction, such as limited time and resources. Effective PD can help teachers learn science content and instructional strategies to make using the outdoors as a setting for teaching and learning an effective and rewarding experience (Holden et al., 2011).
Statement of the Problem

This study was designed to identify teachers’ beliefs of science in the elementary school curriculum and their use of the outdoors as a setting for teaching and learning. The target population was NC elementary teachers who worked in schools that participated in a PD program called UTOTES (Using the Outdoors to Teach Experiential Science), a schoolyard-focused science PD program for elementary teachers, between 1991 and 2016. All teachers, regardless of whether or not they participated in the PD program, were invited to participate in the survey, with the researcher anticipating that a portion of teacher respondents would be PD participants. This study is unique in that it captures the beliefs of PD participants many years after participation.

Framing the Study

This study was grounded in the framework of Bandura’s (1977) theory of self-efficacy and beliefs. Self-efficacy describes the confidence one has in oneself for achieving a desired outcome from doing a certain task, with behavior affected by what one thinks, believes, and feels (Bandura, 1977; Bandura, 1997). Pajares (1992) states that beliefs are deeply personal, difficult to change, and can be “formed by chance, an intense experience, or a succession of events” (p. 309). All teachers hold beliefs about their teaching practice, their students, the subjects they teach, and their roles and responsibilities as teachers (Pajares, 1992), and these beliefs have developed over many years, first as students, then as pre-service teachers, and after that, as in-service teachers (Jones & Leagon, 2014; Lumpe, Haney, & Czerniak, 2000; Milner, Sondergeld, Demir, Johnson, & Czerniak, 2012). Beliefs are powerful and influence how teachers make decisions (Lumpe et al., 2000). A teacher’s actions in the classroom and their instructional and professional practices are greatly influenced by their beliefs of science and science teaching.
Teachers’ beliefs about their ability to teach science are influenced by their perceptions of the skills and knowledge needed to teach effectively and their own abilities to do so (Sandholtz & Ringstaff, 2014).

Many elementary school teachers report low levels of confidence in their science knowledge and teaching compared with other subjects (Abell & Roth, 1992; Appleton, 2006; Kisiel, 2013). Five percent or less of elementary school teachers report having a degree in science, engineering, or science education, and this lack of content knowledge may contribute to a lack of confidence (Banilower, 2013). The National Science Teachers Association (NSTA) recommends that elementary teachers need to be prepared to teach life science, earth science, and physical science, yet only 20% of teachers report that they have taken courses in all three content areas (Banilower, 2013). Teachers play a critical role in students’ learning in all subject areas, but a lack confidence and experience in teaching science may influence their beliefs about science and their instructional practices (Thomson & Gregory, 2013).

Low self-efficacy in science knowledge and teaching may result in a teacher not investing as much of their time and energy into science than they might on a subject for which they felt more confident in their abilities and more confident in the outcomes of their teaching. Research on teachers’ confidence suggests that certain behaviors such as persistence on a task, taking risks, and using innovative teaching techniques are related to degrees of confidence, and that confidence can be improved through experience (Moseley, Reinke, & Bookout, 2002). Teachers can gain knowledge and experience through PD programs that provide teachers with science content and include strategies for effective science teaching. Understanding teacher beliefs and science teaching self-efficacy are necessary in order to provide effective support so teachers can confidently and effectively engage their students in science.
**Purpose of the Study**

The goal of this study was to examine NC elementary teachers’ beliefs about science in the elementary school curriculum and the outdoors as a setting for teaching and learning. Only schools that had participated in the PD program were schools for data collection and the respondents included both teachers who participated in the PD program and teachers who were not PD participants. Specifically, the research questions asked:

**Research Questions**

1. What are elementary teachers’ beliefs of science education?
2. What are elementary teachers’ beliefs of the outdoors as a setting for teaching and learning?
3. What are the relationships between the beliefs of science and the outdoors as a setting for teaching and learning for teachers who participated in the PD program and teachers who did not participate?

**Professional Development: Context for this Study**

*Using The Outdoors to Teach Experiential Science* (UTOTES) is a schoolyard-focused science PD program for elementary teachers that is designed to enhance formal science teaching and learning and is run by the North Carolina Museum of Natural Sciences. The main emphases of the program are: 1) teachers learn how the natural world can be used to motivate and teach children, and how to use school grounds to develop curriculum and support the teaching of hands-on life and physical science; 2) teachers learn how to use the interdisciplinary nature of science to assist teaching in other subject areas; and 3) the principal and community leaders learn the value of school site improvements through projects such as butterfly gardens, mini-ponds, and bird feeding/observation stations. In this study, teachers who worked in schools that
participated in this PD program were the target population because of the PD’s emphasis on using the schoolyard for science instruction.

**Research Design**

In order to better understand the beliefs of elementary school teachers about science education and the use of the outdoors as a setting for teaching and learning, the researcher conducted an exploratory mixed-methods study in which quantitative survey data were the dominant data type and interview data were the less-dominant type (Creswell, 1994). Qualitative data plays a supporting role and enhances the quantitative data, and data analysis techniques for both data types were employed (Creswell & Clark, 2017; Gall, Gall, & Borg, 2007; Plano-Clark, Huddleston-Casas, Churchill, Green, & Garrett, 2008; Tashakkori & Teddlie, 1998). The quantitative data consisted of a survey of teachers who worked in schools that had participated in the schoolyard-focused science PD program. The qualitative data allowed for more in-depth understanding of PD participants’ beliefs beyond survey data and consisted of interviews with selected PD participants from two schools that participated in the PD program. The combination of both types of data provided a more complete understanding of PD and non-PD participants’ beliefs of science and using the outdoors as a setting for teaching and learning. The researcher also was interested in understanding if elementary school teachers who participated in the PD program differed in their beliefs of science and using the outdoors as a setting for teaching and learning compared to non-PD participants.

**Significance of the Study**

This research explores teacher beliefs about science instruction using the outdoors as a setting for teaching and learning, including the benefits and barriers to taking students outside for instruction. In addition, the study examined teachers’ instructional practices as reported in
teacher interviews regarding their teaching of science in outdoor settings, adding to the literature regarding the relationship between participation in PD programs and teachers’ beliefs and instructional practices.

**Organization of the Dissertation**

Chapter 2 of this dissertation presents relevant literature related to the study, followed by the methodology for the quantitative survey and qualitative interviews in Chapter 3, the results are presented in Chapter 4, and Chapter 5 features the discussion of this study’s findings in relation to the literature and future research ideas.
CHAPTER 2: LITERATURE REVIEW

This study was designed to examine the status of NC elementary teachers’ beliefs about elementary school science and the outdoors as a setting for teaching and learning. This research further explores the relationships of the beliefs between teachers who participated in a schoolyard-focused, science PD program and those that did not participate. In this chapter, literature that supports this study will be presented. Key concepts that influence elementary school science teaching include science education in elementary school, outdoor education, the benefits of and barriers to using the outdoors as a setting for teaching and learning, professional development, and teacher beliefs, attitudes, and self-efficacy towards science.

Science education can help students develop a deeper understanding of scientific issues (AAAS, 1993; NRC, 1996, 2012; NGSS, 2013), with the elementary school years being a critical time when students have the potential to develop and maintain a deep interest in science (Sandholtz & Ringstaff, 2016); However, according to the NRC (2012), the goals of elementary science education are often not being met, due in part to testing requirements in math and literacy, time constraints during the school day, and elementary school teachers’ often-reported lack confidence in teaching science (Kisiel, 2013). Curriculum reform efforts over the years have defined and redefined the goals of science education to match societal needs and advances in understanding of teaching and how children learn, including outdoor education.

There is a long and rich history in the United States of teaching and learning in the outdoors including adventure education, camping education, environmental education, and outdoor instruction that connects with the school science curriculum (Hammerman et al., 2001). The outdoors can provide an environment and an opportunity in which students can see the interconnectedness of subjects and the interconnectedness between their education and other
facets of their lives (Dyment, 2005). Learning outdoors can be experiential, where learning happens through doing, reading, and reflecting (Darling-Hammond & McLaughlin, 1995; Kazempour & Amirshokoohi, 2014; Kolb, 1984), and such outdoor experiential learning can enhance knowledge and influence beliefs (Dewey 1910/1997). Teachers who use the outdoors as a setting for teaching and learning often encounter barriers that may make it challenging to take their students outside, including lack of time, resources, support, and lack of skills and knowledge regarding teaching outdoors (Dyment, 2005; Ernst, 2014; Waite, 2009; Waite, Bølling, & Bentsen, 2016). For the outdoors to be used effectively for teaching and learning, teachers must be presented with appropriate curricula and given time to practice (Meichtry & Harrell, 2002). This can be done through PD that addresses teachers’ prior knowledge and experience in outdoors, along with specific needs of using the outdoors as a setting for teaching and learning.

Professional development can be an effective way to support and enhance teachers’ science content knowledge and understanding of science practices to better achieve the goals of science education (NRC, 2012). PD is an integral component of on-going teacher support and PD developers’ knowledge of effective PD design is critical to best impact teacher and student growth (Desimone et al., 2002; Avalos, 2011). Figure 1 shows the relationships between teachers’ beliefs or beliefs, attitudes, and self-efficacy regarding science and outdoor education and the influence of PD.
Figure 1: Relationships between teachers’ beliefs, attitudes, and self-efficacy regarding science, PD, and elementary school science and outdoor education.

Science and Science Education

Science consists of both a body of knowledge and the practices or processes through which that knowledge is established (NRC, 2012). The body of knowledge represents our current understanding of natural systems and science processes represent how that knowledge has and will be established and refined. Throughout K-12 science education, students gain experiences with both scientific knowledge and scientific practices, with the goal being that this knowledge will help guide them in making well-informed decisions about their lives (NRC, 2012).

According to the Framework for K – 12 Science Education (NRC, 2012), goals of science education are to ensure that by the end of 12th grade, all students:
possess sufficient knowledge of science to engage in public discussions on related issues; are careful consumers of scientific and technological information related to their everyday lives; are able to continue to learn about science outside school; and have the skills to enter careers of their choice, including (but not limited to) careers in science, engineering, and technology (p. 1).

For these goals to be accomplished, teachers must receive the education, PD, and materials, including appropriate curriculum, to provide an environment to support student learning (Singer, Marx, Krajcik, & Chambers, 2000).

In 1957, the Soviet Union launched Sputnik, which fueled the United States to call for science education reforms to increase the number of students entering science fields and increase the quality of science education to keep pace with the Soviet Union and rest of the world (DeBoer, 1991). In the 1960s the National Science Foundation (NSF) held summer institutes and curriculum development projects in efforts to reform science teacher education and curriculum. By the mid-1970s, around 60% of U.S. school districts reported using a NSF-sponsored science curriculum (NRC, 2007). Materials for these new curricula, however, were expensive for school systems to implement and required costly PD. (DeBoer, 1991). By the end of 1970s, the reform efforts by the NSF were hindered by a decrease in federal funding. Curriculum developers also underestimated the influence of students’ prior knowledge on learning, the simplistic views of scientific inquiry of both students and teachers, and the enormous challenge of trying to develop a large-scale science curriculum (NRC, 2007).

In the 1980s, the report *A Nation at Risk* (Gardner, 1983), a response to concerns about U.S. economic competitiveness and declining U.S. scientific production, was released (Carey, 2000; DeBoer, 1991; NRC, 2007). This report launched another round of science education
reform in the 1980s and 1990s. Subject matter communities, groups consisting of subject matter experts, teachers, curriculum developers, and others, developed frameworks such as the *Benchmarks for Science Literacy* (AAAS, 1993) and the *National Science Education Standards* (NRC, 1996) to guide science instruction led by state and local authorities. The AAAS and the NRC have been important drivers for the implementation of national science standards. These organizations created standards-based frameworks with recommendations for what students should know and be able to do in science, as well as teaching guidelines (AAAS, 2001; Marx & Harris, 2006; NRC, 1996, 2007). Following the turn of the century, science curriculum reform efforts were influenced by several developments, including the passage of the No Child Left Behind Act (NCLB, 2002), the re-authorization of the Elementary and Secondary Education Act (Marx & Harris, 2006). In the No Child Left Behind Act, federal funding for educational improvements was tied to specific performance goals usually in math and literacy, often resulting in more time and resources directed toward those subjects, to the detriment of other subjects, including science (Marx & Harris, 2006). Another milestone in science education reform was the development of the *Framework for K–12 Science Education* (NRC, 2012) and the resulting *Next Generation Science Standards* (NGSS Lead States, 2013).

Part of the impetus for the development of the *Framework for K–12 Science Education* (NRC, 2012) and the *Next Generation Science Standards* (NGSS, 2013) was that science content was complicated by an overloaded curriculum and topics students do not see as relevant to their lives or are difficult to understand and difficult for teachers to teach (van Driel, Meirink, van Veen, & Zwart, 2012). By the end of 2018, 19 states and the District of Columbia had adopted the *Next Generation Science Standards* and 21 states adopted science standards based on the *Framework for K–12 Science Education* (https://ngss.nsta.org/About.aspx). North Carolina was
one of the lead partners in the development of the NGSS, however, it has not adopted the NGSS (http://www.hunt-institute.org). Instead, it uses the North Carolina Science Essential Standards, adopted by the State Board of Education in 2010 and based in part on the Benchmarks for Science Literacy (AAAS, 1993) and the National Science Education Standards (NRC, 1996).

The Science Essential Standards allows for each Local Education Authority (LEA) to develop their own curricular and instructional strategies to teach science content to students. The adapted Science Essential Standards support tenets of science literacy, NGSS curriculum, and science content and practices as identified in the Framework for K – 12 Science Education where the integration of science content, scientific inquiry, experimentation, and technological design allows for students to understand that science content and processes are linked (http://www.dpi.state.nc.us/curriculum/science/). A principle goal of science education is to “cultivate students’ scientific habits of mind, develop their capability to engage in scientific inquiry, and teach them how to reason in a scientific context” (NRC, 2012, p. 41), and the adoption of science standards are intended to meet these goals, beginning in elementary school.

**Elementary School Science Education**

Elementary school science is a critical part of building a solid foundation for students to develop and maintain an early interest in science and to build the critical thinking skills necessary to make informed decisions about their lives (Banilower et al., 2013; Sandholtz & Ringstaff, 2016). A major learning goal described in the Framework for K – 12 Science Education (NRC, 2012) is that the learning experiences that students participate in should engage them with “fundamental questions about the world” (p. 9). Science education can capture students’ sense of wonder about the world, and when science education is linked with students’ personal interests, experiences, and enthusiasm, students may stay interested in science
throughout their lives (NRC, 2012).

Both science content and practices are necessary to engage elementary school students. Science content in grades K-2 is designed to include phenomena that students can “directly experience and investigate” (NRC, 2012, p. 33). In grades 3-5, science content can be expanded to include entities that are macroscopic but not visible, such as interior of the Earth, where models and pictures can be used for instruction (NRC, 2012). The *Framework for K–12 Science Education* (NRC, 2012) states that explanations of natural phenomena should be central throughout the elementary school years, as elementary school students are capable of engaging in scientific practices and processes. In this way, students begin to understand that science involves actions including but not limited to observation, experimentation, specific ways of talking and writing, and the development of models to represent phenomena that all contribute to the body of science content (NRC, 2012). For students to learn both science content and practices, teachers must be educated, trained, and provided the necessary time, materials, and support to be able to provide an effective learning environment for their students.

Science education in elementary teacher preparation programs may not always provide enough experience in science content and practices to give teachers the foundation they need to teach science effectively to their students. Elementary school teachers are often trained as generalists as they typically teach all subjects to students (Madden & Wiebe, 2015; Thomson & Gregory, 2013). They may also lack science content knowledge in several of the science disciplines as they are more likely to take courses in biology than in earth science, chemistry, or physics, which may impact their ability to effectively teach all of the science content in their curriculum (Banilower et al., 2013). In a large-scale, national report where 10,000 K-12 science and mathematics teachers were surveyed, Trygstad, Smith, Banilower, & Nelson, (2013)
reported that 86% of kindergarten to 2nd grade teachers and 74% of teachers in grades 3-5 believed they were very well prepared to teach reading, 78% of K-2 teachers and 76% of 3-5 teachers felt very well prepared to teach math, but only 44% and 33% of K-2 and 3-5 teachers, respectively, felt very well prepared to teach science. Not only did teachers in this report feel less prepared to teach science, they also reported less time to teach science than other subjects.

Science instructional time is often less than that for language arts and math in elementary school. When the teachers in the survey conducted by Trygstad et al. (2013) were asked how often they teach science, 41% of K-2 teachers and 36% of 3-5 teachers reported that taught science some weeks, but not every week, while 19% of K-2 teachers and 30% of 3-5 teachers reported they taught science all or most days every week. The number of minutes that teachers reported teaching science was significantly lower than that of other subjects. Kindergarten through 2nd grade teachers reported that they taught reading/language arts for 90 minutes per day, math for 52 minutes per day, and science for only 18 minutes per day. Third through 5th grade teachers reported that they taught reading/language arts for 85 minutes per day, math for 61 minutes per day, and science for only 23 minutes per day. With less time allotted to science instructional time than to other subjects, teachers may look for ways to include science content while teaching other subjects.

Integrating science with other subjects in the curriculum is one way that teachers can increase the amount of science content taught in the school day and could aid in a deeper understanding of material because it may help students connect prior knowledge with new experiences and see relationships between ideas (Czerniak & Johnson, 2007). Outdoor education can also help students connect new learning with prior knowledge and students’ experiences with science content.
Outdoor Education

There is a long history of teaching and learning in the outdoors in the United States (Hammerman et al., 2001). Early educators such as John Dewey and William Kilpatrick advocated for outdoor experiences to be a part of the school curriculum, with Dewey (as cited in Hammerman et al., 2001) urging educators to take advantage of all of students’ surroundings (social, physical, and natural), in a way that would result in significant learning experiences for each student. Sharp (1943) said of outdoor education: "That which can best be taught inside the schoolrooms should there be taught, and that which can best be learned through experience dealing directly with native materials and life situations outside the school should there be learned" (p. 363). Outdoor education includes outdoor activities such as hiking and camping, activities that involve direct learning experiences, and a setting for extending the school curriculum (Ford, 1986). Figure 2 shows the relationship between outdoor education locations, the school curriculum, and educational objectives (Hammerman et al., 2001).
During the science education curriculum reforms of the 1970s and 1980s discussed in Chapter 1, outdoor education became part of the discussion due to an increased interest in environmental education (EE) (DeBoer, 1991). Environmental awareness increased during this time with society seeking ways to protect and preserve the health of their environment. The
central components of EE are knowledge, awareness, and motivation about the environment and how to solve problems associated with the human-environment interaction (Troy & Schwaab, 1982). Until this time, outdoor education focused on learning about and preserving nature but did not focus on the environment as a social issue (DeBoer, 1991).

Outdoor education has been used to enhance the following: science education, camping education, adventure education, environmental education, and nature study, as well as encompassing a variety of curricular areas and providing unique opportunities for special populations (Hammerman et al., 2001; Rickinson et al., 2004). The Framework for K-12 Science Education document states that beginning in early elementary school, the ability to directly experience and investigate science content should be a part of science education (NRC, 2012). Priest (1986) defines outdoor education as: 1) a method for learning; 2) experiential; 3) taking place primarily in the outdoors; 4) requiring the use of all senses and domains; 5) based upon interdisciplinary curriculum material; and 6) consisting of relationships involving people and natural resources. Using the outdoors as a setting for teaching and learning can provide opportunities for students to learn science concepts in an authentic environment (Carrier, 2003) and in an experiential manner.

**Experiential learning.** Experiential learning theory purports that learning is on-going and deeply dependent upon experiences, through which the learner assimilates new knowledge through reflection, question-asking, and subsequently building on what they understood about the concept before the experience (Kolb, 1984). Experiential learning is knowledge gained through relationships with people, places, and things, and is the personal and impactful nature of the relationship (Burnard, 1987). It is a “process that develops knowledge, skills, and attitudes based on consciously thinking about an experience” (Malone, 2008, p. 8) and is a social
construction that is an integrated complex of behavior consisting of cognition, aptitude, and attitude (Hovelynck, 2001).

Experiential learning is not simply activities; experiences are co-constructed by everyone involved in an activity. Knowledge gained through experiential learning, therefore, is acquired through experiences with others and not simply as a result of participation in an activity. What one does during and after experiences, such as reflection, plays a central role in learning and development (Kolb, 1984), and can influence beliefs. Dewey (1910/1997) stated that “active, persistent, and careful consideration of any belief…in the light of the grounds that support it, and the further conclusions to which it tends, constitutes reflective thought” (p. 6).

Learning happens through doing, reading, and reflecting (Darling-Hammond & McLaughlin, 1995; Kazempour & Amirshokoohi, 2014), and for learning to be most effective, it should be situated in a context that makes sense for the learner (Avalos, 2011; Lave & Wagner, 1991). Students may gain a deeper understanding of the content when they can use their senses to experience the content more fully (Hammerman et al., 2001).

**Situated learning.** Learning does not occur in a vacuum; learning occurs, and knowledge is created while individuals interact with their environment (Whitworth, Bell, Maeng, & Gonczi, 2017). Situated learning can therefore be thought of as learning that is situated within an activity, a context, and a culture (Brown, Collins, & Duguid, 1989; Lave, 1988). The individual and the context influence and change each other (Whitworth et al., 2017). A student learning science in school has often been a different activity, context, and culture than that in which science practitioners use scientific knowledge in a professional setting (Brown et al., 1989; Lave, 1988). Many methods of teaching assume that a student can transfer knowledge learned in a classroom about a topic, such as how to solve a mathematics problem, to situations outside the classroom
that involve that topic. This separation of where learning takes place and where the use of that knowledge would be most appropriate ignores the “situated nature of cognition” (Brown et al., 1989, p. 32).

Situations structure cognition, and an example given by Brown et al., (1989) is that of children learning vocabulary. People learn vocabulary during the context of normal, everyday interactions and conversations with other people, and not as much through vocabulary lessons taught in a school setting, where the words learned are often out of context and not used in an ordinary conversational kind of way. Learning words is very context-dependent, and thus instruction that consists of abstract concepts independently of authentic situations, “overlooks the way understanding is developed through continued, situated use” (Brown et al., 1989, p. 33). A concept is always being re-constructed every time it is revisited due to new situations, new negotiations, and new activities that frame the concept in a new light. Greeno (1998) states that if students are to learn about a topic, it is often helpful to provide a learning environment where they can learn and practice the material as members of the community of practice might. If possible, authentic activities should be provided for learning as this will better allow students to “engage [in] the relevant domain culture” (p. 34), an activity that will better enable students to use a science concept in an authentic way, instead of just being able to pass exams with no practical understanding of how the concepts are used by practitioners (Brown et al., 1989). The outdoors can provide such an environment where authentic learning can take place.

**Benefits of outdoor instruction.** The outdoors can provide an important setting for cognitive learning (Falk & Balling, 1982; Mayer, Frantz, Bruehlma-Senecal, Dolliver, 2009; Orion, 1993), personal and social development (Brody, Bangert, Dillon, 2008), the development of environmental stewardship (Knapp & Barrie, 2001), and has been shown to positively
influence attitudes and health (Mayer, Frantz, Bruehlmab-Senecal, Dolliver, 2009). Additional benefits of outdoor instruction include increased physical movement, sensory and tactile experiences (Malone, 2008), the joy of discovery, an authentic context for students to see connections between humans and the environment, a greater appreciation for nature, and the potential for learning about the community (Holden et al., 2011; Louv, 2008), and these affective benefits are part of a complete science education (Guthrie et al., 2004).

Outdoor, hands-on experiences can enhance and complement learning for elementary school students in science and other subjects. Guthrie et al., (2004) looked at the role of hands-on, outdoor experiences on reading comprehension. They studied 361 third grade students, where 148 students participated in the Concept-Oriented Reading Instruction (CORI) program and the rest (213) participated in the strategy instruction (SI) method. The CORI program coupled hands-on activities like observations, investigations, and experiments, with interesting reading materials on the same topic. An example of this is students dissecting owl pellets and then reading interesting books about owls. They concluded that the hands-on, outdoor experiences the students had in relation to their study on animals, coupled with interesting texts, increased their motivation to learn about the topic and their reading comprehension over that of the SI method.

Using the outdoors as a setting for teaching and learning has been investigated to better understand its impact on standardized test scores. Klemmer, Waliczek, & Zajicek (2005) examined the role of hands-on, outdoor learning in horticulture and environmental education. They studied 647 students, 453 in the experimental group and 194 in the control group, in grades 3 through 5, where the experimental group received a garden curriculum that offered a hands-on approach to learning horticulture and environmental education. Students in the control group received the same content but in a traditional classroom instruction manner. The results showed
that students in the experimental group scored higher on the science achievement test than those in the control group. The State Education and Environmental Roundtable (SEER, 2000), on behalf of the California Department of Education, conducted a study using a framework called Using the Environment as an Integrating Context for Learning (EIC). In this framework, which is collaborative, student-centered, and hands-on, learning takes place on the school grounds and in the community where students can construct their own learning with guidance from teachers and administrators. The study was designed to determine if there were measurable changes in standardized test scores between students who participated in programs that used the EIC approach and those who did not participate. Comparisons were made between eight schools that participated in the framework and eight that did not participate. The results showed that compared to students in schools that did not participate in the EIC framework, students who did participate in the EIC framework scored higher on 72% of all academic assessments, scored higher on 64% of the science assessments specifically, and scored higher on 77% of attendance assessments.

Outdoor education can enhance learning in many different curricular areas (Hammerman et al., 2001). Outdoor learning experiences can provide an authentic context, using first-hand observations and direct experiences that can help students understand connections between themselves and their environment, the interconnectedness of subjects, and the interconnectedness between their education and other facets of their lives (Dyment, 2005; Hammerman et al., 2001; Holden et al., 2011). Outdoor learning can have different foci, outcomes, and locations (Rickinson et al., 2004). Teachers’ main task is to “guide learning” (Hammerman et al., 2001, p. 63), and teachers’ roles as learners along with their students provides student with models of learning. Locations for outdoor instruction do not need to be cultivated centers. Outdoor
instruction can occur in many locations, like distant parks or nature centers, or more locally, like the schoolyard, which can offer a location that is readily available (Nundy, 2004 in Rickinson et al., 2004). The use of outdoor learning spaces such as gardens, ponds, and other areas on school grounds and beyond to enhance classroom learning, however, can offer students first-hand experiences with objects and organisms which can be beneficial for science learning (Dyment, 2005; Hammerman et al., 2001).

**The schoolyard for outdoor instruction.** The benefits of outdoor education can be realized by using the schoolyard as a place for teaching and learning. Using the schoolyard also allows students the ability to experience repeated exposure to learning outside more easily, it alleviates the planning time associated with a field trip to a natural area, and it can increase connections to the natural world (Dyment, 2005). The schoolyard can help teachers contextualize science topics in a meaningful way for students (Ayotte-Beaudet, Potvin, Lapierre, & Glackin, 2017), and can also provide a place where students can go often and learn about ecological science concepts in an authentic environment (Cronin-Jones, 2000).

In a study consisting of 285 third- and fourth-grade students from 12 classes, Cronin-Jones (2000) investigated whether outdoor schoolyard-based instruction resulted in students learning more about basic ecological concepts than students receiving traditional classroom-based instruction or no formal instruction. She found that the students who received outdoor schoolyard instruction significantly outperformed both the traditional classroom group and the group with no formal instruction in content knowledge post-test scores, and the attitudes of students who learned in the schoolyard were significantly more positive than the group with no formal instruction, but not significantly different from the attitudes of the group who received formal classroom instruction.
Carrier (2009) explored gender differences in outdoor science instruction in the schoolyard. She examined fourth grade and fifth grade boys’ and girls’ environmental knowledge, attitudes, and behaviors, and comfort levels in the outdoors. One fourth grade and one fifth grade class were treatment groups whose environmental education lessons took place in the schoolyard, while fourth grade and fifth grade class control group classes were taught the same information in the classroom. Results showed that boys in the treatment group had statistically significant gains over boys in the control groups in all four of the variables measured. Boys in the treatment group also scored statistically significant greater gain scores than girls in the treatment group on environmental attitudes and behaviors, and both boys and girls in the treatment group had greater gains their environmental knowledge compared to boys and girls in the control group. Boys in the treatment group also showed increased comfort in the outdoors over boys in the control group, whereas there was no significant difference in outdoor comfort level of girls in the treatment or control groups.

Carrier, Tugurian, & Thomson (2013) conducted a study at a school with an emphasis on using the outdoors for science instruction. In order to understand students’ knowledge and attitudes about the outdoors, the principal, two fifth grade science teachers, and 84 fifth grade students participated in the study that included pre- and post-test student assessments and interviews with students, teachers, and the principal. Results showed that the students of the teacher who took their students outside for instruction more often had statistically significant differences in their comfort level in the outdoors. Results also showed that although the teachers had initial intentions for taking their students outside for science, they did not take them out as often as they had planned. Reasons given for this included the pressure of an established science curriculum and high-stakes testing. These results show that even well-intentioned teachers at
schools that encourage outdoor instruction feel pressure from various influences, such as time and testing, which can become barriers to their use of the outdoors as an environment for teaching and learning.

**Barriers to outdoor instruction.** Barriers exist that can make it difficult for teachers to use the outdoors as an environment for teaching and learning (Cronin-Jones, 2000; Dyment, 2005). Reasons teachers cite for not utilizing outside areas include a lack of administrative and financial support, student management and safety issues, lack of time for planning, and lack of skills and knowledge about teaching outdoors (Dyment, 2005; Ernst, 2014; Waite, 2009; Waite, Bølling, & Bentsen, 2016). Rickinson et al. (2004) found additional barriers to outdoor learning that included teachers’ lack of confidence in teaching and learning outdoors, shortages of resources, and school curricula requirements.

Researchers have studied the needs and requirements of outdoor science instruction to learn what teachers need and how those needs can be met. The results of an environmental education needs assessment of K–12 teachers conducted by Meichtry & Harrell (2002) indicated that the three greatest needs of teachers for teaching outdoors, in order of frequency, were (a) training in the use of outdoor learning sites, (b) training in the alignment of curricula with state standards, and (c) the availability and use of curricula. Hanna (1992) interviewed ten outdoor/environmental education consultants and teachers, and through the interviews, outlined challenges they faced to interpreting and presenting outdoor curriculum and techniques they could use to overcome them. Challenges included lack of administrative support, lack of teacher confidence and comfort, lack of curriculum materials, safety and liability issues, lack of time, lack of equipment, and, if traveling off campus, the cost, transportation, and finding appropriate sites for the type of instruction the teacher is interested in. Several of the techniques suggested to
overcome the challenges included using the school grounds instead of traveling, finding lessons that use little to no equipment, and collaborating with other teachers or consultants to find curriculum materials and support for outdoor lessons.

Efforts to incorporate outdoor learning experiences into the elementary school science curriculum were examined by Carrier, Thomson, Tugurian, & Stevenson (2014). They found that teachers’ intentions to use the outdoors for learning did not match their practices. They examined two elementary schools’ science programs, one with a reputation for science and outdoor learning and the other with more traditional science instruction. The study consisted of both quantitative and qualitative data collection procedures, with the quantitative data consisting of students’ ($N = 114$) pre- and post-test survey data using three different surveys that tested their science content knowledge in four 5th grade instructional areas, their comfort in the outdoors, and their attitude toward the environment. Qualitative interviews were conducted with participants from the two schools that included seven 5th grade teachers, 30 5th grade students, 18 parents, and the principals from both schools. Interviews with teachers regarding their impressions of the outdoors showed that in general, there was a discord between their intentions to use the outdoors for instruction and their actual practices, even though they felt that the outdoors was suited for the 5th grade science curriculum. Teachers also felt that going outside for instruction was peripheral to science instruction in general. The study also showed that there was not much of a difference in the outdoor experiences of the 5th grade students at the two schools, even though one school had a reputation for having an outdoor instruction while the other did not. Teachers at both schools noted the lack of time for science instruction. Including outdoor instruction during teacher preparation may support teachers using the outdoors as a setting for teaching and learning.
Pre-service teachers’ training in outdoor education. Carrier (2009) studied fourteen pre-service teachers who participated in a two-week field experience working with elementary school students who attended the local Forestry Ecology Preserve’s summer day camp. The goal was to examine pre-service teachers’ self-efficacy toward teaching science, their views on using the outdoors for teaching science. Carrier spent one week training the pre-service teachers in Project Wild and Project Wild Aquatic curricula (Council for Environmental Education, 2012) before the pre-service teachers’ field experience, both of which focus on outdoor science content and teaching practices. The pre-service teachers also wrote reflection papers at the end of the semester that included their views on their outdoor field experience, and Carrier interviewed them seven months after the end of the semester to examine whether their attitudes, impressions, and intentions for including outdoor opportunities for their students had changed. Results showed that the pre-service teachers’ self-efficacy for teaching science was impacted by the enthusiasm and excitement of the students at the camp. Seeing the students learning in the outdoors and learning along with them illustrated the potential in using the outdoors as a setting for teaching and learning. After seven months, interview data revealed that all of the pre-service teachers had varied intentions of using the outdoors for science instruction.

A teacher’s vision of teaching, learning, and how learning environments should be structured may influence their use of the outdoors for teaching and learning. Teachers enter the teaching profession with a set of ideas about effective teaching that generally does not include outdoor instruction (Bloom, Holden, Sawey, & Weinburgh 2010). By participating in outdoor-focused PD, teachers may learn how to use the outdoors as a setting for teaching and learning.
**Teacher Professional Development**

Professional development (PD) is the “ongoing learning experience of a teacher” and can span from pre-service teaching until a teacher’s final year teaching (Luft & Hewson, 2014, p. 3). Learning is both “personal and professional, individual and collective, inquiry based and technical” (Lieberman, 1995, p. 592). PD is an important support mechanism for teachers’ continuing development and learning (Avalos, 2011; Desimone, 2009; Desimone et al., 2002; Guskey, 2003). PD includes processes and activities that are designed to enhance teachers’ professional knowledge, skills and attributes of teachers to improve the learning opportunities for their students (Guskey, 2003). Certain types of activities have been shown to be more effective than others in enhancing a teacher’s instructional practices. Figure 3 shows Desimone’s (2009) model that represents “interactive, nonrecursive relationships between the critical relationships between the critical features of professional development, teacher knowledge and beliefs, classroom practice, and student outcomes” (Desimone, 2009, p. 184).
Features of effective professional development. Teachers are vital in the success of the implementation of any educational reform efforts that are designed to impact student learning (Lumpe et al., 2012), thus continued PD supports teacher and student learning. There have been many studies over the past several decades on what makes PD effective. This has resulted in the emergence of a consensus about particular characteristics of highly effective PD, which include (1) content focus, (2) active learning, (3) coherence, (4) duration, and (5) collective participation (Desimone et al., 2002; Desimone & Garet, 2016; Kang, Cha, & Ha; 2013) which are described below.

Content focus is important for both deepening teachers’ subject knowledge and their understanding of how students can acquire this knowledge (Desimone et al., 2002; Desimone & Garet, 2016; Zehetmeier & Krainer, 2011). Teachers must be confident in their subject matter knowledge and learning goals to mediate individual student learning, leading to scientific knowledge and ways of knowing (NRC, 2005). Content focus includes factors such as
opportunities to develop both content knowledge and pedagogical content knowledge (PCK), which describes the combination of knowledge of the subject matter, how students learn about the subject matter, and teaching and learning strategies to help students learn; in other words, subject matter knowledge for teaching (Abell, 2008; Shulman, 1986). Content focus also includes links to curriculum, active and inquiry-based learning, prolonged duration, and follow-up activities (Zehetmeier & Krainer, 2011). PD workshops should include an emphasis on specific science content, the nature of science, and PCK learning theory that supports the pedagogical strategies (Appleton, 2006).

Active learning in PD refers to the extent to which PD provides opportunities for teachers to be active participants in analyzing teaching and learning activities (Garet, Porter, Desimone, Birman, & Yoon, 2001). Active learning describes the benefits of actively participating in learning activities (Desimone et al., 2002; Desimone & Garet, 2016). Active learning can present in a number of ways, such as observing and being observed while teaching, planning how new curriculum materials and teaching methods will be used in the classroom, presenting, leading, and writing, and reviewing student work in the subject area to be covered (Garet et al., 2001). Teachers engaging in the same learning activities they hope to provide to their students is also a form of active learning (Darling-Hammond et al., 2017). Active learning techniques are most effective when they align with a teachers’ classroom and school culture.

Coherence describes the degree that the content in the PD connects with teachers’ prior knowledge on the subject and the degree to which the PD is perceived to fit in with a coherent pattern of learning at their school (Desimone et al., 2002; Desimone & Garet, 2016; Garet et al., 2001; Zehetmeier & Krainer, 2011). PD needs to directly link knowledge and strategies learned in the program to the teachers’ daily classroom lessons and routines, as well as the school,
district, and state standards and norms (Desimone & Garet, 2015; Garet et al., 2001). If a PD program does not fit in with the norms of the school, a teacher may perceive it as an isolated experience; unsustainable (van Driel et al., 2012).

Teachers report limited opportunities for science PD. **Duration** describes the length of time (e.g. number of hours) a PD program needs to be to make an impact (Desimone et al., 2002; Desimone & Garet, 2016; Kang, Cha, & Ha, 2013. In their survey of 10,000 K-12 teachers, Trygstad et al., (2013) found that over half of the elementary science teachers reported that they participated in a science-focused PD within the last three years, yet over 60% of those said they spent less than 6 hours on PD and about 22% said they spend between 6 and 15 hours on PD in the last 3 years.

**Collective participation** describes the extent to which multiple teachers from the same school, teaching department, and/or same grade level participate in the same learning opportunities (Desimone et al., 2002; Desimone & Garet, 2016) and is related to community of practices theory (Lave & Wenger, 1991) described in the next section. Collective participation includes support systems for the teachers, which can include fellow PD participants, the PD facilitators, and school administrators, and is a critical factor in the success of a PD program (Kazempour & Amirshokoohi, 2014). It also includes networking and community building, cooperation and joint-practice of teachers, collaborative reflection and discussion, and the empowerment of teachers to take leadership roles in implementing innovative practices (Zehetmeier & Krainer, 2011). Wilson and Berne (1999), in their review of professional development research, found that successfully supporting the use of new practices among teachers required collaboration among peers and within educational communities. Similarly, in a later analysis of science and mathematics teacher data from the US Eisenhower Mathematics and
Science Education program, Garet et al. (2001) found that collective participation within a school, grade level or subject was an important supporting feature of PD programs. They stressed that collective participation was a necessary feature in PD in order for teachers to change their classroom practices. Working collaboratively can help teachers “reinforce, build, expand, and challenge their notions about teaching science” (Luft & Hewson, 2007, p. 16).

**Community of practice.** A community of practice is a group of professionals who are engaged in a shared learning enterprise, commonly focused on a particular topic, where novice members of the group enter on the periphery of the community, learn from the more experienced members and, over time, move in towards the center, becoming one of the experienced members helping to guide newer members (Allen & Crowley, 2013; Buysse, Sparkman, & Wesley, 2003; Castle, 2006; Lave & Wenger, 1991). The newcomer role allows the person the ability to participate in the community and be engaged in the culture of practice of that community (Lave & Wenger, 1991; Smith, 2003). The newcomer role is defined by Lave & Wenger (1991) as “legitimate peripheral participation” or LPP (p. 29). After a time in the community, newcomers begin to make the community’s culture of practice their own, including an increasing understanding of “how, when, and about what old-timers collaborate, collude, and collide, and what they enjoy, dislike, respect, and admire” (Lave & Wenger, 1991, p. 95). Lave & Wenger (1991) discuss LPP in terms of apprenticeships, and how an apprentice enters the community as a newcomer, experiencing various aspects of the community’s culture, with the types of experiences differing by community.

Belonging to a group and sharing beliefs with group members can reaffirm and strengthen those beliefs (Stets & Burke, 2000). A community of practice can be an ideal structure for learning, yet it can also be a system that prevents new ideas and practices from
being explored by its members (Roberts, 2006). A teacher’s community of practice (their fellow teachers, administrators, and school) can influence their implementation of novel practices they have learned in PD experiences. If a novel practice learned in PD is not in alignment with the currently accepted practices at a teacher’s school, it may be more difficult for the teacher to implement the practice. Professional development comprised of the five characteristics of effective PD: content focus, active learning, coherence, duration, and collective participation (Desimone et al., 2002; Desimone & Garet, 2016), as well as focusing on impacting teachers’ beliefs and self-efficacy, is vital in supporting teachers in their efforts to teach science effectively (NRC, 2007; Sandholtz & Ringstaff, 2016).

Science professional development. Professional development for science focused on impacting teachers’ beliefs and self-efficacy can expand teachers’ abilities to engage their students in science understanding by providing them with appropriate content knowledge and instructional strategies (Lee, Hart, Cuevan, & Enders, 2004). Many science PD programs are focused on strategies that will aid teachers in implementing science teaching strategies, such as student-centered instructional approaches (van Driel, Meirink, van Veen, & Zwart, 2012), which can positively influence teachers’ beliefs and self-efficacy towards teaching science (Riggs & Enochs, 1990).

A teacher’s beliefs about teaching science influences their behavior (Riggs & Enochs, 1990). Lumpe, Czerniak, Haney, & Beltyukova (2012) administered two science teaching belief instruments, the Science Teaching Efficacy Belief Instrument (STEBI), developed by Riggs & Enochs (1989) and the Context Beliefs About Teaching Science (CBATS) instrument (Lumpe et al., 2000) to 450 elementary school teachers prior to and after one year of participation in a PD program designed to improve science teaching and learning. They found that after participation
in the PD program for one year, the teachers displayed significantly more positive science teaching self-efficacy beliefs and an increase in the number of times a week that they taught science.

Sandholtz & Ringstaff, (2014) conducted a study with 39 K-2 teachers who participated in a 3-year long PD program that focused on three components: 1) increasing teachers’ content knowledge; 2) training in pedagogy that focused on science instruction and how to connect science to language arts and math; and 3) facilitation of teacher collaboration. Results from the study showed that teachers’ overall self-efficacy for teaching science increased over the 3-year PD, and their comfort level in teaching science and the extent to which they felt prepared to engage in instructional strategies to teach science increased, from 67% before the beginning of the PD indicating they felt either “somewhat prepared” or “not adequately prepared” to teach science, to 100% feeling either “fairly well prepared” to “very well prepared” to teach science after the PD. Prior to the PD, teachers indicated that they felt more prepared to teach math, language arts, and social studies than science, while after the PD, teachers still felt more prepared to teach math and language arts than science but felt more prepared to teach science than social studies. The study found that an increase in teachers’ self-efficacy in teaching science corresponded with an increase in student-centered science instructional strategies such as having students conduct their own investigations and participate in hands-on activities.

Even with well-designed PD that encompasses many of the five characteristics of effective PD, teachers can face barriers to teaching science that may be difficult to overcome, such as a lack of resources that may be due to the lack of funding (Darling-Hammond et al., 2017). Another barrier is the lack of time during the school day to teach lessons using a new
curricula or new instructional practices. There are also school system-level challenges that can impede the effectiveness of PD.

Professional development for science teachers should include workshops that emphasize selected science content and the nature of science, should have both pre- or post-program communication with the participants, and should consider the participants’ needs or any systemic changes that would need to occur for the PD to be successfully implemented (Luft, 1999), especially if the PD program is focused on teaching and learning techniques or environments that might be new to the teacher or to the teacher’s school, such as using the outdoors as a teaching and learning environment.

**Outdoor professional development.** Teachers’ self-efficacy and beliefs regarding using the outdoors as a setting for teaching and learning must be addressed since beliefs and confidence in one’s ability to complete a task are one of the biggest predictors of behavior (Bandura, 1986; Holden et al., 2011). Holden and colleagues administered a modified version of the STEBI version A (for in-service teachers), developed by Riggs & Enochs (1989), to 36 K-12 teachers before and after their participation in a two-week, field-intensive PD experience designed to increase their PCK, improve general science teaching ability, and help participants find ways to use outdoors spaces for environmental science instruction. The researchers modified the STEBI by adding something to the effect of “in the outdoors” after some of the statements. For example, the original STEBI includes the statement, “I know the steps necessary to teach science concepts effectively”, and Holden et al. (2011) added, “using outdoor environments” to the end of the statement. Teachers’ belief scores for outdoor teaching increased after the two-week PD.
Before participating in the PD, teachers stated that although they believed outdoor learning could be beneficial for their students, they perceived challenges, such as the pressure of standardized testing, a distrust that outdoor instruction could lead to student achievement, and their own acknowledged deficiencies in science content, outdoor pedagogy, student management, and aligning outdoor instruction with science standards, that prevented them from using the outdoors as a learning environment. After participating in the two-week PD program, teachers had greater confidence as teachers and outdoor educators, showed knowledge gains in science content, pedagogy, and logistics for outdoor instruction, came up with ideas for outdoor locations to visit (including their own schoolyard), what to do there, and how to align activities with state and district requirements, and realized the opportunities to interact and collaborate with other teachers in an informal setting.

Addressing teacher concerns about outdoor instruction during the PD can help teachers find solutions to the barriers they face taking their students outside. Bloom et al., (2010) surveyed teachers prior to their participation in an outdoor PD experience about their views on the type of outdoor experiences are the most effective for students and the challenges they face taking students outside. They then developed the program, addressing these concerns and viewpoints, in an attempt to alleviate some of these concerns and to make the teachers feel more confident in using outdoor spaces for teaching. Prior to participating in the PD, the reasons that elementary school teachers stated in favor of taking students outside were that students enjoy it, it can make science seem less intimidating, it can reinforce classroom content, and it can connect science to real-world experiences. Reasons they stated that made it more difficult to take students outside were weather, time, classroom management issues, lack of appropriate curriculum, and a lack of PCK. After participation in the PD, the teachers were able to envision solutions to the
challenges they had stated prior to the PD, as well as identifying and addressing other issues such as how to accommodate students with learning disabilities, physical disabilities, English language learners, and a lack of support from fellow teachers. These results suggest that with proper planning, outdoor PD can be successful in helping teachers find solutions to the challenges they face to taking their students outside (Bloom et al., 2010).

**Theoretical Framework**

It is important to understand how elementary teachers’ self-efficacy, beliefs, and attitudes in teaching science influence their teaching practice in order to support and enhance science education in elementary school.

**Teacher Self-efficacy Toward Science**

Self-efficacy describes the confidence one has in oneself for achieving a desired outcome from doing a certain task, with behavior affected by what one thinks, believes, and feels (Bandura, 1977; Bandura, 1997). Self-efficacy is part of someone’s belief system and is influenced by many factors such as prior experiences, successes and failures, and the influences of others (Jones & Leagon, 2014). A person’s sense of control over their life is reflected in how they view their own agency, or their own ability to make things happen (Bandura, 2001), and a lack of agency can lead to lower self-efficacy.

Competence in science teaching can be thought of as a combination of a person’s motivation, skill, and their environment, which includes their social surroundings (Ford, 1992). Motivation includes agency beliefs, consisting of self-efficacy and context, which refers to one’s belief about the responsiveness of external factors like students, administrators, parents, other teachers, and the culture of the school (Lumpe et al., 2000). Many elementary school teachers report low levels of confidence in their science knowledge and science teaching (Abell & Roth, 1992;
Appleton, 2006). If a teacher is not confident that they can teach science effectively, they may not invest as much of their time and energy into science instruction than they might on a subject in which they felt more confident in their abilities and more confident in the outcomes of their teaching.

Research on teachers’ efficacy suggests that behaviors such as persistence on a task, taking risks, and using innovative teaching techniques are related to degrees of efficacy, and that self-efficacy can be improved through experience (Moseley, Reinke, & Bookout, 2002). Often teachers gain experience and learn new innovative teaching techniques through participation in PD programs. Results from a survey of 39 K-2 teachers who participated in a long-term (> 3 years) PD program focused on increasing teachers’ content knowledge and promoting the use of research-based instructional strategies in science showed that before participation in the PD, 51% of teachers questioned whether they had the necessary skills to teach science, and after three years, 0% of teachers questioned their knowledge of the necessary skills (Sandholtz & Ringstaff, 2014). Their self-efficacy assessment using the Science Teaching Efficacy Beliefs Inventory (STEBI) (Riggs & Enochs, 1990) showed significant increases in their overall confidence in science teaching and their personal beliefs about their ability to teach science, and their overall attitudes about engaging in science instruction became more positive. Beliefs affect attitudes which affect behavior (Riggs & Enochs, 1990).

**Teacher Beliefs Toward Science**

Beliefs are defined in various ways, but all emphasize that beliefs influence a person’s thoughts and actions. Pajares (1992) explained that beliefs are deeply personal, difficult to change, and can be “formed by chance, an intense experience, or a succession of events” (p. 309). Beliefs are a person’s psychological constructions linked to their experiences that include
what they see and think to be true, and they steer a person’s actions and support decisions and judgements (Bryan, 2003). Beliefs are information that a person takes to be true, they can influence how people make sense of the world (Pajares, 1992), and can sometimes be hard to change (Bryan, 2003). Beliefs can function as a filter through which new information is analyzed (Jones & Leagon, 2014; Pajares, 1992). Beliefs can emerge through membership in a group, where members may share common beliefs (Stets & Burke, 2000). Beliefs affect behavior (Riggs & Enochs, 1990), and teachers working at a school constitute a group where commonly shared beliefs can influence teaching behavior.

All teachers hold beliefs about their teaching practice, their students, the subjects they teach, and their roles and responsibilities as teachers (Pajares, 1992). These beliefs have developed over many years, first as students, then as pre-service teachers, and after that, as in-service teachers (Jones & Leagon, 2014; Lumpe, Haney, & Czerniak, 2000; Milner, Sondergeld, Demir, Johnson, & Czerniak, 2012). Beliefs are powerful and influence how teachers make decisions, even if they may not match with current literature about best teaching practices (Lumpe et al., 2000). A teacher’s beliefs about what effective teaching looks like coupled with their confidence in their abilities to effectively teach science impacts their decisions on how to teach science.

Teachers’ beliefs about their ability to teach science are influenced by their perceptions of the skills and knowledge needed to teach effectively and their own abilities to do so (Sandholtz & Ringstaff, 2014). Lumpe et al., 2000, conducted a study to gauge teachers’ beliefs about the potential influence of specific factors in their school environment on their science teaching behaviors. They surveyed 262 teachers representing K – 12th grade levels who participated in long-term science teaching PD activities funded by the NSF and Title II Eisenhower Programs. The results showed that most teachers believed that certain factors, such as PD, state standards,
teacher support, team planning, and hands-on kits, would enable them to be more effective science teachers, but they also believed that those factors would not occur in their school. Teachers’ beliefs about their science teaching abilities are impacted by their attitude towards science and towards teaching science (Riggs & Enochs, 1990).

**Teacher Attitudes Toward Science**

A person’s attitude toward a topic consists of different components that work together to form that attitude (Osborne, Simon, & Collins, 2003). Ajzen & Fishbein (2005) state that the construct of attitude can be broken into two types of attitude. The first type describes general attitudes towards physical objects like a park or building, a specific group of people, institutions, policies, and events. The second type describes attitudes towards performing specific behaviors in or with the physical objects, specific group of people, institutions, policies, and events. Professional attitudes toward teaching science involve the attitudes and beliefs teachers have with regards to teaching science in school and about the appropriateness of science for children (Koballa & Crawley, 1985).

Attitude towards science can be thought of as a summary of someone’s various beliefs about science, and it may help predict science-related behavior (Koballa & Crawley, 1985; Riggs & Enochs, 1990). Attitude towards science consists of a general positive or negative feeling about science, such as the attitude, “I like (or hate) science” (p. 223), and that a teacher’s attitude towards science may be reflected in the amount of time and the manner in which they teach science (Koballa & Crawley, 1985). Attitudes may be formed based on certain beliefs, and both attitudes and beliefs influence self-efficacy, which influences behavior (Riggs & Enochs, 1990). The present study surveyed and interviewed teachers who work at schools that have participated
in a schoolyard-focused science PD program described next, where a portion of the study participants were also PD participants.

**UTOTES (Using the Outdoors to Teach Experiential Science):**

The North Carolina Museum of Natural Sciences’ (the Museum) *Using The Outdoors to Teach Experiential Science* (UTOTES) program, referred to as PD program in the present study, is an outdoor-focused elementary teacher education program situated in the school setting and is designed to enhance formal science teaching and learning (North Carolina Museum of Natural Sciences, 2018). This study examined teachers at schools that participated in the UTOTES program to better understand if PD participants used the outdoors as a setting for teaching and learning and if they worked together to do so. UTOTES requires a significant number of teachers at a school to participate so that teachers have a better opportunity to collaborate and “reinforce, build, expand, and challenge their notions about teaching science” (Luft & Hewson, 2007, p. 16).

During the PD, the teacher participants are in the role of students as the PD facilitators model activities that include such investigations as: sheets and nets to sweep insects from bushes, locating and identifying the local flora and fauna on the school grounds (such as mud daubers), using aquatic nets in streams on the school property to look for and identify aquatic life, and ideas for bringing the outdoors inside the classroom. The PD facilitators provide time each session for teacher reflection, for journaling, and for the teachers to talk about how they could incorporate the activities into their curricula. In this way, the school grounds may be ‘transformed’ in the mind of the teacher, where they can start to see the potential of what already exists for teaching and learning. PD staff also work with the school’s teachers, staff, and students to install a natural habitat, so all teachers and students have a place outside to teach and learn.
The PD provides materials for the school that include tools and equipment, field guides and other references, activity guides and handouts, and plants and other resources for the habitat project. All sessions include group work, conducting investigations, and practicing careful observation. The PD program usually requires at least 12 teachers from the school participate. This allows for the potential creation of a community of practice (Lave & Wegner, 1991), wherein the PD participants can help teachers who are less comfortable or unaware of how to use the outdoors. The location of the PD activities on the school grounds allows for a situated learning opportunity; learning is situated within an activity such as plant identification, a context such as the schoolyard with fellow teachers, and a culture of the school (Brown et al., 1989; Lave, 1988). This present study’s research methods are discussed next in Chapter 3.
CHAPTER 3: METHODS

The goal of this exploratory study was to examine North Carolina elementary teachers’ beliefs about science instruction and using the outdoors as a setting for teaching and learning. Schools that had participated in the PD program were the schools of focus for this study and the respondents included both teachers who participated in the PD program and teachers who were not PD program participants. Specifically, the research questions asked:

1. What are elementary teachers’ beliefs of science education?
2. What are elementary teachers’ beliefs of the outdoors as a setting for teaching and learning?
3. What are the relationships between the beliefs of science education and of the outdoors as a setting for teaching and learning for teachers who participated in the PD program and teachers who did not participate?

The researcher hypothesized that elementary teachers would generally believe science instruction in elementary classrooms as somewhat important, and that they would acknowledge that there are benefits to using the outdoors as a setting for teaching and learning, but that the barriers to using the outdoors would be a greater influence on their instructional practices. The researcher further hypothesized that PD participants’ beliefs about science instruction in elementary classrooms would be more positive than non-participants, that PD participants’ beliefs about the benefits of outdoor instruction in elementary school would be more positive than non-participants, and that PD participants’ beliefs about the barriers to outdoor instruction would be less of an influence on their instructional practice than non-participants.

In order to answer the research questions, the researcher used a mixed methods approach, in which quantitative survey data was the dominant data type and interview data was the less-
dominant type (Creswell, 1994). The qualitative data provides support and enhances the quantitative data. The data analysis techniques for both data types included calculating measures of central tendency and correlation coefficients on the quantitative data and coding the qualitative data were employed (Creswell & Clark, 2017; Gall, Gall, & Borg, 2007; Plano-Clark, Huddleston-Casas, Churchill, Green, & Garrett, 2008; Tashakkori & Teddlie, 1998). The quantitative survey was used to better understand the beliefs of participants in the population (Creswell & Clark, 2017), with the population consisting of teachers who work in schools that had participated in the PD program between 1991 and 2016. The qualitative data enhances the quantitative data by allowing for a more in-depth understanding of a few past PD participants’ beliefs and consists of interviews with selected past PD participants from two schools who participated in the PD program. The combination of both types of data provides a more complete understanding of the beliefs of science education and of using the outdoors as a setting for teaching and learning of PD participants and non-PD participants who worked in schools that had participated in the PD program.

Quantitative data, the dominant data type, was a survey (Appendix A) developed and validated by the researcher that asked teachers about their beliefs regarding elementary science instruction, their behaviors regarding teaching science, and their beliefs and behaviors regarding using the outdoors as a setting for teaching and learning. The survey was distributed to teachers who worked in schools where the PD was conducted between 1991 and 2016. Survey data were also used to compare teachers’ beliefs of science instruction and of using the outdoors as a setting for teaching and learning between PD participants and non-participants. Quantitative data were collected online through Qualtrics (Qualtrics, Version Pro 13, 2016), an online survey software tool, between September and December of 2016.
Qualitative data, the supporting data type, consisted of in-person interviews and were conducted with teachers who were past PD-participants (Appendix B) to better understand recent PD participants’ beliefs, goals, confidence, and instructional practices in elementary science, the outdoors as a setting for teaching and learning, and the benefits and challenges they face taking students outside for instruction. The principals of each school were also interviewed (Appendix C) to gain the administrative perspective on science education and using the outdoors as a setting for teaching and learning. Each of the teachers interviewed participated in the PD in 2014-15 school year. Qualitative data were collected between November of 2016 and May of 2017. IRB approval, number 6650, was granted after submittal on July 15, 2016.

Research Methods

Participant Recruiting

To recruit teachers to participate in the online survey, the researcher obtained a list of all schools that had participated in the PD program. Two hundred eight elementary schools in North Carolina participated in the PD program between 1991 and 2016. Out of the 208 schools, 127 (61.5%) schools had websites with teacher emails. From those websites, 4,019 teacher emails were available from which the researcher created the participant list. Teacher email addresses were uploaded to the online survey platform Qualtrics (Qualtrics, 2016), through which the survey could be sent anonymously. All teachers currently working at schools with a history of the program were eligible to participate in the study, regardless of their participation status in or knowledge of the PD program. This sample was intended to represent a population of North Carolina elementary teachers from schools with a history of the PD program. Using Qualtrics survey instrument, an email was sent to the teachers that introduced the purpose of the study (Appendix D) and contained an anonymous link to access the survey. There was also an
incentive stated in the introduction: all participants who completed the survey would be entered to win one of five $20 Amazon gift cards. After participants clicked on the link to the survey, they had to first sign the consent form (Appendix E) before completing the survey. Once finished with the survey, participants completed a demographic questionnaire in Qualtrics (Appendix F). After the initial survey was sent to all 4,019 teachers, two reminders were sent to teachers who had not completed the survey; the first one was sent two weeks after the initial email and the second one four weeks after the initial email. The second reminder email contained an additional incentive: the first 20 teachers to complete the survey online after receiving the reminder email would receive a $10 Amazon gift card.

To recruit teachers for interviews, the researcher contacted the principals at two schools that participated in the PD program during the 2014-2015 school year, Baytree Elementary School and Northside Elementary School (both pseudonyms). Both schools are located in rural counties in North Carolina, one in the Piedmont region and the other in the Coastal Plain. The researcher had previously visited both schools during the year that the schools hosted the PD program to observe the PD. Due to this prior contact, the researcher reached out to these schools to request interviews for this study. After receiving approval from the principals at both schools, the researcher emailed teachers who had participated in the program to inform them of the study and invite them to participate (Appendix G). Teachers interested in participating in the interviews responded to the researcher, and interview days and times were arranged. The researcher then sent the participating teachers the consent form through Qualtrics (Appendix H). The researcher purposefully sampled (Creswell, 2013) by selecting former PD participants for interviews to better understand PD participants’ beliefs of science and outdoor instruction and the benefits and challenges they face in taking students outside for teaching and learning. The
principals at both schools also participated in one interview so the researcher could get an understanding of how both schools’ administrators viewed science and the outdoors as a setting for teaching and learning.

**Study participants.** Final participants for the online survey consisted of the 225 teachers who completed the survey, a 5.5% total response rate. Because the researcher was interested in teachers’ beliefs of science and outdoor instruction of those who teach science, the surveys of teachers who indicated they did not teach science at all or did not indicate a specific number of days per year they taught science were eliminated. This resulted in 34 surveys being removed, all of which came from teachers who had not participated in the PD. This resulted in a sample size of 191 respondents, 43 PD participants (22.5% of the sample) and 148 non-PD participants. Table 1 shows the breakdown of gender, race, and degree level of the sample and how those demographic characteristics compare to those of the 2014-2015 NC public school elementary teachers (http://www.ncpublicschools.org/). Table 2 shows the age and number of years teaching of the survey participants.
Table 1

Demographic Characteristics: Gender, Race, and Degree Level of Survey Respondents Compared with NC Public School Teachers

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>DPI Percentage</th>
<th>Study Percentage (n= 191)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>11%</td>
<td>8%</td>
</tr>
<tr>
<td>Female</td>
<td>89%</td>
<td>92%</td>
</tr>
<tr>
<td><strong>Race</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>82%</td>
<td>85%</td>
</tr>
<tr>
<td>Black</td>
<td>13%</td>
<td>8%</td>
</tr>
<tr>
<td>American Indian or Alaska Native</td>
<td>-</td>
<td>1%</td>
</tr>
<tr>
<td>Hispanic or Latino</td>
<td>-</td>
<td>3%</td>
</tr>
<tr>
<td>Other</td>
<td>5%</td>
<td>3%</td>
</tr>
<tr>
<td><strong>Degree Level</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Associates/Bachelors</td>
<td>69.9%</td>
<td>53%</td>
</tr>
<tr>
<td>Masters</td>
<td>28.8%</td>
<td>45%</td>
</tr>
<tr>
<td>Doctoral</td>
<td>0.1%</td>
<td>2%</td>
</tr>
</tbody>
</table>

Table 2

Demographic Characteristics: Age and Number of Years Teaching of Survey Respondents

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Study Percentage (n= 191)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age Range</strong></td>
<td></td>
</tr>
<tr>
<td>20-25</td>
<td>7%</td>
</tr>
<tr>
<td>26-30</td>
<td>13%</td>
</tr>
<tr>
<td>31-35</td>
<td>18%</td>
</tr>
<tr>
<td>36-40</td>
<td>13%</td>
</tr>
<tr>
<td>41-45</td>
<td>17%</td>
</tr>
<tr>
<td>46-50</td>
<td>15%</td>
</tr>
<tr>
<td>51-55</td>
<td>7%</td>
</tr>
<tr>
<td>56-60</td>
<td>7%</td>
</tr>
<tr>
<td>&gt;60</td>
<td>3%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of Years Teaching</th>
<th>Study Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 5 years</td>
<td>24%</td>
</tr>
<tr>
<td>6 - 10 years</td>
<td>18%</td>
</tr>
<tr>
<td>11 - 15 years</td>
<td>20%</td>
</tr>
<tr>
<td>16 - 20 years</td>
<td>20%</td>
</tr>
<tr>
<td>21 - 25 years</td>
<td>11%</td>
</tr>
<tr>
<td>26 - 30 years</td>
<td>6%</td>
</tr>
<tr>
<td>31 - 35 years</td>
<td>1%</td>
</tr>
<tr>
<td>36 - 40 years</td>
<td>1%</td>
</tr>
</tbody>
</table>
Final participants for the interviews consisted of six teachers total, three from each school, plus the principal from each school. At Baytree Elementary School, two of the teachers taught fifth grade and one taught first grade. At Northside Elementary School, all three teachers taught fifth grade. All teachers taught science either through departmentalization or team teaching. For example, the first-grade teacher at Baytree Elementary was the sole science teacher for first grade (departmentalization), while all three fifth-grade teachers at Northside Elementary taught both science and math to students (team teaching). The two fifth-grade science teachers at Baytree Elementary had one class that they taught all subjects to, and they taught one of the fifth-grade science topics to all of the other fifth grade classes. For both principals, it was their first year at their schools after serving as assistant principals for several years prior, and they did not know about the PD program prior to becoming principals of their schools.

**Data sources, survey development.** The researcher developed a survey to document elementary teachers’ beliefs and instructional practices regarding science instruction and using the outdoors as a setting for teaching and learning, and to compare the beliefs of teachers who participated in the PD program and those who did not participate. The survey was created as a cross-sectional, Likert-type item survey with a scale of 1 (strongly disagree) to 5 (strongly agree) to indicate respondents’ level of agreement with the Likert-type items (Allen & Seamen, 2007; de Winter & Dodou, 2012; Sosu, McWilliam, & Gray, 2008; Visser et al., 2000).

The survey consisted of 34 items, 21 of which are Likert-type items and the rest were either multiple choice or short answer (Appendix C). Most of the survey items fit into one of three broad categories: 1) teachers’ beliefs and instructional practices regarding science instruction, 2) teachers’ beliefs and instructional practices regarding the benefits of using the outdoors as a setting for teaching and learning, and 3) teachers’ beliefs and instructional
practices regarding barriers to using the outdoors as a setting for teaching and learning. Selected survey items in the first category (science instruction) were used to answer Research Question 1, “What are elementary teachers’ beliefs of science education?” and the second and third categories of survey items (benefits and barriers to using the outdoors as a setting for teaching and learning) were used to answer Research Question 2, “What are elementary teachers’ beliefs of the outdoors as a setting for teaching and learning?” Survey items from all three categories were used to answer Research Question 3, “What are the relationships between the beliefs of science education and of the outdoors as a setting for teaching and learning of teachers who participated in the PD program and teachers who did not participate?”

Additional survey items that did not fit into one of the three categories were items that asked teachers about their enjoyment of science in elementary, middle, and high school, and items that asked PD participants specific questions. The three categories and survey items that fit them are described in more detail in the next paragraph.

The first category of questions about teachers’ beliefs of science instruction consisted of one Likert-type statement that asks about beliefs of science instruction: 1) “Science is an important part of elementary school curriculum,” and three questions about their instructional practices regarding teaching science: 1) “I often integrate science with other subjects,” 2) “Given that a school year is 180 days, approximately how many days per year do you teach science?,” and 3) “On the days you teach science, how many minutes per day on average do you teach it?”

The second category of statements about teachers’ beliefs regarding the benefits of using the outdoors as a setting for teaching and learning consisted of four Likert-type items: 1) “I believe that outdoor instruction supports curriculum,” 2) “I believe that outdoor instruction motivates students,” 3) “I believe that outdoor instruction makes abstract concepts more
concrete,” and 4) “I believe that outdoor instruction should be encouraged more in elementary school.”

The third category of questions about teachers’ beliefs about the barriers to using the outdoors as a setting for teaching and learning consisted of nine Likert-type items: 1) “I believe that a barrier to outdoor instruction is time,” 2) “I believe that a barrier to outdoor instruction is weather,” 3) “I believe that a barrier to outdoor instruction is classroom management issues,” 4) “I believe that a barrier to outdoor instruction is adequate resources,” 5) “I believe that a barrier to outdoor instruction is appropriate curriculum,” 6) “I believe that a barrier to outdoor instruction is lack of support from fellow teachers,” 7) “I believe that a barrier to outdoor instruction is administrators,” 8) “I believe that a barrier to outdoor instruction is parents,” and 9) “I believe that a barrier to outdoor instruction is liability issues.”

Survey questions asked teachers about their instructional practices regarding using the outdoors as a setting for teaching and learning were used to better understand the relationship between beliefs and instructional practices: 1) How many times per year do you take your students outside for science (0 times/year, 2 - 5 times/year, 6 – 8 times/year, 9 – 11 times/year, 12 – 14 times/year, or 15+ times/year)?; 2) I use the outdoor habitat that the PD helped build on my school grounds for instruction (Often, Sometimes, Rarely, Never, or The habitat is no longer there); and 3) I use other areas on the school grounds for instruction (Often, Sometimes, or Rarely). “Other areas” on the school grounds refers to areas on the school grounds not enhanced by the PD program.

Survey validity. Content validity for how well the survey items represent the content of the domain that the construct represents (Westen & Rosenthal, 2003) was determined by formal and informal science educators’ evaluation of the survey items and ranking them for clarity and
accuracy (Appendix I). The results of the evaluations indicated that 75% of the survey items were very clear, 25% were clear but needed minor revisions, and all items were either ranked important or very important in describing the construct.

**Scale development.** A full examination of teachers’ beliefs about using the outdoors as a setting for teaching and learning requires asking multiple questions. To try and understand teachers’ beliefs, multiple survey items were used to document their beliefs about using the outdoors as a setting for teaching and learning. When multiple survey items are used and grouped together to describe one idea, or construct, those survey items form a scale. For example, the four survey items that describe the construct of teachers’ beliefs of the benefits of outdoor instruction (“I believe that outdoor instruction supports curriculum,” “I believe that outdoor instruction motivates students,” “I believe that outdoor instruction makes abstract concepts more concrete,” and “I believe that outdoor instruction should be encouraged more in elementary school”) make up a scale that describes the construct labeled benefits of outdoor instruction. This type of scale is called a summed scale, a grouping of interrelated items (Santos, 1999). The summed scale score of 16 can then be used in the analysis instead of or in addition to the scores from the individual survey items that make up the summed scale.

**Scale reliability.** Cronbach’s alpha coefficient, (Croasmun, & Ostrom, 2011; Cronbach, 1951) was used to provide a measure of the internal consistency (a measure of reliability) of the survey items in each of the two scales: (1) benefits of using the outdoors as a setting for teaching and learning; and (2) barriers to using the outdoors as a setting for teaching and learning. Cronbach’s alpha coefficient is a measure of the reliability of a construct, or of how closely related items are as a group and is expressed as a number between 0 and 1 (Santos, 1999; Tavakol & Dennick, 2011). Alpha is a ratio, and the closer alpha gets to ‘1’ the more the items
are correlated and likely measure the same underlying construct. It is generally accepted that an alpha value between 0.70 and 0.95 is an indication of internal consistency (Santos, 1999; Tavakol & Dennick, 2011).

Tests of reliability were conducted on the data after 52 survey responses were collected. The researcher used Cronbach’s alpha to measure for internal consistency of the constructs “teachers’ beliefs about benefits of using the outdoors as a setting for teaching and learning” and “teachers’ beliefs about barriers to using the outdoors as a setting for teaching and learning.” Cronbach’s alpha for this initial test were 0.91 for the benefits of using the outdoors as a setting for teaching and learning construct and 0.87 for the barriers to using the outdoors as a setting for teaching and learning construct. A final Cronbach’s alpha coefficient was calculated for each construct with the final 191 survey responses, and the results were: 1) 0.89 for the benefits of outdoor instruction construct; and 2) 0.80 for the barriers to outdoor instruction construct.

**Scale validation** Exploratory factor analysis was performed to determine if the survey items in the summed scales factor into more than one group (or scale). Factor analysis is a statistical method used to identify a few, unobserved factors through measured, correlated variables (Gall et al., 2007; Thompson, 2007), such as survey questions. Factor analysis results represent the variation that is common to the observed variables, or clusters of variables that are correlated with each other, and is represented by a value, r, a correlation coefficient that will be between -1 and 1. A value of 1 means the variable is 100% positively correlated with the factor it is representing, while a value of -1 means the variable is 100% negatively correlated with the factor. An absolute value of .4 is considered high enough for the variable to be included in the representation of the factor. The first group of variables that are identified in the factor analysis represent the variables that are most intercorrelated (Gall et al., 2007). Factor analysis was
performed using JMP on the four items in the *Benefits Scale* and on the nine items in the *Barriers Scale*.

Table 3

*Factor Loadings for the Four Benefits to Outdoor Instruction Items*

<table>
<thead>
<tr>
<th>Benefit Survey Item</th>
<th>Factor 1</th>
<th>Factor 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>I believe outdoor instruction supports curriculum</td>
<td>0.6722811</td>
<td>0.4928590</td>
</tr>
<tr>
<td>I believe outdoor instruction motivates students</td>
<td>0.8961166</td>
<td>0.1941009</td>
</tr>
<tr>
<td>I believe outdoor instruction can make abstract concepts more concrete</td>
<td>0.8532140</td>
<td>0.3026917</td>
</tr>
<tr>
<td>I believe outdoor instruction should be encouraged more in elementary school</td>
<td>0.7553205</td>
<td>0.4359117</td>
</tr>
</tbody>
</table>

Table 3 shows the factor analysis performed on the four survey items in the *Benefits Scale*. The analysis indicated that all four items in the benefits scale are highly correlated (Factor 1 in Table 3); therefore, the four items together represent the construct.

Table 4

*Factor Loadings for the Nine Barriers to Outdoor Instruction Items*

<table>
<thead>
<tr>
<th>Barrier Survey Item</th>
<th>Factor 1: loadings</th>
<th>Factor 2: loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barriers to going outside include lack of time</td>
<td>0.172241</td>
<td>0.615530</td>
</tr>
<tr>
<td>Barriers to going outside include weather</td>
<td>-0.008925</td>
<td>0.505305</td>
</tr>
<tr>
<td>Barriers to going outside include classroom management issues</td>
<td>0.161582</td>
<td>0.550820</td>
</tr>
<tr>
<td>Barriers to going outside include lack of adequate resources</td>
<td>0.303815</td>
<td>0.619340</td>
</tr>
<tr>
<td>Barriers to going outside include lack of appropriate curriculum</td>
<td>0.458618</td>
<td>0.365169</td>
</tr>
<tr>
<td>Barriers to going outside include lack of support from fellow teachers</td>
<td>0.671024</td>
<td>0.129673</td>
</tr>
<tr>
<td>Barriers to going outside include lack of support from administration</td>
<td>0.763661</td>
<td>0.119161</td>
</tr>
<tr>
<td>Barriers to going outside include lack of support from parents</td>
<td>0.732521</td>
<td>0.081540</td>
</tr>
<tr>
<td>Barriers to going outside include liability issues</td>
<td>0.570559</td>
<td>0.374084</td>
</tr>
</tbody>
</table>
Table 4 shows the factor analysis performed that identified that the nine items in the *Barriers to Outdoor Instruction Scale* were describing two factors and not just one. The analysis indicated that the five variables that combine to form Factor 1 are more interrelated to each other than the four factors that combine to form Factor 2 because the r values are closer to 1. The two factors present in the *Barriers to Outdoor Instruction Scale* each describe two different categories of barriers: Factor 1 was named Resource and Support Barriers to Outdoor Instruction and includes the five survey items asking teachers to rank the following as barriers to outdoor instruction: lack of appropriate curriculum, lack of support from fellow teachers, lack of support from administrators, lack of support from parents, and liability issues. Lack of appropriate outdoor curriculum is considered a barrier to using the outdoors as a setting for teaching and learning. Support from administration, teachers, and parents, and a good understanding of liability issues are all are important support systems for teachers wanting to use the outdoors as a setting for teaching and learning, and a lack of support can hinder a teachers’ outdoor instructional practices.

Factor 2 was named the External Barriers to Outdoor Instruction and describes barriers to outdoor instruction that are external to the teachers’ control and includes the four survey items asking teachers to rank the following as barriers to outdoor instruction: time, weather, classroom management issues, and lack of adequate resources. The two *Barrier* constructs were analyzed separately; therefore, Cronbach’s alpha was calculated for both constructs to test for their internal reliability. Alpha for the External Barriers to Outdoor Instruction construct was 0.69, and alpha for the Resource and Support Barriers to Outdoor Instruction construct was 0.80.

A summed scale for each *Barriers* construct was created by summing the individual scores for each participant for each survey item in the construct. This composite score is then
used in further analysis instead of the scores for each survey item in the construct. Three scales were created from the survey: The Benefits of Outdoor Instruction Scale (Benefits Scale), The External Barriers to Outdoor Instruction Scale (External Barriers), and The Resource and Support Barriers to Outdoor Instruction Scale (Resource and Support Barriers). The Spearman’s rho Correlation Coefficient, which measures the strength between two variables, was calculated to look at the relationships between the scales, and between a scale and other survey items/questions.

To provide additional information for question three that asked, “What are the relationships between the beliefs of science and the outdoors as a setting for teaching and learning of teachers who participated in the PD program and teachers who did not participate?,” semi-structured interviews were conducted with six teachers who participated in the PD during the 2014-2015 school year. The principals of those schools were also interviewed to gain the administrative viewpoint, since support from administrators has been shown influence a teachers’ ability to implement innovative teaching or learning practices (Kazempour & Amirshokoohi, 2014).

A semi-structured interview format was used, where structured questions were first asked, followed by probing questions when appropriate (Creswell, 1994) (Appendix H). Interview questions for PD participants included questions focused on science, such as: “What are your goals this year for science?,” “How do you assess your students in science?,” and “How do you decide what to teach for science?” The researcher also asked about their classroom management style indoors and outdoors, their use of the outdoors for instruction, their memories of the PD and whether the PD participants discussed what they learned in the PD with other PD participants and/or other teachers, and if they incorporated any of what they learned in the PD.
into their science lessons. The researcher also inquired about how confident teachers felt in their science teaching indoors and outdoors, how supportive the administration and other teachers were for outdoor instruction, if they made plans for outdoor instruction for the next year, and what would encourage more teachers to use the outdoors for teaching and learning. The intention of the interviews was to better understand the PD participants’ beliefs about science and the outdoors as a setting for teaching and learning. These data were designed to enhance the quantitative survey data. Interviews with the school principals (Appendix I) were designed to understand the administrative perspective of elementary school science and their beliefs about outdoors as a setting for teaching and learning.

**Data collection.** For the online survey, the researcher sent a link in an email through Qualtrics to each teacher on the participant list. Once a teacher clicked the link in the email, they could access the survey as many times as needed until they completed it or until the survey was closed. The body of the email contained the cover letter stating the purpose of the study and included a link to the survey. When participants clicked the link to the survey, they first read the consent form, and by typing their name in a box in Qualtrics, they consented to participation. After the initial email was sent, two reminder emails were sent to teachers who had not yet completed the survey, asking for their participation.

The interviews took place over the course of the 2016-2017 school year, two years after the teachers at the two schools with previous year’s participation in the PD program. Teacher and principal interviews were conducted in person in a classroom or another area of the school convenient for the teacher or principal and were audiotaped and transcribed by the researcher.

**Data analysis.** The quantitative data from the survey were analyzed by calculating measures of central tendency (mean and standard deviation), measures of variability, and
correlations between one or more variables (Gall et al., 2007; Reyolds, Livingston, & Willson, 2010) using the software JMP® Pro 13.2.0 (JMP, 2016) to better understand the beliefs of teachers in North Carolina elementary schools who participated in the PD program about science and using the outdoors as a setting for teaching and learning, and to compare the relationships between the beliefs of PD participants to those of non-PD participants. Qualtrics data were uploaded into Microsoft Excel and subsequently into JMP and were analyzed first for reliability and validity. Subsequently, the data were analyzed to answer the research questions.

**Survey analysis.** To answer the research questions, descriptive statistics were calculated, which included describing and summarizing the data in terms of measures of central tendency (mean and standard deviation), measures of variability using the Wilcoxon Rank Sum Test, and correlations using Spearman’s rho Correlation Coefficient between one or more variables (Gall et al., 2007; Reyolds, Livingston, & Willson, 2010). The Wilcoxon Rank Sum Test and the Spearman’s rho Correlation Coefficient, both nonparametric statistical tests, were chosen because the data were not normally distributed. Additionally, the researcher used exploratory factor analysis to identify whether a subset of any of the survey items within the constructs were closely interrelated, or highly correlated with each other (Goodwin, 2009). This would mean that the subset of items that were highly correlated with each other might actually describe a different construct. For example, if a construct originally consisted of 10 survey items and a factor analysis showed that five of the items were highly correlated with each other and the other five items were highly correlated with each other, then the factor analysis would show two subgroups, which are actually describing two different constructs.

Research Question 1 asked elementary teachers their beliefs about science instruction. This was calculated through means and standard deviations in JMP using survey data from all
respondents from the survey items that asked them to: 1) rank their beliefs about the importance of science using a 1 – 5 Likert Scale; 2) rank their use of the integration of science with other subjects using a 1 – 5 Likert Scale; 3) indicate, on the days they teach science, the number of minutes per day they teach science using a given range (0 – 15 minutes, 15 – 30 minutes, 30 – 45 minutes, 45 – 60 minutes, and 60+ minutes); and 4) indicate how many days per year they teach science. The analysis showed that the data were not normally distributed (the data were negatively skewed), as most teachers either somewhat- or strongly-agreed (selected a 4 or a 5 on the Likert Scale) to the statements about the importance of science instruction and their integration of science with other subjects. Due to the data being negatively skewed, where the mean is less than (falls to the left of) the median, nonparametric statistical tests were used in data analyses.

Research Question 2 asked elementary teachers what their beliefs were about the outdoors as a setting for teaching and learning. To answer this question, means and standard deviations were calculated in JMP to describe teachers’ beliefs about the benefits and barriers to using the outdoors as a setting for teaching and learning. Three of the four survey items in the benefits of outdoor instruction construct, also known as the *Benefits to Outdoor Instruction Scale* (*Benefits Scale*) had means that were negatively skewed, therefore the nonparametric statistical tests Wilcoxon Rank Sum Test and Spearman’s rho correlation coefficient were used.

The Spearman’s rho Correlation Coefficient was calculated to measure relationships between different *Barriers* scales and between the scales and other survey items among the survey participants. The correlation coefficient equation produces a value between -1 and +1 that indicates how strongly two variables are related to each other (Gall et al., 2007). If the relationship between the two variables is positive, then if a survey respondent chose ‘5’ as their
answer to one of the variables, they will choose a ‘5’ on the other variable, or if they choose a ‘1’ on one variable then they will choose a ‘1’ on the other variable. In other words, the relationship between the variables is in the same direction; if one goes up (or down) the other goes up (or down), and the coefficient is a positive number. If the relationship is negative, then a change in one variable results in a change in the opposite direction in the other variable, and the coefficient is negative. Relationships calculated included those between teacher beliefs of the importance of science, science integration with other subjects, and with science teaching frequency, of relationships between teacher beliefs of benefits to using the outdoors as a setting for teaching and learning, of barriers to using the outdoors as a setting for teaching and learning, and with the frequency of outdoor instruction, and relationships between the teacher beliefs of the benefits and barriers to outdoor instruction and their beliefs about the importance of science and science teaching frequency.

Research Question 3 asked, “What are the relationships between the beliefs of science and of the outdoors as a setting for teaching and learning of teachers who participated in the PD program and teachers who did not participate?” To answer this question, statistical significance between the means of the two groups (PD participants and non-PD participants) was determined using the Wilcoxon/Kruskal-Wallis rank sums test. Statistical significance was determined for both beliefs and frequency of science instruction in elementary school, beliefs of the benefits and barriers to outdoor instruction. The Spearman’s rho Correlation Coefficient was calculated to look at the relationships between different constructs within the two groups and between the PD and non-PD group.

**Interview data analysis.** Interview transcripts were coded using a priori themes and themes that emerged from the data. The coding process was an iterative process (Creswell, 1994)
that involved the researcher reading through the transcripts, first creating themes using the research questions, and then assigning codes to the data by grouping like statements within the themes and naming them with a short description.

Table 5

*Interview Data Analysis Code Table*

<table>
<thead>
<tr>
<th>Theme</th>
<th>Code</th>
<th>Representative Quote</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beliefs about Science Education</td>
<td>Scientific content and process</td>
<td>“I want [students] to have the ability to deal with the scientific process in learning new concepts…to understand concepts and vocabulary, to [be] adept where they can explain, illustrate, give examples of concepts that we teach”</td>
</tr>
<tr>
<td></td>
<td>Science is everywhere</td>
<td>“I want [students] to walk away knowing that it’s around them every day and everywhere they look and to be excited about it. And to question and to wonder and observe and be aware of what [is] around them and their impact on it.”</td>
</tr>
<tr>
<td>Importance of Science</td>
<td></td>
<td>“Science has a lot of value…it’s important for [students] to know all aspects of science…it’s a critical part to a child’s education”</td>
</tr>
<tr>
<td>Motivation</td>
<td></td>
<td>“Make them want to know more and provide them with hands on experiences that are relevant to their lives.”</td>
</tr>
</tbody>
</table>
Table 5 (continued.)

| Prepare students for standardized tests | “My goal is for each of those students to be able to take away the lessons that we have pulled and be successful on the EOG.” |
| Confidence | “[I am] very confident [in teaching science], it’s something I love to do, and when we’re confident in doing something that confidence comes across to the kids.” |
| Benefits of Outdoor Instruction | Makes abstract concepts more concrete | “I think that it’s a good thing. I think it helps kids see in front of their eyes the things you are talking about, to relate instruction with real world experiences and to get out of the mindset that this is just something we are doing in school” |
| Engagement | “Being outside helps the students, it’s more engaging.” |
| Motivation | “It’s absolutely wonderful. It’s essential. I think [students] learn better, they absorb it [science content] better.” |
| Barriers to Outdoor Instruction | Weather | “You have to have the right lesson and the right weather and the same days, and that’s a big part of the problem.” |
| Time | “It’s a matter of just really good planning and finding the time to do it.” |
| Classroom management issues | “The only thing, though, and I hate this, but I would say what keeps me from doing it more than I want to is the dynamics of the group. The behavior gets to be such to a point that [outdoor instruction] makes it difficult.” |
Table 5 (continued.)

<table>
<thead>
<tr>
<th>Outdoor space constraints</th>
<th>“Those picnic tables [would help with outdoor instruction], so we would have someplace to put their things on, and we could make observations, cause kids on the ground.”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confidence</td>
<td>“I love it, I just haven’t been around it enough or felt like I am qualified…but I love the idea of going outside with them.”</td>
</tr>
<tr>
<td>Safety issues</td>
<td>“I like it, but the barriers we have to outdoor instruction. We are working on that in the courtyard area, we are trying to get some picnic tables out there so they have a place to write and sit and a place that’s closed off and safety is not an issue, and the PD portion is in that area.”</td>
</tr>
<tr>
<td>Uncommon instructional practices</td>
<td>“I’ve encouraged people to use the campus. But when we get into our classrooms, and start teaching, the routines lock us in and what we know locks us is, so breaking those routines and fostering a risk-taking atmosphere is what we are trying to do. Changing routines is hard.”</td>
</tr>
</tbody>
</table>

Table 5 shows the themes, codes, and representative quotes from the interview data analysis. The interview data analysis supplemented the quantitative data analysis by providing additional insight into beliefs and instructional practices of former PD participants related to science and outdoor instruction. The interviews were coded using a priori themes: Beliefs about Science Instruction, the Benefits of Outdoor Instruction, and Barriers to Outdoor Instruction.
Within each theme, codes emerged and were organized to construct a picture of the teachers’ beliefs and instructional practices regarding science and using the outdoors as a setting for teaching and learning.

**Trustworthiness of analysis.** The trustworthiness of the analysis was addressed by assuring the credibility of the interview data analysis through peer debriefing (Creswell & Miller, 2000) in which the researcher’s doctoral advisor discussed and challenged the researcher’s results and assumptions through both oral and written feedback. Peer debriefing involves the review of the data and research process by someone who is familiar with the research or the phenomenon being explored (Creswell & Miller, 2000). The use of multiple data types (survey and interview data) strengthen the study by allowing the researcher to look for the convergence of themes among the different data sources.

**Role of the researcher.** In this study, the researcher participated in the interviews and observed the behavior of the past-PD participants that were interviewed and their students. No outdoor lessons were observed. The researcher had visited the two schools in the past to observe the PD program in action during the 2014-2015 school year and did speak with several of the PD participants at that time. In reporting the results of the data, the researcher focused on the quantitative survey findings, with the interview data supporting these, and how these findings relate to the literature and to future research opportunities. The researcher and her doctoral advisor discussed how to remain unbiased and reviewed the dissertation multiple times to remove any suppositions the researcher may have made in the analysis and interpretation of the data.
Limitations

This study has limitations that include the unequal sample sizes of the PD versus the non-PD participants who completed the survey and the overall small sample size decreases the ability to infer the results of this study to the larger population of elementary teachers. Because the PD participants were not surveyed or interviewed prior to their participation, the researcher is unable to describe any influence of participation in the PD program to results from the study. Another limitation is non-response bias due to the low response rate of 5.5%, which is the bias that can result when data are not collected from all of the members of a sample (Visser et al., 2000). Non-response bias results when respondents differ from non-respondents in terms of attitudinal or demographic variables (Sax, Gilmartin, & Bryant, 2003). In this case, some teachers may not have responded to the survey because the survey was focused on beliefs about science and outdoor instruction and this did not interest them, and some teachers may have thought that because they were not PD participants, they could not participate in the survey. Another limitation to the survey is the low number of items used to create the constructs, and the survey items regarding barriers to outdoor instruction could be interpreted to mean general barriers and not ones the teacher feels pertains to them. The analyses of the means, standard deviations, and correlations of the survey data along with the interview data provided results that will be discussed in the following section.
CHAPTER 4: RESULTS

This study was designed to understand NC teachers’ beliefs regarding science education and beliefs about the use of the outdoors as a setting for teaching and learning, including benefits and barriers they face to outdoor instruction. The study also sought to describe relationships between the beliefs of science and of the outdoors as a setting for teaching and learning of teachers who participated in the PD program and teachers who did not participate. Through the use of a Likert-type survey and interviews, teachers whose schools had a history of the PD program completed surveys and a sample of teachers who participated in the PD program at two schools were interviewed to better understand PD participants’ beliefs of science and outdoor instruction. The survey items were divided into three sections that examined teachers’ beliefs about: 1) science in elementary school, 2) benefits of the outdoors as a setting for teaching and learning, and 3) barriers to using the outdoors as a setting for teaching and learning.

To further examine former PD participants’ beliefs of science and using the outdoors as a setting for teaching and learning, the researcher interviewed three teachers from two schools that participated in the PD program (six teachers total) and the two principals at those schools during the 2014 – 2015 school year. Names of the schools and teachers are pseudonyms. Interviews were conducted at Baytree Elementary School with the principal and with Jennifer and Sandra, both fifth grade teachers, and Danielle, a first-grade teacher. Interviews were conducted at Northside Elementary School with the principal and three teachers, Taylor, Pat, and Dora, all fifth-grade teachers. All teachers taught science either through departmentalization, where one teacher teaches one subject to all students in the grade, or team teaching. In both schools, the principals were in their first year at that school and were not the principals when the PD program was at their schools.
Research Question 1

Research Question 1 asked, “What are elementary teachers’ beliefs of science education?” The researcher hypothesized that the majority of elementary teachers surveyed would believe science instruction in elementary classrooms as important. In order to answer this question, one survey item asked teachers about their belief of the importance of science in the elementary school curriculum, and three survey items and/or questions about teachers’ science instructional practices: (1) the integration of science with other subjects; (2) the number of days per school year teachers teach science; and (3) the average length (in minutes per day) of science instruction on the days that teachers teach science.

Measures of central tendency. Measures of central tendency and variability were calculated to describe how the survey participants answered items regarding their beliefs of science instruction in elementary school.
Table 6

**Teacher Responses and Descriptive Statistics for Teachers’ Beliefs of Science and their Instructional Practices**

<table>
<thead>
<tr>
<th>Likert Survey Item</th>
<th>Strongly Disagree (1)</th>
<th>Somewhat Disagree (2)</th>
<th>Neither Agree nor Disagree (3)</th>
<th>Somewhat Agree (4)</th>
<th>Strongly Agree (5)</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science is an important part of elementary school curriculum</td>
<td>12 (6%)</td>
<td>7 (4%)</td>
<td>4 (2%)</td>
<td>28 (15%)</td>
<td>140 (73%)</td>
<td>4.45 (1.13)</td>
</tr>
<tr>
<td>I often integrate science with other subjects</td>
<td>10 (5%)</td>
<td>9 (5%)</td>
<td>7 (4%)</td>
<td>89 (47%)</td>
<td>76 (40%)</td>
<td>4.11 (1.04)</td>
</tr>
</tbody>
</table>

**Teachers’ Responses about their Science Teaching Frequency**

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>0 – 15</th>
<th>15 – 30</th>
<th>30 – 45</th>
<th>45 – 60</th>
<th>60+</th>
</tr>
</thead>
<tbody>
<tr>
<td>On the days you teach science, how many minutes per day do you teach it?</td>
<td>10 (5%)</td>
<td>48 (25%)</td>
<td>82 (43%)</td>
<td>36 (19%)</td>
<td>15 (8%)</td>
</tr>
<tr>
<td>Given that a school year is 180 days, approximately how many days per year to you teach science?</td>
<td>23 (12%)</td>
<td>67 (35%)</td>
<td>36 (19%)</td>
<td>65 (34%)</td>
<td>109.12 (49.31)</td>
</tr>
</tbody>
</table>

Table 6 shows teacher responses to the four survey items describing teachers’ beliefs of science, including the means and standard deviations for the first two survey items which are
Likert-type items. As the table shows, for the first survey item, 88% of teachers either somewhat- or strongly-agreed that science is an important part of the elementary school curriculum, with 73% of teachers strongly agreeing. The second, third, and fourth survey items describe the instructional practices regarding science instruction: integration with other subjects, the number of minutes taught each day, and the number of days taught each year. The majority of teachers either somewhat agreed (47%) or strongly agreed (40%) that they often integrated science with other subjects. The largest group of teachers (43%) taught science for 30 – 45 minutes/day, with the second largest group of teachers (25%) teaching science between 15 and 30 minutes/day.

Table 7

*Teacher Responses Describing Their School’s Instructional Design for Science*

<table>
<thead>
<tr>
<th>How is Science Taught in your Grade?</th>
<th>Percentage of teachers (n = 191)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science is taught separately and integrated with other subjects</td>
<td>45%</td>
</tr>
<tr>
<td>Science and another subject are alternated on a unit basis</td>
<td>24%</td>
</tr>
<tr>
<td>Science is taught as a separate subject</td>
<td>18%</td>
</tr>
<tr>
<td>Science is integrated with other subjects but not taught as a separate subject</td>
<td>13%</td>
</tr>
</tbody>
</table>

Survey respondents were asked to choose from four statements describing their schools’ instructional design for science. Table 7 shows that almost half of the teachers chose the option “Science is taught separately and integrated with other subjects.” Teachers who indicated that “Science is taught as a separate subject” taught science for the most days per year, followed by teachers who chose “Science is taught separately and integrated with other subjects.” Teachers who indicated that “Science is taught as a separate subject” also taught science for the most minutes per day.
Table 8

**Teacher Responses Describing Their Science Teaching Frequency Aligned with their School’s Instructional Design for Science**

<table>
<thead>
<tr>
<th>How is Science Taught in your Grade?</th>
<th>Average Number of days per year teaching science (out of 180)</th>
<th>Category of number of minutes per day for teaching science (1 = 0-15 minutes, 2 = 15-30 minutes, 3 = 30-45 minutes, 4 = 45-60 minutes, 5 = &gt;60 minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science is taught separately and integrated with other subjects</td>
<td>116</td>
<td>2.99 (15-30 minutes)</td>
</tr>
<tr>
<td>Science and another subject are alternated on a unit basis</td>
<td>81</td>
<td>2.89 (15-30 minutes)</td>
</tr>
<tr>
<td>Science is taught as a separate subject</td>
<td>138</td>
<td>3.65 (30-45 minutes)</td>
</tr>
<tr>
<td>Science is integrated with other subjects but not taught as a separate subject</td>
<td>97</td>
<td>2.28 (15-30 minutes)</td>
</tr>
</tbody>
</table>

Table 8 details teachers’ responses about how many minutes per day and days per year they teach science by their schools’ instructional design for science (as shown in Table 7).

**Correlations between beliefs of science and science instructional practices.**

Spearman’s rho correlation coefficient was calculated to measure the strength of the relationship between different variables related to a teacher’s beliefs and instructional practices regarding science instruction.
Table 9

*Spearman’s rho Correlation Coefficients for Survey Items Describing Beliefs of Science Instruction and Behaviors Regarding Science Teaching*

| Belief of Science Teaching | Science Teaching Behavior | Spearman ρ | Prob>|ρ| |
|----------------------------|---------------------------|------------|------|
| Science is an important part of elementary school curriculum. | I often integrate science with other subjects. | 0.37 | <.0001** |
|                             | On the days you teach science, how many minutes per day on average do you teach it? | 0.1834 | 0.0111* |

<table>
<thead>
<tr>
<th>Science Teaching Behavior</th>
<th>Science Teaching Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>On the days you teach science, how many minutes per day on average do you teach it?</td>
<td>Given that a school year is 180 days, approximately how many days per year do you teach science?</td>
</tr>
</tbody>
</table>

** p-value is significant at the 0.001 level
* p-value is significant at the 0.05 level

Table 9 shows the correlation between teachers’ beliefs of the importance of science and science integration, and between the importance of science and science teaching frequency. There is a strong positive relationship between teachers’ beliefs of the importance of science instruction and both the integration of science with other subjects and how many minutes per day they teach science. A strong positive relationship means that a teacher who ranked the importance of science in elementary school high (or low), also ranked their integration of science with other subjects high (or low), indicating a relationship between the importance of science and teaching behavior including integration of science with other subjects and frequency of teaching science.

**Qualitative interviews: PD participants’ beliefs of science instruction.** Within the theme of beliefs about science instruction, six codes emerged from the data that included scientific content and process, science is everywhere, importance of science, motivation, prepare
students for standardized tests, and confidence. The data showed that teachers wanted students to learn both scientific processes and content, such as when Sandra, a 5th grade teacher from Baytree Elementary, explained that she wanted to develop students’ “abilities to deal with the scientific process in learning new concepts…to understand concepts and vocabulary, to [be] adept where they can explain, illustrate, give examples of concepts that we teach.” Another code was “Science is everywhere”, with Dora, a 5th grade teacher from Northside Elementary, explaining that she wants her students to:

walk away knowing that it’s around them every day and everywhere they look and to be excited about it and to question and to wonder and observe and be aware of what [is] around them and their impact on it. Make them want to know more and provide them with hands-on experiences that are relevant to their lives.

Preparing students for standardized tests was another code that emerged from the interviews. When asked about goals for the year in science, two of the 5th grade teachers emphasized that they wanted their students to pass the End of Grade (EOG) standardized test. All teachers mentioned using state standards to help them decide on what to teach, especially the five 5th grade teachers whose students would be taking the 5th grade EOG in science.

Confidence is another code within the “Belief about Science Education” theme. When asked how confident they were in teaching science, answers ranged from “very confident” and “reasonably confident,” depending on the specific science topic. Jennifer said that she felt really good about matter and energy because she taught it to all fifth graders, but she was less confident about teaching other science topics that she doesn’t teach as often, saying, “if I taught it [a specific science topic] every day, I would feel better about it.” This indicates that the more experience she has with teaching a topic the more confident she is with that topic. When asked
about confidence in teaching science, Danielle said she was “very confident [in teaching science], it’s something I love to do, and when we’re confident in doing something that confidence comes across to the kids.” Danielle taught only science to all of the classes in her grade level, allowing her to gain a lot of science teaching experience.

**Qualitative interviews: Principals’ beliefs of science instruction.** Principals of both schools expressed their value of the role of science in elementary school. Baytree Elementary School’s principal felt that science in elementary school “has a lot of value…it’s important for them to know all aspects of science…it’s a critical part to a child’s education.” Northside Elementary School’s principal said this of science in elementary school: “It’s infinite. It ties to everything. It gives us an understanding of the inner-workings, the inner-connectivity of everything. No matter how large or small everything is connected.”

**Research Question 2**

Research Question 2 asked, “What are elementary teachers’ beliefs of the outdoors as a setting for teaching and learning?” The researcher hypothesized that the majority of elementary teachers surveyed would identify that there are benefits to using the outdoors as a setting for teaching and learning but that the barriers to using the outdoors would be a greater influence on their outdoor instructional practices. Three scales were created that describe teachers’ beliefs about using the outdoors for teaching and learning. The first scale describes their beliefs about the benefits of using the outdoors for teaching and learning, the second scale describes teachers’ external barriers to outdoor instruction, and the third scale describes teachers’ resource and support barriers to outdoor instruction.
**Benefits to outdoor instruction.** Measures of central tendency for the survey items related to teachers’ beliefs of the benefits of using the outdoors as a setting for teaching and learning were calculated.

Table 10

*Means and Standard Deviations for Items in the Scale Describing Teachers’ Beliefs on the Benefits of Using the Outdoors as a Setting for Teaching and Learning*

<table>
<thead>
<tr>
<th>Likert Survey Items in the Benefits of Outdoor Instruction Scale</th>
<th>The Number (Percentage) of Teachers Who Ranked the Survey Items as Shown, (n = 191)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I believe outdoor instruction supports curriculum</td>
<td>Strongly Disagree (1) 5 (3%) Somewhat Disagree (2) 5 (3%) Neither Agree nor Disagree (3) 9 (5%) Somewhat Agree (4) 77 (40%) Strongly Agree (5) 95 (49%) Mean (SD) (n = 191) 4.32 (0.89)</td>
</tr>
<tr>
<td>I believe outdoor instruction motivates students</td>
<td>Strongly Disagree (1) 3 (1%) Somewhat Disagree (2) 1 (1%) Neither Agree nor Disagree (3) 5 (3%) Somewhat Agree (4) 59 (31%) Strongly Agree (5) 123 (64%) Mean (SD) (n = 191) 4.55 (0.72)</td>
</tr>
<tr>
<td>I believe outdoor instruction can make abstract concepts more concrete to students</td>
<td>Strongly Disagree (1) 4 (2%) Somewhat Disagree (2) 0 (0%) Neither Agree nor Disagree (3) 7 (4%) Somewhat Agree (4) 56 (29%) Strongly Agree (5) 124 (65%) Mean (SD) (n = 191) 4.54 (0.76)</td>
</tr>
<tr>
<td>I believe outdoor instruction should be encouraged more in elementary school</td>
<td>Strongly Disagree (1) 5 (3%) Somewhat Disagree (2) 0 (0%) Neither Agree nor Disagree (3) 5 (3%) Somewhat Agree (4) 49 (26%) Strongly Agree (5) 132 (69%) Mean (SD) (n = 191) 4.58 (0.78)</td>
</tr>
</tbody>
</table>

Table 10 shows that most teachers (89% or greater) somewhat agreed or strongly agreed that there were benefits using the outdoors as a setting for teaching and learning.

**Qualitative interviews: PD participants’ beliefs of benefits of outdoor instruction.**

Within the theme of beliefs of benefits of outdoor instruction, three codes emerged from the data that included makes abstract concepts more concrete, motivation, and engagement.
Interview data mirrored the quantitative survey data. Teachers expressed beliefs that the outdoors can be motivating and engaging for students, both codes that emerged from the interview question “Describe your views of outdoor instruction.” Pat said that the outdoors is “absolutely wonderful. It’s essential. I think [students] learn better, they absorb it [science content] better,” and Jennifer said that “being outside helps [science content] it’s more engaging.” Jennifer, Pat, and Sandra said that the outdoors is a motivating factor for students and can help them see how what they learn in the classroom can relate to their lives. Sandra said the outdoors “helps kids see in front of their eyes [science content] … to relate instruction with real world experiences and to get out of the mindset that [science] is just something we are doing in school.” She also said that when taking her students outside for a lesson they were “very engaged, they were discussing what they saw in the terms [vocabulary] that I wanted them to, so it was applicable because it was right there before them.”

**Barriers to outdoor instruction.** Measures of central tendency for the survey items related to teachers’ beliefs of the barriers to using the outdoors as a setting for teaching and learning were calculated.
Table 11 shows the means for the *External Barriers to Outdoor Instruction Scale* range between 3 (Neither Agree nor Disagree) and 4 (Somewhat Agree), indicating that while teachers had goals for students to learn outdoors, the external barriers sometimes inhibited their use of the outdoors for teaching and learning. Survey data indicated that approximately 75% of teachers somewhat- to strongly- agreed that a lack of time and weather were barriers to outdoor
instruction, and 63% and 64% of teachers either somewhat- or strongly-agreed that classroom management issues and a lack of adequate resources, respectively, were barriers to outdoor instruction.

Table 12

Means and Standard Deviations for Items in the Resource and Support Barriers to Outdoor Instruction Scale

<table>
<thead>
<tr>
<th>Likert Survey Items in the Resource and Support Barriers to Outdoor Instruction Scale</th>
<th>Teachers Who Ranked the Survey Items as Number (Percentage), (n = 191)</th>
<th>Strongly Disagree (1)</th>
<th>Somewhat Disagree (2)</th>
<th>Neither Agree nor Disagree (3)</th>
<th>Somewhat Agree (4)</th>
<th>Strongly Agree (5)</th>
<th>Mean (SD) (n = 191)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barriers to going outside include lack of appropriate curriculum</td>
<td>25 (13%)</td>
<td>35 (18%)</td>
<td>42 (22%)</td>
<td>68 (36%)</td>
<td>21 (11%)</td>
<td>3.13 (1.23)</td>
<td></td>
</tr>
<tr>
<td>Barriers to going outside include lack of support from fellow teachers</td>
<td>40 (21%)</td>
<td>38 (20%)</td>
<td>52 (27%)</td>
<td>42 (22%)</td>
<td>19 (10%)</td>
<td>2.80 (1.27)</td>
<td></td>
</tr>
<tr>
<td>Barriers to going outside include lack of support from administration</td>
<td>61 (32%)</td>
<td>40 (21%)</td>
<td>50 (26%)</td>
<td>31 (16%)</td>
<td>9 (5%)</td>
<td>2.41 (1.22)</td>
<td></td>
</tr>
<tr>
<td>Barriers to going outside include lack of support from parents</td>
<td>67 (35%)</td>
<td>39 (20%)</td>
<td>61 (32%)</td>
<td>22 (12%)</td>
<td>2 (1%)</td>
<td>2.23 (1.09)</td>
<td></td>
</tr>
<tr>
<td>Barriers to going outside include liability issues.</td>
<td>34 (18%)</td>
<td>32 (17%)</td>
<td>53 (28%)</td>
<td>62 (32%)</td>
<td>10 (5%)</td>
<td>2.91 (1.19)</td>
<td></td>
</tr>
</tbody>
</table>

Table 12 shows the means for the Resource and Support Barriers to Outdoor Instruction Scale, which mostly ranged between 2 (‘Somewhat Disagree’) and 3 (‘Neither Agree nor
Disagree’), indicating that teachers generally felt that the resource and support barriers were not significant barriers to their use of the outdoors for teaching and learning. The data indicate that teachers believed the external barriers as more of a challenge to using the outdoors as a setting for teaching and learning than the resource and support barriers.

Quantitative survey: Correlations between benefits and barriers to outdoor instruction. The Spearman’s rho correlation coefficient was calculated to measure the strength between different variables related to a teachers’ beliefs and instructional practices regarding to the use of outdoor instruction.
Table 13

*Spearman’s rho Correlation Coefficients between Outdoor Instruction Scales and Behavior Regarding the Use of the Outdoors for Instruction*

| Benefits/Barriers to Outdoor Instruction Scale | Outdoor Instructional Practice Items | Spearman ρ | Prob>|ρ| |
|-----------------------------------------------|-------------------------------------|-----------|--------|
| Benefits to Outdoor Instruction Scale         | I use other areas on the school grounds for instruction*** | 0.1813    | 0.0121*|
| Benefits to Outdoor Instruction Scale         | How many times per year do you take your students outside for science | 0.1669    | 0.021* |
| External Barriers to Outdoor Instruction Scale| I use other areas on the school grounds for instruction | -0.1966   | 0.0064**|
| External Barriers to Outdoor Instruction Scale| How many times per year do you take your students outside for science | -0.1581   | 0.0289*|
| Resource and Support Barriers to Outdoor Instruction Scale | I use other areas on the school grounds for instruction | -0.1987   | 0.0059**|
| Resource and Support Barriers to Outdoor Instruction Scale | How many times per year do you take your students outside for science | -0.2011   | 0.0053**|

*** Other areas on the school grounds refers to areas that were not developed through the PD program
** p-value is significant at the 0.01 level
* p-value is significant at the 0.05 level

Table 13 shows that there are both strong positive and negative correlations. Positive correlations were revealed between the *Benefits of Outdoor Instruction Scale* and the survey items asking about teachers’ use of the outdoors for instruction, indicating that as teachers rank the benefits of outdoor instruction higher, they also indicate that they take their students outside for instruction more often. The negative correlations were between the *External Barriers to Outdoor Instruction Scale* and the *Resource and Support Barriers to Outdoor Instruction Scale* and the survey items asking about teachers’ use of the outdoors for instruction. This indicates
that as teachers rank any of the barriers higher, they ranked the number of times they took their students outside for science and their use of the school grounds for instruction lower.

Table 14

*Frequency Teachers Took their Students Outside for Science*

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>0 times/year</th>
<th>2-5 times/year</th>
<th>6-8 times/year</th>
<th>9-11 times/year</th>
<th>12-14 times/year</th>
<th>15+ times/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>How many times per year do you take your students outside for science?</td>
<td>6 (3%)</td>
<td>66 (35%)</td>
<td>50 (26%)</td>
<td>26 (14%)</td>
<td>13 (7%)</td>
<td>30 (16%)</td>
</tr>
</tbody>
</table>

Table 14 shows that the vast majority of teachers (97%) took their students outside at least 2 times per year, and over half of teachers (63%) took their students outside at least 6 times per year.

**Qualitative Interviews: PD participants’ beliefs of barriers to outdoor instruction.**

Within the theme of beliefs of barriers to outdoor instruction, seven codes emerged from the data that included weather, time, classroom management issues, outdoor space constraints, confidence, safety issues, and uncommon instructional practices. Interview data mirrored the quantitative survey data. Confidence was a factor in some teachers’ decisions about using the outdoors for teaching and learning. Jennifer explained that although she likes going outside for teaching and learning, “I just haven’t been around [outdoor instruction] enough or felt like I am qualified…but I love the idea of going outside with [students].” She also commented, when asked about memories of the PD program, that PD facilitators are “the kind of teacher I want to be! But it’s hard to go from the way we’ve been teaching to doing that. I need to take little steps, but I need to be headed in that direction.” When asked about confidence in teaching outdoors,
Pat said, “Very confident, I like it. I would do it more often myself if I could get the kids to cooperate.”

Taylor expressed hesitation to using the outdoors for instruction because of student safety (a code that emerged from the interview data) and classroom management issues (an a priori code):

Outside, especially where we were going on this field [on the school grounds], it’s right next to the main highway, and we have to be super aware of our surroundings, and not [allow the students to] run where ever they need to. They enjoy going outside but they tend to push the boundaries even more because they are not contained.

Pat also commented about classroom management issues:

The only thing, though, and I hate this, but I would say what keeps me from doing [going outside] more than I want to is the dynamics of the group. The behavior gets to be such to a point that it makes it difficult.

Another challenge mentioned by one the teachers interviewed was finding funding to purchase resources for the outdoors that would make taking students outside easier. Danielle was unhappy with the fact that students had nowhere to sit and write, except for the ground, saying, “We are trying to use the courtyard some. We didn’t have anything to put anything on, like picnic tables, but I’m happy to say that that is in the works, we have the funding for it.”

A lack of time for planning and conducting outdoor lessons and the weather also influenced teachers’ use of the outdoors as a setting for teaching and learning. Sandra commented that “You have to have the right lesson and the right weather and the same days, and that’s a big part of the problem.” Taylor said, “It’s a matter of just really good planning, and
finding the time to do it.” And sometimes, they felt like they can do just as good of a job with materials they have inside the classroom. Sandra said:

   Bottom line, I think it’s [outdoor instruction] a real good thing, but I don’t always do it.

   Due to time and weather constraints, and sometimes I think I have something inside that is just as good for the concepts I want to teach.

   When asked what would encourage taking students outside, Jennifer said, “[more] time to do some research, professional development type stuff to find lessons that were already planned, so the resources. And then you’ve got to be deliberate, you’ve got to make the effort.” Taylor echoed the need for more planning to help in taking her students outside when she said, “I think it’s a matter of just really good planning and finding the time to do it.”

**Qualitative interviews: Principals’ beliefs of outdoor instruction.** Administrator voices were deemed important to include in this research because the support of school administrators is a critical factor in the success of a PD program (Kazempour & Amirshokoohi, 2014). Both the principals at Baytree and Northside elementary schools were in their first year as principals at those schools when the researcher conducted the interviews, and both had no knowledge about the PD program prior to arriving at their schools. When asked about their beliefs on outdoor instruction, both principals were positive about it yet mentioned how hard it can be to encourage teachers to use the outdoor space. The principal at Baytree said:

   I like it, but [there are] barriers [that] we have to outdoor instruction. We are working on that in the courtyard area, we are trying to get some picnic tables out there, so they have a place to write and sit and a place that’s closed off and safety is not an issue.

The principal at Northside said:
I’ve encouraged people to use the campus. There is space for everyone. The desire is there. But when we get into our classrooms, and start teaching, the routines lock us in and what we know locks us in, so breaking those routines and fostering a risk-taking atmosphere is what we are trying to do. Changing routines is hard.

Both principals recognized that one of the difficulties teachers face is trying to adapt indoor science lessons to outdoor lessons, where they often do not similar space and resources. Northside’s principal has “toyed with possibly requiring some time each nine weeks or each month that [teachers] engage outside and see what that looks like.” The principal was considering this requirement because she felt some teachers would not use the outdoors as a setting for teaching and learning otherwise. Both principals were thinking about how to encourage and support their teachers in using the outdoors for instruction. Northside’s principal thought maybe she “could get a few teachers to pilot an outdoor program, where the core instruction is conducted outdoors.”

**Quantitative survey: Correlations between teachers’ beliefs of science, outdoor instruction, and instructional practices.** The correlation calculations between how teachers ranked survey items relating to science instruction and those relating to outdoor instruction revealed both positive and negative relationships.
Table 15

*Spearman’s rho Correlation Coefficients Describing the Relationships Between Science and Outdoor Instruction*

| Beliefs and Instructional Practices Regarding Science Instruction | Benefits and Instructional Practices Regarding Outdoor Instruction | Spearman $\rho$ | Prob>|$\rho$| |
|---|---|---|---|
| Science is an important part of elementary school curriculum | Benefits of Outdoor Instruction Scale | 0.273 | 0.0001*** |
| Rank your level of enjoyment of science when you were in high school | I use other areas on the school grounds for instruction | 0.174 | 0.0161* |
| | How many times per year do you take your students outside for science | 0.1739 | 0.0161* |
| | How many times per year do you take your students outside for science | 0.3763 | <.0001*** |
| Given that a school year is 180 days, approximately how many days per year do you teach science | On the days you teach science, how many minutes per day on average do you teach it | 0.254 | 0.0004** |
| | I use other areas on the school grounds for instruction | 0.1941 | 0.0071** |
| I often integrate science with other subjects | I use other areas on the school grounds for instruction | 0.1604 | 0.0267* |

*** p-value significant at the 0.001 level  
** p-value significant at the 0.01 level  
* p-value significant at the 0.05 level

Table 15 shows that a positive relationship between beliefs of science instruction and the *Benefits of Outdoor Instruction* Scale and their outdoor instructional practices. This indicates that as teachers ranked the benefits of outdoor instruction high (strongly agree on the Likert scale), they also indicated they took their students outside for science more frequently. How a teacher ranked their enjoyment of science in high school was also positively correlated with their use of the outdoors as a setting for teaching and learning. The one negative relationship was between the number of days per year a teacher taught science and the *External Barriers to Outdoor*
Instruction Scale. This indicates that teachers who taught science less often may have felt more inhibited by the External barriers to outdoor instruction items such as time, weather, classroom management issues, and lack of adequate resources.

**Research Question 3**

Research Question 3 asked, “What are the relationships between the beliefs of science and the beliefs of the outdoors as a setting for teaching and learning of teachers who participated in the PD program and teachers who did not participate?” The researcher hypothesized that PD participants’ beliefs about science and outdoor instruction in elementary school would be more positive than those of non-PD participants. To answer this question, the researcher calculated measures of central tendency to look at differences between the PD and the non-PD participants’ beliefs of science instruction and their use of the outdoors as a setting for teaching and learning, and correlations were calculated to better understand relationships between survey items.

**Quantitative survey: PD and non-PD participants’ beliefs and instructional practices regarding science.** Measures of central tendency and the results from the Wilcoxon test for the four survey items were used to describe teachers’ beliefs of science instruction and science instructional practices.
Comparison of Means for PD Participants and Non-PD Participants Regarding Their Beliefs of Science Instruction

<table>
<thead>
<tr>
<th>Beliefs and Instructional Practices Regarding Science</th>
<th>PD Participants $(n = 43)$</th>
<th>Non-PD Participants $(n = 148)$</th>
<th>Wilcoxon test $(Z)$</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science is an important part of elementary school curriculum</td>
<td>4.81 (0.76)</td>
<td>4.34 (1.19)</td>
<td>3.19</td>
<td>0.001**</td>
</tr>
<tr>
<td>I often integrate science with other subjects</td>
<td>4.44 (0.59)</td>
<td>4.01 (1.12)</td>
<td>1.92</td>
<td>0.054</td>
</tr>
<tr>
<td>Given that a school year is 180 days, approximately how many days per year do you teach science</td>
<td>117.28 (51.55)</td>
<td>106.74 (48.56)</td>
<td>1.29</td>
<td>0.197</td>
</tr>
<tr>
<td>On the days you teach science, how minutes per day on average do you teach it</td>
<td>3.33 (0.99)</td>
<td>2.89 (0.96)</td>
<td>2.41</td>
<td>0.016*</td>
</tr>
</tbody>
</table>

** p-value is significant at the 0.001 level
* p-value is significant at the 0.05 level

Table 16 shows the statistically significant difference in the means between the PD participants and the non-PD participants in their ranking of the importance of science in the elementary school curriculum. PD participants were significantly more likely than non-PD participants to think science as a very important part of the elementary school curriculum ($Z = 3.19; p = 0.001$) and to teach science for more minutes per day they teach science ($Z = 2.41; p = 0.016$). Ninety-three percent of PD participants (40 out of 43 teachers) strongly agreed that science is an important part of the elementary school curriculum, while one teacher each somewhat agreed, somewhat disagreed, and strongly disagreed that science is an important part of the elementary school curriculum.
Quantitative survey: PD and non-PD participants’ beliefs and instructional practices regarding using the outdoors for teaching and learning. There were no statistically significant differences between the means of the PD participants and non-participants for the survey items describing benefits and barriers to outdoor instruction.

Table 17

Comparison of the Number of Times/Year PD Participants and Non-PD Participants Took their Students Outside for Science

<table>
<thead>
<tr>
<th>Teachers’ Responses to the Number of Times/Year they Take Students Outside for Science</th>
<th>Number of Times/Year</th>
<th>Number (Percentage) of Survey Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PD Participants (n=43)</td>
<td>Non-PD Participants (n=148)</td>
</tr>
<tr>
<td>1 = 0 times/year</td>
<td>2 (5%)</td>
<td>4 (3%)</td>
</tr>
<tr>
<td>2 = 2-5 times/year</td>
<td>9 (21%)</td>
<td>57 (39%)</td>
</tr>
<tr>
<td>3 = 6-8 times/year</td>
<td>13 (30%)</td>
<td>37 (25%)</td>
</tr>
<tr>
<td>4 = 9-11 times/year</td>
<td>5 (12%)</td>
<td>21 (14%)</td>
</tr>
<tr>
<td>5 = 12-14 times/year</td>
<td>2 (5%)</td>
<td>11 (7%)</td>
</tr>
<tr>
<td>6 = 15+ times/year</td>
<td>12 (28%)</td>
<td>18 (12%)</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td><strong>3.74 (1.65)</strong></td>
<td><strong>3.22 (1.41)</strong></td>
</tr>
<tr>
<td>Wilcoxon test (Z)</td>
<td>1.97</td>
<td><em>0.049</em></td>
</tr>
</tbody>
</table>
| p value | *p* value is significant at the 0.05 level

Table 17 shows the statistically significant difference in the mean number of days per year that PD participants took their students outside for science compared with that for the non-PD participants (Z = 1.97; p = 0.049). Seventy-five percent of PD participants and 58% of non-PD participants took their students outside for science at least 6 times a year, and 33% of PD participants and 19% of non-PD participants took their students outside for science 12 or more times per year.

Quantitative survey: PD and non-PD participants’ beliefs of science and outdoor instruction. Spearman’s rho correlation coefficient was calculated to measure the strength of the relationships between teachers’ views of science instruction and the use of the outdoors as a
setting for teaching and learning. Results for the survey respondents who were PD participants are reported first, followed by the survey respondents who were not PD participants.

**Survey respondents who were PD participants’ beliefs on science and outdoor instruction.** Correlations were calculated to reveal relationships between science and outdoor instruction for PD participants.

Table 18

*Spearman’s rho Correlation Coefficients for PD Participants for Survey Items Relating to Science and Outdoor Instruction (n= 43)*

| Outdoor Instruction Scales                     | Science Importance                          | Spearman ρ | Prob>|ρ| |
|-----------------------------------------------|--------------------------------------------|------------|-------|
| *External Barriers to Outdoor Instruction Scale* | Science is an important part of elementary school curriculum | -0.3541    | 0.0198* |
| *Benefits to Outdoor Instruction Scale*       | *Benefits to Outdoor Instruction Scale*     | -0.3074    | 0.0449* |
| *Resource and Support Barriers to Outdoor Instruction Scale* | *External Barriers to Outdoor Instruction Scale* | 0.653      | <.0001** |
| *Outdoor Instruction Scales & Behavior*       | *Outdoor Instruction Behavior*              | 0.3195     | 0.0367* |
| *Benefits to Outdoor Instruction Scale*       | How many times per year do you take your students outside for science | 0.3195 | 0.0367* |
| I use other areas on the school grounds for instruction | How many times per year do you take your students outside for science | 0.8562 | <.0001** |

** p-value significant at the 0.05 level

** p-value significant at the 0.001 level

Table 18 shows both positive and negative correlations; three and two, respectively.

There is a positive correlation between the *External* and *Resource and Support Barriers to Outdoor Instruction Scales*. This indicates that the higher that the PD-participants ranked their beliefs of the survey items in the *External Barriers to Outdoor Instruction Scale*, the higher the
higher they ranked their beliefs of the survey items in the Resource and Support Barriers to Outdoor Instruction Scale. There is also a positive relationship between the Benefits to Outdoor Instruction Scale and how many times per year a teacher takes their students outside for science, and teachers’ use of other areas on the school grounds for instruction (“other areas” refers to any outside area not enhanced by the PD program) and how many times per year a teacher takes their students outside for science. The negative correlations indicate that a teacher that scored high (or low) on the External Barriers to Outdoor Instruction Scale scored the opposite on both the Benefits of Outdoor Instruction Scale and on the importance of science in the curriculum.

Survey respondents who were non-PD participants’ beliefs of science and outdoor instruction. Correlations were calculated to reveal relationships between science and outdoor instruction for non-PD participants.
Table 19

*Spearman’s rho Correlation Coefficients for Non-PD Participants for Survey Items Relating to Science and Outdoor Instruction (n = 148)*

| Science Importance | Science Instruction Behavior | Spearman ρ | Prob>|ρ| |
|--------------------|-------------------------------|------------|------|
| Science is an important part of elementary school curriculum | On the days you teach science, how many minutes per day on average do you teach it | 0.1636 | 0.0469* |

Outdoor Instruction Scales & Behavior

| Science Importance & Behavior | Science Importance & Behavior | Spearman ρ | Prob>|ρ| |
|-------------------------------|-------------------------------|------------|------|
| Benefits to Outdoor Instruction Scale | Science is an important part of elementary school curriculum | 0.1892 | 0.0217* |
| I use other areas on the school grounds for instruction | Given that a school year is 180 days, approximately how many days per year do you teach science | 0.1811 | 0.0276* |

Outdoor Instruction Scales & Behavior

| Science Importance & Behavior | Science Importance & Behavior | Spearman ρ | Prob>|ρ| |
|-------------------------------|-------------------------------|------------|------|
| External Barriers to Outdoor Instruction Scale | I use other areas on the school grounds for instruction | -0.1905 | 0.0204* |
| Resource and Support Barriers to Outdoor Instruction Scale | I use other areas on the school grounds for instruction | -0.1972 | 0.0167* |
| Resource and Support Barriers to Outdoor Instruction Scale | How many times per year do you take your students outside for science | -0.2102 | 0.0106* |
| I use other areas on the school grounds for instruction | How many times per year do you take your students outside for science | 0.553 | <.0001** |

** p-value significant at the 0.001 level
* p-value significant at the 0.05 level

Table 19 shows the relationships between science and outdoor instruction for non-PD participants. There are four positive correlations and three negative correlations. The positive correlations indicate that, as non-PD participants ranked their beliefs of the importance of science in the elementary school curriculum higher on the Likert Scale, they also ranked the number of minutes per day they taught science as well as their beliefs of the benefits of outdoor
instruction higher. The other positive correlations indicate that as the non-PD participants’ use of other areas, areas on the school grounds that were not developed through the PD program, for instruction increases, so does the number of days per year they teach science and the number of days per year they take their students outside for science. The negative correlations indicate that if the rankings for both the External Barriers to Outdoor Instruction Scale and the Resource and Support Barriers to Outdoor Instruction Scale are high, the use of the outdoors for instruction is ranked low.

Both quantitative survey data and qualitative interview data contribute to the following discussion about the research questions and implications for future research into teachers’ beliefs and instructional practices regarding science and outdoor instruction.
CHAPTER 5: DISCUSSION

This study sought to understand elementary teachers’ beliefs of science education and using the outdoors as a setting for teaching and learning, all of whom taught in schools with a history of participation in a schoolyard-focused science PD program. The study also sought to determine what relationships existed between teachers’ beliefs of science and of using the outdoors as a setting for teaching and learning for PD participants and non-PD participants. Additional research goals examined differences in the beliefs and relationships between science and using the outdoors as a setting for teaching and learning between PD participants and non-PD participants. Through a mixed methods design, analysis of the quantitative survey data provided insight into the relationships between teachers’ beliefs of the importance of science in elementary school and their science instructional practices, the relationships between teachers’ beliefs of the benefits and barriers that might influence their use of the outdoors as a setting for teaching and learning, and the differences in the relationships between teachers’ beliefs about science and their beliefs about using the outdoors as a setting for teaching and learning between PD and non-PD participants. Qualitative interview data supported and enhanced survey data on PD participants’ beliefs of science education and the outdoors as a setting for teaching and learning and provided insight into additional factors not included in the survey that influenced their instructional practices. The following discussion presents findings organized by research questions, followed by ideas for future research.

Research Question 1: Teachers’ Beliefs of Science Education

Research Question 1 asked, “What are elementary teachers’ beliefs of science education?” This question was answered quantitatively by calculating the means, standard deviations, and correlations of survey questions that asked teachers about their beliefs of the
importance of science and their frequency of teaching and integration of science with other subjects. Qualitative data were gathered through interviews with past PD participants at Northside and Baytree elementary schools that focused on teachers’ goals for science instruction, how they plan for science, and how confident they are in teaching science.

The researcher hypothesized that the majority of elementary teachers surveyed would believe science instruction in the elementary school curriculum as important, and in the present study, analysis of the survey data ($n = 191$) found that the vast majority of teachers (88%) believed science as an important part of the elementary school curriculum. There is a relationship between a person’s beliefs and their behavior (Bandura, 1977; Bryan, 2003), and in this study, survey data revealed a relationship between teachers’ reported beliefs about the importance of science in the elementary school curriculum and their integration of science with other subjects. Eighty-seven percent of the teachers in the present study reported they integrated science with other subjects. Integration is one method a teacher can use to increase the amount of science in the curriculum and it may help students connect prior knowledge with new experiences and see relationships between ideas learned in the different subjects (Czerniak & Johnson, 2007).

Elementary school science is a critical part of building a solid foundation for students to develop and maintain an interest in science (Banilower et al., 2013; Sandholtz & Ringstaff, 2016), therefore, understanding the importance that elementary teachers place on science in the elementary school curriculum is vital.

Just as there was a positive relationship between teachers’ beliefs of the importance of science and integration of science, there also was a positive relationship between teachers’ beliefs of the importance of science and their frequency of science instruction. The present study found that 70% of teachers surveyed and 100% of teachers interviewed taught science for at least
30 minutes per day. This is longer than the number of minutes per day reported by Trygstad and colleagues (2013) that found teachers devoted 18 minutes per day for K-2nd grade teachers and 23 minutes per day for 3rd-5th grade teachers. The teachers in the present study taught science for longer stretches of time per day which could be influenced by the large percentage of teachers who reported that they integrated science with other subjects. An increase in science teaching experience can lead to an increase in teachers’ science teaching self-efficacy, which then can lead to increase in the desired behavior, which in this case is teaching science (Bandura, 1977; Moseley, Reinke, & Bookout, 2002).

Teachers’ beliefs of science and their science instructional practices are influenced by their self-efficacy (Moseley et al., 2002) and teachers with a higher science-teaching self-efficacy may find ways to increase science instructional time. In the present study, confidence in teaching science was discussed in the interviews with PD participants. As one teacher, Jennifer, from Baytree Elementary School described, she was confident when teaching the science topic (matter and energy) that she teaches more often, but less confident in teaching the science topics she only teaches occasionally. Danielle, the sole teacher interviewed who taught only science every day, expressed the most confidence in teaching science. The more experience and practice a teacher has teaching science, the more confident he or she is in their abilities to successfully teach science (Moseley et al., 2002).

**Research Question 2: Teachers’ Beliefs of Outdoor Instruction**

Research Question 2 asked, “What are elementary teachers’ beliefs of using the outdoors as a setting for teaching and learning?” This was quantitatively analyzed by calculating the means, standard deviations, and correlations of survey questions that asked teachers about their beliefs of the benefits of outdoor instruction and of the barriers to outdoor instruction, as well as
how often they take their students outside for science. Interview questions with former PD participants at Northside and Baytree Elementary schools focused on their beliefs of outdoor instruction, their confidence in teaching outdoors, how often they take their students outside for instruction, what kinds of lessons they teach outside, and what would help them to take their students outside more often. The researcher hypothesized that the majority of elementary teachers surveyed would acknowledge that there are benefits to using the outdoors as a setting for teaching and learning but that the barriers to using the outdoors would be a greater influence on their outdoor instructional practices, which was what the data indicated.

**Benefits to outdoor instruction.** In the present study, at least 89% of teachers surveyed either somewhat- or strongly-agreed with all four statements describing benefits of outdoor instruction (supports curriculum, motivates students, can make abstract concepts more concrete, and should be encouraged more in elementary school). The vast majority of teachers in the present study, 97%, took their students outside for science at least 2 times per year, 63% took their students outside for science at least 6 times per year, and 37% took their students outside for science at least 9 times per year. These data are promising for the potential for outdoor instruction in elementary school classrooms. The PD participants who were interviewed at Northside and Baytree elementary schools also indicated that they felt going outside for science was engaging, motivating, and can help students relate topics learned in the classroom to their lives outside of school. Teachers in the present study agreed with the survey items describing benefits of outdoor instruction as found in other studies (Dyment, 2005; Hammerman et al., 2001; Malone, 2008). Dyment (2005) found that 79% of questionnaire respondents indicated that teachers used the school grounds either sometimes or often/regularly for science, the subject
taught the most outdoors. The practical nature of taking students outside for instruction involves more than just understanding that outdoor instruction can be beneficial for student learning.

**Barriers to outdoor instruction.** The PD participants from Northside and Baytree elementary schools indicated that the science topic they were teaching, how applicable outdoor instruction was to the topic, the weather, the behavior of the students, and their confidence in effectively teaching outdoors, all influenced whether they took their students outside for instruction. Waite (2011) conducted surveys and interviews with preschool and elementary school teachers about their current and future use of the outdoors and found that while teachers acknowledge the outdoors as a setting for teaching and learning, there were tensions between the desire to use the outdoors and the practicality of doing so. Interview results revealed that tensions with the preschool and elementary school teachers resulted from some of the teachers feeling like they did not have the right resources, did not have enough funding, and had external demands placed on them around raising test scores.

Former PD participants interviewed in the present study also discussed the lack of resources in terms of wanting picnic tables for the students to sit and write on, and in discussing the need to prepare students for standardized tests. Teachers face challenges to using the outdoors as a setting for teaching and learning. The barriers listed in the quantitative survey in this study include time, weather, classroom management issues, lack of adequate resources, lack of appropriate curriculum, lack of support from teachers, administrators, and parents, and liability issues. Through factor analysis, these barriers were divided into two groups: external and resource and support barriers. The external barriers include time, weather, lack of adequate resources, and classroom management issues, and the resource and support barriers include lack of appropriate curriculum, lack of support from administrators, from teachers, and from parents,
and liability issues. Through the interview data, confidence in teaching outdoors was also discussed and is included as part of the discussion on external barriers. The external barriers will be discussed first followed by the resource and support barriers, and then the relationship between the barriers and teachers’ outdoor instructional practices will be discussed.

**External barriers to outdoor instruction.** The external barriers to outdoor instruction revealed in the survey data represent barriers that are external to each individual teacher. The external barriers from the survey are time, weather, lack of adequate resources, and classroom management issues. In the present study, survey data indicated that lack of time and weather were the largest external barriers to outdoor instruction, with interview data supporting these as barriers to outdoor instruction.

In the present study, approximately 75% of survey participants somewhat- to strongly-agreed that a lack of time was a barrier to outdoor instruction. The past PD-participants interviewed also indicated that time was a barrier to outdoor instruction, with some saying that there wasn’t enough time in the day to incorporate outdoor instruction while others indicated there wasn’t enough time for planning for outdoor instruction. Teachers generally report a lack of time to teach everything they need to in order to prepare students for standardized tests (Cronin-Jones, 2000; Dyment, 2005; Ernst, 2014; Waite, 2009).

The weather was also a significant barrier to outdoor instruction for both survey participants and PD-participants who were interviewed. The weather became a barrier when teachers had a sequence of lessons about a topic planned and had designated a specific day to go outside, and then if the weather was not conducive to their outdoor lesson, they would have to do something inside instead. Some of the PD participants interviewed at Northside and Baytree elementary schools said that this uncertainty about the weather influenced their decision to on
whether or not to even plan outdoor lessons. Holden et al. (2011) found that teachers may question whether the potential benefits derived from taking the extra time to plan outdoor lessons are worth the cost; with the cost including potential weather disruptions, the extra time needed to get students outside, and the potential difficulties of managing the class in an environment where the students may become distracted due to being outdoors.

Additional barriers to using the outdoors as a setting for teaching and learning include factors such as concern about classroom management (63% of survey participants agreed was a barrier), lack of adequate resources (64% of survey respondents agreed was a barrier), and lack of knowledge of and confidence in teaching and learning outdoors (Cronin-Jones, 2000; Dyment, 2005; Ernst, 2014; Rickinson et al., 2004; Waite, 2009; Waite, Bølling, & Bentsen, 2016). In the present study, past PD participants interviewed at Northside and Baytree elementary schools expressed concern that students would not stay focused on learning when they were outside and would instead try to play. The potential for issues with managing the students outside of the classroom can influence a teachers’ decision on whether to take their students outside for instruction. There is a negative relationship between how teachers ranked the External Barriers to Outdoor Instruction Scale, and how they ranked their frequency of taking their students outside for science. As teachers ranked the External Barriers high, they ranked the other metrics low.

The PD participants had varying levels of confidence in using the outdoors as a setting for teaching and learning, and their confidence included more than just teaching science concepts outdoors. Most of the teachers interviewed said they were confident in teaching science concepts outdoors, but other factors kept them from taking their students outside as often as they would like. Pat was confident in teaching outdoors but was less confident in managing the class
outdoors, and though Sandra was confident that her students would learn the concepts outdoors, she also felt that they would learn the concepts when taught inside just as well as they would when taught outside. Danielle was confident in teaching outdoors but wanted to have picnic tables where her students could sit and write. Dawn, however, felt confident in teaching outdoors and took her students outside often, but she also felt that she was behind in teaching them all the concepts they needed to know for standardized tests, in part because taking students outside for instruction takes more time than staying in the classroom. Dyment (2005) found that a lack of confidence and expertise in teaching and learning outdoors was a major barrier to outdoor learning. Holden et al (2011) found that prior to participating in a two-week, field-intensive PD experience designed to address challenges to using the outdoors as a setting for teaching and learning, teachers felt that the challenges to outdoor instruction included the pressures of standardized testing, a distrust that outdoor instruction could lead to student achievement, and their own acknowledged deficiencies in science content, outdoor pedagogy, student management, and aligning outdoor instruction with science standards. These same challenges are seen in the present study.

**Resource and support barriers to outdoor instruction.** The resource and support barriers to outdoor instruction as revealed in the survey data include lack of appropriate curriculum, lack of support from administrators, from teachers, and from parents, and liability issues. Support from administration, teachers, and parents, and a good understanding of liability issues are all important support systems for teachers wanting to use the outdoors as a setting for teaching and learning, and a lack of appropriate outdoor curriculum and support can hinder a teachers’ outdoor instructional practices.
In the present study, a lack of appropriate curriculum and liability issues were the two highest ranked Resource and Support barriers to outdoor instruction. In the present study, 47% of teachers surveyed agreed that a lack of appropriate curriculum was a barrier to outdoor instruction, with it being the highest ranked resource and support barrier. The interview data also indicated that a lack of curriculum impacted teachers’ use of the outdoors as a setting for teaching and learning, with Jennifer discussing how finding and planning outdoor lessons was difficult. Meichtry & Harrell (2002) found that the availability of outdoor curricula was one of the greatest needs of teachers to teach outdoors, along with training on how to use the outdoors as a setting for teaching and learning. Dyment (2005) found that a lack of outdoor curricula may be part of the reason why few teachers used the school grounds as an outdoor classroom, even though they acknowledged the benefits of using the outdoors as a setting for teaching and learning.

In the present study, liability issues were the second highest ranked resource and support barrier to outdoor instruction by survey respondents, with one of the past-PD participants interviewed expressing concern about the highway being close to the school and having to be “super aware” of where the students were, which influenced her decision on whether to take her students outside for instruction. Rickinson and colleagues (2002) stated that teachers’ fear and concern about students’ safety and lack of support are some of the barriers to outdoor instruction. While 32% of survey respondents indicated that a lack of support from fellow teachers was a barrier, none of the teachers interviewed mentioned this as a barrier to going outside for instruction. This may be due to the administrative support that the PD participants had both during the PD program and at the time of the interviews, and both administrators reported that they encouraged teachers to use the outdoors for instruction. As with the External Barriers to
Instruction Scale, a negative relationship exists between the Resource and Support Barriers to Instruction Scale, how teachers ranked the frequency with which they took their students outside for science.

A higher percentage of teachers surveyed agreed or strongly agreed with all of the External barriers than those that agreed or strongly agreed with the Resource and Support barriers to outdoor instruction. This indicates that measures to increase teachers’ use of the outdoors as a setting for teaching and learning should focus on how teachers believe time, weather, classroom management issues, and lack of adequate resources as influencing their use of the outdoors.

**Relationship between teachers’ beliefs of science and outdoor instruction.** Teacher confidence regarding teaching science effectively outdoors may be related to their beliefs of science instruction and their science instructional practices. The present study suggests that positive beliefs of science and of outdoor instruction are related, and the greater the amount of time a teacher spends teaching science, the smaller the influence the external barriers of time, weather, classroom management issues, and lack of appropriate resources appear to have on their use of the outdoors as a setting for teaching and learning.

In the present study, at least 89% of teachers somewhat- to strongly-agreed that taking students outside for instruction was beneficial, with students taken outside approximately 6% of the number of days per year teachers taught science (approximately seven days out of an average of 109 days of teaching science). These promising findings can help guide PD developers who want to offer support for teachers to use the outdoors as a setting for teaching and learning. Effective PD can give teachers more confidence and resources that may increase their use of the outdoors as a setting for teaching and learning.
Research Question 3: Comparison of PD and non-PD Participants’ Beliefs of Science and Outdoor Instruction

Research Question 3 asked, “What are the relationships between the beliefs of science and the outdoors as a setting for teaching and learning of teachers who participated in the PD program and teachers who did not participate?” The researcher analyzed the differences in survey responses regarding science and outdoor instruction between PD participants and non-participants by comparing the means, standard deviations, and correlations of the survey responses. All of the interviews were conducted with teachers who were former PD participants and their answers to the interview questions supplemented the survey data. The researcher hypothesized that PD participants’ beliefs about science in the elementary school curriculum would be more positive than non-participants, that PD participants’ beliefs about the benefits of outdoor instruction in elementary school would be more positive than non-participants, and that the barriers to outdoor instruction would be less of an influence on PD participants’ instructional practices than on those of non-participants.

In the present study, there was a statistically significant difference in the means of PD and non-PD survey participants’ ranking of the importance of science in the elementary school curriculum ($Z = 3.19$; $p = 0.001$), in the number of minutes/day they teach science ($Z = 2.41$; $p = 0.016$), and in the number of days/year that they took their students outside for science ($Z = 1.97$; $p = 0.49$), with PD participants ranking each higher than non-PD participants. In summary, PD participants believed science as more important, taught science for more minutes per day, and used the outdoors for science more often than non-PD participants. Another interesting finding was that for PD participants, there was a positive relationship between the Benefits of Outdoor Instruction Scale and both the number of times/year teachers took their students outside for
science and their use of other areas on the school grounds. This indicates that using the outdoors as a setting for teaching and learning was related to their beliefs of the benefits of outdoor instruction, while for non-PD participants, the use of the outdoors for instruction was negatively related to their rankings of both the external and resource and support barriers to outdoor instruction and had no relationship with their rankings of the benefits of outdoor instruction.

Teachers who were PD participants expressed beliefs that science in the elementary school is important in the survey responses. This may have influenced their decision to participate in the PD program since participation in the PD program was voluntary in most of the schools that participated. PD participants may have also participated in other science PD programs, which allowed them more opportunities to build their confidence in teaching science and outdoor instruction. Some of the teachers who were interviewed at Northside Elementary School indicated they had participated in other science PD programs. Participation in multiple PD programs that encourage teachers to use the outdoors as a setting for teaching and learning give teachers more outdoor teaching and learning experiences which can enable them to feel more comfortable and more confident in taking their students outside for instruction. Experience can improve confidence which can lead to using innovative teaching techniques (Moseley, Reinke, & Bookout, 2002), such as using the outdoors as a setting for teaching and learning. If teachers believe that they can teach outside and that students will learn the concepts, then they may be more likely to use the outdoors as a setting for teaching and learning, as beliefs and behavior are linked (Lumpe et al., 2000; Sandholtz & Ringstaff, 2014).

**PD participants’ experiences in the PD.** PD participants’ beliefs of science and outdoor instruction may have already been more positive than non-participants, which may have influenced their decision to participate in the PD. The researcher cannot determine if or how
participation in the PD influenced participants’ beliefs of science and outdoor instruction, but for any PD experience to change participants’ beliefs or instructional practices, it should incorporate aspects of the effective characteristics of PD (Desimone et al., 2002; Desimone & Garet, 2016; Kang, Cha, & Ha; 2013) consisting of a focus on content, active learning, coherence, duration, and collective participation.

In the present study, 58% of PD participants said they sometimes used specific activities they learned in the PD, while 21% said they rarely used any of the activities from the PD. PD participants in this study experienced the schoolyard-focused science PD from the perspective of a student; a learner. This is a form of active learning, where teachers engage in the same learning activities they hope to provide to their students, (Darling-Hammond et al., 2017). Active learning can encompass many elements such as collaboration, coaching, feedback, and reflection (Darling-Hammond et al., 2017). While PD participants in the present study engaged in some aspects of active learning, the lack of opportunities to practice teaching what they learned and subsequent feedback from experts and opportunities for reflection may have resulted in the activities experienced in the PD not transferring to the teachers’ instructional practices. They did not receive expert support after participation, which could have helped them implement outdoor activities by seeing experts model the instructional practices and support discussion and collaboration of the impact of the practices on students’ learning (Darling-Hammond et al., 2017). PD programs can be ineffective if there is no post-program communication from the facilitators with the participants, as many participants need and want continued support after participation (Luft, 1999).

The schoolyard-focused science PD described in the present study, in which 22% of the survey participants and all of the interviewees participated, consisted of between eight and 15
hours of PD, spread out over approximately four afterschool, on-site visits by the PD facilitators during the school year, plus one trip to a museum and an initial site visit and orientation. The greater the length of time of PD (e.g. number of hours), the greater the influence on teachers’ practices (Kang, Cha, & Ha, 2013). This short duration of the PD in the present study is consistent with research that indicates that most teachers receive PD that is about eight hours on a topic and taught in afterschool workshops (Darling-Hammond et al., 2017). In a study by Supovitz & Turner (2000), after 80 hours of PD, teachers reported using practices learned in the PD significantly more frequently than the average teacher. This suggests that the duration of the PD in the present study may have been too short to elicit any change in participant’s outdoor instructional practices. Even though there was a statistically significant difference in the number of days PD survey participants took their students outside for science compared to non-PD participants, the researcher was unable to determine if the PD influenced PD-participants’ frequency of using the outdoors for instruction or if the PD participants were already using the outdoors for instruction before participation in the PD, with the PD program simply reaffirming their desire to teach outside.

Another effective PD feature is collective participation, which describes the extent to which multiple teachers from the same school, teaching department, and/or same grade level participate in the same learning opportunities (Desimone et al., 2002; Desimone & Garet, 2016). One of the main emphases of the PD program was to form a local "critical mass" of effort, or a community of practice (Lave & Wegner, 1991), for "hands-on" teaching, with teachers gaining the confidence and knowledge to take students outdoors and to also bring nature into the classroom (North Carolina Museum of Natural Sciences, 2015). Collective participation as one of the five essential characteristics of effective PD describes the extent to which multiple
teachers from the same school, teaching department, and/or same grade level participate in the same learning opportunities (Desimone et al., 2002; Desimone & Garet, 2016). All three teachers interviewed at Baytree Elementary School indicated they did not plan lessons together, and the teachers interviewed at Northside Elementary School said that while they sometimes planned together, it usually did not include using the outdoors as a setting for teaching and learning. A collective or group efficacy around outdoor instruction can positively influence a teacher’s individual self-efficacy and give them the support to try new instructional practices (Bandura, 1982; Jones & Leagon, 2014), which did not appear to occur at Baytree and Northside elementary schools, even with administrative support for outdoor instruction.

This study adds to existing research that looks at how teachers’ belief the benefits and barriers to using the outdoors as a setting for teaching and learning and how their beliefs of the importance of science and their instructional practices influence their use of the outdoors. The primary findings revealed that NC elementary teachers who teach in schools that participated in the schoolyard-focused science PD program overwhelmingly believed science as an important part of the elementary school curriculum and their instructional practices may reflect their desire to teach science. Teachers did not use the outdoors as a setting for teaching and learning as often as they wanted to, with teacher confidence and lack of experiences in outdoor instruction in addition to the other barriers discussed difficult to overcome. One of the challenges teachers reported was finding appropriate outdoor curricula. Resources are available to guide the development of outdoor curricula such as Project WILD (Council for Environmental Education, 2001), Project WET (Project WET Foundation, 2011), and Project Learning Tree (American Forest Foundation, 2000), three well-known outdoor and environmental education programs in the United States (Easton & Monroe, 2002). Some PD programs have shown that many of the
obstacles that teachers felt were barriers to using the outdoors as a setting for teaching and learning can be overcome with proper guidance for outdoor lesson planning, many chances to practice teaching outdoors and receive feedback, and long-term support from PD (Holden et al., 2011).

In conclusion, while effective PD has been shown to influence teachers’ beliefs and instructional practices, data from the present study suggest that teachers who participated in the schoolyard-focused science PD may have already held positive beliefs about science and using the outdoors as a setting for teaching and learning. It is promising for elementary science education that the vast majority of the survey participants held positive beliefs of the importance of science in the elementary school curriculum and acknowledged the benefits of using the outdoors as a setting for teaching and learning. It appears challenging to turn positive beliefs of the benefits of outdoor instruction into practice, though, as has been found in other studies (Cronin-Jones, 2000; Dyment, 2005; Ernst, 2014; Waite, 2009; Waite, Bølling, & Bentsen, 2016). PD facilitators on how to use the outdoors as a setting for teaching and learning should consider all of the barriers teachers face, including both external and resource and support barriers and their beliefs and self-efficacy regarding science and using the outdoors as a setting for teaching and learning. Because the benefits of outdoor education can have positive, long-lasting effects on science learning and interest and on the cognitive, social, and physical health of children (Brody, Bangert, Dillon, 2008; Falk & Balling, 1982; Mayer, Frantz, Bruehlmab-Senecal, Dolliver, 2009; Orion, 1993), it is worthwhile for PD facilitators and science educators to continue to pursue using the outdoors as a setting for teaching and learning.
Future Research

Future studies of teachers’ outdoor science instruction should further examine the link between teacher self-efficacy, barriers to using the outdoors as a setting for teaching and learning, and how effective PD can assist teachers and schools in creating and supporting outdoor curriculum. One of the principals interviewed in this study described that innovative ideas, such as pairing teachers confident in outdoor teaching with those who are not, may be necessary to get some teachers to break out of their classroom comfort zones and use the outdoors as a setting for teaching and learning. Outdoor education has the potential to achieve the primary goals of science education which are, to cultivate students’ scientific habits of mind and engage in scientific inquiry (NRC, 2012).
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APPENDICES
Appendix A

Survey for Teachers at Schools that Participated in the PD

1. Science is an important part of elementary school curriculum.
   1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

2. I often integrate science with other subjects.
   1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

3. How is science taught in your grade?
   Science and another subject, such as social studies, are alternated on a unit basis.
   Science is integrated with other subjects but not taught as a separate subject.
   Science is taught as a separate subject.
   Science is taught separately and integrated with other subjects.

4. Given that a school year is 180 days, approximately how many days per year do you teach science?

5. On the days you teach science, how many minutes per day on average do you teach it?
   0 – 15 minutes
   15 – 30 minutes
   30 – 45 minutes
   45 – 60 minutes
   > 60 minutes

6. Rank your level of enjoyment of science when you were in elementary school:
   a. Very high
   b. High
   c. Neither high nor low
   d. Low
   e. Very low

7. Rank your level of enjoyment of science when you were in middle school:
   a. Very high
   b. High
   c. Neither high nor low
   d. Low
   e. Very low

8. Rank your level of enjoyment of science when you were in high school:
   a. Very high
   b. High
   c. Neither high nor low
   d. Low
   e. Very low
9. The outdoors is an appropriate setting for teaching and learning.
   1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

10. Please identify the accurate statements about your use of the outdoors for instruction (check all that apply).
    I organize learning opportunities in the outdoors.
    I pursue outdoor field trip experiences.
    I do not use the outdoors for instruction.
    Other:

11. How many times per year do you take your students outside for science?
    0 times/year
    2 – 5 times/year
    6 – 8 times/year
    9 – 11 times/year
    12 – 14 times/year
    15+ times/year

12. I believe outdoor instruction supports curriculum:
    1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

13. I believe outdoor instruction motivates students:
    1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

14. I believe outdoor instruction can make abstract concepts more concrete to students:
    1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

15. I believe outdoor instruction should be encouraged more in elementary school
    1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

16. I believe outdoor instruction is not appropriate as a setting for learning in elementary school:
    1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

17. I believe outdoor instruction is a distraction to student learning:
    1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

18. Barriers to going outside include lack of time:
    1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

19. Barriers to going outside include weather:
    1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

20. Barriers to going outside include classroom management issues:
21. Barriers to going outside include lack of adequate resources:
1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

22. Barriers to going outside include lack of appropriate curriculum:
1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

23. Barriers to going outside include lack of support from fellow teachers:
1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

24. Barriers to going outside include lack of support from administration:
1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

25. Barriers to going outside include lack of support from parents:
1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

26. Barriers to going outside include liability issues:
1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

27. Were you working at this school when the PD was here?
   Yes
   No

28. Did you participate in the PD professional development program at your current school?
   Yes (skip to question 17)
   No (skip to question 16)

29. If you were not at the school during the PD professional development program, have you learned about it since you began working at the school?
   Yes
   No

30. If you were a PD participant, how much/often do you incorporate the following elements from the PD?

   Specific activities (e.g. flower dissection, aquatic life identification, and camouflaged wildlife) learned from the PD instructors:
   Many (4 or more)
   A few (1 - 3)
   None

31. If you were a PD participant, how much/often do you incorporate the following elements from the PD?
General elements such as observation, reflection, and journaling:
   Often
   Sometimes
   Rarely

32. If you were a PD participant, how much/often do you incorporate the following elements from the PD?

Using the outdoors as a learning environment:
   More often since the PD
   About the same since the PD
   Less after the PD

33. I use the outdoor habitat that the PD helped build on my school grounds, for instruction.
   Often
   Sometimes
   Rarely
   Never
   The habitat is no longer there

34. I use other areas on the school grounds for instruction.
   Often
   Sometimes
   Rarely
Appendix B

Interview Questions: Teachers

The following questions are about your school’s participation in the NC Museum of Natural Sciences’ Using the Outdoors to Teach Experiential Science professional development in 2014-2015.

A question for the participants before the first interview:

Do you know if any of your current students had a teacher two years ago that participated in the PD? Do they remember anything about the PD?

Interview 1: Late summer/early fall during a science unit: Past: Describe the PD experience and how teachers have incorporated elements of the PD into their teaching.

1. What are your goals this year for science?
2. How do you assess your students in science?
3. How do you decide what to teach for science?
4. Do you plan on your own or do you plan lessons as a team?
5. Describe your classroom management style. Would this change when you go outside?
6. Describe your views on outdoor instruction.
7. Have you conducted any lessons in the outdoors? If so please describe.
8. What do you remember about the PD?
9. Over the past two years, have you collaborated or had discussions with other the PD participants about the PD experience?
10. Have you incorporated any of the PD lessons or concepts with your students? If so, describe. If not, why not?
11. During the program (the 2014-2015 school year), how supportive was your administration towards using the outdoors as a learning environment?

Interview 2: Late fall/early winter during a science unit: Current: How is the year going with science and using the outdoors? Past experiences with science and nature in childhood.

1. Describe your experiences with elementary school science.
2. Do you have any memories of outdoor instruction in science when you were in elementary school? Or in any other subject?

3. What did you do in your free time growing up? Was the outdoors a part of your experiences?

4. What is the administration’s expectations for teaching science?

5. How much time per week do you spend teaching science? How is it organized?

6. How confident are you in teaching science?

7. Have you taken your students outside for science this year? If so, describe the experience. If not, why not?

8. How supportive is the administration for using the outdoors as a learning environment?

9. How supportive are your fellow teachers for using the outdoors as a learning environment?

10. How confident are you in using the outdoors for teaching and learning?

**Interview 3: Mid/late winter during a science unit. Future: Focus on what they think would help outcomes be more sustainable. What would need to change? Advice for PD planners on how to make PD outcomes more sustainable.**

1. How did your year teaching science go?

2. What are your goals for science next year?

3. How do you assess your students in science?

4. Do you integrate science into other subjects? If so, how?

5. Over the last year, have you taken your students outside for learning? If so, describe. If you did, how has this influenced them? What evidence do you have?

6. What support would encourage you and/or your fellow teachers to use the outdoors for instruction?

7. Describe your current views on outdoor instruction.

8. Do you have any plans for using the outdoors as a learning environment for next year?
Appendix C

Interview Questions: Principals

1. How long have you been the principal of this school?
2. Were you here when the PD was here, and if so, did you participate in the PD program yourself?
3. What do you remember about science when you were in elementary school?
4. Do you have any memories of outdoor instruction when you were in elementary school?
   If so, describe.
5. What do you believe the value is of science in elementary school?
6. What are your views on outdoor instruction in elementary school?
7. What do you think are the benefits to taking students outside for teaching and learning?
8. What do you think are the challenges to taking students outside for teaching and learning?
Appendix D

Survey: Email to Participants

Hello! My name is Sarah Luginbuhl and I am a doctoral candidate in the Science Education Department at North Carolina State University. My research interests include understanding how science and the outdoors are incorporated into the elementary school curriculum. I am conducting my dissertation research on teachers’ attitudes and behaviors towards science and towards the outdoors as a learning environment. by examining the influence and sustainability of an outdoor-focused professional development (PD) program called UTOTES (Using The Outdoors to Teach Experiential Science) run by the North Carolina Museum of Natural Sciences.

UTOTES is an outdoor-focused teacher PD program situated in the school setting, and is designed to enhance formal science teaching and learning through a series of six workshops throughout the school year. The program took place at your school during the XXXX-XXXX school year.

I am currently conducting a study with teachers currently working at schools that have participated in the UTOTES PD between 1991 and 2016. I am interested in knowing if the UTOTES PD program influenced the teachers’ views and behavior towards the outdoors as a learning environment, and the lasting impacts of the presence of the PD program. The purpose of this study is to measure the influence and sustainability of the UTOTES PD program by both teachers that participated and by those that did not participate in the program. The study consists of an anonymous survey and demographic questionnaire. All participants that complete the survey and demographic questionnaire have the opportunity to enter a drawing for one of five $20 Amazon gift cards. In addition, participants will be given the opportunity to participate in a short interview with the researcher to elaborate on their views and attitudes towards science and the outdoors as a learning environment in elementary school.

You do NOT have to have participated in the UTOTES PD program or even have been working at the school when the program was there in order to participate in this study.

If you would like to participate in this study, please click on the link provided in this email. It will take you to an online survey platform called Qualtrics. The first form to complete will be a consent form. If you consent to participate in the study, you will then have access to the online survey that asks about your use of the outdoors as a learning environment, views on science, and knowledge of the PD program. A short demographic questionnaire follows the survey.

Please contact me if you have any questions, and thank you!

Sarah C. Luginbuhl
PhD Candidate, Science Education
North Carolina State University
Phone: 919-740-3299
Email: sluginb@ncsu.edu
Appendix E

North Carolina State University
INFORMED CONSENT FORM for RESEARCH
Title of Study: Assessing the Long-Term Implementation and Sustainability of an Outdoor-Focused Science Professional Development Program

Principal Investigator: Sarah C. Luginbuhl
Faculty Sponsor (if applicable): Sarah J. Carrier

What are some general things you should know about research studies?
You are being asked to take part in a research study. Your participation in this study is voluntary. You have the right to be a part of this study, to choose not to participate or to stop participating at any time without penalty. The purpose of research studies is to gain a better understanding of a certain topic or issue. You are not guaranteed any personal benefits from being in a study. Research studies also may pose risks to those that participate. In this consent form you will find specific details about the research in which you are being asked to participate. If you do not understand something in this form it is your right to ask the researcher for clarification or more information. A copy of this consent form will be provided to you. If at any time you have questions about your participation, do not hesitate to contact the researcher(s) named above.

What is the purpose of this study?
This study is designed to examine the influence and sustainability of an outdoor-focused science professional development (PD) program called UTOTES (Using the Outdoors to Teach Experiential Science), run by the North Carolina Museum of Natural Sciences, at the 208 elementary schools in North Carolina that have participated between 1991 and 2016. All current teachers at the schools will be invited to participate in the study, regardless of whether or not they participated in the PD program, or were even working at the school when the UTOTES was there. The researcher is interested in understanding the teachers’ and principals’ views of science in elementary school, of using the outdoors as a learning environment in elementary school, and the lasting impacts of the presence of the PD program on teachers who both did and did not participate. The study looks at the influence and sustainability of the UTOTES PD on teachers in schools that have participated in the PD program between 1991 and 2016.

What will happen if you take part in the study?
If you agree to participate in the study, you will be asked to electronically sign a consent form through an online survey platform called Qualtrics, then complete a survey of consisting of 19 questions, and a demographic questionnaire consisting of 10 questions. After completion of the survey, all participants will be able to enter their email addresses in a raffle for one of five $20 Amazon gift cards. In addition, after completing the survey and demographic questionnaire, participants will be asked if they are willing to give an interview with the researcher about their experiences using the outdoors as a learning environment. If they agree, they will submit their email address and the researcher will contact them. This interview will consist of approximately ten questions and will take place either in person or over the phone.

Risks
There are minimal risks as the questions that the participants are asked are about their experiences with science growing up in and out of school, there use of the outdoors for teaching and learning, and their implementation of outcomes from the PD program and how those outcomes have been sustained at the school.

Benefits
The direct benefit is that each study participant reflects on their science instruction and their use of the outdoors to teach science. Indirect benefits happen if, by the teacher participating in the study, they become more self-aware of their attitudes towards nature and science and are then more aware of how their students may feel about nature and science, fostering a better connection between teacher and student. Other indirect benefits include a deeper understanding of how PD outcomes are implemented in the school and if any barriers they see to implementation can be overcome.
Confidentiality
The information in the study records will be kept confidential to the full extent allowed by law. Data will be stored securely on the researcher’s computer which is password protected, and the interviews will be transcribed and blinded by the researcher after the interview. No reference will be made in oral or written reports which could link you to the study.

Compensation
Participants who complete the survey and demographic questionnaire can enter a drawing for one of five $20 Amazon gift cards. After the second reminder email is sent to teachers, a third and final reminder email will be sent to teachers who have not yet participated with an additional compensation offer stating that the first 20 teachers to complete the survey will receive a $10 Amazon gift card.

What if you have questions about this study?
If you have questions at any time about the study or the procedures, you may contact the researcher, Sarah Luginbuhl, at 919-740-3299.

What if you have questions about your rights as a research participant?
If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact Deb Paxton, Regulatory Compliance Administrator at dapaxton@ncsu.edu or by phone at 1-919-515-4514.

Consent To Participate
"I have read and understand the above information. I have received a copy of this form. I agree to participate in this study with the understanding that I may choose not to participate or to stop participating at any time without penalty or loss of benefits to which I am otherwise entitled."

Subject's signature_______________________________________ Date ______________
Investigator's signature______________________________ Date ______________
Appendix F

Demographic Questions

Please answer the following demographic questions:

1. Gender Identification:
   a. Female
   b. Male
   c. Other

2. Age:

3. Race/Ethnicity
   a. Hispanic or Latino, of any race
   b. American Indian or Alaska Native, not Hispanic or Latino
   c. Asian, not Hispanic or Latino
   d. Black, not Hispanic or Latino
   e. Native Hawaiian or Other Pacific Islander, not Hispanic or Latino
   f. White, not Hispanic or Latino
   g. Two or more races, not Hispanic or Latino

4. What is the highest degree you have earned?
   a. Doctoral or comparable degree (e.g., Ph.D., Ed.D.)
   b. Master’s degree
   c. Bachelor’s degree
   d. Associate’s degree
   e. High School diploma

5. Approximately how many science courses did you take during college?

7. Total years teaching:

8. Years teaching at current school:

9. Current grade teaching:

10. Describe professional development opportunities you have participated in at school or on your own.
Appendix G

Dear teachers and content experts,

I am sending you this document in hopes that you will take a few minutes to help out my research for my dissertation. I am checking my survey instrument for content validity by asking you to rate the survey items listed below for clarity and for their importance for describing the construct (idea, theme). Thank you so much for your time!

Please use the following table as your guide to rate the survey items.

<table>
<thead>
<tr>
<th>Clarity (how clear is the statement – do you understand what you are asked to rate)</th>
<th>Importance for the Construct (how important do you feel this statement is to describe teachers’ beliefs of science instruction)</th>
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</thead>
<tbody>
<tr>
<td>1 [not clear]</td>
<td>1 [not important]</td>
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<tr>
<td>2 [item needs some revision]</td>
<td>2 [slightly important]</td>
</tr>
<tr>
<td>3 [clear but needs minor revision]</td>
<td>3 [relatively important]</td>
</tr>
<tr>
<td>4 [very clear]</td>
<td>4 [important]</td>
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<tr>
<td>5 [very important]</td>
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</table>

There are three constructs (ideas, themes) that are represented by specific survey items. Each construct will be briefly listed, and the survey items that describe the construct are listed afterwards. Please rate each item (do not answer the items itself, just rate it for the clarity and importance) in the box provided below each item. Additionally, at the end of this document is an answer table that you can write your answers in and send back to me. I really only need the last table with all of your ratings, so you can either just copy the last table into an email and send that back to me, or scan (or take a picture) of this document and send it to me.

You may also suggest other items that you feel would help in describing the construct.

**Construct One: Teacher Beliefs of Science Instruction:**

There are two survey items in the survey instrument that are used for a simple look into teachers’ beliefs of science instruction:

**Item 1. Science is an important part of elementary school curriculum.**

1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

<table>
<thead>
<tr>
<th>Clarity</th>
<th>Importance</th>
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**Item 2. I often integrate science with other subjects.**

1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

<table>
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<th>Clarity</th>
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**Construct Two: Teacher Beliefs of the Benefits of Using the Outdoors for Teaching and Learning:**
There are five survey items that are used to describe teachers’ beliefs of the benefits of outdoor instruction:

**Item 1. The outdoors is an appropriate setting for teaching and learning.**
1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

<table>
<thead>
<tr>
<th>Clarity</th>
<th>Importance</th>
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</table>

**Item 2. I believe outdoor instruction supports curriculum.**
1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

<table>
<thead>
<tr>
<th>Clarity</th>
<th>Importance</th>
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</table>

**Item 3. I believe outdoor instruction motivates students.**
1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

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<th>Clarity</th>
<th>Importance</th>
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**Item 4. I believe outdoor instruction can make abstract concepts more concrete to students.**
1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

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<th>Clarity</th>
<th>Importance</th>
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**Item 5. I believe outdoor instruction should be encouraged more in elementary school.**
1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

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<th>Clarity</th>
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**Construct Three: Teacher Beliefs about Barriers to Using the Outdoors for Teaching and Learning:**

There are nine survey items used to describe teachers’ beliefs of the barriers to outdoor instruction:

**Item 1. Barriers to going outside include lack of time.**
1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

<table>
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<tr>
<th>Clarity</th>
<th>Importance</th>
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**Item 2. Barriers to going outside include weather.**
1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

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<tr>
<th>Clarity</th>
<th>Importance</th>
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</table>
Item 3. Barriers to going outside include classroom management issues.
1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

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<th>Clarity</th>
<th>Importance</th>
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Item 4. Barriers to going outside include lack of adequate resources.
1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

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<th>Clarity</th>
<th>Importance</th>
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Item 5. Barriers to going outside include lack of appropriate curriculum.
1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

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<th>Clarity</th>
<th>Importance</th>
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Item 6. Barriers to going outside include lack of support from fellow teachers.
1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

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<th>Clarity</th>
<th>Importance</th>
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Item 7. Barriers to going outside include lack of support from administration.
1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

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<th>Importance</th>
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Item 8. Barriers to going outside include lack of support from parents.
1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

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<th>Clarity</th>
<th>Importance</th>
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Item 9. Barriers to going outside include liability issues.
1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree

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<th>Clarity</th>
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<td>Item 9</td>
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Appendix H

Interviews: Email to participants

Hello! My name is Sarah Luginbuhl and I am a doctoral candidate in the Science Education Department at North Carolina State University. My research interests include understanding how science and the outdoors are incorporated into the elementary school curriculum. I previously conducted a pilot study at your school in late spring of 2015 where I interviewed several teachers about their experiences with UTOTES (Using The Outdoors to Teach Experiential Science) run by the North Carolina Museum of Natural Sciences. I am currently conducting a case study at your school for my dissertation research on teachers’ attitudes and behaviors towards science and towards the outdoors as a learning environment. This case study seeks to examine the influence and sustainability of the UTOTES program at your school.

The UTOTES program is an outdoor-focused teacher PD program situated in the school setting, and is designed to enhance formal science teaching and learning through a series of six workshops throughout the school year. The program took place at your school during the 2014-2015 school year.

You must have participated in the UTOTES program to participate in this study.

This study is an in-depth case study with five teachers at your school that participated in the UTOTES PD, and the influence and sustainability of the program at the school. The purpose of the study is to assess the participants’ views and attitudes of science in elementary school and of the outdoors as a learning environment, and their views of the sustainability of the UTOTES PD. To assess these views and attitudes, I will conduct three, in-person interviews throughout the school year. The first interview will take place in September/October of 2016, the second one in November/December of 2016, and the last one January/February of 2017. Each interview will be approximately 30 minutes, will take place at the school, and will be audio recorded. I will also make classroom observations three times during the school year at approximately the same time as the interviews. During the observations, I will take field notes while the teacher teaches science and will not participate in the lessons. Any student work that relates to the outdoors may be evaluated. I will also conduct one interview with the principal that will be audio recorded.

If you would like to be considered for participation in the study, please click on the link below to access the online consent form. Five teachers will be randomly selected from those that consent. Selected teachers will be contacted by the researcher to further discuss the study. By participating in the study, you will need to commit to three in-person interviews during the 2016-2017 school year and three classroom observations.

Please contact me if you have any questions, and thank you!

(Link to consent form in Qualtrics will go here)

Sarah C. Luginbuhl
PhD Candidate, Science Education
North Carolina State University
Phone: 919-740-3299
Email: sluginb@ncsu.edu
Appendix I

North Carolina State University
INFORMED CONSENT FORM for RESEARCH

Title of Study: Assessing the Implementation and Sustainability of an Outdoor-Focused Science Professional Development Program

| Principal Investigator | Sarah C. Luginbuhl | Faculty Sponsor (if applicable): Sarah J. Carrier |

What are some general things you should know about research studies?
You are being asked to take part in a research study. Your participation in this study is voluntary. You have the right to be a part of this study, to choose not to participate or to stop participating at any time without penalty. The purpose of research studies is to gain a better understanding of a certain topic or issue. You are not guaranteed any personal benefits from being in a study. Research studies also may pose risks to those that participate. In this consent form you will find specific details about the research in which you are being asked to participate. If you do not understand something in this form it is your right to ask the researcher for clarification or more information. A copy of this consent form will be provided to you. If at any time you have questions about your participation, do not hesitate to contact the researcher(s) named above.

What is the purpose of this study?
This in-depth case study is designed to assess factors that influence the implementation and sustainability of an outdoor-focused science professional development (PD) program (Using the Outdoors to Teach Experiential Science), run by the North Carolina Museum of Natural Sciences, at two schools that participated in the PD during the 2014-2015 school year. Only teachers who participated in the PD during the 2014-2015 school are eligible to participate in this case study. Eligible teachers will be given the opportunity to sign a consent form to participate in the case study. Approximately five teachers will be randomly selected out of those who give consent. Over the course of the current school year, the researcher will conduct three interviews, observe three science lessons, and review any student work that is outdoor-inspired, with the participating teachers. The principal from each school will also be interviewed. The researcher is interested in understanding the teachers’ and principals’ views of science and of using the outdoors as a learning environment in elementary school, if participation in the PD program influenced the teachers’ views and behavior towards the outdoors as a learning environment, and the lasting impacts of the presence of the PD at the school.

What will happen if you take part in the study?
You must have participated in the PD during the 2014-2015 school year to be eligible to participate in this study. If you agree to participate in this study, you will be asked to participate in three in-person interviews, three classroom observations, and the evaluation of any student work inspired by the outdoors. The researcher will conduct three in-person interviews throughout the school year with each teacher; one in September/October of 2016, one in November/December of 2016, and the last one January/February of 2017. Each interview will be approximately 30 minutes and will be audio recorded. The researcher will conduct classroom observations three times during the school year at approximately the same time as the interviews. During the observations the researcher will take field notes while the teacher teaches science and will not participate in the lessons. The researcher will evaluate any student work provided by the teacher that relates to the outdoors. The researcher will conduct an interview with the principal that will be audio recorded.

Risks
There are minimal risks as the questions that the participants are asked are about their experiences with science growing up in and out of school, there use of the outdoors for teaching and learning, and their implementation of outcomes from the PD program and how those outcomes have been sustained at the school.

Benefits
The direct benefit is that each study participant reflects on their science instruction and their use of the outdoors to teach science. Indirect benefits happen if, by the teacher participating in the study, they become more self-aware of their attitudes towards nature and science and are then more aware of how their students may feel about nature and
science, fostering a better connection between teacher and student. Other indirect benefits include a deeper understanding of how PD outcomes are implemented in the school and if any barriers they see to implementation can be overcome.

Confidentiality
The information in the study records will be kept confidential to the full extent allowed by law. Data will be stored securely on the researcher’s computer which is password protected, and the interviews will be transcribed and blinded by the researcher after the interview. No reference will be made in oral or written reports which could link you to the study.

Compensation
There is no compensation for participating in this study.

What if you have questions about this study?
If you have questions at any time about the study or the procedures, you may contact the researcher, Sarah Luginbuhl, at 919-740-3299.

What if you have questions about your rights as a research participant?
If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact Deb Paxton, Regulatory Compliance Administrator at dapaxton@ncsu.edu or by phone at 1-919-515-4514.

Consent To Participate
"I have read and understand the above information. I have received a copy of this form. I agree to participate in this study with the understanding that I may choose not to participate or to stop participating at any time without penalty or loss of benefits to which I am otherwise entitled."

Subject's signature_______________________________________ Date ________________
Investigator's signature______________________________ Date ________________