ABSTRACT

GUIN, AUTUMN HOPE. Professional Development for North Carolina 4-H Educators Who Teach Science: A Mixed-Methods Case Study of 4-H Science Curricula Training (Under the direction of Dr. Tamara Young).

The 4-H Youth Development Program, the youth development program for the United States Cooperative Extension service, is a nonformal education program with more than 100 years of history providing experiential learning activities for youth. As growing evidence supports the critical role of nonformal education in STEM literacy (National Research Council, 2015; Falk & Dierking, 2010), the 4-H Youth Development Program is well-suited to serve as a nonformal STEM education partner, working with formal education systems towards improving youth STEM literacy through multiple in-school and out-of-school delivery modes. To realize the goal of providing research- and evidence-based STEM education, 4-H educators need effective and on-going professional development opportunities. Drawing upon the limited empirical literature in training nonformal educators to deliver inquiry-based STEM instruction as well as literature from K-12 teacher professional development, this study used an intrinsic bounded case study approach to explore the professional development activities that contribute to the abilities of nonformal 4-H educators in North Carolina to deliver effective STEM educational programming to youth. In this study, NC 4-H educators who participated in a 4-H STEM curriculum training and pilot completed science teaching self-efficacy and experiential learning teaching self-efficacy surveys and semi-structured interviews to answer to the following research questions: 1) What are participants' experiences in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training?; 2) Does participation in *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training improve science and experiential learning teaching self-efficacies among NC 4-H nonformal educators?; and 3) What are NC 4-H

nonformal educators' attributions of their increased or decreased science and experiential learning teaching self-efficacy experiences related to their participation in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training? NC 4-H educators reported experiencing many of the same professional development training components within the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training that are recommended within the K-12 teacher professional development literature as effective strategies for increasing science teaching proficiency. Survey results showed increases in science and experiential learning teaching self-efficacies and NC 4-H educators attributed their increased teaching self-efficacies to several of the professional development activities.

Professional Development for North Carolina 4-H Educators Who Teach Science:
A Mixed-Methods Case Study of 4-H Science Curricula Training

by
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Dr. Tamara Young Committee Chair	Dr. LaTricia Townsend
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DEDICATION

This work is dedicated to my husband, Michael, and to my children, Joshua and Chaeli. Thank you for always believing in me and for supporting this pursuit for the majority of our lives together.

BIOGRAPHY

Autumn Guin is a first-generation college student, raised in her maternal grandmother's home, who dreamed of going to college from a very young age. Autumn graduated high school with several full ride scholarships and started her educational journey at East Carolina in the fall of 1993 as a pre-med biology major. In the fall of her junior year, Autumn left East Carolina and returned to her home in East Fayetteville, North Carolina. A year later, after her son was born, Autumn returned to school at Fayetteville State University where she became interested in psychology. A short time later, Autumn married the love of her life, and later that year, they welcomed a daughter. It was at Fayetteville State University that Autumn was first introduced to research. Working under the direction of Dr. Susan Franzblau with a small group of students, Autumn learned to conduct and analyze focus group and survey research. It was also at Fayetteville State University that Autumn was introduced to the field of community psychology and the possibility of graduate school. Two years later, Autumn graduated from Fayetteville State University with a Bachelor of Science in Psychology. She was accepted to and awarded a teaching assistantship in the Human Resource Development Psychology doctoral program at North Carolina State University.

Autumn's work in the psychology program at North Carolina State University provided an opportunity to teach lifespan and adolescent developmental psychology and to conduct research while pursuing her doctorate degree. In the summer of her third year, Autumn received news that her grandmother was missing and returned home. Shortly after the Fall 2003 semester began, Autumn received word that her grandmother was found and returned home to prepare funeral arrangements. Losing her grandmother was devastating and took a toll on her work and health. Despite this loss, Autumn completed her Master of Science in Psychology in 2005.

In 2006, Autumn was hired to work with the Department of Family and Consumer Sciences at NC State University for a small role as a database manager which quickly became a much larger role as a program evaluator. Later that year, the Family and Consumer Sciences Department merged with the 4-H Department. This merger opened opportunities for Autumn to work with Cooperative Extension to create and evaluate multiple programs and curricula that focus on improving the lives of youth and families across North Carolina. Autumn directed evaluation for the North Carolina E-Conservation Program and for North Carolina's Children Youth and Families at Risk Sustainable Communities Program, as well as provided support for the Children, Youth, and Families Education Research Network as the assistant editor for the Community Editorial Board. This work led to several national conference presentations, workshops, partnership opportunities, and publications. In 2011, Autumn joined the NC 4-H Curriculum Development Team as the Program Design and Evaluation Lead, partnering with Mrs. Amy Chilcote and Dr. Mitzi Downing to strengthen and streamline NC 4-H curriculum design. That same year, she began to work with Dr. Kim Allen, Dr. Susan Jakes, and Robin Roper to build the Very Important Parents Program. In 2011, with encouragement from her colleagues and friends, Autumn reached out to Dr. Tamara Young in the doctoral program Educational Research and Policy Analysis at North Carolina State University to discuss the possibility of graduate school. In 2012, Autumn began a new journey as a graduate student.

Autumn currently serves as Co-PI on several programs for NC 4-H including the Empowering Youth and Families Program and the North Carolina and South Carolina CYFAR 4-H STEM Program. She also is contracted as a national program coach and evaluation consultant for USDA NIFA's Children, Youth, and Families at Risk Programs and serves as one of the Research Subgroup Co-Chairs for the National Program Leaders Advancing the 4-H

Thriving Model Taskforce. With the completion of her doctorate degree, Autumn will continue to pursue her passion and calling to better the lives of youth, families, and communities.

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Shinn–your encouraging words and text messages and knowing you were covering me in prayer sustained me on many days.

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CHAPTER 1: Introduction

Overview

Science, technology, engineering, and math (STEM) literacy in the United States is critical to the continued development and success of the national economy (National Science Board, 2018). For example, according to the 2018 Science and Engineering Indicators Report, an annual report from the National Science Foundation on the state of science and engineering in the United States, knowledge- and technology-intensive businesses comprise 38 percent of the nation's gross domestic product. Growth in science, technology, engineering, and math job sectors is projected to create a need for more than 9 million workers by 2022 (Vilorio, 2014). Yet, among first university degrees (i.e., equivalent to bachelor's) in science and engineering, the United States provided only ten percent of conferred degrees in 2014, outpaced by India, China, and the European Union. Further, international student performance measures reveal that American youth consistently fall behind their peers in other countries in math and science (National Science Board, 2018).

STEM literacy in the United States has been a focus for decades, with the most recent push for STEM literacy being The Next Generation Science Standards (National Research Council, 2013), a prescriptive set of national standards for K-12 science education released in 2013. These standards emerged from a research and evidence-based framework for science literacy and were created by a committee of science and education experts convened by the National Research Council of the National Academy of Sciences (National Research Council, 2012). To meet these standards, science educators require a high-quality professional development that differs from traditional professional development (Wilson, 2013). Traditional professional development provides teachers with opportunities to learn content and pedagogical knowledge and is often composed of episodic, short duration workshops which lack direct association to student or teacher outcomes (Darling-Hammond, et al., 2017). Yet, to meet the needs identified within the Next Generation Science Standards, which include a push for more hands-on science and the integration of engineering principles, teachers need an approach that engages them in active, scientific inquiry (Wilson, 2013). This style of STEM-specific professional development within the K-12 literature and positively influences student outcomes and STEM teaching efficacy (Desimone, et al., 2013; Grigg, 2013; Lotter, 2018; Ross & Bruce, 2007; Tschannen-Moran & Hoy, 2001). These trainings are of longer duration, content-focused, and collaborative (Darling-Hammond et al., 2017). The need for STEM-specific professional development also applies to educators who work within informal and nonformal educational organizations because, although the K-12 environment is an important component of increasing STEM literacy, STEM learning does not happen solely within the K-12 classroom walls (Falk & Dierking, 2010; Mosatche, et al., 2013; Wilkerson & Haden, 2014; Young, et al., 2017).

Much of the literature that provides information on what constitutes effective professional development for educators is situated in the context of K-12 education. Factors identified within this literature as important to professional development include workshops that are of longer duration, networking or study group activities, opportunities for active learning, coherence with professional goals, and a focus a specific content area (Darling-Hammond, et al., 2017; Desimone, et al., 2002; Garet, et al., 2001; Grigg, et al., 2013; Lumpe, et al., 2012; Penuel, et al., 2007). Further, the research in K-12 professional development links student outcomes and teacher success with teacher efficacy (Kleinasser, 2014; Ross & Bruce, 2007; Tschannen-Moran & Hoy, 2001; Yoo, 2016;). Adaptation of these professional development concepts to nonformal and informal educators is complex yet critical to the development of STEM literacy among youth.

Some authors refer to nonformal learning activities as informal programs (see for example National Research Council, 2009; Patrick, 2017). However, informal learning opportunities are more often one-time experiences that are often self-guided and, in contrast, nonformal learning opportunities are continued, structured, often facilitator-lead forms of learning (UIS, 2012; Werquin, 2010). There are many informal (e.g., museums and parks) and nonformal (e.g., 4-H and Boy Scouts) venues for youth to participate in STEM learning activities. Yet, not all of these venues provide continued, research-based educational experiences for youth. The 4-H program, the youth development program component of the Cooperative Extension Service, is the largest youth serving nonformal educational program in the United States (National 4-H Council, 2016). With a strong history of using experiential learning and inquiry-based instruction, the 4-H program provides in school and out-of-school time opportunities for youth between the ages of 5 and 19 years to participate in structured and unstructured STEM learning opportunities (Enfield, 2001; Smith, 2010).

Statement of the Problem

Although it is established within the research literature that nonformal learning plays a major role in student success, there is a continued focus on the K-12 school environment as the predominant context whereby youth acquire knowledge (Falk & Dierking, 2010; Weiss, et al., 2009). Nonformal education programs, like 4-H, are well positioned to increase STEM literacy among youth. As such, there is a need for more effective professional development among nonformal educators (Smith, 2010; Smith et al., 2017). The research literature on professional development for educators focuses largely on the needs of K-12 educators, with what does exist for nonformal educators largely drawing from the literature for K-12 educators. Yet, the needs of nonformal educators are distinct from those of K-12 educators because nonformal educators may not have the same training in STEM content or pedagogical knowledge as K-12 educators. Thus, there is a need for more research into the processes and factors which are important for training nonformal educators to deliver STEM education to youth because they may have different needs than their K-12 peers. Identification of the training needs of nonformal educators which may increase their science teaching self-efficacy may contribute to more robust STEM instruction for youth.

In North Carolina 4-H serves over 263,000 youth each year through the work of 4-H field faculty in each of the counties and the Eastern Band of Cherokee Indians and nearly 17,000 volunteer educators across the state (North Carolina 4-H, 2019). The majority of the 4-H programming within North Carolina focuses on STEM content areas. Although field faculty in 4-H are required to hold a bachelor's degree in a youth development related field, the adult volunteers who provide programming for youth come from a variety of educational backgrounds. They are parents, grandparents, policy makers, business owners, college students, or other adults with a common goal of serving the youth in North Carolina. Some have undergraduate degrees, some have graduate degrees, and many have no post-secondary education. This diversity creates a need to develop professional development that includes knowledge and practice with STEM content and educational pedagogy.

The current model of professional development often brings 4-H field faculty and volunteers to a central location for training that is provided by university-based researchers and educators, who are referred to as content specialists. During these trainings, which usually last for one to two days in duration, content specialists share knowledge and basic instructional content with 4-H agents and volunteers. The 4-H agents and volunteers are provided opportunities to practice each of the learning activities with their peers. Lecture, hands-on practice, peer-observation and feedback are often included within these workshops. Although these trainings include some elements identified as important within the professional development literature (Darling-Hammond et al., 2017; Smith, 2010), they have not yet been effectively evaluated to determine which of those factors currently included impact, predict, or moderate educator performance, notably self-efficacy, nor has it been determined whether additional professional development content is needed.

Purpose of the Study

The purpose of this study is to investigate what factors contribute to the abilities of 4-H nonformal educators to deliver effective STEM educational opportunities to youth. A planned curriculum training for the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* provides the context in which to explore nonformal educators' experiences in a typical NC 4-H curriculum training. Measures of science teaching self-efficacy and experiential learning teaching efficacy are included in this exploration to understand the relationship between 4-H curricula training and nonformal educators' perceptions of their abilities to teach using experiential learning and to effectively deliver STEM content.

Research Questions

1. What are participants' experiences in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training?
2. Does participation in *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training improve science and experiential learning teaching self-efficacies among NC 4-H educators?

3. What are NC 4-H educators' attributions of their increased or decreased science and experiential learning teaching self-efficacy experiences related to their participation in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training?

Theoretical and Conceptual Framework

Adult learning theory and experiential learning theory each guide the process of professional development whereby 4-H nonformal educators learn to teach STEM curricula. Self-efficacy theory provides a foundation from which to understand how professional development with 4-H nonformal educators improves their confidence in their abilities to teach. Each of these theories is briefly explored in this section.

Adult Learning Theories

Much of the educator professional development literature draws upon adult learning theories. The field of adult learning is "extraordinarily diverse" with each adult learning theory focusing on a different aspect of the adult learning experience (Merriam, et al., 2007, p. ix). Several theories, for example Erikson's (1959) theory of psychosocial development, Piaget's (1972) theory of cognitive development, or Kohlberg's (1973) stages of moral development, focus on the role of maturity in the individual's ability to learn. Other theories, like Mezirow's (1991) transformational learning theory or Lewin's field theory (Lewin & Grabbe, 1945), address the process that adults go through when an unexpected event occurs which requires the adult to question and make changes to their identity (Mezirow, 1991). Additional adult learning theories, like Tough's (1971) self-directed learning theory, focus on the role of the adult learner in guiding their own educational journey with the goal of personal change and application of that learning.

Gregson and Sturko (2007) discuss the importance of considering Knowles' (1970) framework of adult learning or andragogy to maintain educators' interest by treating them as active rather than passive learners. It is important to note that although andragogy is considered valuable to understanding adult learning, according to critics there is a lack of empirical evidence to support the assumptions of andragogy (Taylor & Kroth, 2009). In response to criticisms, Knowles (1989) described andragogy as a "model of assumptions about learning or a conceptual framework that serves as a basis for an emergent theory" (p. 112). However, because andragogy as a framework is central to much of the educator professional development literature, and brings together several other important ideas about how adults who are educators learn (Darling-Hammond et al., 2017; Gregson & Sturko, 2007; Taylor & Kroth, 2009), it is presented here as a framework for thinking about educator professional development.

Andragogy postulates several assumptions about how learning changes across the lifespan. First, a student's learning process moves from dependence on an instructor to more independent pursuits of knowledge as the student matures (Knowles, 1980; Merriam, et al., 2007). As independent learners, it is important for educators to be actively involved in planning their own learning (Darling-Hammond et al., 2017; Gregson & Sturko, 2007). "Active learning is also an 'umbrella' element that often incorporates the elements of collaboration, coaching, feedback, and reflection and the use of models and modeling" (Darling-Hammond et al., 2017, p.7). Second, adults use their lifetime of experience as a resource for learning new information, building knowledge upon existing knowledge whenever possible (Darling-Hammond et al., 2017; Knowles, 1990; Merriam et al., 2007). These experiences include knowledge of their own learning styles, opportunities for learning cooperatively with peers, and an existing understanding of teaching strategies or pedagogy (Darling-Hammond et al., 2017; Gregson &

Sturko, 2007). A third assumption of andragogy is that adults develop a readiness to learn that is correspondent to their level of development (Gregson & Sturko, 2007; Knowles, 1990; Merriam et al., 2007). Educator professional development for someone who is a new educator will therefore be necessarily different than that which is designed for someone with more years of experience (Gregson & Sturko, 2007). A fourth assumption of andragogy is that adults are problem-centered and prefer to learn when the application of that knowledge is more immediate (Gregson & Sturko, 2007; Knowles, 1980; Merriam et al., 2007). For educators, this means that professional development should include elements that can be used immediately in their practice (Darling-Hammond et al., 2017; Gregson & Sturko, 2007). A fifth component of andragogy is that adults are more internally than externally motivated (Gregson & Sturko, 2007; Knowles, 1984; Merriam et al., 2007). As Gregson and Sturko (2007) explain, fostering an inclusive, respectful environment; including relevant and challenging educational experiences; and focusing on increasing competence are among the factors which are recognized to increase adults' motivations to learn. A final element of andragogy, which relates closely to internal motivation, is the need which adults have to know why new knowledge and skills matter to them (Knowles, 1984; Merriam et al., 2007).

Experiential Learning Theory

Experiential Learning Theory connects life experience or hands-on-practice with learning for youth and adults. John Dewey was developing experiential learning theory during the same period in which Seaman Knapp, the founder of Cooperative Extension, was working to develop the early 4-H club model (Enfield, 2001; John Dewey, 2014). Dewey's (1938) Experiential Learning Theory founded experiential learning on two principles, the principles of continuity and interaction. According to Merriam et al., (2007), Dewey's principle of continuity posited that in order for someone to learn new information, the new information must build upon existing information. Thus, information is additive or continuous over time. Through the principle of interaction, Dewey proposed learning is directly influenced and guided by the individual's context (Merriam et al., 2007). Time and opportunity are important factors in the types of learning experiences to which an individual has access (Dewey, 1938; Merriam et al., 2007).

Building on the work of Dewey, among others, Kolb (1984) developed a four-stage model of experiential learning (Merriam, et al., 2007). In this model, the learner first has a concrete experience which is then followed by an opportunity to observe and reflect on that experience (Enfield, 2001; Enfield, et al., 2007; Kolb, 1984; Merriam et al., 2007). Next, the learner's reflection leads them to analyze the situation in light of prior experience and to create generalizations about the possible application of the new knowledge (Enfield, 2001; Enfield et al., 2007; Kolb, 1984; Merriam et al., 2007). These generalizations are then tested through new and different experiences which leads to a repetition of the cycle of learning (Enfield, 2001; Enfield et al., 2007; Kolb, 1984; Merriam et al., 2007).

Experiential Learning with 4-H Youth. Experiential Learning Theory is an important part of the training for 4-H nonformal educators because the curricula developed in 4-H is based on that theory as it applies youth learning (Enfield, 2001; Smith, 2010). The Experiential Learning Model used most often within 4-H is conceptualized as a five-step cycle (Enfield et al., 2007; Norman & Jordan, 2006). This model, as outlined in Norman and Jordan (2006) includes the following steps: 1) Experience, 2) Share, 3) Process, 4) Generalize, and 5) Apply. As in Kolb's (1984) model, the first step is for youth to experience or to perform a hands-on activity which provides them with ability to reflect on the activity. However, to make the model more salient for application by educators, the 4-H model breaks down the observation and reflect step into the two separate processes of *Share* and *Process* (Norman & Jordan, 2006). During the *Share* phase, youth discuss the experience as a group, sharing and describing what happened during the experience. Then youth *Process* the experience as a group, determining commonalities within the experience and why the experience matters on a broader level. Youth then begin to *Generalize* what they learned to understand how their learning applies to other aspects of their lives and to their development of new knowledge or new life skills. Finally, youth enter the *Apply* stage during which they are asked how the lesson and experience can be applied in the future and in new situations (Norman & Jordan, 2006). Providing these types of continuous, hand-on experiences are central to youth development and to the work of 4-H (Enfield, 2001; Enfield et al., 2007; Norman & Jordan, 2006).

Experiential Learning with 4-H Educators. "Numerous adult educators have underscored the fundamental role that experience plays in learning in adulthood. (Merriam, et al., 2007, p. 161). Just as youth move through the five-step cycle as identified by Norman and Jordan (2006), the experiential learning process is central to professional development for 4-H educators. Within curriculum training in NC, 4-H educators experience the lessons alongside their peers and have conversations about the activities. They process the experience and discuss how the experience might apply to their lives, as well as identify any new information they found within the lessons. For the 4-H educator, application happens in real-time as they are expected to collaborate with their peers and practice teaching what they have learned to their colleagues in the curriculum training workshop.

Self-Efficacy

Self-efficacy is comprised of the beliefs and judgments that someone has about their ability to complete an action (Bandura, 1997). As Bandura (1977) explained, "efficacy expectations determine how much effort people will expend and how long they will persist in the face of aversive experiences. The stronger the perceived self-efficacy, the more active the efforts" (p. 194). A person derives self-efficacy from four experiences including performance accomplishments, which Bandura later referred to as mastery experiences, vicarious experiences, verbal persuasion, and emotional arousal (Bandura, 1997; Bandura, 1977). Mastery experiences are the most important components of self-efficacy as these are evidence of successful performance of a given competence (Bandura, 1997). Mastery experiences might include opportunities to practice learned content. Observing similar others model a task successfully (i.e., vicarious experience) also contributes to self-efficacy, though not as strongly as self-performance. Watching someone else accomplish a task is also a less stable source of self-efficacy information (Bandura, 1977). Another source of self-efficacy is the feedback provided by a trusted colleague or authority figure, such as a coach providing affirming statements to get an athlete to perform an action. This verbal persuasion is not a particularly strong source of efficacy information and requires additional support through opportunities for action to be effective. In his own work, Bandura (1977) discussed verbal persuasion as something with "definite limitations as a means of creating and enduring sense of personal efficacy" (p. 198). A final source of efficacy information is personal affect, specifically the amount of stress or anxiety perceived about performance capability impacts the belief someone has about their ability to perform a given action. Adequate experiences in practicing, learning positive self-talk, or having others provide positive affirmation of one's performance may contribute to positive emotions about the ability to perform.

Unlike general feelings of worth or self-esteem, self-efficacy is most often specific to a distinct action or set of skills (Bandura, 1997). Within the context of this study, two distinct types of self-efficacy for teaching are explored: science teaching efficacy and experiential learning teaching efficacy. Science teaching efficacy is divided into two subconstructs, science teaching self-efficacy and science teaching outcome expectancy. Although there is growing literature that supports the ability of educator professional development to increase science teaching efficacy, there is no such research which explores experiential learning teaching efficacy. Therefore, using existing measures of science teaching efficacy as a guide, this study includes a newly created measure of experiential learning teaching efficacy. That measure includes proposed subconstructs of experiential learning teaching self-efficacy and experiential learning teaching outcome expectancy.

Overview of Research Design

To understand participant experiences in *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* training and the potential factors which may produce gains in science teaching self-efficacy and perceived ability for teaching STEM content for NC 4-H nonformal educators, an intrinsic bounded case study was employed. This study included both quantitative and qualitative methods which worked together to add richness to and strengthen the veracity of the case study description (Patton, 2015; Saldaña, 2011). The goal of this inquiry was to determine if and which components of the current NC 4-H STEM Curricula trainings increased nonformal educators' STEM teaching capacity and science and experiential learning teaching self-efficacies, in a way that was only possible through the use of multiple data forms and a rich, detailed account of the experiences of those nonformal educators (Creswell & Poth, 2018; Stake, 1995). For this study, 4-H nonformal educators were invited to participate in a curriculum pilot for a newly developed dairy science curriculum which was built in partnership with content specialists in Animal Science at North Carolina State University to include a variety of STEM content using the K-12 North Carolina Essential Standards for youth in kindergarten through third grade. Participants were trained by members of the NC 4-H Curriculum Team and by university content specialists. Following training, participants piloted the curriculum in their home counties to youth in the appropriate age range within community club settings. Data collection included interviews with the training designers and observation of the professional development training. Participants completed retrospective post-then-pre science and experiential learning teaching self-efficacy survey questionnaires at the end of the pilot and participated in semi-structured interviews.

Overview of the Selected Curriculum and 4-H Professional Development Process

The *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* training was the focus of this study. The *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* is a newly developed dairy science curriculum for youth who fall within early elementary school ages. Youth within this age range were provided with an opportunity to participate in the curriculum activities in community club settings within their resident counties. There are 6 lessons in the curriculum which were built upon the North Carolina Essential Standards for kindergarten through third grade. In the curriculum, youth: 1) compare and contrast life cycles and physical development of cows and humans; 2) explore body systems and conduct experiments to understand the differences between monogastric and ruminant digestive systems; 3) learn about nutritional needs of living organisms and the role of proper nutrition in the milk making process; 4) investigate the production technologies used to process milk as they calculate distances and use maps to learn about milk's journey to their local store; 5) compare and contrast the sugar content in various beverages; and 6) learn about the chemistry involved in the conversion of milk to cheese and develop graphical skills as they classify different types of cheese based on flavor preference.

As with all curriculum produced through North Carolina 4-H, the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* was developed in partnership with university content specialists. The training for the curriculum was the launch of a required pilot process to determine the quality and effectiveness of the curriculum through formative and summative evaluation processes. During the training, content specialists provided educational background, walked 4-H educators through each of the activities within the curriculum, and answered any questions about program delivery. The 4-H team provided instruction on experiential learning, the framework for all 4-H curricula, and practiced using experiential learning processing questions with participants. In addition, access to an online pilot community where educators may ask questions of each other or any member of the training team, share pictures with their peers, and access additional content was provided during the training. Then, the 4-H educators implemented the curriculum with youth within their resident counties. Once instruction concluded, 4-H educators were invited to complete the measures for this study.

Significance of the Study

In 2018, the National Science and Technology Council released strategic goals for the successful future of STEM education in the United States, directing the Department of Education to increase the accessibility of STEM education (OSTP, 2018). The report highlighted the need for a more STEM literate workforce and included a focus on equal access to STEM education and equal representation of women, people of color, and people with disabilities. The lack of a level educational field is most apparent during the current events surrounding COVID-19 as many students and educators struggle to adapt to the provision of and participation in online learning systems. The impacts of learning loss due to students' inability to access online instruction exacerbates already present gaps in achievement for students with limited resources (Dorn, et al., 2020). "This learning loss will probably be greatest among low-income, black, and Hispanic students" (Dorn et al., 2020, p. 4). Preparing youth to lead in the 21st century, to overcome real problems in scientific and technological contexts is critical to the economic future and national security of the United States (OSTP, 2018). Cures for illness, new ways of virtual interaction, and new ways to produce clean energy are just a few of those STEM-related problems that loom large. Yet, youth in the United States continue to lag behind their international peers in measures of science and math literacy (National Science Board, 2018).

One way to address STEM literacy is to focus on providing quality professional development for educators. The K-12 education literature has identified several factors which are important for quality professional development which impacts student outcomes and teacher efficacy for teaching STEM (Desimone, et al., 2013; Grigg, 2013; Lotter, 2018; Ross & Bruce, 2007; Tschannen-Moran & Hoy, 2001). However, K-12 is not the only environment in which youth increase STEM literacy and a parallel focus on professional development which increases STEM teaching efficacy for nonformal educators who teach STEM to youth ages 5 to 19 is largely missing from the professional development literature. Indeed, the few models of professional development for 4-H educators that are present within the research literature are those identified as ineffective, comprised of one-time large-group lecture-type expert-led events (Smith, 2010; Smith et al., 2017). This study is a first step in exploring whether nonformal educators within the context of NC 4-H STEM curriculum training experience the same training activities identified within the K-12 literature; whether nonformal educators' STEM and experiential learning teaching efficacies are enhanced through participation in that training; and whether those nonformal educators attribute any efficacy changes to specific training elements.

This research adds to the professional development literature which attends to how teacher efficacy is improved through professional development and includes reflections from the educators. There are few studies in the literature which investigate teacher efficacy in connection with professional development or that investigate the role of science teaching efficacy and professional development. This study also expands the literature on experiential learning self-efficacy, a construct that is not yet well defined in the literature, and adds a newly developed measure of experiential learning teaching self-efficacy.

The results of this study are expected to inform the future of professional development for 4-H nonformal educators. For policy makers in 4-H who work with nonformal educators, this work may provide information to develop new processes for providing more generalized training in educational methods to increase the abilities of all nonformal educators to become comfortable in teaching STEM content. Further, the information gained in this inquiry, when shared with 4-H leadership, may inform the volunteer recruitment process. Through that process, those who recruit volunteers to teach STEM content specifically may be more equipped to identify volunteers who are comfortable teaching STEM content.

Practically, the way that NC 4-H curricula trainings are conducted will be informed and changed by the outcomes of this inquiry. There is a need for more effective professional development opportunities among 4-H educators (Smith, 2010; Smith et al., 2017). Indeed, such professional development may be more critical for nonformal 4-H educators because they may have limited STEM content and pedagogical knowledge. It is expected that specific needs of the 4-H educators identified in this investigation will aid in the identification of training components which contribute to science and experiential learning teaching self-efficacy and ultimately to the provision of STEM content to youth. It is also expected that using an adult learning theoretical lens to understand professional development for nonformal 4-H educators will assist in the development of a more comprehensive training model. Content of the curricula created may also be impacted by the outcome of this inquiry as nonformal 4-H educators identified a need for additional background or content within curricula to feel more confident in their abilities to deliver curricula to youth audiences.

Although this study is limited in scope and size, it may provide the foundation for the development of a theoretical framework from which to begin constructing a model, like that identified in the K-12 literature, which outlines the critical factors for effective professional development for 4-H nonformal educators who teach STEM content. Drawing from the work of K-12 STEM professional development, a more robust literature than currently exists within 4-H professional development, provides a way to effectively evaluate current professional development practices within North Carolina and to identify additional factors that may improve professional development for 4-H nonformal educators. Coupled with work being done in K-12 currently to create professional development models that match teacher effectiveness to national science standards, this work has the potential to increase STEM literacy and bridge the current gap in youth STEM literacy which exists between the United States and its similarly developed peers. Ultimately, the adaptation of processes and practice and the improvement of training models within 4-H STEM education is expected to impact the education that youth receive thereby increasing their STEM literacy and their desire to pursue careers in STEM.

Limitations and Delimitations

There are several factors which limit the ability to generalize the results of this study to the larger Cooperative Extension System. Those factors are outlined in this section.

This study is delimited to those 4-H educators who participated in a single NC 4-H STEM curriculum training and pilot. This included a small group of educators who work in out-of-school-time settings, such as clubs, in ten out of 101 Extension offices within North Carolina. They all live in one state in the Southeastern region of the United States. Extension offices within each state and territory of the United States. Nationally, 4-H serves nearly 6 million youth each year with more than 600,000 nonformal youth and adult volunteer educators. North Carolina serves around 263,000 youth each year with just over 17,000 nonformal volunteer educators. Therefore, the results may not be generalized to the Cooperative Extension System.

The sample for the current study was a convenience sample. Nonformal 4-H educators self-selected to be a part of the *NC 4-H Mooving Milk from Farm to Fridge Curriculum* training and pilot based on the needs of the youth they serve and their location in the state. Limitations to generalizability can be overcome by applying this research to other trainings to other locations in the future.

The research methodology chosen for this study was an intrinsic bounded case study. This method is used when the researcher desires to gain a deep understanding of a particular case (Creswell & Poth, 2018; Denzin & Lincoln, 2000; Miles et al., 2014; Rovai et al., 2014; Saldaña, 2016; Stake, 2005; Stake 1995). This methodology, necessarily limits generalizability in order to study the perceptions and experiences of a few individuals to understand the case at hand, those perceptions and experiences of 4-H nonformal educators who participated in a STEM curriculum training and pilot.

There is subjectivity within qualitative inquiry because the researcher is the source of interpretation and analysis (Creswell & Poth, 2018). Steps were taken to limit this subjectivity and bolster the trustworthiness of the qualitative components of this study, such as using different methods to collect data and providing thick, rich description using participants' own words (Guba & Lincoln, 1989; Miles, et al., 2014; Patton, 2015).

The survey used in this study to examine science teaching self-efficacy was not specifically designed for nonformal educators and is based on self-report items. The research literature identifies potential limitation of self-report measures such as self-presentation bias, recall bias, and confirmation bias (Althubaiti, 2016). There may be educational differences between nonformal educators and K-12 teachers which affect the ways that nonformal educators approach the science teaching self-efficacy measures. The survey used in this study to examine experiential learning teaching self-efficacy was created from the science teaching self-efficacy survey. Therefore, it may be subject to the same limitations as the science teaching self-efficacy survey. There may also be factors such as self-presentation bias or recall which are known to play a role in self-report questionnaires (Althubaiti, 2016).

There is a limited literature base within 4-H nonformal education to follow. This requires selection of additional literatures outside 4-H nonformal education, specifically the literature that applies to K-12 professional development, to better understand the factors contributing to effective educator professional development. This creates an imperfect understanding of the factors that may or may not apply to 4-H nonformal educators who do not have the same training provided to K-12 educators.

Delimitations in this study include those things which are chosen by the researcher to bound the study. The delimitations for this study are identified below.

The study focused on one 4-H science-based curriculum training. The choice to focus on this single training allowed for a deeper exploration of the experiences of the individuals involved in the training but limited the scope of the investigation.

Portions of the literature that address nonformal educator training discussed the need for pedagogical training as an important part of nonformal educator training. Pedagogical content is an important part of training for 4-H nonformal educators. However, this content is predominantly taught during orientation processes and through various annual general training events for nonformal educators. Such trainings include content on how students learn, inquiry-based and experiential methods of teaching, youth development, student learning styles, and youth risk-management. This research focused specifically on the training that occurred within one 4-H science-based curriculum training and it is assumed that the 4-H nonformal educators had already had this type of training. However, there may be some reinforcement of pedagogical practice during the curriculum training activities.

There is a small literature on informal science education professional development, specific to museum docents and curators at institutions which individuals visit for a few hours for a day, which was not explored. The training needs for these docents and curators and the interactions between these individuals and the public are perceived as markedly different than the training needs and youth-instructor interactions of 4-H nonformal educators delivering continuous STEM program content over an extended time period.

Definition of Key Terms

Content Specialist: Content specialists are those educators and researchers working in academic departments at a university or within a research center who are responsible for the generation of knowledge and coordination of research-related projects (Franz & Townson, 2008). These individuals provide subject matter expertise to support the work of educators through development of curricula and programs, through publication in peer-reviewed and mainstream media sources, and through consultation as needed.

Cooperative Extension: The Cooperative Extension Service was created in 1914 by the Smith-Lever Act to provide sound research to improve farming practices (United States Department of Agriculture, 2018; U.S. General Accounting Office, 1981). Cooperative Extension today provides nonformal educational programs based on the research created within the Land Grant University System. These programs include research-based information within science, technology, agriculture, economics, health, and civic engagement, among other content areas being pursued by content specialists within Land Grant Universities. Cooperative Extension is funded by congressionally appropriated grants and by county and state funds in every state and in the territories of the United States (United States Department of Agriculture, 2018).

Formal Education: Education that happens within traditional school classrooms, that is directed by a teacher, through which students are grouped by age and are graded by pre-defined standards, and which is often established by governmental policy is considered formal education (Fallik, et al., 2013; La-Belle, 1982; Romi & Schmida, 2009; Tal & Dierking, 2014).

Informal Education: Informal education occurs outside of the traditional school setting, is lifelong, and self-directed (Fallik et al., 2013; La-Belle, 1982; Romi & Schmida, 2009). Building on the definitions from Coombs and Ahmed (1974), La Belle (1982) defines informal education as inclusive of daily experiences that lead to learning. For example, Katz (2017) credited informally learning the Heimlich maneuver through seeing posters in restaurants as playing a role in saving her child's life. The literature however, conflates informal and nonformal education, sometimes referring to learning that occurs in museums and other institutions as informal learning opportunities and sometimes referring to longer-term educational programs which occur outside of formal settings, those which fit the definition of nonformal education, as informal programs (Fallik, et al., 2013; Katz, 2017). This is true in Patrick's (2017) edited volume on informal science education and within Fallik, et al. (2013) where the term nonformal is replaced completely by the term informal, neglecting the important distinctions between the types of programs and settings that occur in structured nonformal environments (e.g., learning in longer-term structured afterschool or in school programs) and unstructured informal learning environments (e.g., learning from posters or self-guided museum tours).

Nonformal Education: Nonformal education is education that happens outside formal systems, is voluntary, planned, organized, and deliberate (La Belle, 1982; Romi & Schmida, 2009). The deliberate and planned nature of nonformal education distinguishes it from informal education and the occurrence of nonformal education outside of formal, government-sponsored education system distinguishes nonformal from formal education (La Belle, 1982).

Out-of-School-Time Education: Out-of-school-time (OST) education is a term used to refer to any learning opportunity that occurs outside of the formal school environment. This term is inclusive of both informal and nonformal learning contexts, and can therefore be either structured (i.e., nonformal) or unstructured (i.e., informal) (Dabney, et al., 2012).

Informal Science Education: Another term that combines informal (i.e., unstructured) and nonformal (i.e., structured) educational activities which focus on science-learning that is used interchangeably with OST science education is Informal Science Education (ISE) (Katz, 2017; Patrick, 2017).

Nonformal Volunteer Educator: This is a term used to describe someone who volunteers their time (i.e., is not paid) to teach within a nonformal organization (e.g., 4-H). These individuals are most often not trained in teaching pedagogy, come from diverse educational backgrounds, and rely on training, curricula, and content expertise provided by content specialists to provide education to participants who volunteer to attend nonformal educational programs (Carlson & Maxa, 1997; Smith, 2010).

4-H Youth Development Program: The 4-H program, the youth development program for the Cooperative Extension Service and the United States Department of Agriculture, provides nearly 6 million youth with nonformal educational program opportunities which are conducted by 4-H educators and over 600,000 volunteers nationally (National 4-H Council, 2016). Most programs are delivered in afterschool and community club settings, are provided to youth in urban and suburban communities, and include content in STEM and healthy living (National 4-H Council, 2016; United States Department of Agriculture, 2015).

STEM Education: A focus on teaching that integrates content in science, technology, engineering, and math as these subjects are conceptually connected (National Research Council, 2011).

STEM Literacy: The individual attainment of knowledge and understanding of science, technology, engineering, and mathematics which allows the individual to be civically, culturally, and economically productive (National Research Council, 2011; National Research Council, 1996).

STEM Teaching Self-Efficacy: The beliefs that a teacher holds about their abilities to effectively teach within the content areas of science, technology, engineering and math. This belief in teaching efficacy is linked to persistence in challenges and willingness to invest time and effort in teaching (Bandura, 1997; Bandura, 1977; Bruce & Ross, 2007; Friday Institute for Educational Innovation, 2012; Gibson & Dembo, 1984; Guskey, 1981; Lumpe et al., 2012; Riggs & Enochs, 1990; Ross & Bruce, 2008; Tschannen-Moran & Hoy, 2001).

Research-based Programs: Research-based programs are built upon solid research in a given field and use techniques associated with changes in knowledge, attitudes, or behaviors. Research-based programs may be supported by evidence from non-experimental designs and may become evidence-based programs if appropriate long-term research is conducted (EPISCenter, 2015; National Center on Early Childhood Development, Teaching and Learning, 2017; Olson, et al., 2015; Puddy & Wilkins, 2011).

Evidence-based Programs: Evidence-based programs are research-based programs which have undergone rigorous experimental or quasi-experimental testing, are known to be effective with different populations, and have results that last over an extended time period (EPISCenter, 2015; Olson, et al., 2015; Puddy & Wilkins, 2011).

Summary

This chapter presented the rationale for the investigation of STEM educator professional development within the context of the 4-H nonformal education system. This study endeavored to clarify the professional development activities that are most important to STEM teaching success for 4-H nonformal educators who are not formally trained as K-12 teachers. This chapter also specified research questions, defined key-terms, and explained the significant contributions this work makes to the research literature and practically for nonformal educators. Chapter Two includes an overview of the theoretical and empirical literature associated with nonformal STEM professional development, STEM literacy, science teaching self-efficacy, and K-12 professional development. The conceptual framework for this study was constructed through the exploration of these literatures. Chapter Three details the methodology by which the relationships between nonformal STEM teaching success, science and experiential learning teaching self-efficacies, and participant experiences in 4-H STEM curricula training were evaluated. This chapter includes a description of the participant sample, data collection protocols, and processes for data analyses. Chapter four provides the results of the educator interviews and teaching self-efficacy surveys. In that chapter, comments from the educators tell the story of their experiences in the *NC 4-H Mooving Milk from Farm to Fridge Curriculum* training; nonparametric statistical analyses are used to explain changes in science and experiential learning teaching self-efficacies; and educator comments provide their attributions for the changes in their teaching self-efficacies. Chapter 5 includes a discussion of the results, implications for future practice, and directions for future research.

CHAPTER 2: Literature Review

Introduction

Improving professional development for 4-H agents and volunteers who teach STEM content requires understanding several areas of literature, including: a) the current state of STEM literacy in the United States, b) the role of nonformal education in STEM instruction, c) the current state of professional development for 4-H agents and volunteers, d) the K-12 science educator professional development models which 4-H consults given the limited scope of similar professional development literature for nonformal science educator, e) the specific needs of nonformal educators, f) the linkages between teacher self-efficacy for teaching STEM content and student performance in STEM activities, and g) the professional development needs for 4-H nonformal agents and volunteers. Therefore, this literature review first establishes the importance of STEM literacy as a basis for a recent focus by formal and nonformal educational institutions on improving STEM instruction. Next, literature that discusses the connection between nonformal education and STEM instruction is used to underscore the importance of professional development for nonformal educators who are responsible for a substantial amount of STEM instruction that occurs outside of the K-12 classroom (Falk & Dierking, 2010). After establishing the role of nonformal education in increasing STEM literacy, the case of 4-H as a nonformal education program with strong roots in experiential learning and science is presented. Next, given limitations in the literature specific to training nonformal STEM educators, literature on K-12 professional development opportunities for educators who teach STEM content is presented. Following the review of the literature on K-12 educator professional development, the literature which addresses the unique needs of nonformal educators is presented. Additional literature that points to the role of teaching self-efficacy and STEM-specific teaching self-efficacy follows.

Next, the construct of self-efficacy for teaching with the experiential learning method is conceptualized. The final section of the literature review focuses on the existing research literature that addresses professional development needs for 4-H agents and volunteers.

STEM Literacy in the United States

Nearly 40 percent of the nation's gross domestic product is comprised by businesses which focus on knowledge and technology production (National Science Board, 2018). A continued pipeline of students to fill jobs in these knowledge- and technology-intensive fields, which are projected to increase substantially by 2022, is critical to the national economy (Vilorio, 2014). Although the United States includes more opportunities for employment in these STEM occupations than other large developed countries, performance by students on international math and science assessments reveal that students in the United States trail behind students in other similarly developed countries in their STEM-based content knowledge. The primary sources of these international comparisons are the Trends in International Mathematics and Science Study (TIMSS), a measure that is given to fourth- and eighth-grade students every four years (Provasik, et al., 2012), and the Program for International Student Assessment (PISA), a measure that compares high school-aged youths' scores on reading, science, and math assessments which explore how students process and apply knowledge in these subject areas (Snyder & Dillow, 2013). On the latest available TIMSS report, eighth-grade students in the United States ranked ninth in math and eighth in science among 43 similarly developed nations (McFarland, et al., 2017). The 2015 PISA assessment ranks high school students in the United States fifteenth in reading, nineteenth in science, and thirty-seventh in mathematics among the seventy participating countries (Snyder, de Brey, & Dillow, 2018).

The need for the United States to establish a competitive edge in STEM education has led to collaborative efforts among institutions that support educational innovation and research. For example, the pursuit of STEM educational improvement is at the heart of a partnership between Carnegie Corporation of New York and the Institute for Advanced Study that convened leading researchers, scholars, business leaders, and public officials to study STEM education in the United States. The goal of this partnership was to create an action plan which outlined steps to improve STEM education for all students. In their final report, the Carnegie Corporation of New York (2009) identified four primary goals: 1) promote greater math and science learning; 2) implement clear performance standards and assessments; 3) provide better professional development for teachers and better management of school systems; and 4) shift schools' cultures to more effectively meet the needs of students. Among many steps outlined within this report was a charge to increase STEM educational opportunities through nonformal educational initiatives (Carnegie Corporation of New York, 2009).

Another initiative with a focus on the improvement of STEM education in the United States was led by the National Research Council (NRC) of the National Academy of Sciences. Like the partnership between Carnegie Corporation and the Institute for Advanced Study, the NRC convened a committee of experts in science and education to create an action plan for STEM education improvement (National Research Council, 2013b). The NRC also developed a research and evidence-based framework for STEM education which became the Next Generation Science Standards (NGSS) (National Research Council, 2012). Released in 2013, the NGSS provided a prescriptive framework of science educational standards intended to guide K-12 science education. Three primary goals were outlined in the NRC's original report, with emphasis on supporting women and students of color, including: 1) increase students pursuing

STEM careers; 2) create a workforce that is “STEM-capable” to fill jobs that require specialized STEM knowledge but do not necessarily require a 4-year degree; and 3) develop STEM literacy broadly so that all students increase knowledge and understanding of STEM concepts (National Research Council, 2011). To meet the demanding benchmarks put forth in these standards will require significant changes to professional development for educators who teach STEM content. As Wilson (2013) explains, “helping current teachers acquire the knowledge, skill, and will to meet these new standards is a daunting enterprise requiring large-scale professional development (PD) of high quality that is adaptable across myriad contexts” (p. 310).

The establishment of standards and accountability through testing are not new approaches for K-12 STEM education. However, the call for an increase in nonformal STEM educational opportunities from the Carnegie Corporation coupled with the documented need for educator professional development that assists educators in developing the knowledge and skills to meet the needs of students is a reminder that not all science learning happens in the classroom. In addition to finding ways to train K-12 educators, the science literacy of the United States also depends upon the ability of informal and nonformal educational initiatives (Falk & Dierking, 2010; Mosatche, et al., 2013; Wilkerson & Haden, 2014; Young, et al., 2017) to provide experiences outside, and sometimes inside, classrooms that assist both students and K-12 teachers in moving STEM learning forward. Training for these nonformal educators is largely ignored in the research literature. The following section discusses the important role of informal or nonformal science educators to increase science literacy outside of the K-12 environment.

The Role of Informal and Nonformal Education in STEM Instruction

Informal and nonformal STEM education, also known as out-of-school-time (OST) STEM education, provide important contributions to STEM literacy among youth (Afterschool

Alliance, 2011; Carnegie Corporation of New York, 2009; National Research Council, 2009, National Research Council, 2015; Werquin, 2010; Worker & Smith, 2014). However, "while quality teachers and facilitators contribute pivotally to effective learning, non-formal educators tend to be under-valued in many national education systems" (Yasunaga, 2014, p. 15).

A synthesis of research from sources that included the Harvard Family Research Project and the National Research Council's (2009) report on informal science education, offers evidence to support the premise that most science learning happens outside of K-12 classrooms in informal and nonformal educational settings (Falk & Dierking, 2010). Because a significant proportion of STEM education occurs in informal and nonformal learning environments (National Research Council, 2009), with some researchers reporting that the average American spends about five percent of their life in a formal classroom (Falk & Dierking, 2010; Tal & Dierking, 2014), it is paramount to look outside of K-12 education to address STEM literacy in the United States.

If STEM literacy were solely a function of learning within the K-12 classroom setting, it may be reasonable to expect that adults, who no longer pursue STEM education after graduation from high school, continue to perform more poorly on science literacy measures than their peers in other nations. Yet, adults in the U.S. "consistently outperformed their international counterparts on science literacy measures" (Falk & Dierking, 2010, p. 487). It may also be reasonable to expect elementary-aged youth to perform less well than their international peers on the PISA and TIMSS assessments, as these differences in STEM performance are apparent between American youth in middle school and their international peers. However, although science learning is mostly absent from K-12 classrooms prior to middle school (Blank, 2013), PISA and TIMSS scores among elementary school youth in the United States are similar to their international peers' scores (Falk & Dierking, 2010) even though middle school youth rank below their international peers.

In a 349-page report that documented the impact of science learning in informal and nonformal environments and established an agenda for additional research, the Committee for Learning Science in Informal Environments concluded that "there is abundant evidence that across all venues—everyday experiences, designed settings, and programs—individuals of all ages learn science" (National Research Council, 2009, p. 2). Nonformal programs that address STEM learning that is sustained, community-based, structured and interactive "may positively influence academic achievement for students and may expand participants' sense of future science career options" (p. 3). Although some authors often refer to nonformal learning activities as informal programs (Katz, 2017; National Research Council, 2009), there are differences between informal and nonformal education settings which affect the ways learners engage and how much time they spend learning. The one thing that is clear is that these OST learning activities are valuable contributors to holistic STEM education.

> The dominant assumption behind much current educational policy and practice [is] that school is the only place where and when children learn. This assumption is wrong. Forty years of steadily accumulating research shows that out-of-school, or "complementary learning" opportunities are major predictors of children's development, learning, and educational achievement. (Weiss et al., 2009, p. 1)

Evidence for the types of STEM learning activities that nonformal education allows, such as active engagement in learning using inquiry-based science practices, are supported within the analysis of research studies that investigated the impact of inquiry-based instruction on children's understanding of science concepts. Minner, et al. (2010), for example, analyzed findings from 138 studies between 1984 and 2002 and concluded that "teaching strategies that actively engage students in the learning process through scientific investigations are more likely to increase conceptual understanding than are strategies that rely on more passive techniques" (p. 493). These kinds of inquiry-based experiences create excitement and encourage curiosity and exploration of STEM content in ways that are often not possible given the demands to cover large amounts of information as is now common among K-12 classrooms (Fenichel & Scheweingruber, 2010; Minner et al., 2010; Smith, 2010).

Recently, in a report sponsored by the RAND Corporation, McCombs, et al. (2017) reviewed existing evaluation studies and meta-analyses of OST programs since 2000. They list multiple primary and secondary outcomes produced through OST programs including: 1) increased supervision by caring adults, which may decrease youth participation in unsafe behaviors; 2) adequate dosage, which may improve student achievement in some OST programs; and 3) targeted social and emotional skill development, which may show improvements in youth social and emotional skills. McCombs et al. (2017) also discuss a need for OST programs to more intentionally measure the impact on outcomes such as caregiver benefits, youth social support, and youth social and emotional competence. Programs with high implementation quality, regular youth attendance, and specifically targeted outcomes are most likely to produce evidence of benefits for youth.

A longitudinal sequential research design was used to specifically examine the impact of 4-H programs on youth learning and development surveyed more than 7,000 youth from fifth through twelfth grade over a period of eight years (Lerner, et al., 2013). This research identified significant benefits for 4-H youth compared to youth in other OST programs. For example, 4-H participants tend to have healthier habits, be civically engaged, make positive contributions to their communities, and be involved in programs that include science, engineering and technology instruction. There were differences in gender in several of the study findings, with 4-H girls significantly more likely to participate in science programs than girls in other OST programs (Lerner et al., 2013). As the authors admit, there were significant challenges to generalizability throughout the study, including the increasing attrition of youth in later study waves from limited-resource backgrounds and those who face the most significant levels of risk factors. If the reported sample of 7000 youth had participated in all years of the study, that would include less than one percent of the nearly 6 million youth who participate in 4-H programs in the nation. In the first year, however, the research included just over 1,700 youth from 13 states and in data from year 6, which authors report included a compilation of data from 45 states, it is clear that of the 2,371 tenth-grade youth participants, only 797 indicated participation in at least two other years (Lerner et al., 2011; Lerner et al., 2013). These factors, among others, make it difficult to apply the findings of this work to 4-H youth overall.

Opportunities to make connections between OST science learning and science learning within the classroom has an additive impact on student science achievement, perseverance, effort, and science career aspirations. For example, Tran (2011) investigated the association between an OST lab experience learning opportunities on science learning for a large urban sample of high school students with diverse cultural and economic backgrounds. Students were engaged in lab experiences which were not possible within the classroom. When students were able to make connections between the out-of-classroom activities and their learning in the classroom, there was an additive impact on factors associated with STEM learning. There was a modest but significant impact on achievement, a moderate effect on science career aspirations, science-efficacy, perseverance in science, and effort in science learning, and a larger effect on interest in science learning (Tran, 2011).

Nonformal educational opportunities also positively impact youth attitudes and interests in STEM subjects and STEM careers. For example, Mosatche (2011) reports statistically significant positive changes for Girl Scouts who participated in the *Girls Go Techbridge* Program, a packaged curriculum program that involves girls in STEM design activities. The program provides afterschool and summer STEM program opportunities for girls in fifth- through twelfth-grade (Mosatche, et al., 2013). In a sample of 1,234 girls, there was a statistically significant positive change in attitudes about science ability, knowledge of science processes, and career aspirations.

Another example of research that investigates the impact of OST STEM activities, is the work of Dabney et al. (2012) which included a large nationally representative sample of university students in the United States. Students in this study who reported participation in OST STEM educational activities, such as participation in clubs, camps, and competitions, were significantly more likely to report an interest in pursuing a STEM career. Males, students who were interested in STEM careers in middle school, students with higher math scores in middle school, and students from neighborhoods with higher economic status also reported statistically significantly higher interest in STEM careers. In a meta-analysis that investigated the effect of students' OST STEM experiences on their interest in STEM, Young, et al. (2017) found larger effect sizes for nonformal activities which include both academic and social elements. Additionally, researchers of programs outside of the U. S., found middle school youth who were involved in a university-provided engineering design program reported statistically significant STEM career interest after the lab experience than before (Shahali, et al., 2017).

Differences in content and location of informal and nonformal science education provide learners with the freedom to experience science learning on their own terms. Although this diversity in learning opportunities is attractive in its own right, one of the main draws of nonformal STEM education is that it is directed by a caring and competent adult educator who can strengthen the learners' abilities to apply and more deeply explore the educational content (National Research Council, 2015). It is especially important for these nonformal educators to receive training to facilitate youth learning as several national and international reports point to nonformal education as an important pathway for youth to explore science and as a critical partner in formal STEM education (National Research Council, 2015; Werquin, 2010).

To create and facilitate the kinds of programs that allow youth to explore STEM content, nonformal educators need funding, tools, and skills to develop and deliver research- and evidence-based science education programs. Indeed, several criteria for creating programs of quality include: programs that involve young people in hands on experiences that emphasize STEM practice within a supportive environment; programs that are relevant to youth and allow them to lead alongside competent caring adults; and programs that connect the multiple spheres of youths' lives, make creative use of community resources, and connects to additional opportunities to learn (National Research Council, 2015).

This section addressed the important role of nonformal OST learning activities in STEM education, the additive impact of nonformal programs to in-school STEM learning, and the positive changes in attitudes about and interest in STEM that nonformal educational programs foster. The next section describes how 4-H provides education differently than other nonformal education organizations and how these differences make 4-H a critical partner in increasing STEM literacy in the United States. Distinct from the informal and nonformal educational opportunities addressed in the previous research examples, 4-H provides STEM education to youth through multiple contexts, which are referred to as delivery modes. These program contexts include in school, afterschool, summer camp, and community club opportunities. Further, 4-H considers professional development for all 4-H agents and volunteers a critical component of STEM program delivery.

Contextualizing 4-H Experiential Education

As the youth development program for the Cooperative Extension Service and for the United States Department of Agriculture, the 4-H Youth Development Program serves youth between the ages of 5 and 19 (Enfield, 2001; National 4-H Council, 2016; Smith, 2010). The Cooperative Extension Service and 4-H share the mission of taking the research-based knowledge produced at leading land-grant research universities across the country and distilling that information into educational programs for public participation across the United States as well as in some international locations. According to the latest 4-H enrollment reports, there are just over 5.7 million youth enrolled in 4-H programs across the United States. Although 4-H is most often associated with agricultural programs, more than half of the youth enrolled in 4-H today live in urban and suburban communities and most often participate in STEM programs (National 4-H Council, 2016; United States Department of Agriculture, 2015). These data show a shift in the enrollment patterns from the origins of historically agriculture-based programs toward more diverse science-, engineering-, and technology-related curricula. This shift is reflective of the science and research being produced at 110 land grant universities nationwide. In 2016, there were over 600,000 youth and adult volunteers involved in 4-H program delivery (National 4-H Council, 2016).

The 4-H program has a rich history of providing experience-based learning opportunities. The first 4-H clubs began in the early 1900's as Agricultural Clubs for boys and girls. Those clubs emphasized the learning by doing experience- and inquiry-based educational strategies that guide the creation and implementation of 4-H programs today (Enfield, 2001; Smith, 2010). Seaman Knapp, who is considered the founder of Cooperative Extension, advocated this experiential learning approach during the early 1900's, around the same time that John Dewey was working on his experiential learning theory at the University of Chicago Laboratory Schools (John Dewey, 2014; Enfield, 2001). By demonstrating the technologies through the work of the farmers' children, Knapp used the early 4-H clubs to attract farmers to see the possibilities of new crop technologies (Enfield, 2001).

Most of the current 4-H educational programs are afterschool or community club programs that allow youth to focus over an extended period of time on a particular content area (National 4-H Council, 2016; Enfield, 2001). This model of nonformal education is congruent with Dewey's (1938) principles of interaction and continuity. The interaction principle postulates that learning occurs as individuals interact with their environment, and the continuity principle expands this notion to include the impact that experiences overtime have to build upon other experiences to deepen learning. These principles are at the core of how 4-H provides nonformal education to strengthen youth content knowledge, scaffolding experiences by providing youth the opportunities to engage with a particular content area under the guidance of a caring adult educator over months and years (Enfield, 2001).

Training for 4-H educators in STEM content and educational pedagogy are critical to the success of 4-H STEM programs. However, there is a documented need for more effective professional development opportunities among 4-H volunteer educators (Smith, 2010; Smith et al. 2017). The empirical literature on 4-H educator professional development is sparse. Because of the lack of empirically supported models for nonformal educators, many who are not trained for the K-12 classroom, the K-12 professional development literature provides a proximal match for the professional development needs of 4-H educators (Smith, 2010). The next section presents literature that addresses professional development for K-12 educators, identifying factors that are considered most important for effective professional development of educators who teach STEM content.

K-12 Professional Development for STEM Instruction

Professional development within the K-12 system is continuously evolving to meet the changing needs of students and society. Teacher professional development is expected to incorporate attention to diverse learning styles (Mundry, 2005), student-centered education which attends to diverse student realities (Grigg et al., 2013; Lumpe et al., 2012; Mundry, 2005), evaluation of students based on nationally-recognized standards (Mundry, 2005; Wilson, 2013), content- and pedagogy-specific professional development (Darling-Hammond et al., 2017; Desimone et al., 2002; Garet et al., 2001; Grigg et al. 2013; Lumpe et al., 2012; Penuel et al., 2007), the use of inquiry-based methods (Grigg et al. 2013; Mundry, 2005), and the recognition of the limited effectiveness of one-time teacher workshops (Darling-Hammond et al., 2017; Desimone et al., 2002; Garet et al., 2001; Grigg et al. 2013; Lumpe et al., 2012; Penuel et al., 2007). Most recently, the creation of the Next Generation Science Standards prompted a renewed push to adapt K-12 professional development to increase youth science literacy through recognition of a national set of educational standards for science learning (Wilson, 2013). This section presents literature and research from K-12 professional development studies that identify features of K-12 teacher professional development considered essential for educators teaching STEM content.

Garet et al. (2001) examined the relationship between features of professional development identified as important in the K-12 professional development literature and changes in teacher knowledge, skills and classroom teacher practices as a part of a national evaluation of a federal program that supports math and science teacher professional development. They compared six features of the professional development including: 1) whether the professional development was reform- or traditional-type; 2) duration of the activity including contact hours and time span; 3) the degree of collective participation involved in the activity; 4) how much the professional development focused on content knowledge; 5) whether the activity offered opportunities for active learning; and 6) the degree of coherence apparent in the professional development activity (i.e., alignment with teacher goals and state standards, encouragement of professional communication among teachers). The professional development activities that included more reform-type activities (e.g., networking or study group activities) and more contact hours than traditional (e.g., workshop or lecture) activities had a modest direct effect on enhanced teacher knowledge and skills. The longer reform-type activities also allowed more opportunities for active learning, planning, and coherence with teachers' professional goals. A focus on content, coherence with professional goals, and active learning improved teacher knowledge and skills. Enhanced knowledge and skills and coherence with teacher professional goals had a positive effect on changes in teaching practice.

Expanding the work presented in Garet et al. (2001), Desimone, et al. (2002) used data from a three-year longitudinal evaluation of a large federally funded professional development program to explore whether professional development impacted teaching practice while controlling for prior teaching practice. The teaching sample included five states and 207 teachers. Professional development that included collective participation opportunities within similar grade, school, or department; engagement in active learning activities; coherence with teachers' professional goals, and reform-type activities was found to positively impact teaching practice. There was also a positive relationship between professional development that focused on a specific teaching practice and the use of that teaching practice in the classroom (Desimone et al., 2002).

Penuel et al. (2007) examined the effects of an inquiry science educator professional development on teacher knowledge, changes to science teaching practice, and teachers' abilities to implement an international earth science education program. The sample for this research included 454 teachers at 28 different program delivery sites. In addition to the professional development factors identified in Garet et al. (2001), this study included local supports for program implementation. Outcome variables included data reporting, protocol use, preparation for student inquiry, and knowledge of pedagogy and teacher change in practice. Similar to Garet et al. (2001), teachers reported feeling more prepared to answer students' questions and used program protocols more often when the professional development was consistent with teacher goals, curriculum, classroom activities, and requirements. Reform-type professional development, coherence with professional goals, active learning opportunities, and opportunities for collective participation were positively related to changes in teacher knowledge and practice. When professional development was content-focused, teachers felt more prepared for student inquiry. However, there was a negative relationship between teachers feeling prepared for student inquiry and using program protocols when professional development was longer. The addition of local support for equipment and technology use significantly increased teacher knowledge, changes in teacher practice, and program implementation.

Grigg et al. (2013) investigated the impact of professional development on inquiry-based teaching practice in fourth- and fifth-grade classrooms. In a 3-year randomized study with 73 schools, selection to participate in the five-day immersion program was associated with 84 percent higher likelihood of classroom observer reports of witnessing scientific-inquiry in a lesson than in control schools. The introduction of a system-wide professional development confounded the results observed between years 2 and 3 of the study. Between years 1 and 2, lessons from the schools assigned to the intervention were nearly twice as likely to show evidence of scientific inquiry in practice than in the control schools. Among five identified features of scientific inquiry included in the National Science Education Standards model, there was evidence that the targeted professional development program increased student questioning, improved students' abilities to form explanations from evidence, and increased student attention to scientific evidence. However, there was little to no evidence that either the control or intervention influenced students' abilities to connect their explanations to scientific knowledge or to justify those explanations. The researchers recognized that these last two features of inquiry-based practice are more difficult to teach and were less effectively taught during the professional development condition. As identified by others, teaching practice changes in response to content-specific instruction (Desimone et al., 2002; Desimone, et al., 2013; Garet et al., 2001; Penuel et al., 2007). However, there is still work to be done to clarify the most effective ways to teach the more complex critical thinking skills involved in connecting explanations to scientific knowledge and justifying those explanations in relation to scientific knowledge.

Lotter et al. (2018) investigated the impact of a year-long professional development program on the use of inquiry-based methods. Participants attended a two-week summer program and three additional follow-up sessions over the course of an academic year. Practice in using inquiry-based teaching, learning content in an inquiry-based process from a content specialist at the University, collaborative reflection and observation of teaching, and feedback from the professional development team were included in the two-week summer program. Conversations about pedagogy, lessons to enhance content knowledge, and reflection on practice were included in the follow-up sessions. Additionally, teachers could request for a project team member to observe them during instruction time for additional feedback. Teachers showed statistically significant growth in their instructional use of inquiry-based methods but did not reach a pre-determined level of proficiency. Positive significant changes in personal self-efficacy and outcome expectancy for inquiry-based teaching were reported. Additionally, teachers reported that their abilities to use inquiry-based teaching practices and strategies with their students increased as a result of the professional development activities.

The need for the types of professional development learning opportunities required for teachers to "help young people learn the more complex and analytical skills they need for the 21st century" (Darling-Hamond & Richardson, 2009, p. 46.) has prompted researchers in the K-12 formal education environment to move beyond one-time workshops toward more comprehensive professional development activities. This K-12 focused research has supported collaborative learning environments, active learning, coherence with goals, longer duration, and modeling and coaching within professional development opportunities (Darling-Hammond & McLaughlin, 1995) for more than 20 years. These activities are among the elements of professional development advocated for by Darling-Hammond and McLaughlin (1995) and are documented in numerous studies and in a recent research review by Darling-Hammond and others. Darling-Hammond et al. (2017) examined thirty years of rigorous professional development research, with a focus on research which demonstrated that effective professional development both changes teachers' practice and improves student outcomes. Within this work, they narrowed the literature down to 35 studies which met their criterial for inclusion, half of those studies involved science and math content specifically and the other half overview literacy-related professional development programs. From the identified studies, Darling-Hammond, et al. (2017) identified seven factors, confirming the identified characteristics described above (i.e. content focus, incorporation of active learning, opportunities for collaboration and feedback in reform-type activities, longer duration, and goal coherence) and adding the inclusion of a coach or expert guide, and the existence of a model or the use of activities that model effective practice.

Although the K-12 professional development literature includes areas that need further clarification, such as the relationship between professional development and student achievement, this literature provides the most promising and relevant research base for developing professional development for nonformal science educators. However, the needs of nonformal and informal educators are not the same as the needs for formal educators. The following section overviews contemporary thought and research on the distinct professional development needs of nonformal and informal science educators.

Distinct Needs of Nonformal Educators

Patrick (2017) argues in favor of university preparatory programs for OST science educators which include elements of educational theory, learning, and evaluation which are specific to learning science in out-of-school contexts. Katz (2017) advocates for adding a certificate program to formal educator programs. As she explains, "There are very few certificate programs for people who want to teach outside of schools. Those people usually apprentice at institutions or programs and learn how to communicate to the public through practice." (p. 30). Such programs would require different content than current university preparatory programs for formal educators. There is a need for instructors in these out-of-school time educational settings to have a greater degree of comfort with teaching in the less structured environment and a need for stronger content knowledge (Patrick, 2017).

In their work teaching physics undergraduate students to teach middle school aged youth about science in an afterschool setting, Mayhew and Finkelstein (2009) engaged the undergraduate students in training workshops which, in addition to formal teaching pedagogy, included content on inquiry-based science, how to engage children from underserved groups, how to work in afterschool environments, and targeted content in science and technology. Undergraduates showed significant gains in their abilities to communicate with youth using accessible language after workshop participation.

As Hinko et al. (2016) discovered in their work with university educators, including undergraduate students, graduate students, and postdoctoral researchers who were asked to provide afterschool programs, the pedagogy that works in the classroom is distinct from that which works in out-of-school time programs. In their work, they explore the ways that pre-service teachers work with youth in an afterschool physics program and present the implications for training educators to teach in out-of-school settings. Through analysis of video-taped educator and student interactions in the afterschool program, Hinko, et al. (2016) identified 3 specific ways that educators interacted with students. Traditional, teacher-focused instruction, that might be observed in any classroom activity during which the teacher directs the student through a series of experimental steps was used least often in the afterschool program. The most often used interaction type observed was what the researchers describe as the *consultation mode* of interaction. The educator as consultant offers guidance in response to the student and the student controls the activity. When approached, the educator prompts students to reflect on their activities but does not correct students. The focus of student activities is largely exploration and is not contingent on a pre-determined answer. In the third interaction type, which occurred more than the instruction mode and less than the consultation mode, the educator takes on the role of participant and becomes a part of the group rather than providing instruction or guidance.

In addition to the development of teaching pedagogy, targeted content, and culturally responsive practice as identified in the work of Hinko et al. (2016) and Mayhew and Finkelsten (2009), Patrick (2017) advocates for OST educators to receive training in reflective practice, a skill used by formal educators to consciously evaluate and improve their own teaching practice. King and Tran (2017) also provide support for reflective practice, the need for ongoing professional development, and what they refer to as *deep conceptual learning* such that OST educators are "flexible and confident in supporting the diverse range of learners" (p. 72) to whom they provide instruction. As King and Tran (2017) explain, "Reflection—the ongoing learning for and about ones' practice in which professionals engage in order to increase their expertise and skill—helps practitioners to better understand what they know and what they do" (p. 77). Patrick (2017) also promotes the need for training for OST educators that includes ongoing communities of practice and continuous professional development to improve teaching quality

This section summarized literature that specifies the distinct training needs for nonformal educators including university preparatory programs, practice in OST contexts, and targeted science-content learning. The call for more content knowledge and for additional comfort in teaching within OST contexts for OST educators relates to their self-efficacy for teaching, or the educator's perceptions about their knowledge and ability to teach a given subject (Tschannen-Moran & Hoy, 2001). The next section of this literature review provides an overview of self-efficacy and teaching self-efficacy as they relate to professional development for teaching science.

Professional Development and Science Teaching Self-efficacy

Self-efficacy for teaching has produced over 100 articles in one journal alone since 1985 (Kleinsasser, 2014), and the study of this construct and recognition of its importance in teaching goes back even further (Armor et al., 1976). In their review of teacher efficacy measures, Tschannen-Moran and Hoy (2001) explain that teaching efficacy, the belief a teacher has in their ability to teach effectively, contributes to the teacher's endurance in the face of trials, and their willingness to invest time and effort in teaching. The first attempts to measure teacher efficacy were focused on the teacher's locus of control over a student's learning (Armor et al., 1976; Tschannen-Moran & Hoy, 2001). This measure included 2 questions on a lengthy survey. The second attempt at measuring the construct now known as teacher efficacy included 30 items which measured locus of control using percentages (Guskey, 1981; Tschannen-Moran & Hoy, 2001). Subsequent measures adapted more of Bandura's (1977) social cognitive theory, including two factors, personal teaching efficacy and a more general teaching efficacy. Gibson and Dembo (1984), for example, created the Teacher Efficacy Scale (TES) and were the first to discover a two factor (i.e. personal teaching efficacy and general teaching efficacy) model of teaching efficacy through factor analysis of their 30-item measure. Bandura took issue with many of the created scales which treated teacher efficacy as a common construct for overall teaching and created his own teaching efficacy scale with seven subscales that intended to measure different facets of teaching such as instruction, discipline, and getting parents involved (Bandura, n.d.; Tschannen-Moran, 2001). Tschannen & Hoy (2001) created the Teachers' Sense of Efficacy Scale (TSES), which is still widely used in the measurement of teacher efficacy (Ross & Bruce, 2007). Originally named the Ohio State Teacher Efficacy Scale, the TSES includes 24 items divided among three subscales that measure teacher efficacy for instruction, student engagement, and classroom management (Tschannen & Hoy, 2001; Yoo, 2016).

The first measure of science teaching efficacy, the Science Teaching Efficacy Belief Instrument (STEBI) was designed using Gibson and Dembo's (1984) TES as a foundation (Riggs & Enochs, 1990). Recognizing the need for measures of teaching to be content- and situation-specific, Riggs and Enochs (1990) modified the TES to incorporate language related to an elementary science classroom. This scale resulted in two subscales, the Personal Science Teacher Efficacy subscale with a reported Cronbach's Alpha of .90 and a Science Teacher Outcome Expectancy subscale with a reported Cronbach's Alpha of .76. This measure is still widely used (Aurah & McConnell, 2014).

Although there is a recognition of teacher efficacy as an important component of teacher behaviors and student outcomes, "little attention has been given to how teacher efficacy evolves as a result of professional enhancement programs or through teachers' own reflection within the context" (Yoo, 2016, p. 86). This statement also applies to the low number of research studies which investigate the relationship between science teaching efficacy and teacher professional development (Mintzes, et al., 2013). However, there is growing evidence that professional development can have an impact on science teaching efficacy. For example, Lumpe, et al. (2012) studied teachers who participated in a yearlong professional development program. The program included teachers from two school districts in an intensive program built to incorporate

Desimone's (2009) identified factors of content focus, active learning, coherence, duration, and collective participation. The goal of the program was to improve science teaching for all teachers in each of the participating elementary schools. Two-week summer programs were conducted each year of the program during which teachers were provided instruction in science-based content and inquiry-based teaching methods. Throughout the academic year, teachers were assigned support teachers and were provided with professional development to support the implementation of a selected curriculum for up to an hour for 3 or 4 days each week. Lumpe, et al. (2012) used the Science Teaching Efficacy Beliefs Instrument to measure teachers' science teaching efficacy and science outcome expectancy. Additionally, this research used a measure developed by study authors, the Context Beliefs about Teaching Science (CBATS) to measure teachers' judgments about the supportiveness of their work environment (Lumpe, et al., 2000). The 450 elementary teachers who participated held significantly more positive science teaching efficacy beliefs following the professional development program than before the program as measured via the STEBI subscale for science teaching efficacy beliefs (Lumpe, et al., 2012). However, teachers did not show congruent gains in their responses on the STEBI measure of outcome expectancy which measures teachers' beliefs about their responsibilities for student science achievement following the program. Additionally, teachers' scores on the CBATS showed a statistically significant decrease indicating that teachers' beliefs about the supportiveness of their professional environment were lower post-program than before program (Lumpe, et al., 2012). Taken together, these findings suggest that professional development duration, as originally identified in Garet et al. (2001) as an important factor in effective professional development, might be more complex than originally postulated. Lumpe, et al. (2012) also did something that is largely missing from other teacher professional development studies. They matched student achievement scores to the corresponding teachers and investigated the impact of science teaching self-efficacy, science teaching outcome expectancy, and the number of professional development hours on student achievement for fourth-grade students. All three variables were significant indicators of student achievement. As science teaching self-efficacy and the number of professional development hours increased, so did student achievement. However, the teachers' beliefs about their abilities to impact student achievement was a negative predictor of student achievement. The authors postulate that this is an artifact of the intensive science professional development among teachers who were not required to teach science prior to the professional development. Although, these predictors together only accounted for four percent of the variance in student achievement, the results for sixth-grade students also showed significant relationships between these factors and student achievement. Further investigations into the myriad of factors that predict student achievement, such as access to resources, student support systems, student background variables, as well as physical classroom characteristics such as safety and comfort are needed to more clearly understand the adaptations necessary to provide effective learning environments for all students.

Sandholtz and Ringstaff (2014) studied the impact of a 3-year professional development program on science teaching efficacy among teachers who taught kindergarten through second-grade. The professional development program included over 100 contact hours in science content and pedagogy as well as focused instruction on peer collaboration. Each year of the program a new science content area was introduced with physical science the focus of instruction in the first year, earth science the focus in the second year, and life sciences the focus in the third year (Sandholtz & Ringstaff, 2014). Because classroom instruction in early elementary integrates science alongside other content areas, integrating science into mathematical and language arts was also a part of the professional development. Teachers were given the Science Teaching Efficacy Belief Instrument (STEBI) four times over the course of the professional development program, once each spring and one prior to the start of the program. The STEBI includes 25 items and includes a Personal Science Teaching Efficacy Belief (PSTE) subscale and Science Teaching Outcome Expectancy (STOE) subscale. In addition to the STEBI, observations of teaching and a survey which asked teachers about their experiences with the program and its impact on their teaching was included in the research. After the first year, there was a significant increase in science teaching self-efficacy and teachers reported increases in their confidence to teach science. Further, the increases in science teaching efficacy correlated with the use of instructional strategies such that teachers were more likely to engage students in hands-on science activities, to demonstrate science principles and use real-world contexts to teach science. However, the authors did not find a relationship between the amount or length of science lessons and increases in science teaching efficacy. Sandholtz and Ringstaff postulate that this lack of association may be due to the teachers' lack of control over instructional time. This is similar to findings from the work of Yoo (2016) who found that, although general teaching efficacy was enhanced by a professional development program, teachers attributed a portion of their teaching efficacy scores to their lack of control over school policies and requirements.

Another study of elementary teacher professional development in science teaching brought teachers together into professional learning communities (PLCs), each with 4 to 5 teachers who met biweekly (Mintzes et al., 2013). This study included 55 teachers from one school district and a comparison group of 61 teachers from an alternate school district. In addition to the PLCs, this study, which spanned 3 years, included attendance of *Summer Institutes*, participation in *Demonstration Laboratories*, and collaboration through *Lesson Study* activities. The *Summer Institutes* were one-week long professional development events that included: instruction in science and English language development and the demonstration of science lessons from the laboratories. The *Demonstration Laboratories* were attended by teachers and their students each semester for 90 minutes. These visits allowed students to move through science activity stations and for teachers to observe the students. Observations and discussions from those observations were used as a launching point for the *Lesson Study* activities of each PLC. The *Lesson Study* activities included working together as a PLC to design a lesson, analyzing the lesson as a group for grade-level appropriateness, revising the lesson, and then implementing the lesson within the classroom setting. Mintzes et al. (2013) measured teacher self-efficacy for teaching science using the Teaching Science as Inquiry Instrument (TSI) which is comprised of 69 items and is divided into personal self-efficacy (PE) and outcome expectancy (OE) subscales. In addition, teachers participated in brief interviews during which they were asked about changes to their instructional practices in relation to their participation in the professional development program. Results indicated that teachers in the experimental group showed greater improvement on each of the PE and OE subscales than teachers in the comparison group. Interviews with teachers revealed that a lack of pre-service training in science contributed to initially low science teaching efficacy scores. The hands-on experiences gained during the professional development activities coupled with the support within the PLCs empowered teachers, as did seeing positive outcomes in their children. The activities described provided opportunities for teachers to experience each of Bandura's (1997, 1977) self-efficacy performance accomplishments (i.e., mastery experiences, vicarious experiences, emotional arousal, and social persuasion).

Flores (2015) investigated the impact of a field-based science training program which placed 30 pre-service teachers into an elementary school classroom. The pre-service teachers spent 10 weeks in a content-focused science methods course during which they participated in instruction, collaborated with peers, and co-created lessons for use in a classroom setting. The lessons created were to include a scientific inquiry-based activity which resulted in an unexpected outcome. Each team of 3 pre-service teachers were then required to take the co-created lessons and teach 5 to 6 fifth grade students once each week for a total of five weeks. The Science Teaching Efficacy Beliefs Instrument for preservice teachers (STEBI-B) was given to each pre-service teacher at the beginning and end of the 16-week experience. The STEBI-B includes 2 subscales which measure Personal Science Teaching Efficacy Belief (PSTE) and Science Teaching Outcome Expectancy (STOE) (Flores, 2015). Preservice teachers reported statistically significant gains on both the PSTE and STOE. Practical, hands-on experiences coupled with opportunities to collaborate with peers and to practice teaching were among the factors that Flores (2015) credits with the preservice teachers' gains in personal science teaching efficacy.

Additional studies of pre-service teacher education and its connections to science teaching efficacy look at the impact of science coursework on science teaching efficacy for one semester and for the duration of undergraduate study with mixed results. Hechter (2011), for example, studied 69 undergraduates using the STEBI-B and found that the number of science courses a pre-service teaching student attended had a positive impact on their personal science teaching efficacy score but had no effect on their science teaching outcome expectancy. Hechter also found that how these students felt about their courses impacted their personal science efficacy scores but not their personal science outcome scores. Another study of preservice elementary teachers' science teaching efficacy measured the science teaching efficacy of undergraduate students enrolled in a teacher preparation program (Smolleck & Mongan, 2011). In this work, Smolleck and Mongan (2011) administered the Teaching Science as Inquiry Instrument at the beginning and end of a science methods course during students' junior year and again at the beginning and end of students' teaching practicum. Science teaching efficacy and science outcome expectancy both increased for students in their junior and senior year. However, there was not a large difference in science teaching efficacy reported at the end of the science methods course and science teaching efficacy at the end of the practicum. Further, science teaching outcome expectancy was lower at the end of the teaching practicum than it was at the end of the science methods course. From these studies of preservice teachers, it is clear that science content knowledge and classroom practice each play a role in science teaching efficacy and science teaching outcome expectancy.

There is a rich and varied history within the science teaching efficacy literature with some studies indicating that professional development may be important in increasing this important construct and other studies finding conflicting information about the impact of professional development of teaching self-efficacy. Differences in academic subject area, teacher characteristics, student factors, training duration, and training content may each contribute to these conflicting results. However, as a construct, teaching self-efficacy lends itself easily as a measure of teacher confidence in translating behavior to action and therefore may provide a window into the impact of professional development as it translates from formal to nonformal venues. The next section conceptualizes the construct of self-efficacy for teaching with the experiential learning method.

Conceptualizing Experiential Learning Teaching Self-efficacy

Although there is a strong research base on teaching self-efficacy and science-teaching self-efficacy, there is no corresponding research base or measure of self-efficacy for teaching with the experiential learning process. The 4-H Youth Development program has facilitated youth education through the use of the experiential learning method since the inception of the program in the early 1900s (4-H History in Brief, n.d.). Building on the Experiential Learning Theory as conceptualized by Dewey (1938), the 4-H model of experiential learning includes five stages: 1) Experience, 2) Share, 3) Process, 4) Generalize, and 5) Apply (Norman & Jordan, 2006). Professional development for 4-H educators provides an overview of the model and focuses on teaching the 4-H educators how to facilitate youth learning by first assisting youth with a hands-on experience, then coaching youth through the additional stages by asking questions that help youth co-construct knowledge about that experience (Enfield, 2001; Enfield et al., 2007; Norman & Jordan, 2006).

For the purposes of this research, drawing from the research on teaching-efficacy (Gibson & Dembo, 1984) and science teaching efficacy measurement (Riggs & Enochs, 1990), it is postulated that experiential teaching efficacy likewise is defined as having a personal component and an outcome expectancy component. The personal component of self-efficacy for teaching with the experiential learning model is expected to reflect the educator's belief in their ability to use the experiential learning model effectively within their teaching practice. The outcome expectancy component of self-efficacy for teaching with the experiential learning model is expected to reflect the educator's beliefs about their ability to impact student success through their use of the experiential learning model within their teaching practice.

The experiential learning method is foundational to the work of 4-H yet, unlike general teaching efficacy or science-teaching efficacy there is not an existing measure of this construct. In this section, as a first step in developing a measure of experiential learning teaching self-efficacy, the construct of experiential learning teaching self-efficacy was conceptualized by modeling the construct on existing self-efficacy measures for teaching self-efficacy and for science teaching self-efficacy. The next section reviews the literature that reflects the current status of professional development for 4-H educators.

Current Status of 4-H Educator Professional Development

The majority of professional development for nonformal educators continues to use traditional, episodic, expert-led workshops as the primary means for educator professional development (Smith, et al., 2017). As King and Tran explain in reference to the competencies and knowledge needs of OST educators, there is significant variance in OST educator practice and "the profession as a whole [lacks] a conceptual framework" (p. 71-72). Likewise, Patrick (2017) takes the argument for this lack of a clear framework for preparing OST STEM educators to task, citing a lack of structured preparatory programs, diverse pathways to the work of OST educator, and low status conveyed to OST STEM educators among other factors. For these reasons, nonformal programs like 4-H are looking to K-12 professional development models to better prepare 4-H educators to deliver STEM programs using experiential and inquiry-based learning approaches. However, there are challenges in adapting the K-12 professional development models because 4-H educators are often lacking the same pedagogical knowledge that K-12 educators gain through time in a teaching preparatory program at university. The inclusion of elements in 4-H educator professional development which might otherwise be assumed as known to teachers are essential to the successful preparation of 4-H educators.

Keeping this distinction in mind, this section presents the limited empirical work that included evidence for effective ways to prepare 4-H educators to teach STEM content.

Few models for training 4-H educators are described in the empirical literature and of those, most are short-term, episodic workshops which have been shown to be ineffective (Smith, 2010). In a recent study, Smith et al. (2017) used a mixed methods study design to inquire about the types of professional development training offered to 4-H educators, adult volunteers and youth volunteers in 4-H nationally. Surveys of each 4-H State Program Leader were sent via email of which 44 percent responded themselves and another 13 percent had members of the state staff who were responsible for professional development complete the survey. The majority of respondents reported using some hybrid of face-to-face and online training with staff and volunteers whereas for teen volunteers, face-to-face trainings were the most used method. These trainings were most often one-time events which were attended by a large group and lead by an expert. Follow up interviews supported these data. Further, there was limited use of evaluation data informing practice.

Smith, et al. (2004) describe a professional development process that they used to train adult volunteer leaders to teach science. Recognizing that teaching science requires more in-depth training, Smith and colleagues designed training that included multiple workshops to build competence among the adult volunteers through coaching and modeling of inquiry-based teaching. The adult volunteers were then charged to train the teen volunteers who would then teach youth in out-of-school programs. Although these trainings were implemented with a small number of adult (n = 14) and youth (n = 19) volunteers, the evaluation data indicated that the trainings were effective at teaching adult and youth volunteers. Further, youth participants who were between the ages of 9 and 11 reported statistically significant increases in their use of science-based thinking. The longer duration, active learning, and opportunities for collaboration which were a part of these workshops is more in line with the suggested features identified in the K-12 literature as important (Garet, et al., 2001).

Enfield et al. (2007) reported on experiential learning workshops designed for 4-H volunteers. These workshops used the five-step cycle of the experiential learning model (i.e. experience, share, process, generalize, apply) in a three-workshop series that included hands-on opportunities to learn, reflective practice and modeling. Each workshop built upon the previous workshop and added content such that the second workshop focused more deeply on making sure participants understood inquiry-based teaching and how hands-on learning might be different when used in an inquiry-based activity compared to other types of hands-on learning. The third workshop added opportunities for collaboration with peers and coaching as participants review and adapt curricula to include the educational tools they learned in the first two workshops. Nearly 100 percent of the 120 participants in the first workshop reported increased understanding of experiential learning; 67 percent of the 51 participants in the second workshop reported increased knowledge of inquiry-based learning and 80 percent reported that they were confident in their ability to apply inquiry-based instruction in their work with youth. A smaller number of participants (n = 29) attended the final workshop. However, a majority of them reported increases in curriculum development knowledge (67%) compared to before the workshop (7%).

Barker, et al. (2009) discuss a potential move away from using 4-H adult volunteers to deliver STEM programming that is occurring in some areas. In this article, Barker and colleagues question the abilities of traditional, episodic, expert lead training models to provide the kinds of skills and competencies required for 4-H volunteers to develop the requisite skills to teach STEM content and put forth a model for volunteer competency development that includes face-to-face training, online supplementary modules, monthly online sessions with colleagues and professional staff, and continued self-directed learning.

Lesson study, another type of professional development has emerged as a promising practice for teaching 4-H educators to teach STEM content. Lesson study is a constructivist educational approach that brings individuals together into a collaborative group with a shared goal of designing, testing, and revising lessons (Smith & Schmitt-McQuitty, 2013). In a deeper exploration of lesson study as a dissertation topic, Smith (2010) brought together a group of 4-H volunteer educators to plan, implement, and revise a veterinary science curriculum. Using a mixed methods approach that included retrospective surveys and focus group interviews with three different lesson study groups, Smith explored the impact of lesson study on veterinary content knowledge and understanding inquiry-based teaching strategies. Statistically significant mean differences on the retrospective post-then-pre surveys provide evidence of improved content knowledge and improved teaching practice. This evidence is bolstered by the descriptions offered in the focus group interviews in which participants describe gains in pedagogical knowledge and skills, subject matter knowledge, confidence, and improvement in learning among participants in the veterinary science programs. A majority of 4-H volunteers reported that improvement in pedagogical knowledge and skills were the greatest benefit from participation in the professional development activities. Nearly half of the volunteers had a strong formal background and prior experience with the subject matter. Therefore, learning effective teaching strategies, having defined goals, and shared responsibilities were more useful than content knowledge for this group. The groups also reported appreciating the extended duration of the lesson study groups and the opportunity to share ideas and use data to modify instructional practices through a collective process. Active learning, extended duration, a focus on content knowledge, collective action, and coherence with professional goals, as identified within the K-12 professional development literature were important features of this exploration of lesson study as a means for training 4-H volunteer educators. Content knowledge, while less important for this group, needs to be explored with 4-H volunteers with less a priori content knowledge. Further, this research only explored the use of this professional development model with community clubs. There are multiple other delivery modes in 4-H including school enrichment, afterschool, and camp programs.

Conclusions and Implications

With a strong history of experiential and inquiry-based program activities that have endured for over a century, the 4-H Youth Development program is well suited to bridge the gap between formal and nonformal STEM education and to be an important partner in improving youth STEM literacy through multiple in-school and out-of-school delivery modes. Growing evidence supports nonformal science education as playing a critical role in STEM education in the United States as the majority of STEM learning occurs outside of the K-12 classroom walls (National Research Council, 2015; Falk & Dierking, 2010). However, to realize the goal of providing research- and evidence-based STEM education, 4-H educators need effective professional development opportunities. Limited empirical literature in training nonformal educators to deliver inquiry-based STEM instruction requires looking to other complementary disciplines, such as K-12 teacher professional development, to design effective models of 4-H STEM educator training. There is a clear line of empirical investigation in the K-12 inquiry-based STEM educator professional development literature that delineates factors for effective professional development. This research line contends that effective professional development for STEM educators includes reform-type activities (e.g. networking or study groups), is longer in duration than the typical traditional one-day workshop, provides more opportunities for active learning, includes a program model, involves a mentor or coach, allows for collective participation of educators with their peers, is coherent with the educators' professional goals, and focuses on enhancing both pedagogical and content knowledge. Table 2.1 provides an overview of the professional development activities identified within each of the literatures discussed within this chapter.

Table 2.1

Theoretical Links to Training Components with Specification of Expected Training Components

Experiential Learning	Adult Learning	Professional Development	Science Professional Development	Nonformal Educator Needs
Context influences timing and opportunities to learn.	Adults' readiness to learn is based upon their current level of knowledge. Learning moves from instructor-dependent to independent.	**Training is attentive to diverse learning styles.** Training is student-centered.		**Training includes opportunities for continuous professional development.**
Learner participates in a concrete experience.	Adults are active learners.	Training is content-focused. Training provides active learning opportunities. Training includes modeling effective practice.	**Training is content-focused.** **Training provides active learning opportunities.** **Training includes modeling effective practice.**	**Training is content-focused.** **Training provides opportunities for deep conceptual learning.**
Learner describes the experience with peers.	Adults are active learners.	Training includes opportunities for collaborative learning. **Training includes networking or study group activities.**	**Training includes collaborative learning environments.**	**Training extends into communities of practice.**

Table 2.1 (Continued).

Learner makes connections between the experience and prior knowledge.	Adults build knowledge upon former experience.	Training includes opportunities for coaching.	**Training includes opportunities for coaching.** **Training provides opportunities for reflective practice.** **Training includes opportunities for observation and feedback.**	**Training provides instruction in reflective practice.**
Learner determines why the experience matters. The learner generalizes the new knowledge to other areas of their life. The learner determines ways to apply the new knowledge.	Adults need to understand why learning new information or skills matters to them. Adults are problem-centered learners. Adults are internally motivated.	Training is aligned with educators' goals.	**Training is aligned with educators' goals.**	
		Training is of longer duration.	Training is of longer duration.	**Training includes opportunities for continuous professional development.**

Note: Training components expected within the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training are in boldface.

CHAPTER 3: Methods

Overview

This study investigated the professional development activities that contribute to the abilities of nonformal 4-H educators in North Carolina to deliver effective STEM educational programming to youth. The research literature presents substantial evidence about the types of activities that constitute quality professional development among K-12 educators who teach STEM content. However, despite a compelling case for the inclusion of nonformal programs in increasing STEM literacy among youth, the research literature that presents professional development activities that increase effectiveness in teaching STEM content among nonformal organizations, like 4-H, is only beginning to explore these professional development components. One way of gauging the success of STEM professional development in the K-12 literature is by measuring increases to teaching self-efficacy, a measure of a teacher's confidence in teaching ability for a given content area. Therefore, a measure of science teaching self-efficacy was included in this study to understand the relationship between 4-H curriculum training and nonformal educators' perceptions of their abilities to effectively deliver science content. A measure of experiential learning teaching efficacy, created specifically for this study, was also included to begin to understand the role that 4-H curriculum training plays in nonformal educators' perceptions of their abilities to teach using the experiential learning method. It was expected that focusing on the components that contribute to more effective professional development for 4-H educators in NC who teach STEM would expand understanding of those components and provide input into the development of more effective STEM curriculum trainings.

Research Questions

Therefore, this research focused on the following research questions:

1. What are participants' experiences in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training?
2. Does participation in *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training improve science and experiential learning teaching self-efficacies among NC 4-H educators?
3. What are NC 4-H educators' attributions of their increased or decreased science and experiential learning teaching self-efficacy experiences related to their participation in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training?

This chapter presents the research methodology for this study. First, the research design and approach are presented. Following discussion of the research approach, an intrinsic bounded case study, the procedures that were used to select the sites and participants for the study are discussed. An overview of data collection procedures and intended data analysis steps are described, along with a presentation of research that frames what constitutes credibility within qualitative inquiry. At the end of this chapter, to increase transparency, the researcher's role is framed to bracket any potential biases so that the researcher can maintain the integrity of the existing data, presenting the voices of the participants separate from that of the researcher.

Research Design

This study used an intrinsic bounded case study approach (Stake, 1995) to explore whether participation in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training improved teaching self-efficacies for science and for the use of experiential learning methods among NC 4-H educators. This study also investigated the experiences of 4-H educators who participated in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training and the ways that those experiences contributed to their perceived abilities to deliver STEM programming to youth. The first of these purposes lent itself to quantitative inquiry and was answerable using quantitative methods, surveys that produced a quantitative picture of teaching self-efficacy ratings. The second of these purposes required a deeper exploration of educator experiences which was answerable using qualitative methods (Creswell & Poth, 2018). Therefore, a mixture of quantitative methods and qualitative inquiry were used to craft an intrinsic bounded case study approach.

Saldaña (2011) speaks about the strengths of a mixed methods approach as "it is assumed that the epistemological (i.e., ways of knowing) and methodological advantages of each paradigm can work in concert to corroborate or more robustly support the findings, or to reveal complementary or even contradictory outcomes" (p. 10). Methodological rigor may also be strengthened when more than one method is used with different types of data adding to the veracity of findings (Patton, 2015).

Although this study included a quantitative aspect, making it by definition mixed methods, the primary leaning was qualitative. The use of mixed methods is not new to qualitative work, as Creswell and Poth (2018) present: "Qualitative researchers typically gather multiple forms of data, such as interviews, observations, and documents rather than rely on a single data source" (p.43). The use of a qualitative approach provides a rich, detailed account of an issue that is only possible through engaging with people and inviting them to share their stories (Creswell & Poth, 2018).

Case study research is qualitative in that the researcher acts as the instrument of measurement and analysis and is most concerned with process, meaning, experiences, and description (Creswell & Poth, 2018; Denzin and Lincoln, 2000; Rovai, et al., 2014). As Stake (1995) explains, an intrinsic case study approach is selected when the goal is to understand a specific concern or issue that applies uniquely to that particular case. Indeed, Stake considers case study more about what is to be studied rather than as a specific method, the case is about how the boundaries are set around what is being studied (Creswell & Poth, 2018; Stake, 2005). Other researchers consider case study to be a type of qualitative research design that progresses through stages including: outlining the case, defining the types of data that will be used to describe the case, providing the ways that data analysis will proceed; and reporting the data through a rich descriptive process that invites the reader into the narrative (Creswell & Poth, 2018; Yin, 2014).

Site Selection: Bounding the Case

The research methodology chosen for this study, the intrinsic bounded case study, allows the researcher to deeply understand a particular context or situation. Miles, et al. (2014) and others define the case as the unit of analysis which occurs within a bounded context (Creswell & Poth, 2018; Denzin & Lincoln, 2000; Miles et al., 2014; Rovai et al., 2014; Saldaña, 2016; Stake, 2005; Stake 1995). The generalizability of the intrinsic bounded case study is necessarily limited as the goal is to understand a specific situation or set of activities within a natural context. The nature of the units of analysis in this study, the perspectives of the 4-H educators who participated in *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training and who subsequently provided youth STEM programming, within the context of 4-H created the boundedness of this case study. The context was NC 4-H, the context was also one specific

4-H STEM curriculum training, and the educators were the embedded units of analysis. Case studies are also holistic forms of inquiry which include the collection of multiple sources of data in order to tell the story of the case as completely as (Creswell & Poth, 2018; Denzin & Lincoln, 2000; Miles et al., 2014; Rovai et al., 2014; Saldaña, 2016; Stake, 2005; Stake 1995). Although generalizability is sacrificed, a deeper understanding of the case is gained. A more complete description of the training context and procedures used to bound the case are found in Appendices A through D.

The sampling strategy for this study was purposive and stratified. A purposive sample is used when there is something about the particular group of participants selected that makes them relevant to this research (Rovai et al., 2014). "Purposeful sampling focuses on selecting information-rich cases whose study will illuminate the questions under study" (Patton, 2002, p. 230). As the point of this research was to understand perspectives and experiences of 4-H educators who participated in 4-H STEM curricula training, it was necessary to use their attendance of a professional development workshop as a condition for inclusion in the study sample. It was also necessary to seek participants who were representative of all areas which NC 4-H serves. There are differences in demographic representation, resource availability, training access, and population density within each region which were expected to add richness to understanding participants' experiences. Therefore, when recruiting participants for the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training, attention was paid to inviting participants from each of the 5 regionally distinct districts: Northeast, Southeast, North Central, South Central, and West.

The Program and Participants

For the purposes of this study, participants were those 4-H educators who participated in *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* training. The *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* is a newly developed dairy science curriculum for youth who fall within early elementary school ages. There are six lessons in the curriculum which were built using the North Carolina Essential Standards for kindergarten through third grade. The targeted delivery mode for this curriculum was community clubs throughout North Carolina. The 4-H agents, program assistants, and volunteer club leaders served as the nonformal 4-H educators throughout the curriculum pilot. The training they received followed standard procedures for 4-H STEM curricula trainings. These trainings are co-taught by the university researchers who serve as content specialists and by members of the NC 4-H team who describe expected implementation and evaluation procedures for the curriculum program. The university researchers for this curriculum were faculty members of the Animal Sciences Department and members of the Randleigh Dairy Heritage Museum and Dairy Farm Museum in the College of Agriculture and Life Sciences at NC State University. During the curriculum training, these content specialists provided educational background, walked 4-H educators through each of the activities within the curriculum, and answered any questions about program delivery. The 4-H team provided instruction on experiential learning, the framework for all 4-H curricula, and practiced experientially appropriate questioning activities with participants. The 4-H educators were then invited to participate in an online community of practice whereby they could ask questions of each other and of the training team, share pictures from their activities with youth, and discuss their experiences with their peers.

The sampling frame in North Carolina is quite large as there are 101 Cooperative Extension offices in North Carolina, one for each county and one for the Eastern Band of Cherokee Indians, and each of those offices has a 4-H educator and adult volunteer educators. As of the latest NC 4-H data report, there are 16,378 adult volunteers who provide support to the 4-H program. County 4-H agents were contacted within each of the five Cooperative Extension districts (Northeast, Southeast, North Central, South Central, and Western) and asked to provide the name and contact information for volunteer educators who were in a position to join the 4-H agent to co-lead a pilot curriculum program throughout the fall and spring of 2019. Individual 4-H educators, program assistants, and volunteers were contacted and invited to participate in the curriculum pilot. It was expected that there would be between 10 and 15 participating educators, with a mix from each of the 5 Cooperative Extension districts. Following the pilot activities, the 4-H educators were invited to participate in an individual interview process and to complete a retrospective post-then-pre questionnaire which included the science teaching efficacy and experiential learning teaching efficacy surveys.

Participant Characteristics

Twenty-two 4-H educators from eleven counties participated in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training. Participating educators were from each of the five Extension districts with more participation within the South Central district than any other region. Of the twenty-two 4-H educators who attended training, three had K-12 education backgrounds, one cancelled participation and was then unreachable, one was under the age of 18, four did not complete the training requirements, and three did not respond to requests for participation. Ten 4-H educators participated in this research, a response rate of 45%. Nine participants (90%) were female and one participant (10%) was male; this accurately reflects the population of 4-H educators in NC. Four educators were volunteers with between 1 year and 48 years of experience in that role, four educators were 4-H agents with between 2 and 10 years within that role, and two educators were 4-H Program Assistants. The median years of service for all educators was four years. Each of the four volunteer educators who participated in the study completed high school, one earned an associate degree in early childhood education and one earned a bachelor of social work degree. Of the four 4-H agents who participated in the study, one earned a master's degree in agricultural education, one earned a bachelor's in agricultural science, one earned a bachelor's in human ecology, and one earned a bachelor's in arts applications. One 4-H Program Assistant who participated in the study earned a bachelor's degree in animal science and one completed a certificate in early childhood education.

Data Collection

Prior to data collection, the researcher submitted all required paperwork to the Institutional Review Board (IRB) in order to request approval to conduct the research study. Once permission was granted, the researcher began the data collection process.

To allow for thick, rich description of the issues being studied and the in-depth understanding that is a hallmark of case study research, there were multiple sources of data collection in this research including survey questionnaires and interviews (Creswell & Poth, 2018). The proposed process for each of these data types is described below. Table 3.1 provides an overview of the sources, methods, and analyses proposed for each research question.

1. What are participants' experiences in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training?

2. Does participation in *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training improve science and experiential learning teaching self-efficacies among NC 4-H educators?
3. What are NC 4-H educators' attributions of their increased or decreased science and experiential learning teaching self-efficacy experiences related to their participation in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training?

Table 3.1.

Data Collection

Research Question	Source	Method	Analysis	Reliability	Trustworthiness
What are participants' experiences in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training?	4-H Educators	Individual Interview	First Cycle In Vivo and Provisional Coding; Second Cycle Axial Coding	N/A	Bracketing Training Observation Instructor Interviews Participant Interviews Thick, rich description
Does participation in *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training improve science and experiential learning teaching self-efficacies among NC 4-H educators?	4-H Educators	Science and Experiential Learning Teaching Efficacy Surveys	Wilcoxon matched-pair signed rank test	Cronbach's alpha	N/A
		Individual Interview	First Cycle In Vivo and Provisional Coding; Second Cycle Axial Coding	N/A	Bracketing Training Observation Instructor Interviews Participant Interviews Thick, rich description
What are NC 4-H educators' attributions of their increased or decreased science and experiential learning teaching self-efficacy experiences related to their participation in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training?	4-H Educators	Individual Interview	First Cycle In Vivo and Provisional Coding; Second Cycle Axial Coding	N/A	Bracketing Training Observation Instructor Interviews Participant Interviews Thick, rich description

Consent to Participate

Every 4-H educator who participated in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* workshop was invited via email (Appendix E) to participate in the research study. A participant consent form for the study (Appendix F) was included as an attachment within that email. Those educators who agreed to participate were sent a Qualtrics survey link that included an online consent form along with the science and experiential learning teaching efficacy surveys described below. Potential participants were then contacted via email, phone, and text message to schedule individual interviews.

Teaching Efficacy Surveys

Following participation in the training, 4-H educators who agreed to participate in the research study were sent a web address via email to take the science and experiential learning teaching efficacy surveys. Access to surveys were provided via Qualtrics, an online survey platform. Surveys were given using a retrospective post-then-pre design. A retrospective post-then-pre survey captures responses that reflect participants' knowledge, attitudes, skills, and abilities before and after a training or program during a single measurement point at the end of the training or program. A retrospective post-then-pre survey design may reduce a type of response-shift bias found during traditional pre-then-post-test survey administration. This type of bias happens when a participant gains knowledge during a program which changes the way they think about what they knew before the program (Howard, 1980; Rockwell & Kohn, 1989; Stolz, et al., 2013).

Science Teaching Efficacy Survey. For this research, the Teacher Efficacy and Attitudes toward STEM (T-STEM) Survey, an instrument developed by the William and Ida Friday Institute for Educational Innovation (2012), provided the survey measurement for science teaching efficacy. There are seven subscales within the T-STEM survey for elementary school teachers including: Personal Teaching Efficacy and Beliefs (PTEB), Teaching Outcome Expectancy Beliefs (TOEB), Student Technology Use, STEM Instruction, 21st Century Learning Attitudes, Teacher Leadership Attitudes, and STEM Career Awareness (Friday Institute for Educational Innovation, 2012). For this research, only the Personal Teaching Efficacy Belief for Science (PTEB-S) and the Teaching Outcome Expectancy Belief for Science (TOEB-S) Subscales were used. These subscales were developed using Riggs and Enochs' (1990) Science Teaching Efficacy Belief Instrument (STEBI) as the foundation of the PTEB and TOEB scales. The PTEB-S measures self-efficacy and confidence in teaching science-related content and the TOEB-S measures the teacher's belief that their actions impact student learning in science-related subjects. The PTEB- includes 11 subject-specific items TOEB-S includes 9 subject-specific items. Permission to use the T-STEM was granted to the researcher in September 2015.

Experiential Learning Teaching Efficacy Survey. The Experiential Learning Teaching Efficacy and Beliefs Survey was specifically designed for this study to measure educators' self-efficacies in teaching with the experiential learning approach. This survey includes two scales. The first scale, the Experiential Teaching Efficacy Belief Scale, measures the educator's self-efficacy and confidence in teaching with the experiential learning approach. It was developed based on the Friday Institute's Personal Teaching Efficacy Belief for Science. The second scale, the Experiential Outcome Expectancy Scale, measures the educator's belief that their actions through the use of the experiential learning approach will impact student learning. It was developed based on the Friday Institute's Outcome Expectancy Belief for Science. This survey was completed along with the science teaching efficacy survey. More information about this measure is available in Appendix G.

Semi-Structured Interviews with Participants

Because of the small size of the cohort for the curriculum training, all participants and training instructors were invited to participate in individual interviews. It was expected that including all participants would provide a richness to the data and allow the researcher to include perspectives of individuals from each Cooperative Extension district. Interviews provide a way to effectively document the "perspectives, feelings, opinions, values, attitudes, and beliefs" (Saldaña, 2011, p. 32) that someone has about a particular experience as well as to gain factual information about that experience. Designing the interview protocol to be semi-structured allowed room for the researcher to ask deeper follow up questions based on the individual educator's experiences. This type of interview is more flexible than a fully structured interview which has prescribed set of questions but less flexible than an unstructured or informal conversational interview which might only list a general set of topics to be explored (Patton, 2015; Rubin & Rubin, 2012; Saldaña, 2011). An interview protocol was developed for participants (Appendix H) which asked about their experiences in all aspects of the training and curriculum pilot process. The interview protocol included a guiding set of questions for participants to answer. Possible follow-up probes and prompts were included in the interview protocol to allow for clarification throughout the interview process (Rubin & Rubin, 2012). A training outline was sent to participants prior to the interview to assist with recall (Appendix I).

Interviews were conducted via Zoom, an online web meeting platform. The use of this platform allowed for the recording of voice and video. Advantages to using online platforms include reductions of cost and time required for participant travel (Creswell & Poth, 2018). This was especially salient for this research as the researcher is located centrally within the state while some of the participants are located in the far west and far east points in the state. An additional strength of this web meeting platform was the ability to record sound and video as a part of the meeting rather than as an additional distraction. Zoom also has the benefit of automatic transcription which allowed the researcher to reduce the time and cost required for transcription of the interviews. Although some clean-up of the transcripts was necessary, this took significantly less time than other transcription options. Participants were assigned pseudonyms after transcription was complete to provide confidentiality to the 4-H educators. There are some concerns about technical skills needed and access to the Internet for some groups (Creswell & Poth, 2018). However, for the participants in this research, nonformal educators who regularly work with the land grant university for training and support, these are skills and resources which they already possess.

Data Analysis Plan

Each part of the data collected played a role in building the case. The quantitative data, for example, yielded descriptive information that helped to thoroughly describe the case and setting, thus bounding the case. This was the first step in establishing the richness of the case context (Creswell & Poth, 2018). The observation of the training allowed for a rich description of the context and activities of the training from the perspective of an insider. The interview analysis provided deeper description of the experiences of each participant and instructor and further illuminated what factors in training increased educators' science and experiential learning teaching efficacies.

Science Teaching Efficacy Survey

To analyze the science teaching self-efficacy survey results, the researcher used IBM SPSS Statistics (Version 25) to calculate descriptive statistics including the mean, median, mode, and standard deviation for each scale score. To explore whether participants perceived a statistically significant difference between their science teaching efficacy prior to and following their participation in *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* training, the researcher used IBM SPSS Statistics (Version 25) statistical software to conduct Wilcoxon matched-pair signed ranks test. The Wilcoxon matched-pair signed rank test is the nonparametric equivalent of the paired samples t-test. It provides a comparison of the differences between two dependent samples. The Wilcoxon matched-pair signed ranks test is appropriate for use to determine whether there is a statistical difference when the sample size is small, data is from the same population, and data cannot be assumed to be normally distributed (Agresti & Finlay, 1999; Rovai, et al., 2014).

Experiential Learning Teaching Efficacy Survey

To analyze the experiential learning teaching self-efficacy survey results, the researcher used IBM SPSS Statistics (Version 25) to calculate descriptive statistics including the mean, median, mode, and standard deviation for each scale score. To explore whether participants perceive a statistically significant difference between their experiential learning teaching efficacy prior to and following their participation in *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* training, the researcher used IBM SPSS Statistics (Version 25) to conduct Wilcoxon matched-pair signed ranks test. The Wilcoxon matched-pair signed rank test is the nonparametric equivalent of the paired samples t-test. It provides a comparison of the differences between two dependent samples. The Wilcoxon matched-pair signed ranks test is appropriate for use to determine whether there is a statistical difference when the sample size is small, data is from the same population, and data cannot be assumed to be normally distributed (Agresti & Finlay, 1999; Rovai, et al., 2014).

Semi-structured Interviews

The constant-comparative, inductive approach to qualitative data analysis includes an "immersion in the details and specifics of the data to discover important patterns, themes, and interrelationships" (Patton, 2002, p. 41). This approach requires the researcher to put aside preconceived ideas and to allow themes to emerge from the data (Patton, 2015). Prior to interview analysis, the researcher reviewed the existing literatures to identify provisional or a priori codes. To document whether the curriculum training activities matched with the identified provisional codes, the researcher used an observation checklist (Appendix B). These codes were used to guide the analysis of the interview data which began during the interviews with the researcher writing preliminary thoughts or potential code phrases within notes and memos (Saldaña, 2016). Analysis then moved into first-cycle coding. First cycle coding allows for the initial summarization of the transcript into meaning units. Provisional codes from the existing professional development literatures were matched with In Vivo statements from participants which use the words of the participants themselves in defining the codes (Saldaña, 2016). For this approach, each interview was transcribed verbatim and the words from the participants were read and re-read to determine the essence of the participants' own words, their experiences. That essence was then matched with the provisional code and given a name or a code using the participants' own words. Saldaña (2016) recommends In Vivo coding as a first cycle coding method for case study methods. Second cycle coding allows for the grouping of the first cycle codes into larger categories or themes (Saldaña, 2016). Following the confirmation of the provisional codes and the identification of In Vivo codes for all interview transcripts, a Pattern Coding method was used to group the data conceptually. Pattern codes group codes into "more meaningful and parsimonious units of analysis" (Saldaña, 2016, p. 236). Pattern coding is especially useful in identifying explanations in data (Miles et al., 2014), such as to identify those components which were deemed important in the provision of effective training.

Validity and Reliability

The quality of quantitative research measures is judged based on reliability and validity. Reliability is the degree to which the measures yield consistent and stable results across time and validity is the degree to which the instrument measures the intended construct (Rovai, et al., 2014). To establish the validity and reliability of the T-STEM surveys, the measure was piloted with 257 science teachers, 72 technology teachers, 17 engineering teachers, 120 math teachers, and 218 elementary teachers (Friday Institute for Educational Innovation, 2012). Cronbach's alpha, a widely accepted measure of internal consistency, for each of the scales ranges between 0.85 and 0.95 (Friday Institute for Educational Innovation, 2012; Rovai, et al., 2014).

To establish the validity and reliability of the Experiential Teaching Efficacy Survey for use in this research, the measure was piloted with eleven 4-H educators at a separate curriculum training during the Spring of 2019. Cronbach's alpha for the Experiential Teaching Efficacy Belief Scale ranges between 0.91 and 0.96, depending on whether the statistic was calculated for the pre or post measure, respectively. Cronbach's alpha for the Experiential Outcome Expectancy Scale, ranges between 0.83 and 0.91, depending on whether the statistic was calculated for the pre or post measure, respectively.

Trustworthiness

In conducting qualitative research, there is agreement within the literature that certain research processes increase the credibility, transferability, and confirmability of qualitative research (Guba & Lincoln, 1989; Miles, et al., 2014; Patton, 2015). This research used the standards set by Miles, et al. (2014) and others (see Guba & Lincoln, 1989 and Patton, 2015) to establish trustworthiness. The first step in this process is to bracket or write down any biases or knowledge which may subjectively influence the research process (Creswell & Poth, 2018). That information is included in the Researcher's Role statement that follows this section. Triangulation of the data, including multiple methods for collecting similar information to understand the case, adds to the confirmability of qualitative research (Miles, et al., 2014). This was achieved within this research through the use of training observation, instructor interviews, participant surveys, and semi-structured participant interviews. Additional steps to achieve credibility and accuracy were taken once preliminary analyses are completed. The participants were asked to check the research findings to make sure that the findings provide an accurate account of their perspectives and experiences. Guba and Lincoln (1989) recommended this step as important to establishing credibility in qualitative research. Finally, the use of thick, rich description through the voices and lenses of the participants themselves add to the transferability of this research (Guba & Lincoln, 1989; Miles, et al., 2014; Patton, 2015).

Researcher's Role

I have been involved with research for more than 20 years. In that time, I have conducted, analyzed, and published quantitative and qualitative research. I was first trained to facilitate focus groups with university faculty and students in 1998 and worked as part of a team to analyze and share the data from those focus groups. I have worked in Cooperative Extension for more than 14 years as a professional evaluator and program designer. This research is to learn about experiences that 4-H educators have in their professional development participation with the NC 4-H Curriculum Team. I am employed as a member of NC 4-H Curriculum Team and I have an inside view of the professional development trainings in which the 4-H educators participate. I evaluate, assist in the creation of, and in some instances provide instruction for the

STEM workshops on which this research is built. This work and my role as evaluation researcher gives me a critical lens through which to view the professional development opportunities. My work as evaluator has also made it possible for me to learn to separate myself when needed to provide a somewhat more objective view.

I have a firm grasp on my views as a pragmatist as well as a social constructivist. Both of these lenses provide unique ways of approaching the work of training educators and of evaluating educational programs. I believe that people co-construct meaning through lived experiences and that we are each a compilation of experiences, and of the co-constructed meanings we and others give to those experiences. I believe it is my privilege and responsibility to listen, to learn, and to provide an authentic and trustworthy description of the experiences that participants share while accurately capturing their voices and stories. According to Patton (2015), this is the job of the qualitative researcher. Yet, as an evaluator, my approach is most often utilization focused; we must inform practice in realistic, very often time-limited, ways to improve practice. In this work, I hoped to balance and do both of those things.

My goal in this research was to improve practice and to better equip the valued 4-H educators who give their time to teach the youth to understand, appreciate, and pursue a future in science, technology, engineering, or math. Through this inquiry, I hoped to find that we do some things well, we have room to do some things better, and we are not doing some things at all which we should be doing. Identifying these factors will translate into better professional development for all of our educators, staff and volunteers, but most importantly changes made as a result of this research will result in better outcomes, including better STEM literacy, for the nearly 300,000 youth served by NC 4-H nonformal education programs.

Chapter Summary

This chapter presented the research design of this mixed-methods intrinsic bounded case study. This study used quantitative inquiry to determine whether participation in 4-H STEM Curricula training improved science and experiential learning teaching self-efficacies among NC 4-H educators and followed those surveys with semi-structured interviews to describe the experiences of 4-H educators who participated in curriculum training and to unpack the ways that those experiences contributed to their perceived abilities to deliver STEM programming to youth. Participants were chosen using purposive, stratified sampling. Purposive sampling allows for the selection of specific information-rich cases which provide the ability to answer the research questions. Stratified sampling was used to make sure that participants who were selected were representative of each of the five Cooperative Extension districts in the state. Data from surveys were analyzed using descriptive statistics and Wilcoxon matched-pair signed ranks tests. Interviews were analyzed using a constant comparative approach and the coding cycles set out in Saldaña (2016) and Miles, et al. (2014). Appendix J provides an alignment of the research questions with each participant measure. Steps to ensure the credibility, transferability, and dependability of the research included bracketing the researcher’s knowledge and biases, triangulation of the data, member-checking, and thick rich description using the voices of the participants. Chapter 4 presents the findings of this study.

CHAPTER 4: Results

Introduction

The research design for this study, an intrinsic bounded case study approach, used a mixture of quantitative and qualitative methods to explore the experiences of 4-H educators who participated in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training. Prior to data collection, the researcher focused on collecting and summarizing information about the training context in order to bound the case. The information derived from the observation of the training and interviews with the training providers that describes the training context is included in Appendix A and an observation checklist to identify training activities which correspond with the existing literature is included in Appendix B. Following the training, the researcher invited 4-H educators to complete surveys about their science and experiential learning teaching self-efficacies. Then, the 4-H educators who participated in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training were invited to participate in semi-structured interviews to explore their experiences in the training and their attributions for change in their science and experiential learning teaching efficacies.

This chapter presents the results from this mixed-methods intrinsic bounded case study. First, results from the semi-structured interviews will be summarized. The results from the self-efficacy surveys will then be presented alongside the semi-structured interview responses which provide educators' attributions for changes in their science and experiential learning teaching self-efficacy scores.

Educators' Experiences in the Curriculum Training

Most of the questions in the semi-structured interview protocol were designed to answer the research question: What are participants' experiences in the *NC 4-H Dairy Science: Mooving*

Milk from Farm to Fridge Curriculum Training? It was expected that insight into 4-H educators' training experiences would aid in the identification of the components within the training which improve 4-H educators' abilities to provide science education to youth in their county programs. Provisional codes, or a priori codes, were selected based on the existing professional development literatures reviewed for this research. Following Saldaña's (2016) approach to coding qualitative data, preliminary thoughts and potential meaningful units within the data were noted during the interview process. Employing Saldaña's (2016) suggestion to use In Vivo coding, or coding in the participant's own words, throughout the first-cycle coding process, the researcher sought to identify participants' words which were also aligned with the a priori provisional codes from the literature. The original provisional codes included: *Attentive to Diverse Learning Styles, Content Focus, Deep Conceptual Learning, Active Learning Opportunities, Modeling Effective Practice, Coaching Opportunities and Opportunities for Observation and Feedback, Reflective Practice Instruction, Aligned with Educators' Goals, Networking or Study Group Activities, Collaborative Learning Environment, Continuous Professional Development Opportunities, and Extension to Communities of Practice*. Reading through the transcripts during the first cycle of coding eliminated several provisional codes, yielding 9 of the original codes and adding an additional code of *Quality Educational Materials*. See Table 4.2 for a presentation of final provisional codes and the corresponding in vivo code for each provisional code.

Table 4.1

First Cycle Provisional and In Vivo Codes

Provisional Code	In Vivo Code
Content Focus	"Facts and Things"
Deep Conceptual Learning	"above and beyond what you get in the book"
Modeling Effective Practice	"having somebody walk you through"
EXPERT Coaching and Support	"open door access to the creators"
Active Learning Opportunities	"hands-on…do it myself"
Attentive to Diverse Learning Styles	"change what you're doing to suit their needs"
Adapting Lessons during Delivery	"bring stuff down to their level"
Collaborative Learning Environment	"work with other groups that will be facilitating"
Networking & Cohort Support	"getting to network (...) and bounce around ideas"
*Quality Materials	"Curriculum is the greatest tool"

*Note: Quality Materials was not one of the original provisional codes identified in the literature but was often mentioned among the training factors that helped educators deliver programming to youth.

During the second cycle of coding, data was conceptually reduced into parsimonious units, identifying categories to simplify and group the data. This process of pattern and axial coding yielded three categories or themes including: Subject Matter Expertise, Educational Differentiation, and Peer Collaboration. The remainder of this section describes the 4-H educators' experiences with the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training from the 4-H educators' interview transcripts. Table 4.3 provides a breakdown of the categories and the associated provisional and in vivo codes. Appendix K provides definitions of categories and the associated provisional and in vivo codes. For the purposes of writing the narrative analysis to share the educators' experiences, pseudonyms were assigned to each educator.

Subject Matter Expertise

As educators described their experiences in the training and in implementing the curriculum with youth, they reflected on several activities which were directed by the content specialist and represented five of the theoretical components identified within the professional literature: *Content Focus, Deep Conceptual Learning, Modeling Effective Practice, Expert Coaching and Support, and Quality Educational Materials*. The educators' descriptions of these activities described the provision of various types of content-specific instruction and support by the content specialists which coalesced into an overarching theme of *Subject Matter Expertise.* The educators provided 107 distinct comments which focused on some aspect of *Subject Matter Expertise*, with some overlap between comments which represented more than one of the five theoretical components of *Content Focus, Deep Conceptual Learning, Modeling Effective Practice, Expert Coaching and Support, and Quality Educational Materials*. Educator experiences, as those experiences related to the components from the professional development literature which comprise the theme of *Subject Matter Expertise,* are discussed in turn in this section.

Table 4.2

Second Cycle Categories and Associated Provisional and In Vivo Codes

Categories	Provisional & In Vivo Codes
Subject Matter Expertise	Content Focus: "Facts and Things"
	Deep Conceptual Learning: "above and beyond what you get in the book"
	Modeling Effective Practice: "having somebody walk you through
	*EXPERT Coaching & Support: "open door access to the creators"
	Quality Materials: "Curriculum is the greatest tool"
Educational Differentiation	Active Learning Opportunities: "hands-on…do it myself"
	Attentive to Diverse Learning Styles: "change what you're doing to suit their needs"
	Adapting Lessons during Delivery: "bring stuff down to their level"
Peer Collaboration	Collaborative Learning Environment: "work with other groups that will be facilitating"
	Networking & Cohort Support: "getting to network (...) and bounce around ideas"

*Note: During the coding process, Coaching Opportunities and Opportunities for Observation and Feedback was renamed to more accurately reflect the comments from the educators.

Content Focus. Educators shared that one of the most important components of the training was the instructors' coverage of basic, foundational knowledge within the content area of the curriculum. This *Content Focus* was best described by one educator's as the content specialists' coverage of essential "facts and things." Having a knowledgeable content specialist explain the key information that educators require to deliver the curriculum to youth, in Anna's words "made [the educators] more comfortable of what [they] were going to do, of how we could do it." Mary explained that,

> during our training that we had, [content specialist] had a PowerPoint that had where she went through, like the very bare minimum of everything (...) it had like facts and things so that way you could you could feel more comfortable when you went into the classroom."

Beth provided a similar opinion pointing out that "just thoroughly having that research base knowledge provided gave me the information that I needed to share it with the kids." Beth also commented on the thorough coverage provided by the content specialist who "walked [educators] through all of these different pieces. And so, it was not just trying to imagine what was going on. It was explained and had pictures and backup and we weren't just forcing a story." Erica likewise expressed that the content covered "was a lot that, you know, they packed a lot in in the small amount." She also thought that the content specialists "did a really good job of going through everything that we needed to go through." She went on to say that she "felt like the training was very thorough in explaining what we needed to do and explaining the activities… it just gave you a lot of information and you feel more equipped."

The importance of this *Content Focus* to educators' abilities to teach youth was also apparent as the educators described their successful teaching of the content with youth and their families. Educators' observations of their own abilities to teach youth content that they learned from the content specialists reflects their own understandings of the foundational knowledge provided during the training. For example, Lynn described the experiences with her youth in a lesson "about the calcium in the bone. And why we need to be drinking milk and why we need to be really looking at our dairy in a different way." She explained the different steps in the lesson and reflected on the response of youth to that lesson.

> [Educators] used the drink cards that were given so that [youth] could see the amount of sugars in things (...) Calcium tablets (...) got dropped down in the soft drinks. We did different types of soft drinks to see how much was left and they weighed those (...) we weighed them and they said, 'oh, look, this one was much less.' Of course, the one that was in water, you know same and the one that was in milk same. And so [youth] were like 'so water and milk really are good for us. Look that one doesn't have anything left.' And so, [youth] really got it when you did that activity.

Similarly, Mary, one of the educators without a background in science, described her experiences teaching youth and family members about the science-based content she learned during the training. She shared about lessons in refrigeration, how acids dissolve calcium in bone, and the digestive processes of ruminant animals. Her excitement of being able to take the content provided during the training and translate it into teaching that content was discernable in her description of her experiences teaching.

> We did the chicken bone too. They had fun with that. Putting the gloves on, they had to figure out how to put the gloves on. We put the gloves on, so they could touch the bone (…) When we did the rumen race and they all had their stomach, their like, what [cows]

> ate, they went through all the different things and we got to the whatever the one stomach was they sorted out the little beads into the different containers…

Most of the educators shared a story or experience about the importance of the *Content Focus* within the curriculum training and how that foundational content knowledge impacted their ability to effectively teach that curriculum content to youth and their families.

Deep Conceptual Learning. One educator described the experience of *Deep Conceptual Learning* as having the content specialist provide instruction that was "above and beyond what you get in the book." Several of the 4-H educators shared their *Deep Conceptual Learning* experiences, describing how the content specialists' exploration of the subject area was more comprehensive than was possible within the curriculum, often went beyond what would be shared with youth, and allowed a deeper understanding of the subject area from which educators might adapt their practice more easily. That "there was a lot of subject matter expertise (...) shared" was especially important for educators who "didn't have any background in dairy." Beth captured this idea best.

> So in the training, there at the farm, the state lab, was a great introduction for teaching the class because it gave background information that was above and beyond what you were going to get in the book (...) That was (...) an experiential learning for me and for my volunteers (...) Seeing how different farms work on a research scale versus a work scale gave you information going in [so] that you could explain to the kids the differences (...) Having the activities that were provided was a jumping off point to be able to create different and new things to add on (...) there was so much [information] there that I was able to do more with (...) We did get a hands-on walk through the research barn um milking barn to see all of those different types of machineries and talked about the

> tractors and combines and all the different tractor pieces that go to make the silage, to be able to better explain to the kids, too.

It was especially important that the content specialist was available during the training and after to answer questions and provide deeper conceptual knowledge. Mary explained that the content specialist "could get a little deep, like if we asked questions but she told us what we needed to know."

The importance of learning deeper content knowledge was true even for educators with a background in animal science. Lynn shared that she

> learned from [the content specialist] some things about the industry that kids are going to ask. So, it was good to be knowledgeable and be able to advocate for agriculture in that way. To learn some things from [the content specialist] even though I had been an animal science major. I learned more about the science itself.

Modeling Effective Practice. The essence of Modeling Effective Practice is best reflected in the voice of one educator who said that "being able to do [lessons] beforehand and having somebody walk you through" those lessons helped them deliver the content to youth effectively. The educators' reflections on *Modeling Effective Practice* referred to the content specialists' demonstrations of how each lesson and activity should be taught as critical to educators' teaching success. All educators mentioned that having the content specialists model effective practice was important to their teaching success.

Erica explained how the training made her "feel more equipped" because of "the way that the curriculum was set up to train." She went on to talk about how the content specialist "had a lot of activities there and she went through how you use them. So, when we started actually teach it–It was like, ‘oh yeah, I remember this.’” Darcy echoed the sentiment that having someone model effective practice prepared them to teach the content to youth:

> It was just really useful for me to go in there and see what the people who came up with the curriculum expected us to teach the children through this. [The content specialists] kind of helped me to understand (...) how I would run my meetings each week because I knew how they had done the experiment with us (...) So just to see how they expected it to go helped me the most of all.

The importance of demonstration is best captured in the words of Lynn who has a background in animal science. She explained that

> if you had just sat there and told us, ‘All right, they're going to roll through this, they're going to hop through this, they're gonna eat this, they're going to crunch up this, and they're going to talk about this when they get done’ everybody would have sat there and said, ‘Oh, yeah, that makes complete sense.’ And then when we got home, we’d have been like, ‘Now, why did I need these four sheets that say rumen and reticulum?’ So that was good, being able to go through the steps.

Lynn continued to share that “if somebody had set me down and had me roll from different things in a college class, (...) I would have been better prepared for my exam.”

Although every educator felt that the demonstration of activities was important and helpful to their teaching, Mary mentioned that she needed a “refresher on how the Penn State sorter works and (...) what each thing is and why it's that way because (...) there were some parents there, I remember, and they were asking me questions, and I was like, well, I'm not really sure of the answer to that.”

Expert Coaching and Support. Educator's described their experiences with *Expert Coaching and Support* as having "open door access to the creators" of the curriculum during the in-person training and throughout the implementation process. During the coding process, *Coaching Opportunities* and *Opportunities for* Observation and Feedback was renamed to *Expert Coaching and Support*. This change more accurately reflects the educators' own descriptions of their experiences and reveals that there were not opportunities for educators to be observed outside of the in-person training context. Most of the educators shared examples of *Expert Coaching and Support* in their interviews. Beth expressed that she and her colleagues

> were given support by having an open-door access to the creators of the curriculum and being able to call and ask questions, being able to ask for resources, being able to plan our visit out to the dairy research dairy farm. Yeah. I think we had a lot of support.

Ben, who reached out for support and materials from the state 4-H team shared that

> anytime I would email or call for a particular thing like with the flashcards, or you know, just extra support, I think I specifically asked for a digital copy of the curriculum because I wanted to print off (...) some photos and things. [The support] was super, super timely and super (...) helpful as far as emails (...) and sending us stuff that we needed.

Lynn also offered her perspective on the proactive support that the state 4-H team offered.

> The support that I was given is, if I did have a question, (...) we knew that we could go to [evaluator] or [curriculum specialist] or anybody and say, 'Hey, we have this question, please help us.' Also (...) the state office reached out. [The state office] said, 'Hey, we're not just, we don't just need your information. We also need to know how are you doing? How is it going? Can you send pictures? What is your favorite part so far?' You know, [the state office] gave us that support and even if [the state office] didn't hear anything

back from us because we're so busy, we appreciated the support on our end…Being able to email you if I had a question to ask, and knowing [the state office] were right there is really good. I knew you weren't going to disappear on me. So that was good.

Even when educators did not require help, knowing that the support was available was perceived as an important factor in their success. As Crystal expressed, “I'm sure if I asked, I would have [received support] (...) I've been pretty good, but they're happy to help if I need it.”

Quality Educational Materials. Educators’ perceptions about the importance of *Quality Educational Materials*, emerged during the first cycle of coding as a distinct point of discussion. Many of the educators interviewed reflected on their need for *Quality Educational Materials*, specifically, the importance of having a quality research-based curriculum. As Lynn stated, “the curriculum itself was the greatest tool.” Beth also shared her thoughts on how the curriculum

> was set up so it took you from beginning to end, there wasn't any jumping around in it (...) You could, if you wanted to take one lesson out and we were shown how you could take one lesson out, if you just had to go really quick somewhere (...) and you could use it. But if you wanted to use it from start to finish, it was laid out in a way that showed the entire life of cow.

The foundation of every training that the state 4-H team delivers is research-based curricula which are written under the direction of a content specialist. Having this research-based tool was perceived as an asset by many of the educators who participated in the *Mooving Milk from Farm to Fridge Curriculum Training*. Mary shared that within the 4-H curricula, “there’s always like the first page [with] information about (...) the science and the information” to allow the educator who is delivering the curriculum to youth to “give them more background. So, you're not just like, I don't know.”

Educational Differentiation

All of the 4-H educators discussed the importance of the instructional differentiation that was offered throughout the training course and built into the curriculum. Educators commented on 44 separate occasions about some aspect of *Educational Differentiation*, or offering a range of different activities to provide instruction in a way that different learners' needs were addressed, with some overlap between their experiences with training activities identified within the three provisional codes: *Active Learning Opportunities, Attending to Diverse Learning Styles, and Adapting Lessons during Delivery*. The experiences that the educators shared in relation to each of these ideas are discussed in this section.

Active Learning Opportunities. All of the educators described the importance of *Active Learning Opportunities* which allowed them to participate in "hands-on (...) do-it-myself" activities during the in-person training. These types of *Active Learning Opportunities* included opportunities to practice the activities within the curriculum within small groups just as youth would experience the activities within the educational setting. Crystal described the importance of active learning opportunities in relation to their practice: "Anytime I do hands on stuff it, it helps with learning." Dawn explained that "just being able to do it, you know, have that experience beforehand, made me more comfortable going into it because I knew, I knew what to expect." Lynn echoed this idea, sharing the importance to her own practice:

> As an [educator, we] actually got to do the things. We didn't just gloss over it and say, 'okay, well, here's what you can do and make sure you read through it in your own time.' (...) We did those activities. When we went over to the Dairy Unit, we actually did the rolling through and the munching and the bringing it back (...) I learned some different ways, some hands-on different activities that I could take to them that I knew they would

> just take and absorb like a sponge, because it was hands on and it was fun. It doesn't always have to be you stayed in there and teaching at them that hands-on learning really is where it's at.

Marcy shared:

> I think, generally speaking, whenever we can have a hands-on training where we're actually acting out, even the doing the ages and stages and pairing the ages and stages with people with the cows, I think that was even helpful because it always gives you a different spin on how to reach the young person. I believe that, oh my goodness, just, just opportunity to, you know, experience the activities to make sure that we were doing them correctly, is always very helpful. Because a lot of times if you read something, I know personally if I read something, it's different than actually acting it out and doing them (...) I believe again and I know I'm repeating myself, being able to experience that in a classroom setting with, you know, the facilitators prior to having to be out in in the classroom with without having already done that in a classroom setting, and the thing that was that's, that's, that in itself is very invaluable.

No matter the age, experience, or position of the educator, all of them discussed the utility of hands-on practice during the training. As Anna shared, "So, like I say, I can't say enough good about our training session. I'm old school so I like all the going through the hands-on stuff and learning and all and not all technology stuff. I like the hands-on."

Attentive to Diverse Learning Styles. Many of the educators reflected on the instructors' abilities to provide flexibility within the training activities and to provide flexibility within the planned curriculum activities to be *Attentive to Diverse Learning Styles* or to "change what you're doing to suit [student] needs." Several of the educators who commented on the ways that the training was attentive to their learning styles started with a statement about how they learn. For example, one educator began with "I'm not a good auditory person," another shared that "I'm not a very mechanical person," and a third shared that "I'll be honest, science is not my strong suit." These self-deprecating statements were followed by examples of the ways that training met their personal learning needs. In the words of Ben: "I'm very hands on and if you can teach it to me then I can share it." This need for hands-on instruction was echoed by Erica:

> I've got to do the hands-on and watch somebody do it or do it myself. And that helps me so much more. And the way that the curriculum was set up to train and they had a lot of activities there and she went through how you use them was wonderful. So, when we started [to] actually teach it – It was like, oh yeah, I remember this.

Other educators discussed the linkages between learning styles and their interests in specific topics within the training. Dawn mentioned how her interests guide her learning in science and math. "That is definitely not where my attention would go. I tend to put more attention on the things like reading arts and crafts." Mary discussed this same linkage between interest and focus in relation to the different ways she and her co-educator were able to gain information during the training:

> (...) my [co-educator], she really was into the nutritional part of it and so she did that when we did the [training and] when we did the program. She did a little bit more and was excited about talking to the kids about their nutrition versus I was excited about talking to them about the cow growing up. So, it's all in (...) the person and what you're passionate about and what you want to focus on. So (...) because my [co-educator] knew that information, I didn't have to.

Other educators discussed how the training met their needs as well as how the educational differentiation provided within the training applied to their work with youth. As Anna explained:

> I take notes (...) I can sit back down and go by my notes. That's why I always say when somebody is teaching a workshop, make sure you have a handout because you have some that learns by listening, you have some that learns by reading, and some by having to do it, you know, hands-on. So, I encourage that with anybody that I'm talking to about teaching workshops. So, this hit the spot on that, you know we learned all the way around.

As Lynn explained:

> I just assumed, you know, that kids, the way they felt about science wouldn't change very much just because I taught them about dairy and or the way that I taught didn't really influence how they learned about science. Does that make sense? The way the way I orient myself isn't going to matter. They're still going to get it regardless of how I teach it. But you've got so many different types of learners sitting in front of you and being able to sit there and talk about that in that training. I thought to myself, well, it's going to matter if I do this or if I do that, and you can see the kids in the room that are not getting it. They're very obvious, they're looking at you and you have to change what you're doing to suit their needs and then that in turn helps them learn. So that's why before the training, I'm going, 'It ain't going to matter if all we do is sing songs about dairy but or if all we do is hands on activities.' But there were kids that needed me to write on the big post it note—even though they can't read, they needed me to be able to point to the things and show them. And then there were kids who wanted to do the activity. There were some

> that didn't want to do the activity. So, you know, I just, I have to think about that as an instructor. There's going to be kids that aren't comfortable doing some things. How am I going to change myself.

Adapting Lessons During Delivery. Educators' experiences *Adapting Lessons during Delivery* reflected the changes that educators made to the lessons and activities in order to "bring stuff down to [youths'] level" or adapt the lessons to address the ability level of the youth within their programs. Many educators mentioned needing to add to or adapt lessons in order to meet the needs of the youth that they served. Erica spoke about modifying the rumen race activity where youth moved through each of the cow's 4 stomachs while pretending to be nutrients. She shared that because her group "couldn't do that activity at the dairy farm" as had been done at the training, she set up each station "in a hula hoop" and youth "moved from one hula hoop to the other hula hoop." By doing this "the kids really understood a lot more, even though we talked about the process of the four stomachs when we actually did it."

Darcy mentioned the addition of manipulatives to occupy youth who were younger.

> I had a group of (...) five-year olds (...) My kids would kind of get lost whenever I was talking, and so I finally (...) brought some of my son's cows from home, his little play cows, and they would play with them while I was talking or I would do like a playdough activity that they needed to work on while I was talking to keep them focused.

Likewise, Mary brought "a couple of crafts in to help to engage that age group, because that's something that they focus on." Youth were able to strengthen vocabulary while working on the crafts. As Mary explained, when her students "made these little cows after we had gone through the breeds of the cows, they were like 'I'm making a Brown Swiss,' or 'I'm making a Holstein.' So, they were using the words that they learned when they [were] making."

Lynn brought in additional content through the use of “different YouTube videos that (...) were out there from when [she] was in animal science and used those to show a cow chewing her cud so that they would understand that a little better.” She also “encouraged [youth] every day to bring something dairy related in their lunch box and [they] did a show-and-tell on what was dairy related in the lunch box.”

Anna “found out that a lot of [youth] didn't know anything about dairy, except it was a cow and for second graders, we found out the new curriculum stuff was kind of over their head. So, we had to find ways to bring you know, bring stuff down to their level.” So, she brought in pictures to “show them the difference between a beef cow and the dairy cow” and she had her “grandson, bring in a [live] cow and a calf.” These extra activities enhanced the youths' understanding from “the week before [when they] went over the cow with the body parts.” Having a personal connection with the local dairy was an asset for the youth Anna taught.

Sometimes, the educator extended the activity beyond the curriculum. As Dawn explained, “after we did the cooler activity, the kids wanted to redo it. So, we actually added some things to our science center.” This also made it possible for children who missed the lesson to do the activity and learn from their peers.

Peer Collaboration

A few educators reflected about their perceptions of the *Collaborative Learning Environment* and the opportunities for *Networking and Cohort Support* offered during the in person training and throughout the implementation process. During these conversations about the ways in which educators worked collaboratively, received support, and discussed their work with their peers within the in-person training and during the implementation of the curriculum, the overarching theme of *Peer Collaboration* emerged. Educators mentioned experiences with some aspect of *Peer Collaboration* ten times throughout the interviews. Educators' experiences within the *Collaborative Learning Environment* provided during the in-person training and in opportunities for *Networking and Cohort Support* during the in-person training and throughout their implementation of the pilot are discussed in this section.

Collaborative Learning Environment. Several educators mentioned the importance of the *Collaborative Learning Environment* provided throughout the training which allowed them to "work with other groups that will be facilitating the program." During the in-person training, educators worked in teams and experienced the activities that youth would go through during the implementation of the curriculum.

Lynn shared that "the support that [educators] were given to network and talk to others around [them] (...) really helped me better." Working through the activities with a co-educator who would be implementing the curriculum with her was reassuring. As she explained, "If I mess up she's going to be right there with me." She strongly recommended "that if you're going to pilot something to have a [co-educator] with you so she can be like 'Lynn, that's not the way we did it in the training. You need to back it up.'" Mary, likewise, discussed the benefits of having a co-educator during the training. As she described:

> If I wasn't necessarily prepared fully to go in, and when we were going in me and the [co-educator]. Like she had been through the training and I had been through the training. So, we kind of knew, like what we were going from if we hadn't read through everything (...) because my volunteer knew that information, I didn't have to.

Marcy's also brought out the importance of the collaborative learning environment. However, her focus was on the benefit of having a cohort of her peers.

> I think too, being able to identify and work with other groups that will be facilitating the program is very helpful in that we know you know—because it's different than reading curriculum and doing it with other adults versus in the classroom. So being able to have that (...) cohort that we can identify with and work with and be able to talk to.

Networking and Cohort Support. Educators experiences with *Networking and Cohort Support* were originally conceptualized within the professional development literature as *Networking or Study Group Activities*. However, during the first cycle of coding, the educators' descriptions of their experiences reflected the ways in which educators appreciated "getting to network…and bounce around ideas" with their peers during the in-person training and during implementation. Educators did not discuss participation in study group activities. Therefore, the essence of these experiences was better captured as *Networking and Cohort Support*. Several educators shared the importance of opportunities for *Networking and Cohort Support* to their experiences during the training and throughout implementation.

Erica described her experience using the process evaluation for the curriculum as an opportunity to reflect on her own practice with her co-educator. "The awesome part of that is we did that on a daily basis, every time we taught a lesson. And as soon as the lesson was over, and the kids left we sit down and did the evaluations." Anna spoke to other educators "who [were] teaching this and several others that I've talked to in different counties" about the complexities of the curriculum for younger youth and about the best audience for the curriculum. As she stated, "Now we can (...) go into a school that's (...) out in the county [in an area where] they knew a little bit more and do it and make a comparison."

Lynn was excited about the opportunity that the training provided to "network with other people. There were, ladies and gentlemen, in the room who thought of ideas for that. And being able to bounce around those ideas and add to the curriculum in that way, was very helpful." Marcy enjoyed being able to reach out to those in her cohort for their ideas as well. She spoke specifically about reaching out to Ben "a couple times (...) he helped [Marcy] with some of the some of the things [she] forgot from the training."

Educators' Change in Teaching Self-Efficacy Experiences

To answer the research question: "Does participation in *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training improve science and experiential learning teaching self-efficacies among NC 4-H educators?" educators completed science teaching efficacy and experiential learning teaching efficacy surveys. The results from these surveys are discussed in turn below.

Science Teaching Self-Efficacy Survey Results

To determine whether the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training increased science teaching efficacy among 4-H educators, training participants completed the Personal Teaching Efficacy Belief for Science (PTEB-S) and the Teaching Outcome Expectancy Belief for Science (TOEB-S) Subscales from the Teacher Efficacy and Attitudes toward STEM (T-STEM) Survey, an instrument developed by the William and Ida Friday Institute for Educational Innovation. Scores were calculated by averaging participant responses for individual items within each scale to obtain an overall scale score. Higher mean scores indicate a higher perception of science teaching efficacy with individual item responses ranging from "1 = Strongly Disagree" to "5 = Strongly Agree." To analyze the science teaching efficacy survey results, data from Qualtrics was downloaded as a csv file and analyzed using IBM SPSS Statistics (Version 25). To determine whether participants perceived a statistically significant difference between their science teaching efficacy prior to and following their participation in *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* training, a Wilcoxon matched-pair signed ranks test was conducted.

Scores on the PTEB-S pre-training survey items ranged from 1 to 5 (M = 3.35, SD = 0.50). Scores on the PTEB-S post-training survey ranged from 3 to 5 (M = 4.13, SD = 0.48). The results of the Wilcoxon matched-pair signed ranks test indicated that the post-training scores on the PTEB-S (M = 4.13, SD = 0.48) were significantly higher than the pre-training scores on the PTEB-S (M =3.35, SD = 0.50), Z = -2.67, $p = 0.008$. Thus, the perceptions of science teaching efficacy among 4-H educators who participated in the *Mooving Milk from Farm to Fridge Curriculum* training was determined to be significantly improved after participation in the training as compared to before training participation.

On the TOEB-S, pre-training survey scores ranged from 2 to 5 (M = 3.50, SD = 0.30) and post-training survey scores ranged from 2 to 5 (M = 3.68, SD = 0.33). The results of the Wilcoxon matched-pair signed ranks test indicated that the post-training scores on the TOEB-S (M = 3.68, SD = 0.33) were not statistically higher than the pre-training scores on the TOEB-S (M = 3.50, SD = 0.30), Z = -1.897, $p = 0.058$. Thus, 4-H educators' perceptions of their abilities to impact student science learning outcomes did not significantly change after participation in the training as compared to before training participation. Table 4.5 provides an overview of science teaching efficacy scores and the results from the Wilcoxon matched-pair signed ranks test.

Table 4.3

Science Teaching Efficacy Wilcoxon Matched-Pair Signed Rank Test Results

	N	*Mean*	*Median*	*Mode*	*Range*	*SD*	*Z*	*p*
PTEB-S Post	10	4.13	4.05	3.64	1.36	0.48	-2.668	0.008
PTEB-S Pre	10	3.35	3.50	2.64	1.27	0.50		
TOEB-S Post	10	3.68	3.78	3.78	0.89	0.33	-1.897	0.058
TOEB-S Pre	10	3.50	3.50	3.78	0.89	0.30		

Experiential Learning Teaching Self-Efficacy Survey Results

A brief survey was designed for this study to measure self-efficacy in teaching using the experiential learning approach. This survey included two scales. The first scale, the Experiential Teaching Efficacy Belief Scale (ETEBS) was designed to measure the educator's self-efficacy and confidence in teaching with the experiential learning approach. The second scale, the Experiential Outcome Expectancy Scale (EOES) was designed to measure the educator's belief that their actions through the use of the experiential learning approach will impact student learning. This survey was completed via Qualtrics along with the science teaching efficacy survey. Scores were calculated by averaging participant responses for individual items within each scale to obtain an overall scale score. Higher mean scores indicate a higher perception of experiential learning teaching efficacy with individual item responses ranging from "1 = Strongly Disagree" to "5 = Strongly Agree." To analyze the experiential teaching efficacy survey results, data from Qualtrics was downloaded as a csv file and processed using IBM SPSS Statistics (Version 25) to calculate descriptive statistics. To explore whether participants perceive a statistically significant difference between their experiential learning teaching efficacy prior to and following their participation in *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* training, IBM SPSS Statistics (Version 25) was used to conduct a Wilcoxon matched-pair signed ranks test.

Scores on the ETEBS pre-training survey ranged from 1 to 5 (M =3.37, SD = 0.55). Scores on the ETEBS post-training survey ranged from 2 to 5 (M = 4.08, SD = 0.51). The results of the Wilcoxon matched-pair signed ranks test indicated that the post-training scores on the ETEBS (M = 4.08, SD = 0.51) were significantly higher than the pre-training scores on the ETEBS (M =3.37, SD = 0.55), Z = -2.67, $p = 0.008$. Thus, the 4-H educators' perceptions of their self-efficacy and confidence in teaching with the experiential learning approach was determined to be significantly improved after participation in the *Mooving Milk from Farm to Fridge Curriculum* training as compared to before training participation.

On the EOES, pre-training survey scores ranged from 2 to 5 ($M = 3.64$, $SD = 0.60$) and post-training survey scores ranged from 3 to 5 ($M = 3.98$, $SD = 0.63$). The results of the Wilcoxon matched-pair signed ranks test indicated that the post-training scores on the EOES ($M = 3.98$, $SD = 0.63$) were significantly higher than the pre-training scores on the EOES ($M = 3.64$, $SD = 0.60$), $Z = -2.21$, $p = 0.027$. Thus, the 4-H educators' beliefs that their actions through the use of the experiential learning approach will impact student learning was determined to be significantly improved after participation in the *Mooving Milk from Farm to Fridge Curriculum* training as compared to before training participation. Table 4.6 provides an overview of experiential teaching efficacy scores and the results from the Wilcoxon matched-pair signed ranks tests.

Table 4.4

Experiential Teaching Efficacy Wilcoxon Matched-Pair Signed Rank Test Results

	N	*Mean*	*Median*	*Mode*	*Range*	*SD*	*Z*	*p*
ETEBS Post	10	4.08	3.86	3.82	1.45	0.51	-2.668	0.008
ETEBS Pre	10	3.37	3.27	3.27	1.64	0.55		
EOES Post	10	3.98	3.89	4.00	1.78	0.63	-2.207	0.027
EOES Pre	10	3.64	3.61	3.00	2.00	0.60		

Teaching Self-Efficacy Survey Outlier Analysis

An outlier analysis was conducted to determine whether there were any outliers among participants' scores on the 4 teaching efficacy scales. A box plot created for participant scores on each of the efficacy scales using IBM SPSS Statistics (Version 25) revealed one outlier on the EOES pre-training survey. Removal of this outlier from analysis revealed an outlier on the EOES post-training survey. Removal of this outlier yielded no additional outliers. The researcher then re-ran the Wilcoxon matched-pair signed ranks test for the EOES survey. The results of the Wilcoxon matched-pair signed ranks test remained significant $Z = -2.023$, $p = 0.043$. Thus, the perceptions of experiential teaching efficacy among 4-H educators who participated in the *Mooving Milk from Farm to Fridge Curriculum* training was determined to be significantly improved after participation in the training as compared to before training participation.

Educators' Attributions for Change in Teaching Self-Efficacy Experiences

To answer the research question: "What are NC 4-H nonformal educators' attributions of their increased or decreased science and experiential learning teaching self-efficacy experiences related to their participation in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training?", 4-H educators provided a response to the question: "Before this interview, I shared your results from the survey you completed. Thinking about the experiences you've had with the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training what are some thoughts you have on why your score changed in the way it did?" The results of their responses to the teaching efficacy surveys were then shared to allow them to contemplate whether specific activities throughout the curriculum training had an impact on their science and experiential learning teaching efficacies. Every educator interviewed perceived an increase in their science and experiential learning teaching efficacies. This perception of growth was even apparent for one educator who did not show change on their individual responses to the teaching efficacy surveys. This section presents the results of those conversations.

As the educators each discussed their training-related changes in teaching efficacies, many of them attributed those changes to opportunities to learn the content with knowledgeable content specialists who provided the "research-based knowledge," modeled effective practice, and allowed time for hands-on practice. In addition to content focus, active learning opportunities, and modeling effective practice, one educator mentioned the importance of attending to diverse learning styles and another educator attributed part of her efficacy growth to the collaborative learning environment and to opportunities for networking.

Marcy explained that content focus contributed to her increased science teaching efficacy because "it's helpful to get the specialist to come in and help us understand a little bit more of the groundwork before we go into the classroom." Beth also shared that, "just thoroughly having that research-based knowledge provided gave me the information that I needed to share it with the kids." According to Ben, the training provided "a background of what needed to be taught" so that he could "start thinking about how to present it" to youth. Dawn, who mentioned the importance of both the focus on content and active learning opportunities shared that the training "helped me come up with some more ideas and it [has] helped me be a little bit more confident in doing science activities." Darcy also perceived that her score changed due to active learning opportunities

> because we had done all the experiments and stuff from the pilot program, [youth in the program] said that science was fun for them now and that they really enjoyed it, and it wasn't as hard as they thought it was going to be—even at five and six and seven years old. So, I think that's kind of where I'm leaning as to why my answers changed some.

Crystal's scores on the science and experiential learning teaching self-efficacy surveys did not change. Unlike other educators in the study, Crystal had a strong educational background in animal science. Despite this lack of change, during the interview, she explained that the active learning opportunities offered in the training contributed to her science and experiential learning teaching efficacies. She shared that, "anytime I do hands on stuff it, it helps with learning."

Further, her previous interview responses also supported her perception of growth in her abilities to teach the science content and to use the experiential learning method while teaching youth.

Several educators discussed the impact that having instructors who modeled effective practice or "just going through and seeing it played out in the different lesson plans" contributed to their teaching efficacies. Erica discussed the way the instructor "went through how you use [the activities] (…) explaining what we needed to do and explaining the activities." Lynn also shared that having instructors, "actually showing us the materials we could use," and "showing us how to make our own if we needed to make more (…) was really awesome."

Marcy discussed the importance of the collaborative learning environment and ability to network with peers as contributing to her growth in teaching efficacies.

> I think too, being able to identify and work with other groups that will be facilitating the program is very helpful (…) because it's different than reading curriculum and doing it with other adults versus in the classroom. So being able to have that…cohort that we can identify with and work with and be able to talk to.

Lynn shared that her teaching efficacies were profoundly changed by the training instructors' attention to diverse learning styles.

> Well, I just felt like you may have some misconceptions going into some things. That's true in all things in life but I just assumed you know that kids, the way they felt about science wouldn't change very much just because I taught them about dairy and or the way that I taught did really influence how they learned about science. Does that make sense? The way the way I orient myself isn't going to matter. They're still going to get it regardless of how I teach it. But you've got so many different types of learners sitting in front of you and being able to sit there and talk about that in that training. I thought to

myself, well, it's going to matter if I do this or if I do that, and you can see the kids in the room that are not getting it. They're very obvious, they're looking at you and you have to change what you're doing to suit their needs and then that in turn helps them learn. So that's why before the training, I'm going ‘It ain’t going to matter if all we do is sing songs about dairy but or if all we do is hands on activities,’ but there were kids that needed me to write on the big post it note—even though they can't read. They needed me to be able to point to the things and show them. And then there were kids who wanted to do the activity. There were some that didn't want to do the activity. So, you know, I just, I have to think about that as a as an instructor. There's going to be kids that aren't comfortable doing some things. How am I going to change myself?

Summary

This chapter provided the results of the data collected via surveys and semi-structured interviews for this mixed-methods intrinsic bounded case study designed to answer three research questions:

1. What are participants’ experiences in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training?
2. Does participation in *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training improve science and experiential learning teaching self-efficacies among NC 4-H educators?
3. What are NC 4-H educators’ attributions of their increased or decreased science and experiential learning teaching self-efficacy experiences related to their participation in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training?

Data were collected from 4-H educators within each of five Cooperative Extension regions in North Carolina. Participants who reported their experiences in the curriculum training during semi-structured interviews perceived that many of the factors identified within the research literature on professional development, nonformal educators' training needs, and experiential learning needs were present within the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training.

NC 4-H educators increased their scores on the Personal Teaching Efficacy Belief for Science subscale from the Teacher Efficacy and Attitudes toward STEM (T-STEM) Survey (PTEB-S) but did not significantly increase their scores on the Teaching Outcome Expectancy Belief for Science (TOEB-S) subscales from the Teacher Efficacy and Attitudes toward STEM (T-STEM) Survey. NC 4-H educators increased their scores on the Experiential Teaching Efficacy Belief Scale (ETEBS) and the Experiential Outcome Expectancy Scale (EOES) of the Experiential Learning Teaching Efficacy Survey. These outcomes persisted when outliers were removed from the analysis.

The reasons that educators perceived changes in their teaching self-efficacies were also discussed within this chapter. Those reasons, as stated by the NC 4-H educators, included six of the nine provisionally identified training activities: Content Focus, Active Learning Opportunities, Modeling Effective Practice, Attention to Diverse Learning Styles, Collaborative Learning Environment, and Networking and Cohort Support.

A few components that were included in the original coding plan for the study were not observed during the training nor were they reported by participants during the interviews. One factor, alignment with educators' goals, was not observed or reported. However, it may be that self-selection to the training and pilot are evidence of this alignment. Other factors such as the inclusion of networking or study group activities and opportunities for observation and feedback were not observed during the training but were reported as present within their training-related activities by the participants during the interviews. Two factors were not observed during the training activities nor reported during the interviews: the extension of the training to communities of practice and opportunities for continuous professional development. Chapter 5 provides conclusions, implications, and recommendations for future research based on the results presented in this Chapter.

CHAPTER 5: Conclusions and Implications

This chapter provides a summary and a discussion of the results of this research study in relation to the experiences of nonformal 4-H educators who participated in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training, their identification of activities within that training that were deemed important within the educator professional development literatures, their increases in science and experiential learning teaching self-efficacies, and the reasons that they ascribe to those increases in teaching self-efficacies. After the summary of the study and results, practical implications, limitations, and directions for future research are provided. The final section of this chapter offers concluding remarks.

Students who are literate in STEM and who pursue careers in STEM fields are critical to the economic future of our country and our world (National Science Board, 2018). Youth establish a STEM identity early in their elementary school years, that is they perceive themselves as someone who is competent in science, technology, engineering, and math. Greater STEM identity is associated with a greater likelihood of pursuing a career in STEM (Dou, et al., 2019). To help youth establish a STEM identity early in their educational pathways, and to meet the call for action established within the Next Generation Science Standards, youth need educators who are well prepared through professional development opportunities which increase educator efficacy for teaching STEM content to youth (Desimone, et al., 2013; Grigg, 2013; Lotter, 2018; Ross & Bruce, 2007; Tschannen-Moran & Hoy, 2001). There is a strong literature base within the K-12 literature which outlines the kinds of professional development activities required for K-12 educators to provide effective STEM educational opportunities for youth (Darling-Hammond, et al., 2017). However, because STEM learning is not solely within the domain of the K-12 environment (Falk and Dierking, 2010; Mosatche, et al., 2013; Wilkerson & Haden, 2014;

Young, et al., 2017), there is a documented need to identify effective professional development activities to train educators in nonformal and informal organizations, such as 4-H to teach STEM (Smith, 2010; Smith et al., 2017). It is also necessary to research the processes, components, and activities for training nonformal and informal educators who are distinct from K-12 educators as they often lack the formal pedagogical and content-focused training that is provided within the K-12 teaching degree.

Therefore, the focus of this research was to investigate the components within a specific 4-H STEM curriculum training which was designed to enhance the abilities of 4-H nonformal educators to provide effective STEM educational opportunities for youth ages 5 to 7 years. To that end, this research used a mixed-methods intrinsic bounded case study approach to explore the experiences of the 4-H educators within the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* training, their reported changes in science and experiential learning teaching efficacies, and their perceived reasons for those changes in teaching efficacies. The following three research questions guided this research:

1. What are participants' experiences in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training?
2. Does participation in *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training improve science and experiential learning teaching self-efficacies among NC 4-H nonformal educators?
3. What are NC 4-H nonformal educators' attributions of their increased or decreased science and experiential learning teaching self-efficacy experiences related to their participation in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training?

This research was conducted with 4-H educators from each of the 5 Cooperative Extension regions within North Carolina. Ten 4-H educators provided survey and semi-structured interview responses. Two subscales from the Teacher Efficacy and Attitudes toward STEM (T-STEM) Survey and the Experiential Learning Teaching Efficacy Survey each included 20 pre and 20 post Likert-type questions per construct to measure educators' efficacy in teaching science and experiential learning, respectively. Surveys were administered through the use of the Qualtrics software and data were imported into IBM SPSS Statistics (Version 25) for analysis. Descriptive statistics were used to describe educators' responses and a *Wilcoxon matched-pair signed rank test* was used to identify meaningful change in educators' teaching efficacy scores before and after the curriculum training and pilot activities. Semi-structured interviews were conducted via the Zoom Video Communications platform. Each interview was recorded and transcribed. Interviews were analyzed using Saldaña's (2016) coding approach. First, provisional codes were identified within the educator professional development and nonformal educator literatures. Those codes were refined throughout the observation of the training and during the interviews. In the first cycle of coding, provisional codes were matched with participants' in vivo comments. Data were further reduced during a second cycle of coding by grouping meaningful units into categories or themes which included: *Subject Matter Expertise, Educational Differentiation, and Peer Collaboration*. At the end of each interview, participants were asked to provide their attribution for any changes in their teaching self-efficacy scores. Participant responses were categorized using the provisional codes which were refined within the first and second coding cycles. Finally, quotes from participants were selected to represent their responses to that question.

Discussion of Results

Educator Experiences

Applying Saldaña's coding approach and using provisional codes identified within Darling-Hammond, et al.'s (2017) work and the literatures on K-12 professional development, science teaching professional development, and nonformal educator needs, analysis of the semi-structured interview transcripts revealed that participant experiences could be categorized into three categories and ten codes, with 8 of the original provisional and in vivo codes and two emergent codes.

Subject Matter Expertise

In turn, each educator discussed the importance of *Subject Matter Expertise* to their training-related experiences. These experiences are congruent with the conversation in Darling-Hammond, et al. (2017) about the importance of the coach or expert and their ability to model the use of activities as central to effective professional development for K-12 educators. In turn, each educator shared their thoughts and experiences about instruction and support from a subject matter expert and provided confirmation of the crossover of training components identified within the K-12 professional development literature including: *Content Focus*, *Deep Conceptual Learning*, *Modeling Effective Practice*, and *Expert Coaching and Support*. Additionally, a fifth component related to the importance of the subject matter expert providing guidance emerged as many educators shared that *Quality Educational Materials* were central to their success as educators.

Participants' shared experiences which reflected the inclusion of basic background information included within the curriculum provided evidence for the importance of the *Content Focus* of the training. Such experiences were often coupled with, yet distinct from, educators' experiences with *Deep Conceptual Learning* activities which reflected training activities during which content was shared that went “above and beyond” what was included within the curriculum. The need for training to include both a content focus and opportunities for deep conceptual learning align with King and Tran’s (2017) discussion on the need for out of school time educators to participate in deep conceptual learning so that they are better prepared to be flexible and so that they are more confident in their abilities to support learners with different learning styles. Multiple researchers within K-12 STEM professional development literature have reported that teaching practice improves in response to content-specific instruction (Desimone et al., 2002; Desimone, et al., 2013; Garet et al., 2001; Penuel et al., 2007). Because 4-H educators provide long-term support for youth who pursue their sparks in particular content areas (Arnold, 2018), there may be more of a need for nonformal 4-H educators to participate in content-focused and deep conceptual learning than there is for K-12 educators who are limited to teaching youth based on a prescribed pacing schedule that does not allow for deep exploration of youths’ sparks. The importance of opportunities for *Deep Conceptual Learning* was mentioned by each of the 4-H educators who were staff members but not by any of the 4-H educators who were volunteers. As professional 4-H educators are responsible for directing programs within their communities, it may be that they are more attentive to the needs to have depth of content in multiple different disciplines in order to support the youth they serve.

All participants mentioned that “having somebody walk you through” the lessons (i.e., *Modeling Effective Practice*) was an important determinant of their ability to effectively deliver content to youth. In the work of Mintzes, et al. (2013), educators who attended demonstration laboratories showed gains in their science teaching self-efficacy. The instructors of the *NC 4-H Mooving Milk from Farm to Fridge Curriculum* Training modeled teaching science content while using the experiential learning method. These types of vicarious professional development experiences are among factors which Bandura (1997, 1977) considers self-efficacy performance accomplishments and which are expected to contribute to growth in teaching self-efficacy.

A majority of educators within the study identified the provision of *Expert Coaching and Support* as an important training activity. Their perceptions of having "open door access to the creators" of the curriculum and training during the training and throughout the pilot implementation process was relevant to educators' perceptions of their success in teaching. Educators' access to expert coaching and support was also one of the factors that Darling-Hammond et al. (2017) confirmed as instrumental in quality professional development for K-12 educators.

Throughout the interview process, many educators discussed the importance of having the physical curriculum and accompanying resources in their abilities to provide effective instruction. The curriculum provided "more background," included "the science and the information" for the educators to enhance their lessons, and was built to allow the educators to "use it from start to finish" to teach youth about "the entire life of a cow." The importance of *Quality Educational Materials* was mentioned by each of the 4-H educators who were staff members but not by any of the 4-H educators who were volunteers. Frontline 4-H staff may be more attuned to the importance of having the guiding documents in front of them during their programs than volunteers because they are responsible for maintaining curricula within their offices for use by volunteers within their communities. Although there is limited information in the literature about the importance of materials and supplies, many of the studies cited within this research did include a curriculum-based program component as the foundation of their professional development activities.

Educational Differentiation

Every one of the 4-H educators in the study mentioned the importance of "hands-on…do it myself" activities (i.e. *Active Learning Opportunities*) which were performed within small groups of their peers during the training. Many of the educators also addressed the importance of the training instructors' attention to providing information that allowed for other forms of *Educational Differentiation* including *Attention to Diverse Learning Styles*, and a focus on the necessary skills and resources for *Adapting Lessons during Delivery*. According to Bandura (1997, 1977), hands-on educational differentiation experiences provide mastery experiences which benefit learners by providing safe opportunities for failure, correction, and success as they learn and develop new skills. In the study by Mitzes et al. (2013) and the study by Flores (2015) these hands-on experiences empowered teachers and contributed to gains in personal science teaching self-efficacy.

When training instructors were *Attentive to Diverse Learning Styles* the participating educators responded in ways that addressed both the benefit to youth who would attend their programs, as well as in ways that reflected on their own needs as diverse learners. Multiple studies mention the importance of paying attention to diverse learning styles within educator professional development (see for example: Grigg et al., 2013; Lumpe et al., 2012; Mundry, 2005).

Several educators also commented on the changes they made to the lessons and activities in order to adapt to the needs of the youth in their program. This experience *of Adapting Lessons During Delivery*, which emerged during the interviews as important to the educators and their abilities to make these changes, reflects on the deep conceptual learning that was allowed within the training. Penuel (2007) examined how an inquiry science educator professional development, which included a strong content focus, prepared educators for leading student inquiry. Likewise, the ability to teach in less structured nonformal environments is reliant on deeper conceptual learning so that educators are able to adapt their practice as teaching takes on less teacher-focused instructional methods and is more student-focused with the instructor serving as a consultant (Hinko, et al., 2016; Patrick, 2017).

Peer Collaboration

4-H educators' opportunities for *Peer Collaboration* were reflective of their perceptions of the importance of the *Collaborative Learning Environment* provided within the training and of the opportunities for *Networking and Cohort Support*. Although there were a handful of comments for these types of peer interactions, the comments that were made were important in understanding the role of peer collaboration within the training as well as during the implementation period of the curriculum pilot. Comments about the *Collaborative Learning Environment* were reflective of experiences on the day of the curriculum training during which the educators "got to work with other groups that [would] be facilitating the program." Educators mentioned feeling more prepared because they shared these experiences with a fellow educator. Training activities identified by educators as allowing for opportunities for *Networking and Cohort Support*, originally identified within the selected professional development literatures as *Networking or Study Group Activities*, included references to educators' abilities to "reflect on practice," "bounce around ideas," and "reach out to those in [their] cohort" throughout the training day as well as during program implementation.

Orphaned Provisional Codes

Several components identified within the literatures on educator professional development and nonformal educator needs were identified within the *NC 4-H Mooving Milk* *from Farm to Fridge Curriculum* Training. A few activities that were unobserved during the training day were recognized as existing during the semi-structured interviews. However, a few components identified as important within the educator professional development literatures were not evident in the training or within the comments. The research supports the importance of aligning training opportunities with professional goals of the educators, providing continuous professional development opportunities for educators, and extension of the professional development to communities of practice (Barker, et al., 2009; Darling-Hamond, et al., 2017, Desimone et al., 2002, King & Tran, 2017; Patrick, 2017). Although these types of experiences were not readily observable during the training day, and although educators did not mention these opportunities within their interviews, it remains unknow whether and how these experiences played a role in the successful implementation of the program with youth. Indeed, the exposure for NC 4-H educators to regular training opportunities designed to align with their goals and opportunities for participation in communities of practice with content specialists and peers may have limited their identification of these factors as important to their teaching self-efficacy experiences. The focus of the inquiry on one-specific training may have masked the consideration of these activities as important to NC 4-H educators' professional development. However, the self-selected participation of NC 4-H educators within each region of the state is likely due to the alignment of the training with their programming goals or with the goals for programming defined by their counties' needs assessments. Although undocumented within the study procedures, it is also reasonable to expect that NC 4-H educators are exposed to continuous professional development activities. As part of NC Cooperative Extension, NC 4-H educators have access to content specialists and trainings that are regularly offered at North Carolina State University. NC 4-H educators also work within regions and regularly collaborate with each other and with the NC 4-H state team for training and program development. Although these elements were not captured by the measures used within this study, it may be reasonable to expect that they are happening. Future studies should more explicitly address whether or not the perceptions of support associated with these activities (i.e. continuous professional development opportunities for educators and extension of the professional development to communities of practice) are natural artifacts of being educators within the Cooperative Extension and Land Grant University systems.

Science Teaching Self-Efficacy

The 4-H educators in this study reported greater science teaching self-efficacy after the training than before. The PTEB-S measures self-efficacy and confidence in teaching science-related content. Scores on the PTEB-S post-training survey were higher than scores on the PTEB-S pre-training survey. These differences were found to be statistically significant via a Wilcoxon matched-pair signed rank test. The research literature on science teaching efficacy and educator professional development has supported the premise that higher science teaching self-efficacy is associated with educator and student performance (Lumpe, et al., 2012; Sandholtz & Ringstaff, 2014; Tschannen-Moran and Hoy, 2001).

Scores on the TOEB-S post-training survey were higher than scores on the TOEB-S pre-training survey. However, these differences were not found to be statistically significant via a Wilcoxon matched-pair signed rank test. The TOEB-S measures the teacher's belief that their actions impact student learning in science-related content. This goes beyond just understanding the science content or how to teach a science lesson and intersects with many factors outside of the educators' control. Several researchers identified that outcome expectancy may be affected by outside factors such as educators' lack of control over policies and requirements within the educational environment (Yoo, 2016), lack of control of instructional time (Sandholtz & Ringstaff, 2014), and opportunities for practice (Smolleck & Mongan, 2011). Opportunities to see positive student outcomes were also associated with higher outcome expectancy (Mintzes, 2013) and training that focuses on teaching science content may not attend to outcome expectancy (Hechter, 2011). This finding may be strengthened by a larger, more representative sample size.

Experiential Learning Teaching Self-Efficacy

Due to the focus 4-H places on the experiential learning model, a brief survey was designed for this study to measure teaching self-efficacy for using the experiential learning approach. Scores on the ETEBS post-training survey were higher than scores on the ETEBS pre-training survey. These differences were found to be statistically significant via a Wilcoxon matched-pair signed rank test. Scores on the EOES post-training survey were higher than scores on the EOES pre-training. These differences were found to be statistically significant via a Wilcoxon matched-pair signed rank test.

Through their participation in *NC 4-H Mooving Milk from Farm to Fridge Curriculum* training, NC 4-H educators became more comfortable using the experiential learning method when teaching youth. The experiential learning instructional method is central to curriculum development in 4-H and therefore is an ingrained part of the pedagogical practice that 4-H educators use in teaching all content types. Growth in both their efficacy in using this method and in their belief that how they use this method matters to youth learning is likely to increase their effectiveness as 4-H educators and the learning outcomes for youth in their programs.

Educators' Attributions for Change in Teaching Self-Efficacies

It is interesting to note that, although one of the educators interviewed who had a degree in animal science did not show an increase in her teaching self-efficacy scores, she still shared reasons that the training improved her teaching self-efficacies. Every educator interviewed provided reasons for their increased teaching efficacies. Changes in science and experiential learning teaching self-efficacies were most often attributed to the *Content Focus* and the inclusion of *Active Learning Opportunities*. Having "the background of what needed to be taught" and "doing all of the experiments" contributed to participants' confidence in teaching the content. Having the content specialists demonstrate the activities (i.e., *Modeling Effective Practice*) was also mentioned by a majority of the educators as an important part of their growth science and experiential learning teaching self-efficacies. Collaboration and networking with a cohort of their peers (i.e., *Collaborative Learning Environment* and *Networking and Cohort Support*) was perceived as a contributor to science and experiential learning teaching self-efficacies for one of the educators in the study. Another educator specifically reported that her outcome expectancy efficacy changed and that after the training, she realized that how she teaches (i.e., *Attention to Diverse Learning Styles* and *Adapting Lessons during Delivery)* makes a difference in students' learning. In her words, prior to the training she believed that "the way [youth] felt about science wouldn't change very much just because I taught them about dairy." Yet, going through the training, she realized that "you have to change what you're doing to suit their needs and then that in turn helps them learn."

Practical Implications

Preparing youth for successful futures in STEM fields is critical for their successful future and for the world in which we live (National Science Board, 2018). To this end, a group of science and education experts came together to create the Next Generation Science Standards (National Research Council, 2013). Addressing STEM education within K-12 educational settings is only a part of the solution as youth interest and learning of STEM content is often sparked outside of the K-12 environment (Young, et al., 2017; Wilkerson & Haden, 2014; Mosatche, et al., 2013; Falk and Dierking, 2010). The 4-H Youth Development Program is structured to serve youth from the age of 5 to the age of 19 with research-based programming which comes directly from the land grant university system (National 4-H Council, 2016). Indeed, researchers are currently investigating the ways in which "4-H programs provide a rich context for youth to identify, explore, and sustain their personal interests, often resulting in the development of a young person's spark" (Arnold, 2018, p. 145). Now more than ever, it is critical to understand the best ways to train 4-H educators to provide STEM educational programs for youth.

This study showed that 4-H professional development increased science and experiential learning teaching self-efficacies and revealed professional development activities which 4-H educators considered important in their increased science and experiential learning teaching self-efficacies. Understanding the components of professional development training for teaching STEM content will allow content specialists to purposefully design professional development opportunities that include those elements to which 4-H educators attributed their growth in self-efficacies for teaching science and for teaching with the experiential learning method. Specifically, time spent teaching content and allowing for deep conceptual learning allows for 4-H educators to more effectively translate content knowledge when working with youth and may be more important for 4-H educators who help youth engage in long-term content exploration than for K-12 teachers who have limited time to teach youth a specific set of standardized information. This deep conceptual learning allowed 4-H educators in this study to feel more comfortable adapting lessons for their youth by bringing in manipulatives, toys, and crafts and by facilitating youth learning with in-person and virtual field trips. Explicitly including lesson adaptations, adapting professional development to include elements for educators with diverse learning styles, and being intentional about providing ideas for 4-H educators to adapt lessons with their students are important activities within 4-H professional development trainings. More broadly, understanding those components of professional development training which lead to successful curriculum implementation may provide information for 4-H leaders and content specialists to develop professional development within other content domains.

Although 4-H educators in this study mentioned the importance of collaboration and networking with peers, there were fewer instances of these activities than expected. This may be due to the geographical distancing of the 4-H educators. Within K-12, teachers usually participate in professional development with their co-workers who are located within the same community and often within the same school. Collaboration and networking with peers who are more proximally located may be much easier for K-12 teachers than it is for 4-H educators. However, as this was included as important by 4-H educators in this study, future professional development instructors may consider providing more time and opportunities, either virtual or in-person, for networking to occur.

Further, this work will add to the evaluation protocols in place to determine the efficacy of professional development for 4-H educators in North Carolina. Most importantly, understanding what makes a professional development workshop successful may provide a pathway for training 4-H educators to become more comfortable teaching STEM educational programs for youth, thereby increasing youth STEM literacy and identifying those young people with a spark for pursuing STEM careers.

Theoretical & Methodological Implications

This research adds to the literature that seeks to understand what components or activities within professional development trainings for 4-H educators contribute to their successful practice. Additionally, this research adds to the understanding of science teaching self-efficacy and experiential learning self-efficacy for nonformal educators. More work will need to be done, as the sample size of 4-H educators in this study was small. However, this work may provide a foundation for beginning to develop a theoretical framework for professional development of 4-H nonformal educators like that which exists in the K-12 literature. Indeed, the components found to be effective for K-12 educators were also those components which supported growth in science and experiential learning teaching self-efficacies for nonformal 4-H educators. The development of a professional development framework for nonformal educators may also lend itself to the development and refinement of educational models, certificate programs, or online learning opportunities for individuals who wish to work in nonformal educational programs. However, the variety of content areas which 4-H educators teach annually will require continuous professional development which includes deep conceptual learning and hands-on opportunities for content exploration that is not confineable to a certificate program or online learning program.

Being able to deliver content effectively with the experiential learning method is central to the work of 4-H nationally. Therefore, understanding the construct of educators' self-efficacy for teaching with the experiential learning method, operationalizing and measuring this construct, and translating this construct into practical training opportunities is important for the work of 4-H specifically. This work adds to the literature on experiential learning teaching self-efficacy as a construct and calls for a much deeper exploration of the specific professional development activities that contribute to the increase of experiential learning teaching self-efficacy.

Study Limitations

Several factors limit the generalizability of this research. The sample size for this research was ten 4-H nonformal educators associated with the NC Cooperative Extension Service. They represent ten percent of the counties in North Carolina and a much smaller percentage of the potential population of 4-H educators in North Carolina. Although one of the educators had 48 years of experience working with NC 4-H, the majority had spent far less time within 4-H. The majority of the 4-H educators were female and worked in rural communities.

The study sample was comprised of 4-H educators who chose to attend the *NC 4-H Mooving Milk from Farm to Fridge Curriculum* training. Several of these educators joined this training and pilot because of a pre-existing interest in dairy content. Several of these educators also have a background in animal science. A different sample of 4-H educators without this motivation to learn and teach the content offered within this training may have had different outcomes. Future studies should more explicitly address whether or not the perceptions of 4-H educators are natural artifacts of being educators within the Cooperative Extension and Land Grant University systems.

The methodology used in this research, an intrinsic bounded case study, which is by definition non-experimental. Although this methodology allowed the research to seek a deep understanding of the professional development experiences of 4-H educators, it also limits the generalizability to the perceptions and experiences of 4-H nonformal educators in NC who attended the *NC 4-H Mooving Milk from Farm to Fridge Curriculum* training. It also limits the ability of the researcher to parse out whether training activities were directly responsible for changes in the educators' science and experiential learning teaching self-efficacies.

Qualitative inquiry is subjective (Creswell & Poth, 2018). Steps were taken to limit the subjectivity of this research and to increase the trustworthiness of the findings as identified in the qualitative inquiry literatures (Guba & Lincoln, 1989; Miles, et al., 2014; Patton, 2015). For example, this study used different methods of data collection including observation of the training, surveys, and semi-structured interviews and used the participants' own words to describe their experiences.

The T-STEM survey scales used in this study were not designed for use with nonformal educators and there may be differences between K-12 and 4-H educators which differentiate the way they answer the questions on this survey. The ETEBS was designed for use in this study and was validated with a small sample of 4-H educators in another 4-H curriculum training. More testing of this survey with a larger, more diverse sample that includes the potential removal of items is needed. Both the T-STEM and ETEBS surveys are based on self-report Likert-type items. Both surveys were provided as retrospective post-then-pre surveys through Qualtrics, an online survey software. There may be factors such as self-presentation bias, recall, or the interaction between the 4-H educators and the online survey process.

This study was implemented in conjunction with a curriculum pilot which included the training and implementation of the *NC 4-H Mooving Milk from Farm to Fridge Curriculum* program. Therefore, it is difficult to separate whether the influences on teaching efficacies were due to activities that happened on the day of training or were due to activities that happened as 4-H educators implemented the curriculum with youth.

The 4-H educators who participated in this study overall provided positive thoughts and comments about their experiences within the *NC 4-H Mooving Milk from Farm to Fridge Curriculum* training. The lack of disconfirming cases may be reflective of the role of the researcher as a member of the NC 4-H State Program Team who regularly interacts with the 4-H educators who participated in this study. Although she does not hold a supervisory role, it is possible that participants hesitated to share their negative thoughts and experiences with the researcher because they perceived her as holding a position of authority.

This research intentionally selected a model of STEM professional development that exists within the K-12 professional development literature as the basis from which to explore professional development with 4-H educators without K-12 teaching experience or degrees. The K-12 model was selected because there was and is a limited literature base within 4-H nonformal education to follow. Using a model created outside of the nonformal education setting may affect the researcher's ability to identify factors which impact 4-H educators' professional development as the researcher was primed to look for those factors from the K-12 literature. Additionally, within the K-12 research and in this study, it is not possible to rank order the professional development activities or to determine the relationship between the activities.

Directions for Future Research

This research investigated the experiences of nonformal 4-H educators in a STEM curriculum training to better understand the components in STEM professional development those educators perceived as important in directing their practice and increasing their self-efficacies for using the experiential learning method and teaching science to youth. This section identifies potential opportunities for future studies but is by no means exhaustive of the possible directions for future research on STEM professional development with nonformal 4-H educators.

This work complements Smith's (2010) research on *Lesson Study* which found that active learning opportunities, extended duration, content focus, peer collaboration, and coherence with professional goals were important for successful implementation. However, it also deviates from that research as content knowledge was found to be less important for the *Lesson Study* participants who had pre-existing subject matter knowledge than it was in this research. Clarification of the professional development activities that matter for 4-H educators nationally is an important area of exploration. This work needs to be done with a nationally representative sample of 4-H educators who participate in STEM curriculum trainings from a variety of content areas to determine whether the results are similar for different content areas and across the 4-H educator population. This research should include questions specific to identifying factors within Cooperative Extension and Land Grant University programs which have an existing role in the development of science and experiential learning teaching efficacies and whether these activities include those activities which were not readily mentioned within the results of this inquiry.

Another area for future study is to investigate the role of the curriculum and implementation activities separately in order to discern whether activities in each of these portions of the pilot process contribute separately or in combination to increase science and experiential learning teaching self-efficacies among 4-H educators. This will contribute to the refinement of a professional development framework for 4-H nonformal educators and allow for differentiation from the K-12 model used as the foundation for this research.

Additional research with the *Experiential Teaching Efficacy Survey* to determine the efficacy of this survey should include a larger, more diverse sample and different content areas and should include more robust analyses, such as confirmatory factor analysis to determine whether all items on the measure are necessary. The size of this study limited the full exploration of this measure which was also tested on a small sample of 4-H educators. Further, a better understanding of the construct of self-efficacy for teaching with the experiential learning method is an area for further investigation and construct operationalization. A review of the research literature for experiential learning teaching self-efficacy reveals that using the experiential learning method to teach increases competence and self-efficacy in many domains (see for example: Banfield & Wilkerson, 2014 or Tzafilkou, et al., 2020). However, what is missing is the ability to measure an educator's competence for teaching while using the experiential learning method.

The model of professional development in the K-12 literature should be intentionally used to design curriculum training for 4-H educators and research should be conducted on that model to determine whether each of the components in that model plays a role in increasing the science teaching and experiential learning teaching self-efficacies among 4-H educators. It may also be interesting to examine the qualities of the 4-H educators, for example years of service or educational degree, which impact their responsiveness to the type of professional development described herein. Further, another worthwhile area of study is the application of the professional development model to professional development trainings for nonformal and informal educators outside the 4-H Youth Development Program.

Conclusion

The world needs scientists, technologists, engineers, and mathematicians to solve real problems (National Academies of Sciences, Engineering, and Medicine, 2019). Issues of energy use, climate change, disease prevention, and the interface of humans with computers are just a few of those issues which are known—there are more on the horizon than are conceivable. Many of the careers that these future STEM professionals will hold do not yet exist. To provide the education that will spark interest in these fields will require educators across all formal, nonformal, and informal educational contexts to provide quality educational experiences for youth. This work requires quality professional development for the educators in each of these contexts (Falk & Dierking, 2010; Smith et al., 2017).

This study provides a step towards creating a model of effective professional development for 4-H educators to teach STEM by drawing connections with K-12 professional development for teaching STEM content, by determining whether science and experiential learning teaching self-efficacies were improved by 4-H professional development, and by seeking to understand the perspectives of 4-H educators on the activities in professional development to which they attributed their increased science and experiential learning teaching self-efficacies. The 4-H Youth Development Program has a strong history of providing STEM educational programs in out-of-school-time and within school programs (National 4-H, 2016; Smith et al., 2017). Strengthening the STEM teaching efficacy of educators within quality STEM professional development training programs improves teacher success and student outcomes (Kleinasser, 2014; Ross & Bruce, 2007; Tschannen-Moran & Hoy, 2001). It is therefore imperative that 4-H educators are provided with quality STEM professional development opportunities which increase their experiential learning and science teaching efficacies and increase their STEM teaching capacity so that they may thereby ignite each youth's spark for learning and pursuing careers in STEM fields.

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APPENDICES

Appendix A

Training Context Description

In addition to the collection of data to explore the experiences of participants, the researcher observed the training, carefully documented the process, and interviewed the instructors to determine their thoughts, experiences, and expectations in the design of the curriculum training. These instructors included the content specialists and members of the NC 4-H team who provided complementary portions of the curriculum training.

The researcher observed the curriculum training to document the variety of training activities, the training context, and participant and instructor reactions during the training. Patton (2015) describes the importance of data collected during observation to provide insight into the setting, activities, participants, and the ability to understand the situational context from the participants' points of view. To document the curriculum training activities, the researcher, who is part of the NC 4-H Curriculum Team used an observation checklist (Appendix B) to determine whether the training addressed features identified within the literature as important. Careful field notes were taken to capture the context and activities in a way that provided thick, rich description of the situation and context. The researcher's perspective was simultaneously that of an insider to the training and an outsider. Instructors and participants were made aware of the researcher's goals to document the training prior to any training activities. In addition to the training observation, an interview protocol was created for instructors (Appendix C) to determine their experiences in designing the training, their theories behind what they planned to include in the training, and the activities they intended to include in the training. Each member of the training team was asked to complete a consent form (Appendix D) prior to interviews.

Three content specialists, two with knowledge of dairy cattle and dairy farm operations and one with knowledge of 4-H curriculum design, were instrumental in designing the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training. To allow for a thorough description of the training context, the researcher observed the training and interviewed each of the content specialists who designed the curriculum and the training. During the training observation, the researcher used an observation checklist to document the features addressed within the training which correspond with the training literature. The researcher also endeavored to capture careful field notes during the training to allow for a thick, rich description of the training. The content specialists also provided important information about the training context during semi-structured interviews. Each content specialist completed a consent form and set up a time to meet via Zoom with the researcher to discuss their experiences and perspectives about planning and implementing the training and pilot activities. Within this section, the training context is described using a combination of the researcher's field notes, the observation checklist, and the voices of the content specialists.

The training provided many of the documented elements described within the literature. However, there were a few elements that were either not apparent within the training or that were not outwardly observable during the training. For example, each person who attended the training did so because they wanted to provide youth with an educational experience focused on dairy cows. Therefore, the training was aligned with the goals of those educators who chose to attend. However, observing the individuals within the training would not provide this insight. The results of the checklist are included in Table 4.1 below.

Table 4.1

Training Observation Checklist

Observed (Yes/No)	Training Element
Yes	Learner participates in a concrete experience.
Yes	Learner describes the experience with peers.
Yes	Learner makes connections between the experience and prior knowledge
Yes	Learner determines why the experience matters.
Yes	The learner generalizes the new knowledge to other areas of their life.
Yes	The learner determines ways to apply the new knowledge.
Yes	Training is attentive to diverse learning styles.
Yes	Training is content-focused.
Yes	Training provides active learning opportunities.
Yes	Training includes modeling effective practice.
Yes	Training includes collaborative learning environments.
No	Training includes networking or study group activities.
Yes	Training includes opportunities for coaching.
No	Training provides opportunities for reflective practice.
No	Training includes opportunities for observation and feedback.
*	Training is aligned with educators' goals.
Yes	Training is content-focused.
Yes	Training provides opportunities for deep conceptual learning.
*	Training extends into communities of practice.
Yes	Training provides instruction in reflective practice.
*	Training includes opportunities for continuous professional development.

*Note: These elements would not be observable during the day of training but may be discernable outside of the training context.

The content specialists who planned the training provided insight into their plans during semi-structured interviews. One specialist described their approach to training adults as a combination of lecture and hands on experience "depending on the topic." As they explained, "If it's information [that is] based on research that we've done, it's primarily lecture type interactions, but if we're teaching a new technique or trying to refresh people on things then that could be hands on." Another specialist discussed the importance for educators to have "that opportunity to put their hands on it before they work with the kids." The third specialist discussed the importance of scaffolding the experiences by "breaking [the content] down into smaller chunks," so that the educators gain a more complete understanding. This specialist also mentioned the importance of combining content with practical experience. Each of the specialist had a slightly different focus in the training, with the dairy content specialists putting greater emphasis on the provision of information and the curriculum specialist focusing more attention on the how the information is conveyed to the 4-H educators.

> You have to take them where they are and help them understand you, and empower them for what they know and encourage them to learn other things because most of the volunteers that we teach, they're coming in with a somewhat open mind because they know that they got to teach it to the young people. So, they're already somewhat primed to some degree.

At the end of their interviews, the content specialists were each asked to provide an overall rating for the training. Each content specialist gave the training an 8 out of 10. One of the specialists shared that educators would have benefited from an "extra day, allowing them to teach it back to us." This would have allowed for more coaching and feedback and a greater emphasis on reflective practice. It also would have allowed the content specialists to "assist them in gaps or where content may have been lost." One of the other specialists shared that they "could have provided different information or [could have taken] a different approach to the training" to think about it as more "training the trainer and less about you're just showing them what the activities are." However, the specialists worked as a team, and "other people that helped with it that day that had that mindset." This collaboration and team work "increases the quality of the training" as did the ability to hold the training "at the farm and the museum" where they "could demonstrate [the farm and museum] as a resource."

The training was held in early February of 2018 at the beef research farm and at the dairy museum to allow participants access to a classroom, the dairy museum, and the dairy farm. The training team was comprised of two dairy specialists, three dairy graduate students, a curriculum specialist, an evaluation specialist, a curriculum writer, and twenty-two participants. The training began at 9:30 a.m. with introductions and an overview of how the curriculum was developed. Two participants shared their experiences from previous curriculum pilots and the content specialist for curriculum development discusses the role of the 4-H educator in the curriculum pilot and revision process. As she explained, "The state team uses the feedback from educators to create new tools and to improve the curriculum." She continued with a request for educators to participate in and "experience the [curriculum training] activities fully, act and pretend as needed because the curriculum was designed for 5 to 8-year-olds."

At 9:50 a.m. the primary content specialist for dairy provides an overview of content within the first lesson before breaking the educators into groups to practice the life cycle activity. This activity requires participants to act out the different life cycles of a human and a cow in order to understand the differences in the life cycles. During this activity, connections are made to timelines in addition to life cycles.

Each lesson in turn is taught using a combination of lecture, modeling by the instructor, hands-on activity experience, opportunities for questions, and time for reflective practice. Educators take turns in the role of child or educator and are fully immersed in the curriculum lessons. Content specialists and graduate students provide instruction and coaching for participants as they work through each of the activities in teams. Participants move from the classroom to the dairy museum and farm to experience a lesson on ruminant digestion. During this excursion, educators tour the farm, walk through the milking parlor, and have an opportunity to ask questions. After the farm tour, educators return to the museum and are assigned roles of nutrients to be processed through the digestive tract. They jump and roll and crawl through a series of stations that represent different parts of the cow's digestive tract. They ask questions and listen to specialists and graduate students who provide explanations of the ruminant digestive process.

Educators return to the beef unit classroom for a quick lunch. After lunch, it is on to the fourth lesson. Educators build coolers in teams and learn from the content specialist about how milk gets from the farm to the store. Educators hypothesize how their coolers will work, monitor ice in their coolers for 15 minutes, and record their observations. Three more lessons on how products like cheese and yogurt are made and the nutritional content of dairy products follow. A discussion and overview of the evaluation protocols, the distribution of materials and supplies, and a final opportunity to ask questions rounds out the day.

Appendix B

Training Observation Checklist

Experiential Learning Reinforcement

	Learner participates in a concrete experience.
	Learner describes the experience with peers.
	Learner makes connections between the experience and prior knowledge
	Learner determines why the experience matters.
	The learner generalizes the new knowledge to other areas of their life.
	The learner determines ways to apply the new knowledge.

Professional Development Factors

	Training is attentive to diverse learning styles.
	Training is content-focused.
	Training provides active learning opportunities.
	Training includes modeling effective practice.
	Training includes collaborative learning environments.
	Training includes networking or study group activities.
	Training includes opportunities for coaching.
	Training provides opportunities for reflective practice.
	Training includes opportunities for observation and feedback.
	Training is aligned with educators' goals.

Nonformal Educator Needs

	Training is content-focused.
	Training provides opportunities for deep conceptual learning.
	Training extends into communities of practice.
	Training provides instruction in reflective practice.
	Training includes opportunities for continuous professional development.

Appendix C

Training Instructor Consent Form

North Carolina State University
INFORMED CONSENT FORM for RESEARCH

Title of Study: Exploring Professional Development for Nonformal 4-H Volunteer Educators Teaching Science.
Principal Investigator: Autumn Guin

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 participate, 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 may participate in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training without participating in the research activities.

You are not guaranteed any personal benefits from being in a study. Research studies may also pose risks to participants. 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 named above.

What is the purpose of this study?
The purpose of the study is to collect information about the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training which you are conducting. The goals of the research activities are to learn more about your experiences in designing training in order to make future trainings better; to understand how the training works; and to determine what changes you expect training participants to make based on the education that they receive within the training.

What will happen if you take part in the study?
If you agree to participate in this study, you will be asked to: participate in an interview to share your experiences in designing the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training, and share your perspective on the important training components necessary when teaching adults to teach science-based content to youth.

Risks and Benefits
There are minimal risks associated with participation in this research. There are no direct benefits to you for your participation in the research. The indirect benefits for you are the possible improvements to future 4-H curriculum trainings.

Confidentiality
The information in the study records will be kept confidential to the full extent allowed by law. Data will be stored securely in password protected electronic files or locked filing cabinets within the primary researcher's office. No reference will be made in oral or written reports which could link you to the study.

Compensation
There is no compensation for participation in this study.

What if you have questions about this study?
If you have questions at any time about the study itself or the procedures implemented in this study, you may contact the researcher: Autumn Guin, autumn_guin@ncsu.edu.

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 the NC State IRB office via email at irb-coordinator@ncsu.edu.

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."

Participant's signature____ **Date** _________________

Investigator's signature_____________________________________ **Date** _________________

Appendix D

Instructor Interview Protocol

Consent forms will be emailed ahead of time for participants to send to the 4-H office by mail or will be delivered via Qualtrics for participants to complete online prior to the interview session.

Opening Script

Thank you for agreeing to participate in this interview. Before we begin, I would like to thank you for agreeing to participate in this meeting and for returning your informed consent documents to me in a timely manner. The interview session will take about an hour.

Just as a reminder, your participation is voluntary and you may choose to stop at any time.

Is it ok if I record our interview?
(assuming yes – ready to take copious notes if no)

I am trying to learn more about some of the 4-H STEM curriculum training in North Carolina. This is for my dissertation and will also be something that we can hopefully use to make future training stronger. I am going to ask you some questions and give you time to respond. There are no right or wrong answers. These questions are to gain your perspectives and experiences in creating 4-H STEM curriculum training.

The primary research questions in my study are:

1. What are participants' experiences in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training?

2. Does participation in *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training improve science and experiential learning teaching self-efficacies among NC 4-H educators?

3. What are NC 4-H volunteer educators' attributions of their increased or decreased science and experiential learning teaching self-efficacy experiences related to their participation in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training?

Are you ready to begin?

Guiding Interview Questions

1. How long have you served your current role as a specialist in the content for the curriculum on which you are training?

2. How did you come to be involved with 4-H?

3. What kinds of background, education, or experiences have you had that help you in your role as a content specialist with 4-H?

4. What kinds of background, education, or experiences have you had that help you provide professional development experiences for adult educators?

5. In your experiences with teaching adults and with learning how to teach adults, what types of strategies have you used or experienced that promote adult learning?

6. Outside of the 4-H Dairy Science Curriculum, what other educational experiences do you provide for youth? What other professional development opportunities do you or have you provided for adult educators?

   (follow up – Do you provide educational experiences that you lead alone? Do you partner with someone else and if so do you take a primary leadership role, an assistant role, or do you co-lead?)

7. For the Dairy Science curriculum training specifically, can you tell me how you planned the activities for the educators?

   a. What specific skills, competencies or activities did you include in that training to prepare educators to teach the content?
   b. Were there specific hands-on skills you felt were more important for educators to learn?
   c. Was there specific content you felt you needed to spend more time on?
   d. Did you provide any support to educators after the curriculum training? What types of support? How would you describe that support? (content, skills, resources)
   e. If given the opportunity to conduct the training in the future, what would you change? What would you keep the same? (Would it be longer? Would there be different activities? Would you provide support after the training differently?

8. If you had to provide a numerical rating for the 4-H curriculum training where 1 is very poor quality and 10 is outstanding, what number would you give to the training you conducted?

I want to change gears a bit and talk about how your training plans were built to specifically help educators gain skills to provide instruction for youth in the programs.

NOTE: Questions depend on the curriculum which the volunteer was trained to deliver.

1. Tell me about the kinds of scientific information that you built into the training for youth to learn. Were there experiences in the training you provided to help educators feel more comfortable when providing science instruction to the youth? If so, what were those experiences?

2. Tell me what kinds of technology youth might be expected to use when they experience the curriculum. Were there experiences in the training you provided to help educators feel more comfortable when providing technological support to youth? If so, what were those experiences?

3. Tell me what kinds of engineering activities youth might be expected to experience during their participation in the curriculum. Were there experiences in the training you provided to help educators feel more comfortable in leading those engineering experiences? If so, what were those experiences?

4. Tell me what kinds of mathematical activities the youth might be expected to experience during their participation in the curriculum. Were there experiences in the training you provided to help educators feel more comfortable in providing mathematical instruction to the youth? If so, what were those experiences?

Wrap up

Thank you for participating in this interview process. I will be transcribing the interview and, if it is ok, I may have more questions for you once that transcription is done. I appreciate you taking time out of your day to speak with me. If you have any questions for me, please do not hesitate to contact me.

Appendix E

Email Invitation to Participants

Dear 4-H Educator,

My name is Autumn Guin, 4-H Program Planning and Evaluation Associate and doctoral candidate in the Educational Research and Policy Analysis program in the Department of Educational Leadership, Policy, and Human Development at North Carolina State University. For my dissertation, under the direction of Dr. Tamara Young, I am studying the experiences of 4-H educators in learning to teach science-based curricula through 4-H curriculum training in North Carolina. As a participant in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training, I am asking for your help in studying this topic.

My research includes 2 activities: a post-then-pre one-time retrospective survey and an online interview.

The survey will include questions about your comfort and confidence teaching science and your comfort and comfort and confidence teaching experiential learning processes. It includes 40 items and will be completed online. Completing the survey will take approximately 15 minutes.

The interview will include questions about your experiences in the curriculum training with specific questions about learning to teach science content. The interview will take approximately an hour. It will be online using a web-based conference platform called Zoom which is supported by the university.

After I've finished analyzing the interviews and the surveys, I will send you a draft summary of the experiences you and your fellow 4-H volunteer participants shared reach out to ask for your feedback on the summary of the experiences you and your fellow volunteer participants.

Your contribution is imperative to the success of this study and will be instrumental in improving future NC 4-H curriculum trainings.

If you agree to participate in the study, simply click on the link below. You will be presented with a consent form, like the one attached to this email. Once you click to signify your agreement, the survey will begin.

Thank you in advance for your support.

Appendix F

Participant Consent Form

North Carolina State University
INFORMED CONSENT FORM for RESEARCH

Title of Study: Exploring Professional Development for Nonformal 4-H Volunteer Educators Teaching Science.
Principal Investigator: Autumn Guin

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 participate, 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 may participate in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training without participating in the research activities.

You are not guaranteed any personal benefits from being in a study. Research studies may also pose risks to participants. 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 named above.

What is the purpose of this study?
The purpose of the study is to collect information about the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training. The goals of the study activities are to gain knowledge about educator experiences in the training in order to make future trainings better, to understand how the training works, and to determine what changes people in the training make based on the education that they receive within the training.

What will happen if you take part in the study?
If you agree to participate in this study, you will be asked to: complete a survey at the end of the training activities; participate in an interview to share your experiences about the training; and participate in a focus group of your peers to share experiences with the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* training.

Risks and Benefits
There are minimal risks associated with participation in this research. There are no direct benefits to you for your participation in the research. The indirect benefits for you are the possible improvements to future 4-H curriculum trainings in which you may participate.

Confidentiality
The information in the study records will be kept confidential to the full extent allowed by law. Data will be stored securely in password protected electronic files or locked filing cabinets within the primary researcher's office. No reference will be made in oral or written reports which could link you to the study.

Compensation
There is no compensation for participation in this study.

What if you have questions about this study?
If you have questions at any time about the study itself or the procedures implemented in this study, you may contact the researcher: Autumn Guin, autumn_guin@ncsu.edu.

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 the NC State IRB office via email at irb-coordinator@ncsu.edu.

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."

Participant's signature______________________________________ **Date** ________________

Investigator's signature___________________________________ **Date** ________________

Appendix G

Experiential Learning Teaching Efficacy and Beliefs Survey: Development and Psychometric Properties and Request for Information

The Experiential Learning Teaching Efficacy and Beliefs Survey (ELTEB) was designed to capture nonformal educators' beliefs about their self-efficacy for teaching using the experiential learning method. There are two subscales within the ELTEB: The Personal Efficacy for Experiential Teaching Efficacy Belief Scale is designed to measure the educator's self-efficacy and confidence in teaching with the experiential learning approach. The second subscale, the Experiential Outcome Expectancy Scale, is designed to measure the educator's belief that they can impact student outcomes. This measure was derived from the Personal Teaching Efficacy and Beliefs – Science (PTEB-S) and Teaching Outcome Expectancy Beliefs – Science subscales from the Friday Institute for Educational Innovation's (2012) Teaching Efficacy and Attitudes toward STEM (T-STEM) which was derived from Riggs and Enoch's (1990) Science Teaching Efficacy Belief Instrument (STEBI). Permission for use of the T-STEM was requested from the Friday Institute using the Instrument Request form found at https://miso.fi.ncsu.edu/articles/t-stem-survey-2.

To create the ELTEB, the items within the PTEB-S and TOEB-S were revised to reflect the construct change from science to experiential learning. For example, the original item was "I am continually improving my science teaching practice" and the new item is "I am continually improving my ability to teach using the experiential learning process." This ELTEB was tested with a small group of 4-H educators (n=11) to determine psychometrics for the two scales.

Table 1: Experiential Learning Teaching Efficacy and Beliefs Survey Reliability

Scale	Number of Items	Cronbach's Alpha
Experiential Teaching Efficacy Belief Scale - Pre	11	0.91
Experiential Teaching Efficacy Belief Scale - Post	11	0.96
Experiential Outcomes Expectancy Scale - Pre	9	0.83
Experiential Outcomes Expectancy Scale - Post	9	0.91

For more information about the Experiential Learning Teaching Efficacy and Beliefs Survey (ELTEB), please contact the study author at: autumn_guin@ncsu.edu

References

Friday Institute for Educational Innovation (2012). Teacher Efficacy and Beliefs toward STEM Survey. Raleigh, NC: Author.

Riggs, I.M., & Enochs, L.G. (1990). Toward the development of an Elementary Teacher's Science Teaching Efficacy Belief Instrument. Science Education, 74(6), 625-637.

Appendix H

Participant Interview Protocol

Note: An outline of the training events, found at the end of this protocol, will be provided to participants at the beginning of the interview process to assist with recollection.

Opening Script

Thank you for agreeing to participate in this interview. Before we begin, I would like to thank you for agreeing to participate in this meeting and for returning your informed consent documents to me in a timely manner. I also want to reassure you about the confidentiality in this interview process. Any reports I create will not include identifying information. The interview session will take about an hour.

Just as a reminder, your participation is voluntary and you may choose to stop at any time.

Is it ok if I record our interview?
(assuming yes – ready to take copious notes if no)

I am trying to learn more about some of the 4-H STEM curriculum training in North Carolina. This is for my dissertation and will also be something that we can hopefully use to make future training stronger. I am going to ask you some questions and give you time to respond. There are no right or wrong answers. These questions are to gain your perspectives and experiences in 4-H STEM curriculum training.

The primary research questions in my study are:

1. What are participants' experiences in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training?
2. Does participation in *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training improve science and experiential learning teaching self-efficacies among NC 4-H educators?
3. What are NC 4-H volunteer educators' attributions of their increased or decreased science and experiential learning teaching self-efficacy experiences related to their participation in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training?

Are you ready to begin?

Guiding Interview Questions

1. How long have you been a 4-H volunteer?

2. How did you come to be involved as a volunteer with 4-H?

3. What kinds of background, education, or experiences have you had that help you in your role as a volunteer educator with 4-H?
4. What is your role in providing educational experiences for youth?

   (follow up – Do you provide educational experiences that you lead alone? Do you partner with someone else and if so do you take a primary leadership role, an assistant role, or do you co-lead?)

5. How often do those experiences include instruction in science, technology, engineering, or math?

6. In your role as a volunteer, you've been invited to participate in curriculum trainings for curriculum that include science, technology, engineering, or math related content. You recently participated in a Dairy Science Curriculum Pilot. Have you participated in other 4-H curriculum trainings or pilots in the past 2 years? If so, what were the topic areas for those pilots?

7. For the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* training specifically, can you tell me what you learned from the training that helped you provide educational experiences for youth?

   f. Were there specific skills, competencies or activities included in that training that were useful for you?

   g. Were there specific skills, competencies, or activities included in that training that were not useful?

   h. Were there specific skills, competencies, or activities not included in that training that you believe would have helped you in providing educational experiences for youth?

   i. Were you given support in your work after the curriculum training? What types of support? How would you describe that support? (helpful, not helpful, excellent, poor)

8. If you could design a training for educators like you, what would you include in that training? What would that look like? How long would it be and what kinds of activities would you include? What kinds of support would you provide after the training? How would it be different or the same as the trainings you were a part of?

9. In that ideal training, what would be the most important skills or competencies for the educators to learn?

10. If you had to provide a numerical training for the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* training where 1 is very poor quality and 10 is outstanding, what number would you give to the training you participated in?

I want to change gears a bit and talk about your experiences with youth in the programs you lead.

NOTE: Questions depend on the curriculum which the volunteer was trained to deliver.

11. Tell me what kinds of science activities the youth experienced when you taught the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum*. Were you comfortable helping youth with those activities? Were there experiences in the training you received that helped you feel more comfortable when providing science instruction to the youth? If so, what were those experiences?

12. Tell me what kinds of technology the youth got to use when you taught the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum*. Were you comfortable helping youth with those technologies? Were there experiences in the training you received that helped you feel more comfortable in those technology experiences? If so, what were those experiences?

13. Tell me what kinds of engineering activities the youth experienced when you taught the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum*. Were you comfortable helping youth with those activities? Were there experiences in the training you received that helped you feel more comfortable in leading those engineering experiences? If so, what were those experiences?

14. Tell me what kinds of mathematical activities the youth experienced when you taught the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum*. Were you comfortable helping youth with those mathematical activities? Were there experiences in the training you received that helped you feel more comfortable in those providing mathematical instruction to the youth? If so, what were those experiences?

15. Before this interview, I shared your results from the survey you completed. Thinking about the experiences you've had with the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training what are some thoughts you have on why your score changed in the way it did?

Wrap up

Thank you for participating in this interview process. I will be transcribing the interview and, if it is ok, I may have more questions for you once that transcription is done. I appreciate you taking time out of your day to speak with me. If you have any questions for me, please do not hesitate to contact me.

Appendix I

NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum Training Outline

Note: This will be revised once training design is completed.

Day 1

I. Introduction to the Training Team
II. Overview of the NC 4-H Curriculum Pilot Process
   a. 4-H Curriculum Framework
   b. Roles and Responsibilities
      i. Content Specialists
      ii. Pilot Manager
      iii. Evaluation
   c. Support Structures
      i. Closed Learning Community on Facebook
      ii. Visits as Needed from Team, On-demand Coaching
      iii. Google Drive Access
   d. Submission of Receipts
   e. Evaluation Protocols
III. Primer on Experiential Learning
IV. Lesson 1: How Does a Calf Grow
   a. compare and contrast life cycles and physical development of cows and humans
V. Lesson 2: What Do Cows Eat?
   a. explore body systems and conduct experiments to understand the differences between monogastric and ruminant digestive systems
VI. Lesson 3: How Does a Cow Make Milk?
   a. learn about nutritional needs of living organisms and the role of proper nutrition in the milk making process
VII. Lesson 4: How Does Milk Get from Farm to Store?
   a. investigate the production technologies used to process milk as they calculate distances and use maps to learn about milk's journey to their local store
VIII. Lesson 5: Why Should You Drink Milk?
   a. compare and contrast the sugar content in various beverages
IX. Lesson 6: How Does Milk become Cheese?
   a. learn about the chemistry involved in the conversion of milk to cheese
   b. develop graphical skills through the classification of different types of cheese based on flavor preference.
X. Paperwork, Reminders, Questions

Continued Support

I. Monthly Webinar Check-ins and Continued Sharing of Resources
II. On-Demand Coaching from Specialists & 4-H State Team
III. Google Drive Resources
IV. Closed Learning Community on Facebook
V. Evaluation Reports and Data Sharing

Appendix J

Alignment of Research Questions with Participant Measures

Research Question	Participant Measurement Question
What are participants' experiences in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training?	I-7 For the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* training specifically, can you tell me what you learned from the training that helped you provide educational experiences for youth? j. Were there specific skills, competencies or activities included in that training that were useful for you? k. Were there specific skills, competencies, or activities included in that training that were not useful? l. Were there specific skills, competencies, or activities not included in that training that you believe would have helped you in providing educational experiences for youth? m. Were you given support in your work after the curriculum training? What types of support? How would you describe that support? (helpful, not helpful, excellent, poor) I-8. If you could design a training for educators like you, what would you include in that training? What would that look like? How long would it be and what kinds of activities would you include? What kinds of support would you provide after the training? How would it be different or the same as the trainings you were a part of? I-9. In that ideal training, what would be the most important skills or competencies for the educators to learn? I-10 If you had to provide a numerical training for the 4-H curriculum training where 1 is very poor quality and 10 is outstanding, what number would you give to the training you participated in?
Does participation in *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training improve science and experiential learning teaching self-efficacies among NC 4-H educators?	Science Teaching Efficacy and Beliefs (STEB) Science Teaching Outcome Expectancy (STOE) General Science Teaching Efficacy (STEB + STOE)

Note: Interview questions are labeled with I-1, I-2, and so on. Focus group questions are labeled with F-1, F-2 and so on. Surveys titles are included as survey scores are computed as scale and as composite scores.

Alignment of Research Questions with Participant Measures (continued)

Research Question	Participant Measurement Question
What are NC 4-H volunteer educators' attributions of their increased or decreased science and experiential learning teaching self-efficacy experiences related to their participation in the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training?	I-11 Tell me what kinds of science activities the youth experienced when you taught the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum*. Were you comfortable helping youth with those activities? Were there experiences in the training you received that helped you feel more comfortable when providing science instruction to the youth? If so, what were those experiences?
	I-12. Tell me what kinds of technology the youth got to use when you taught the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum*. Were you comfortable helping youth with those technologies? Were there experiences in the training you received that helped you feel more comfortable in those technology experiences? If so, what were those experiences?
	I-13. Tell me what kinds of engineering activities the youth experienced when you taught the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum*. Were you comfortable helping youth with those activities? Were there experiences in the training you received that helped you feel more comfortable in leading those engineering experiences? If so, what were those experiences?
	I-14. Tell me what kinds of mathematical activities the youth experienced when you taught the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum*. Were you comfortable helping youth with those mathematical activities? Were there experiences in the training you received that helped you feel more comfortable in those providing mathematical instruction to the youth? If so, what were those experiences?
	I-15 Before this interview, I shared your results from the survey you completed. Thinking about the experiences you've had with the *NC 4-H Dairy Science: Mooving Milk from Farm to Fridge Curriculum* Training what are some thoughts you have on why your score changed in the way it did?

Note: Interview questions are labeled with I-1, I-2, and so on. Surveys titles are included as survey scores are computed as scale and as composite scores.

Appendix K

Definitions of Categories and Associated Provisional and In Vivo Codes

Category		**Provisional Codes**		
Name	**Definition**	**Provisional Code Name**	**Corresponding In Vivo Code**	**Definition**
Subject Matter Expertise	Comments from 4-H educators about some aspect of subject matter expertise	Content Focus	""Facts and Things"	Comments about the focus of the training on content within the planned curriculum
		Deep Conceptual Learning	"above and beyond what you get in the book"	Comments about content knowledge that was shared by the content specialist which explores the subject area more deeply than is possible within the curriculum
		Modeling Effective Practice	"having somebody walk you through	Comments from educators which described content specialists' demonstration of how each of the lessons and activities should be taught
		Expert Coaching and support	"open door access to the creators"	Comments about educators' experiences that were related to the accessibility of the content specialists during the in-person training and throughout the implementation process
		Quality Materials	"Curriculum is the greatest tool"	Comments from the educators about the importance of having quality curriculum

Category		**Provisional Codes**		
Name	**Definition**	**Provisional Code Name**	**Corresponding In Vivo Code**	**Definition**
Educational Differentiation	Comments from educators about the inclusion of different activities to provide instruction in a way that different learners' needs were addressed	Active learning Opportunities	"hands-on…do it myself"	Comments about opportunities to practice the activities within the curriculum within small groups just as youth would experience the activities within the educational setting
		Attentive to Diverse Learning Styles	"change what you're doing to suit their needs"	Comments about how the educator or the content specialists worked to provide educational experiences to meet the needs of different learners
		Adapting Lessons During Delivery	"bring stuff down to their level"	Comments about changes that educators made to the lessons and activities to adapt the lessons to address the ability level of the youth within their programs
Peer Collaboration	Comments about the ways in which educators worked collaboratively within the in-person training and during the implementation of the curriculum	Collaborative Learning Environment	"work with other groups that will be facilitating"	Comments about the ways in which educators during the training got to work with other educator groups
		Networking & Cohort Support	"getting to network (...) and bounce around ideas"	Comments about continued connection with peers to improve practice related to instruction of the curriculum during the in-person training and during implementation

Category		**Provisional Codes**		
Name	**Definition**	**Provisional Code Name**	**Corresponding In Vivo Code**	**Definition**
Orphaned	Provisional Codes identified within the research literature which were not reported within the comments from the educators	Aligned with Educator Goals		Comments about how the training opportunities align with the goals of the educators in the training.
		Continuous Professional Development Opportunities		Comments about additional opportunities for learning within the same content area after the conclusion of the planned training activities
		Extension to Communities of Practice		Comments about the formation of a content-focused group that continues to work together within the content area after the conclusion of the planned training activities