TEACHERS AND LEADERS WORKING TOGETHER TOWARDS STEM INTEGRATION:
AN EARLY CHILDHOOD SCHOOL BASED CASE STUDY

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Abstract

This descriptive single-case study, using interviews, a focus group, document analysis and observation/field notes explored how pedagogical and leadership practices at a preschool impacted Science, Technology, Engineering, and Math (STEM) integration. This study sought to understand how STEM was integrated daily within the classroom environment and to develop a more precise understanding of how school leaders in Early Childhood Education (ECE) support STEM. A Distributive Pedagogical Leadership framework was the analytic lens used in this examination. The main research questions guiding this study were: How do teachers integrate STEM practices in ECE settings? and, How do preschool directors support STEM integration within ECE settings? Findings indicated that pedagogical leadership demonstrated by teachers was a significant factor in how STEM was integrated daily in the preschool environment. The ability of a school to establish a strong school culture and identity amongst staff, parents and community members were also found to have a positive impact on the success of STEM integration in ECE. Overall, the main implications that emerged from this study were that STEM integration is best facilitated when learning activities are student-focused and when teachers, parents, school leaders, and community stakeholders collaborate to establish a culture of STEM integration.

*Keywords*: Science, Technology, Engineering, Mathematics, STEM integration, distributive and pedagogical leadership, DAP
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Chapter One: Introduction

According to the U.S. Department of Commerce, Science Technology Engineering Mathematics (STEM) occupations have grown by 17%, compared with a 9.8% growth for all other trades in the past decade alone (Langdon, 2011). Chesloff (2013) explained that there is one person for every 1.9 jobs in STEM careers and despite very competitive salaries, employers are still scrambling to find skilled individuals who are proficient in STEM competencies. Business leaders, policymakers, and organizations all over the country have worked on strategic plans that would ensure the increase in the number of students interested in and graduating with the necessary STEM skills to keep the United States of America secure in the global marketplace (Barker, Nugent, & Grandgenett, 2014). This study focused on exploring how STEM can be successfully integrated into preschool, which encompasses the foundational years in a child’s development.

The Topic. Today's young children are tomorrow's workforce (Aguilar, 2016; Early Childhood STEM Working Group, 2017). Therefore emphasis on STEM education early in their educational experiences can lead to productive and innovative employment for the next generations of workers (Honey, Pearson, & Schweingruber, 2009). STEM continues to be an exciting, revolutionary field with lots of funding geared towards STEM learning in K-12 and post-secondary education (Kelley & Knowles, 2016). For instance, the federal government has allocated over $4.3 billion for STEM workforce readiness; however, to get the most out of this investment, it is essential to start fostering STEM skills in young children (Chesloff, 2013). Even with the abundance of enthusiasm for STEM careers, inadequate attention is being paid to the successful integration of STEM in Early Childhood Education (ECE) (Park, Dimitrov, Patterson, & Park, 2017).
Research Problem

Even though the foundations for STEM can be established well before Kindergarten, currently, a variety of barriers exist that hinder STEM integration within preschool settings. For instance, Mcclure, Clements, Bales, and Nichols (2017) found that parents and teachers are eager and want to embrace STEM learning, however they need to be better educated and supported in order to eliminate “anxiety, low self-confidence, and gendered assumptions about STEM topics,” (p. 9). Results from Park, Dimitrov, Patterson, and Park’s (2017) research on ECE teachers’ readiness to teach STEM revealed seven challenges being faced by those on the frontlines: “1) lack of time to teach STEM; 2) lack of instructional resources; 3) lack of professional development; 4) lack of administrative support; 5) lack of knowledge about STEM topics, particularly engineering; 6) lack of parental participation; and 7) reluctance of teachers to collaborate” (p. 284). Unfortunately, thirty percent of teachers in the study perceived STEM disciplines as not being developmentally appropriate for ECE children and should be taught in older grades (Park et al., 2017).

The assumption that younger children are too young to engage with STEM disciplines such as engineering has long plagued the ECE field as many continue to believe: 1) literacy is more vital, 2) STEM should be taught separately, or 3) that only some students can/will excel in STEM content (McClure, Clements, Bales, & Nichols, 2017). These assumptions cannot be allowed to influence schools and communities if the goal is to increase 21st-century skills in students. Though much progress has been made to change misconceptions, collaboration from leaders in various sectors will be needed to bring about lasting change (Breffni, 2011; Mcclure et al., 2017).
The shift in leadership ideology. Aubrey, Godfrey, and Harris (2013) explained that past leadership models embraced a top-down bureaucratic paradigm that was suitable for the industrial era. Leadership was also viewed as the ability of individuals to be daring, persuasive, or transformational (Aubrey, Godfrey, & Harris, 2013). Many believed that leaders were born, and copious amounts of research were conducted to validate those who fit into the leadership mold (Spillane, 2006). The need for understanding effective ECE leadership within various preschool models remains vital because “STEM learning is not an extra luxury but a necessity” (McClure et al., 2017, p. 44). During this age of informational technology and era of accountability (Talan, 2010), it will be essential for leaders to transform their approaches and make adjustments to help educators prepare students for the global demand for STEM experts (Kelley & Knowles, 2016).

In their research Aubrey et al., (2013) suggested the use of contemporary leadership models that are situational, socially constructed and interpretative can lead to more success in this information age. They propose a distributed approach that expands leadership roles and targets specific situations (such as STEM integration). ECE leadership encompasses multiple individuals and is not a ‘one-man show’ (Talan, 2010). There are official and unofficial leaders where positive interactions can exist between school leaders, staff and the situation (Spillane, 2006). Ho (2011) revealed that an effective leader is someone others can look up to, one that adequately runs the school operations and is an instructional leader of curriculum and teaching. Also, the study found the delivery of quality service to be the number one purpose of leaders next to their responsibility as a voice for stakeholders. This research demonstrates that even though leaders are laden with multi-layered challenges within their preschools and the
communities they serve, they are ultimately responsible for the teaching and learning that does or does not take place at their schools (Aubrey et al., 2013).

**Professional Development Practices in ECE.** Based on the researcher’s professional experience in ECE, STEM learning is already present in classrooms. One issue is that teachers are having trouble weaving STEM seamlessly into their existing lessons and recreation times because they need to know the ‘how-to.’ Teachers have shared with the researcher that they are left in even more vulnerable situations when their supervisors (preschool directors or school principals) are unequipped to help them and do not provide adequate opportunities for professional development (PD). College coursework or PD sessions outside of an actual preschool classroom make it difficult to grasp STEM as a mutually-inclusive focus of other early learning standards (Ritchie, Phillips, & Garrett, 2001). High-quality teacher-training on STEM should be a continuous norm in early childhood environments because teachers need the same hands-on, engaging learning practices that they are expected to use with students (Mcclure et al., 2017; Tippett & Milford, 2017). Hands-on approaches to PD can help build the confidence of educators in STEM (Stamopoulos, 2015). If educators are not onboard with STEM or think it is too complicated to integrate into their teaching, they will not be able to provide students with tools to be innovative and STEM-literate (Mansfield, Woods-Mcconney, & Mansfield, 2012).

There is a need within ECE leadership to use research-based strategies from experts to provide staff development or PD that allows ECE leaders to analyze their practices and utilize a leader-plus model (Talan, 2010). Well-modeled professional development needs to focus on child developmental learning progressions in STEM so that teachers are using developmentally appropriate STEM practiced pedagogy (Zambo, 2008). As leaders in ECE gain a greater understanding of the diversity that exists within their staff, shared principles can be established
for “socially just educational communities to emerge” (Hard, Press, & Gibson, 2013, p. 331). Within these communities, teachers can engage in discourse regarding STEM integration and best practices.

**Teacher Leaders.** In addition to the stress associated with the newness of STEM, teachers in this field consistently voice their lack of understanding of how students learn and apply STEM content (Kelley & Knowles, 2016; Park et al., 2017). Preschool teachers have days filled with interacting with children and families in addition to various other responsibilities such as preparing lesson plans and completing documentation. Additionally, teachers rarely get the opportunity to step away from their daily duties to observe and have an on-going conversation with others in the field (Ritchie et al., 2001). Consequently, dialogue and interaction are vital in helping create opportunities for organizational learning where teachers can work together rather than remain in the silos of their classrooms (Kangas, Venninen, & Ojala, 2016). Studies on teacher leaders (TLs) indicate that teachers need: an understanding of their leadership styles (Ho & Lin, 2015) and spaces to create, nourish and sustain learning communities within their organizations (Rönnerman et al., 2015). A collaborative culture must exist where teachers can participate in reflective practice (Drago-Severson, 2009) if organizations want to build capacity that leads to high-quality STEM integration.

**Pedagogy.** Pedagogy is described as the teaching and learning taking place within a classroom. Rosch and Anthony (2012) explained that pedagogy is rooted in the Greek term paidagogeo, meaning to “lead the child” (p. 37). This meaning implies that teachers are the leaders in their class and they use an array of teaching strategies to safeguard the growth and development of their diverse students. In this sense, teaching is an art form where educators are instructional leaders and program designers that combine child development and evidence-based
teaching practices to focus on improving learning outcomes for each student (Rosch & Anthony, 2012). Thus, effective pedagogical practices reassure confidence in the quality of teaching and learning in a school and promote the well-being of students, teachers and the school community. Building this capability of students and teachers is particularly important within STEM disciplines which may have been perceived as confusing and intimidating for children as well as adults (Park et al., 2017).

**Purpose Statement**

The purpose of this study was to examine how ECE pedagogical and leadership practices impact STEM integration at a preschool in a Southeastern state. Therefore, this study explored how STEM integration is supported by school leaders in a specific ECE setting. The knowledge generated from this study can inform how preschool administrators intentionally plan for, execute and assess STEM integration which is vital for strengthening the early childhood field.

**Justification for the research problem.** We now know that high-quality early STEM experiences can support children's brain, executive functions, critical thinking, and problem-solving skills (Mcclure et al., 2017). Chesloff (2013) also cautioned that a high-quality early-learning environment is paramount to any STEM integration initiative. Therefore, STEM should be integrated within an interdisciplinary approach of stimulating practices that encourage curiosity, creativity, collaboration, and critical thinking (Mcclure et al., 2017; Park et al., 2017; Tippett & Milford, 2017).

**Deficiencies in the evidence.** Due to limited literature in ECE this study used educational leadership literature from various countries such as Australia (Cartmel, Macfarlane, & Nolan, 2013; Davison et al., n.d., 2013; Krieg, Davis, & Smith, 2014; Sims, Waniganayake, & Hadley, 2017; Stamopoulos, 2015), China (He & Ho, 2017; Ho, 2012; Ho, 2011; Li, 2015), and Finland
(Kangas et. al., 2016; Lahtero, Lång, & Alava, 2017). One common thread is that a large amount of these studies embraced the use of distributive leadership (DL), an approach to understanding how the work of leadership takes place among the people and in context of a complex organization (Distributed leadership, n.d.). American research lacks evidence to support using this approach for school improvement including curriculum integration such as STEM.

Education studies across the board are available that focus on the specific STEM disciplines in isolation with technology having the most provision in research, then math and science. For instance, Maier, Greenfield, & Bulotsky-Shearer (2013) found that adequate attention has been put forth to elementary school teachers’ attitudes and beliefs toward science teaching, but research was limited in ECE. They suggest that teacher attitudes and beliefs influence the frequency and quality of science-related instruction that takes place in preschool classrooms. Minimal research attention has been directed toward studies that specifically address leadership practices that promote high-quality education in preschool regarding STEM. More empirical data is needed on STEM integration using an interdisciplinary approach within the United States.

They are relating the discussion to audiences. By exploring how leadership and STEM integration in ECE are linked, preschool programs that serve children from birth to age five will gain generated knowledge on how to improve the quality of their curriculum (explicit or implicit). Throughout the nation, this research will boost partnerships with various organizations that provide funding for improving the quality of ECE and will assist in the development of more inclusive professional development that focus on various stakeholders. Preschool teachers and parents will be able to work together and support each other in maintaining stimulating activities for children at school and at home. Lastly, this research can help diagnose issues within childcare
centers who are considered at risk and provide support for designing a plan to engage staff in positive practices while connecting with families and community organizations in a meaningful way.

**Significance of Research Problem**

In the 1980s National Association for the Education of Young Children (NAEYC) found that preschool instruction was increasingly becoming more like the direct instructional practices typically used in elementary school (Copple & Bredekamp, 2009). ECE educators were making efforts to guarantee that all children were ready for kindergarten because teachers were reporting one of three children are not prepared for kindergarten. As such, ECE moved towards the development of high-quality programs as many in the field transitioned from being labeled as childcare centers to early learning centers (Brown & Lan, 2013). Being a mostly privatized industry in most of America, ECE leaders felt the pressure to demonstrate that their preschools were thriving academically. Preschools typically compete with each other to obtain business from families (their customers) and to receive local, state or federal funding. More than ever before teachers were encouraged to "teach-to" pre-kindergarten assessments and kindergarten readiness test so that centers looked good on paper, while skills and concepts that were not on a test were often neglected (Parker & Neuharth-Pritchett, 2006).

Based on professional experience in ECE, unfortunately, the trend of teaching only certain subject areas continues to persist within ECE classrooms. Teachers tend to focus more on topics they feel comfortable with like literacy and number concepts and tend to devote less energy towards activities critical for STEM learning. Improved teaching strategies in STEM is one thing (Aronin & Floyd, 2013), however strong leadership has been identified as a critical characteristic of higher-quality early childhood settings (Hard et al., 2013). Therefore, school
leaders and teacher training programs must create stronger agendas to develop high-quality teaching and learning. Hence, research, which helps teachers and leaders to better understand instructional practices that reflect the growth and development of individual children, is imperative for the overall vitality of ECE and in preparing children for school.

While simultaneously focusing on high-quality programs, at the turn of the 21st Century, the National Science Foundation (NSF) recognized STEM education as a topic of urgency in education (Estrada et al., 2016). Americans were anxious about research that reported the following conclusions: 1) America did not have enough STEM workers, 2) educators needed to support minorities in STEM fields, and 3) the general public need to understand STEM concepts better (Carmichael, 2017). As such, there is a growing necessity to start STEM education in preschool because STEM concepts of curiosity, creativity, collaboration, critical thinking are a perfect way to engage children in activities that promote healthy brain development and kindergarten readiness (Park et al., 2017).

STEM can be perfectly woven with literacy to reduce the achievement gap so that; all preschoolers are ready for kindergarten, understand the relevance of STEM in their daily lives, are driven to get degrees in STEM and work in STEM fields (Mcclure et al., 2017). These researchers advise,

Just as the industrial revolution made it necessary for all children to learn to read, the technology revolution has made it critical for all children to develop the habits of mind associated with high-quality science, technology, engineering, and math (STEM) exposure (p. 8).
Thus, leadership practices in ECE that promote STEM learning should include: 1) strong school vision and direction (Talan, Bloom, & Kelton, 2014); 2) relevant, high-quality professional development (Capraro, Capraro, & Morgan, 2013); and 3) school, home and community partnerships within preschools (Stamopoulos, 2015). Therefore, this study will explore how STEM is integrated into the preschool context and make recommendations for furthering the progress of STEM throughout the ECE profession (Capraro et al., 2013).

**Positionality Statement**

Carlton Parsons (2008) suggested positionality can be a very complicated concept that brings to significant light issues within society such as race, class, gender. I will share my background and how it potentially influences my view (position) of the deficiencies I have witnessed within K-12 education as a teacher, an instructor within higher education, an educational consultant and middle-level manager in the field of ECE. I will share thoughts about my biases and privileged role as a researcher. My problem of practice is based on learning how distinct pedagogical and leadership practices have an impact on STEM integration within a preschool setting.

**Positionality as a teacher.** Starting my career as a fifth-grade teacher has had a significant influence on my ideology and in shaping my passion for providing children with stimulating environments. The school I started my career in was a Title I school, and I became intrigued with why some of my students were several years behind in math and literacy skills and had very little exposure to social studies and science-related topics. I eventually realized that I was limited in what I can do to help some of my struggling ten and eleven-year-olds. After going to my principal to inquire on ways to improve myself as a teacher, it was clear to me that my principal was only concerned about what I was doing to ensure that these struggling students
would indeed make learning gains on the upcoming standardized exam. However, I felt in my heart that I was too late (Tubman, 2009). Nothing I could do now could make the impact that my students need to be prepared for middle school. I wanted to figure out how and why students could make it to intermediate grades with such deficiencies.

When thinking back to my first-year teaching and the deficiencies that were present in my class, one fifth grade student, in particular, stands out in my memory. This eleven-year-old young man did not recognize certain letters of the alphabet which meant he was reading well below a first-grade level. Though socially flamboyant, this student struggled in every area academically, and everyone else in the class knew it. I can still remember the hope he had in his eyes during a class read-aloud as he identified with the main character of the book, *Thank You, Mr. Faulker*, by Patricia Polacco. This book was about a transformative teacher that helped a young girl go from being at the bottom of the class (due to dyslexia) to becoming a confidently stellar student. However, my bitter reality was, I knew very little about this student’s history and was ill-equipped on how to meet his individual needs. Also, issues such as lesson planning and classroom management sucked up the majority of my time. Several students left my classroom that year still lacking so much. Something was inherently wrong with this picture, and I wanted to figure out how I could be a more substantial part of the solution, so I enrolled in an Educational Leadership Graduate program. The experience with my fifth-grade students has led to this research study because I often wondered how different my classroom would have been if some of the students who struggled in my class had the opportunity to attend a high-quality early learning program that used developmentally appropriate strategies that were fun and exciting.
**Positionality as a graduate student.** During my first few years of teaching elementary school, I was also enrolled in an educational leadership program to become a school leader. Ironically, the contrasts between what I was learning in school and what took place at work were very apparent. The school where I worked went through three different principals in a matter of three years. I witnessed a school where I spent most of my professional career go through the rollercoaster of effective and ineffective leadership which had a significant impact on the climate and culture of the school from year to year. This experience laid a framework for my educational philosophy. My philosophy is that school programs and initiatives need situational leaders who understand the uniqueness of their school context and are willing to embrace the expertise of all stakeholders involved to promote an equitable education for all children.

**Positionality as a mother.** Before having children, I had several positions where I worked with children and youth and felt confident that I was an effective teacher. However, after having my son, I could see the difference in the way I approached my students (as if they were each my very own). Becoming a mother changed my teaching as I became more caring, intentional, and consistent in the classroom. Then the birth of my second child brought on a new passion for the field of ECE and the fact that all children need high-quality interactions during the years before entering Kindergarten. I began to realize that providing children with quality experiences during the early years of life will have more of a profound and lasting impact later on in life (McWayne, Melzi, Schick, Kennedy, & Mundt, 2013). Witnessing the growth of my children from childhood shifted my perspective in various ways I cannot explain and solidified my decision to transition from teaching in K-12 to becoming a leader in ECE. Parents, communities, and entire ecosystems (Ryan, 2001) depend on those (like myself) in the ECE field to not only take good care of children by providing a safe and loving environment but to also
prepare children to become innovative, creative thinkers with a passion for learning (Sharapan, 2012).

**Positionality as an ECE professional.** Within the past six years my knowledge of education, specifically ECE, has grown tremendously. My last full-time position was as an Instructional Designer creating and teaching courses geared towards the ECE workforce in a large county in the Southeast region of the United States. During this time, I taught classes which equip preschool teachers with strategies to incorporate into their daily instruction. I experienced firsthand the struggles preschool teachers were faced with; however, what was thought-provoking was the fact that teachers felt often limited by leaders who were not supportive. In my own experiences as a teacher, I can understand the frustration teachers face when their leaders use ineffective practices.

Also, I have been in leadership positions as a curriculum specialist and supervisor within the local Head Start Program, and those experiences along with my role as an educational consultant allowed me to visit many preschools to observe the daily challenges directors face. Staffing is always on the top of the priority list as I have had to fill in for teachers (on the spot) to meet licensing ratios until the director found someone else to fill in the gap. I have been in schools which captured my heart to the point where I did not want to leave and on the other hand, I have been in schools with staff that should not be working in ECE. I have seen the lack of materials in classrooms and the absence of a playground area. My travels all over the state have revealed best practices and exposed common missing threads.

**Bias.** My most prominent personal bias is the fact that I have been in ECE classrooms and I understand how difficult it is to manage the day-to-day challenges of running a school. I have seen teachers spend hours creating lesson plans, getting to work early, dealing with student
behavior issues as well as pushback from parents. I have witness teachers give of themselves non-stop for hours on end. Furthermore, having personal relationships with individuals who run preschools and knowing the struggles with leading staff, managing budgets, and ensuring the safety of students causes me to question my assumptions.

Though I am a black woman and have been a victim of discrimination, I have also seen what happens when teachers and school leaders use a deficit mindset, give up, and refuse to believe that their school conditions could be improved. I want to assist leaders in becoming more informed about their practice and not focus on placing blame on people, processes, and routines. I will admit my prejudices such as; when I assume schools should perform a certain way based on the make-up of their demographics. I must consider that many of the issues facing leaders (including those in my study) could stem from local, state and federal policies and structural barriers within the ECE field. After reading Briscoe’s (2005) assessment of the other, I know that it is possible for me to misrepresented the very group I am advocating on behalf of. Therefore, my hope is to other in a way that does not diminish or reduce one’s view of stakeholders but to uplift and mutually respect my participants.

**Privilege.** My positionality is complicated because I often find it a bit difficult to consider myself privileged given the fact that I am a Haitian-American female born of immigrant parents who barely spoke English. My parents used their working-class incomes to provide what they could for my brother and I. During my upbringing I did not understand the difference between working class or middle class, I only knew that I was not rich and I was poor. I realize that having the ability to graduate from college was a privilege in comparison to others that did not get the same opportunity such as some of my relatives in Haiti. I consider myself privileged
to be one of the youngest in my family to get married and have children all while obtaining my undergraduate and graduate degrees.

As a researcher, I am automatically considered educationally privileged because my research can get published in academic journals and may never reach the hands of the teachers and leaders on the frontlines (Briscoe, 2005). However, my hope is to provide an inclusive rather than an exclusive representation of participants despite my current position as an instructor at a community college. I would hope that my positive intents to research a bounded case to benefit other schools, would not come off as threatening to directors and school staff. Though in my role as a consultant, I have been in an evaluative position, I made a conscious effort to protect my participants from any feeling of judgment or discomfort.

I am a young Haitian-American scholar-practitioner who has a deep love for learning and empowering leaders, teachers, and parents, and this shapes my perception. This research project can now provide knowledge to stakeholders in ECE regarding the type of practices that are highly engaging for children, teachers, and the learning organization as a whole. Throughout my research, I became more aware of my positionality and the biases that shaped my thinking.

**Research Question**

My positionality, including my professional and personal experiences in conjunction with the literature, led me to the following research questions, which guided this thesis project:

1) How do teachers integrate STEM practices in ECE settings?

2) How do preschool directors support STEM integration within ECE settings?
Definition of Key Terminology

**Early Childhood Education**- Educational programs and strategies geared toward children from birth to the age of eight and considered the most vulnerable and crucial stage of a person's life (Nicholson & Kroll, 2015). Within this study, ECE will specifically refer to children who are between the ages of 0-5 and have not yet entered kindergarten.

**STEM**- STEM is an interdisciplinary approach to learning where content is joined with real-world applications as students utilize science, technology, engineering, and mathematics in a context that makes connections between various aspects of their lives (Park et al., 2017; Tippett & Milford, 2017).

**Distributive Leadership**- An approach to understanding how the work of leadership takes place among the people and in context of a complex organization (Distributed leadership, n.d.); the interaction of school leaders, followers and the situation (Spillane, 2006).

**Followers**- For this study, followers are considered those who may or may not have a formal leadership role within a school environment (this term is not meant to be condescending in any way) (Spillane, 2006).

**Pedagogical Leadership**- Form of practice that shape and form teaching and learning to be integrated into leadership (Male & Palaiologou, 2015).
Theoretical Framework

Using Distributive and Pedagogical Leadership to Frame STEM Integration in ECE

Due to the complexities involved in leading within ECE settings, the need for understanding current early childhood leadership within various preschool models is vital especially during this data-driven era of accountability (Talan, 2010). Two leadership concepts associated with effective ECE practices that can be advantageous to successful STEM integration efforts are distributive leadership (DL) (Heikka, Waniganayake, & Hujala, 2013; Ho, 2012; Honey, Pearson, & Schweingruber, n.d.; Merrill & Daugherty, 2010; Lin & Lee, 2013; Miller, 2013; Nicholson & Kroll, 2015; Sims, Forrest, Semann, & Slattery, 2015) and pedagogical leadership (PL) (Bøe & Hognestad, 2017; Cartmel et al., 2013; Dimmock & Goh, 2011; Lahtero et al., 2017; Male & Palaiologou, 2015; Rosch & Anthony, 2012; Turner & Baker, 2017). Both these leadership practices have currently been found to provide a foundation for developing well-organized and healthy learning environments for children and adults.

Tenets & Application of Distributive Leadership

For the past twenty years, distributed leadership has been a focus in the research literature of school leadership (Lahtero et al., 2017) and can be traced to the works of Gronn (2002), Leithwood et al. (2009), Mayrowetz (2008) and Spillane (2006). This conceptual framework mainly evolved due to the direct result of the growth in the sizes of schools and a significant increase in leadership tasks and responsibilities. Unlike other leadership frameworks that focus on specifying leadership roles, the primary focus of DL is leadership practice. Spillane (2006) explained that “leadership practice is viewed as a product of the interactions of (1) school leaders, (2) followers, and (3) their situation,” (p. 144). The central dynamic that sets the
foundation for the DL approach is the interaction between the leaders, followers, and situation.

*Figure 1. Leadership Practice from a Distributed Perspective. (Spillane, 2006, p. 3).*

This diagram depicts how leadership practice spreads across leaders, followers, the situation, and time. Spillane argues that the situation/context matter, when determining actions or methods, is needed in schools. Within this perspective is the understanding that interactions between people and their situation go beyond the "what" of leadership-structures, functions, routines, and roles and focuses on the "how" of school leadership-the daily performance of leadership routines, functions, and structures (Hallinger & Heck, 1998). Also, the DL framework is purely another analytical tool for the study of leadership and is regarded explicitly as a set of diagnostic and design tools that can be used to examine ways of experiencing or practicing leadership (Heikka et al., 2013). The interactions between the three founding elements (leaders, followers, situation) of a distributed perspective are critical. It is essential to note leadership practice is not something done to followers where they are merely told what to do without any real connection to the leader and the decisions being made (Spillane, 2005).
**Shifting from heroism.** The notion of school leadership has been synonymous with an individual leader, typically the school principal or in the case of ECE, the director. The DL approach was established as an alternative framing to the heroic undertones of leadership (Bøe & Hognestad, 2017) because as the landscape of leadership changes, complex and unpredictable challenges arise that no one school leader can manage alone (Lahtero et al., 2017). The pursuit for attracting leaders that will ‘lead the pack’ as the most robust, most knowledgeable and most skilled person in an organization is inaccurate because school principals, or any other leader for that matter, do not lead schools to greatness. Leadership involves an array of individuals with various tools and structures. It is essential, therefore, to challenge the assumption that leaders should have superhuman actions and instead establish everyday ways of sharing tasks that will minimize the possibility of mistakes made through leadership decisions by individuals acting alone (Heikka et al., 2013).

**Significance of stakeholders.** The DL framework moves beyond the ‘superhero’ view of leadership and allows space for leadership practice that involves a web of leaders, followers and their situations (Spillane, 2006; Talan, 2010). Within a school setting, stakeholders include administrators, teachers, teacher assistants, parents, and legislators. ECE requires leadership practices that provide opportunities for a culture of learning within preschools where the professional expertise of all stakeholders is acknowledged and utilized (Heikka et al., 2013). It is essential that all stakeholders to work together to ensure children can thrive in STEM whether they are home or within the early childhood centers they attend (Parette, Quesenberry, & Blum, 2010).

**Other leadership theories.** From its commencement, the concept of DL has become an appealing leadership approach for various reasons. Leadership practices in DL typically involve
multiple leaders, some with and some without formal leadership positions (Spillane, 2010). This "leader plus" factor is where multiple individuals take responsibility for leadership in schools, not just directors and assistant directors. Then again, this view has commonly been used to redefine other approaches such as shared leadership, team leadership, and democratic leadership, participative leadership, collaborative leadership, and so on. Spillane (2005) cautioned that DL will end up being everything and nothing at the same time if it is “not lived by in the practice of leadership, leadership development, and leadership scholarship,” (p. 98). Instead, he suggested that a distributive perspective can coexist with other leadership methods and can even be used to explore hierarchically and top-down leadership approaches.

**Limitation of DL.** Though DL is an excellent framework for involving all employees and staff within a preschool and addresses issues related to the complexities being faced in ECE today, one factor that is extremely important to STEM integration is pedagogy. As previously mentioned, problems with STEM integration have been that teachers do not believe young children can or should be exposed to STEM disciplines and teachers are unaware of how to integrate STEM appropriately due to varying age groups, developmental, and skill levels. Planning instruction for children who are in the most critical growth process in their lives requires teachers first to have a solid understanding of (pedagogy) core teaching and learning principles for the age groups they work with before attempting to integrate STEM concepts. With current requirements for ECE teachers being simply 45-hours of course work (in most states), this presents a disparity in teacher preparation in comparison to K-12 who engage in years of coursework and are required to have a bachelor’s degree. Even with the mismatch in credentialing, ECE leadership have a unique opportunity to develop PL within their schools assisting teachers in becoming pedagogical leaders. Understanding pedagogy is critical not only
to any curriculum implementation, but to the emotional, physical, and cognitive health of young children.

**Tenets & Application of Pedagogical Leadership**

In addition to the administrative duties, supporting quality early learning environments for children is the most significant role leaders play in ECE settings (Aubrey et al., 2013). This type of leadership approach known as pedagogical leadership (PL) involves the practice that shapes and crafts teaching and learning. PL is referred to as the central task of improving teaching and learning takes place in educational settings (Ord et al., 2013). The word pedagogy is understood as a set of practices that shape educational organizations around teaching and learning to match externally applied standards and expectations of student outcomes. Sergiovanni (1996) recounted pedagogical leadership as the teachers’ pedagogical work with learners, proposing the term ‘leadership as pedagogy.’ In his view, teachers are the leaders in the classroom (pedagogical leadership) because they get first-hand experiences with children and their learning.

**Vision and adaptability.** Like DL, pedagogical leaders have the responsibility of setting the course of action within their preschools such as establishing the school mission and vision. These actions will also encompass creating a plan for the allocation of time and resources which promote an engaging, quality learning environment for children and adults (Rönnerman, Edwards-Groves, & Grootenboer, 2015). Those working in preschools such as teachers, teacher assistants, paraprofessionals, and floaters, can grow in their practice when in a nurturing learning environment where they have the time and means to reflect on their practice, study children and explore various approaches (Caudle, Moran, & Hobbs, 2014). So then, PL adds to the frame of distributing the responsibility of task and emphasizes the necessity of creating a learning culture
where teachers are stimulated intellectually and emotionally, where they are researchers of theory and practice, and where reflection and inquiry are the foundation for transforming practice (Coughlin & Baird, 2013).

Leadership as praxis. When speaking of pedagogical leadership, Male and Palaiologou (2015) explained that effective leadership is not a task, an activity, or a practice, but it is a praxis. Praxis is described as “reflection and action upon the world to transform it” (Male & Palaiologou, 2015, p. 228). They continue to explain leadership as a process that involves interpretation, understanding, and application. In this context, PL is an ethical approach that respects, values, and does not engage in any lesson that will only benefit the individual but instead looks after the ecology of the community (Male & Palaiologou, 2015).
Figure 2. The relationship between pedagogy and social axes (Male & Palaiologou, 2015, p. 220).

Pedagogy becomes fundamentally the creation of learning environments where the associations among communities also involve interactions with external elements. Male and Palaiologou (2015) emphasized that PL is also focused on an integrated conceptualization of the relationship between teaching and learning along with the social set of axes in which the educational organization is set. This form of leadership can lead to high-quality professional development needed to help teachers better understand STEM and link it to classroom practice (Breffni, 2011).

Leadership for STEM in ECE

Though ECE has made much progress in quality improvement, ECE has been labeled as a marginalized sector in STEM education and falls behind in providing high-quality programs especially when it comes to STEM integration (Parette et al., 2010). Hence, stronger leadership at every level (federal, state, local and school-wide) is essential for improving program quality. The DL framework is an effective method for thinking and investigating leadership practice (Spillane, 2006), and when combined with the tenants of PL, this makes for a seamless pairing to analyze the relationships that take place in the teaching and learning process that take place in preschools seeking to integrate STEM.

Relationships. STEM Integration is commonly associated with how teachers make use of curriculum materials such as a "STEM in the Box" kit. Without leadership practices that assess the leaders, followers, and situation, schools run the risk of focusing solely on curriculum(s) and lack knowledge on how to create, foster and sustain trust, support, and collaboration (Bøe & Hognestad, 2017). Using DL and PL within ECE environments will assist preschool leaders in
directing and facilitate knowledge development by balancing their influential positional authority. Studies have shown that when schools develop strong relationships schoolwide and within and the community around them, high-quality STEM experiences for young learners are more likely (Early Childhood STEM Working Group, 2017).

**Distributive pedagogical leadership.** In research on hybrid leadership, Bøe & Hognestad (2017) explained that distributed leadership perspectives have been previously linked with pedagogical leadership approaches in Norway. This approach emphasized how pedagogical practices include interaction, collaboration, and interdependency between staff at multiple levels. A distributed pedagogical leadership (DPL) is an alternative to the preschool director leading a solo show. Teacher leaders are also encouraged to take part in daily operation responsibilities and play a significant role in decision-making, efficiently driving staff resources, and operationalizing pedagogical work. Their study posits that “formal and informal tasks are a catalyst for building and sustaining the conditions required for DPL practices in ECE” (Bøe & Hognestad, 2017, p.146).

**Conclusion**

STEM integration cannot take place through a one-size-fits-all attitude in which the purchase of technology tools or a curriculum series will suffice to lead all efforts. If this is the case, directors, and school leaders will sit back and watch the teachers work their STEM magic while the school continues with business as usual. With a DPL approach, the behaviors of each individual in the organization matters and leadership practice involve not only what people do, but incorporates the ‘how’ and ‘why’ of certain practices. What ECE needs for STEM integration to function in preschools at their optimum potential is not a recipe for effective
leadership but the understanding of how relationships and leadership practices blend to diagnostic and design teaching and learning in a unique blueprint.
Chapter Two: Literature Review

Introduction

The field of educational research has highlighted the need for increasing science, technology, engineering and math (STEM) skills among students, mostly at the secondary and postsecondary level (Mcclure et al., 2017). However, due to the uniqueness of Early Childhood Education (ECE), it has been frequently left out of STEM education efforts (Tippett & Milford, 2017). Aldemir and Kermani (2017) explained that some of the reasons for the exclusion of ECE may be due to inadequate quality in early childhood and lack of professional preparedness of ECE practitioners. This chapter reviews the literature to present a rationale for beginning STEM teaching and learning during a child’s earliest years and is guided by the following questions: How do teachers integrate STEM practices in ECE settings? and How do preschool directors support STEM integration within ECE settings?

While there is some consensus among researchers regarding ways to better prepare the United States (US) students for Global competitiveness in STEM fields, researchers have taken various approaches to STEM education. Some have specifically addressed one or more of the STEM disciplines in their research, others have focused on understanding teachers’ attitudes and self-efficacy when it comes to teaching STEM, and a broad body of work contains studies which suggest the use of effective professional development as a means of increasing teachers’ pedagogical content knowledge in STEM. Due to limited research on STEM in ECE only, this literature review will cover research conducted in both ECE and Kindergarten through 12th Grade (K-12) settings.
STEM Education

For decades the American school system has experienced declining test scores, national standings, and graduation rate (Carew & Magsamen, 2010). Lawmakers have made several attempts to improve education through mandates such as No Child Left Behind (NCLB) and Race to The Top (RTTT) (Boots, 2013; Honey et al., 2009). Students in developing nations such as India and Malaysia have had an increased interest in STEM, while Europe and the United States have a growing gap in STEM skills among those joining the workforce (Kelley & Knowles, 2016). Some have suggested that enthusiasm for STEM disciplines (especially engineering) at an early age can remedy the low student enrollment in STEM majors while addressing the issue of underrepresentation of women and minorities in STEM professions (Bagiati, Yoon, Evangelou, & Ngambeki, 2010; Tay, Salazar, & Lee, 2018). Recent reforms, the Next Generation Science Standards (NGSS) and Common Core State Standards for Mathematics (CCSSM) were both enacted to improve teaching and learning specifically within STEM and make connections across the disciplines (Honey et al., 2009).

Defining STEM

Defining STEM can be a difficult task due to the ambiguity associated with what STEM teaching looks like and the fact that various definitions exist for STEM education (National Research Council). However, the following descriptions characterize a consensus of what researchers consider STEM and STEM integration to be at various levels.

1) Vasquez (2015) described STEM as “a meta-discipline—an integration of formerly separate subjects into a new and coherent field of study” (p. 11).
2) Park (2017) described STEM education as “an integrated approach that teaches technology and engineering based on science and mathematics in kindergarten through 12th grades” (p. 276).

3) Tippet (2017) believed that if any two of the four disciplines are intentionally emphasized, then a lesson or activity can be considered STEM.

4) Similarly, Kelley and Knowles (2016) defined integrated STEM education “as the approach to teaching the STEM content of two or more STEM domains, bound by STEM practices within an authentic context for the purpose of connecting these subjects to enhance student learning” (p. 3).

Though an unlimited combination of the four disciplines can exist, what the above definitions all have in common is the integration aspect (combining, interconnectedness, and interdependence of the STEM disciplines), which is fundamental to implementing STEM as a “meta-discipline” (Vasquez, 2015). In their content analysis, Carmichael (2017) examined how all 50 states defined STEM in their policies, and four significant STEM models emerged:

1) Disciplinary STEM (Science, Technology, Engineering, Mathematics” addressed separately);

2) Integrated STEM (focusing on combining two or more disciplines to produce critical thinking, real-world application, and creative problem solving);

3) Disciplinary and Integrated STEM model that acknowledged both;

4) the model with no definition of STEM education (p. v).

Majority of the states (42%) used an Integrated definition (Carmichael, 2017)). Thirty percent used both Integrated and Disciplinary terminology, 18% of states had no definition in policy documents, and 10% of states used the Disciplinary model which resembles more traditional
methods that address disciplines one at a time (Carmichael, 2017). These models are some of the most common ways STEM education surfaces in education and confirm the use of integration as the preferred method of teaching STEM for many states. In their report ‘Early STEM Matters,’ the Early Childhood STEM Working Group (2017) explained that valuable opportunities for integration across STEM disciplines exist even in ECE. They acknowledge the fact that connections and distinctions amongst disciplines can provide children with a variety of rich, authentic STEM experiences.

**Stem Integration**

Vasquez (2015) posited that defining STEM can be a difficult task. She views “STEM teaching and learning as an inclined plane that has increasing levels of integration” (p.13), and labels the four levels as “disciplinary, multidisciplinary, interdisciplinary and transdisciplinary integration” (p. 13). Vasquez (2015) also perceived both multidisciplinary and interdisciplinary levels as valuable towards STEM instruction yet recommends moving up the plane to transdisciplinary integration. Transdisciplinary integration is viewed as the “most advanced level of STEM teaching and learning” and also the “hardest to achieve” (Vasquez, 2015, p. 12-13). Nevertheless, educators around the country are making attempts to use higher levels of integration as analysis of National Science Foundation confirm that majority of the NSF STEM projects for both pre-k and K-5 embrace a multidisciplinary and possibility transdisciplinary use of STEM teaching and learning (Mcclure et al., 2017).

To further support the use of integration, Kennedy and Odell (2014) listed integration “of technology and engineering into science and mathematics curriculum” (p. 246) as the first component needed in high-quality STEM education programs. They also recommended other essentials such as promoting scientific inquiry and engineering design, connecting students and
educators with STEM professionals, and using project-based learning in STEM teaching and learning. Similarly, Hansen and Gonzalez (2014) suggested that STEM education should be interdisciplinary to include disciplines beyond STEM fields, integrate technology, and focus on real-world problems. Though some (Vasquez, 2015) believe that STEM may not need to be taught through a problem or project, the use of problem or project-based learning when teaching STEM is often a foundational feature of STEM education (Aldemir & Kermani, 2017; Bencze, 2010; Hansen & Gonzalez, 2014; Kermani & Aldemir, 2015; Sias, Nadelson, Juth, & Seifert, 2017; Tippett & Milford, 2017; Trepanier-Street, 1993). When considering the above, STEM education is, therefore, a multidisciplinary approach to teaching that embraces the use of problems and projects to engage students, broaden their skills and deepen their understanding of STEM content.

**Engineering and Science**

**Engineering.** Engineering education in K-12 classrooms has been on an upsurge because using engineering design as a catalyst can bring all four STEM disciplines on an equal platform (Katehi, Pearson, & Feder, 2009). Engineering provides students with an efficient vehicle for solving real-world problems in STEM fields (Kelley & Knowles, 2016). For instance, Fan and Yu (2017) found that students who participated in a STEM engineering module outperformed students in the technology module in the areas of conceptual knowledge, higher-order thinking skills, and the design project activity.

In their analysis of NSF grant awards, McClure et al. (2017) found that engineering was the most valuable subject receiving the highest award amount when studied. However, only 25% of awards were geared towards engineering, demonstrating that there is more of a demand for engineering research than there are projects. Of the pre-K grants awarded Engineering was
likely to be studied with science and was (100%) paired with technology. They also report that Massachusetts also had one of the highest numbers of awards for Pre-K and K-5 STEM from the NSF. Shin, Recchia, Lee, Lee, and Mullarkey (2004) confirmed that Massachusetts is one of the only states that have developed engineering standards and has implemented a K-12 engineering curriculum.

Early exposure to engineering can spark interest in students and increase the likeliness of them selecting engineering as a career (Bagiati et al., 2010). Bagiati, Yoon, Evangelou, and Ngambeki (2010) found that though there was an increase in the number of online documents (not Web sites) related to PreK-12 engineering education published annually between 1991-2004, there was still a critical need for educators of young children to become familiar with the field of engineering. They suggested introducing engineering early and recommend the use of an engineering curriculum instead of a variety of activities encompassing engineering concepts.

Science has been widely linked to engineering design when considering best practices for teaching STEM due to their unique qualities (Honey, Pearson, & Schweingruber, 2009). Even in the workplace, both disciplines are equally valuable with scientists producing knowledge (facts) and engineers producing designs, products, and processes (artifacts) (Pinelli & Haynie, 2010). According to A Science Framework for K-12 Science, knowledge and understanding of science concepts alone will not be sufficient for success on future assessments which seek to validate what students can do (NGSS Lead States, 2013). The Next Generation Science Standards (NGSS) within the framework expects students to use what they “know” to investigate and solve problems using both scientific inquiry and engineering design. Additionally, there were eight science and engineering related practices for students to learn, describe, and perform. These eight practices (based on what professional scientists and engineers do) are:
1) Asking questions (for science) and defining problems (for engineering)

2) Developing and using models

3) Planning and carrying out investigations

4) Analyzing and interpreting data

5) Using mathematics and computational thinking

6) Constructing explanations (for science) and designing solutions (for engineering)

7) Engaging in argument from evidence

8) Obtaining, evaluating, and communicating information (p. 1).

The eight practices in the NGSS communicate what young children are expected to do within each age group, but it does not focus on a specific curriculum. The eight practices, however, can be simply incorporated into teachers’ lesson plans since they are interconnected and sequential. For instance, “asking questions” may lead to “modeling” or “planning and carrying out an investigation” (NGSS Lead States, 2013, p. 3). With support from teachers, students can become more advanced as their use of the practices increase and improve over time.

**Science.** The application of principles learned by students is fundamental in STEM education (Vasquez, 2015), whereas disciplines like math and science have traditionally been taught through memorization of facts and terms (Kermani & Aldemir, 2015). Tippet (2017) pointed out the difference between academic and intellectual goals in early childhood education and explained that academic skills could be learned as children are involved in intellectual endeavors they enjoy. They recommend STEM in ECE be explored through an inquiry approach instead of instruction that requires memorized information (Tippet, 2017). Similarly, Aguilar (2016) quoted a preschool teacher and her experiences with science instruction:

Children learn best through direct experiences that interest them and are important to
them. Ineffective ways…So often when grown-ups think of science, it is very rigid and about memorization and formulas, but that is not what is effective for young children. Right answers are not what is truly important for young children, asking them to memorize something that they have not been scaffolded up to learn and internalize yet, will not lead to long-lasting learning. (Aguilar, 2016, p. 49)

With so much easy access to information via computers, phones or through artificial intelligence software such as Alexa, Google, and Siri, researchers Capraro et al. (2013) advised that there is less of a need for memorizing large quantities of information. “Machines have also decreased the need for unskilled labor, making it vital that our students know how to apply concepts instead of merely understanding concepts” (Capraro et al., 2013, p. 28). Their view is that students instead need to understand how to gain information from reliable sources and apply this information in new ways.

Scientific Inquiry. Engaging students in inquiry-based instruction can be challenging for educators (Atkinson-Hamilton et al., 2017) however, scientific inquiry is essential for helping all students understand scientific and engineering practices (NGSS Lead States, 2013). The use of scientific inquiry in ECE builds on young children’s natural curiosity about the world around them while also preparing them for subjects such as literacy and mathematics (Maier et al., 2013). Middle school teachers using project-based inquiry saw better outcomes for students in high-stakes state exams and an increased understanding of science content and process skills (Hansen & Gonzalez, 2014).

The Mathematics and Science Partnerships (MSP), funded United States Department of Education, list mathematical and scientific inquiry and technological/engineering design as vital aspects in helping teachers to become highly qualified (Merrill & Daugherty, 2010). The report
STEM Integration in K-12 Education: Status, Prospects, and an Agenda for Research informs that “Scientific inquiry, engineering design, and PBL share features that can provide students with opportunities to apply STEM concepts and engage in STEM practices in interesting and relevant contexts” (Honey et al., 2009, p. 43). Along with the aforementioned, inquiry does not need to be limited to ‘science block,’ but can be optimized throughout the academic day to enrich students with 21st-century skills including students usually underrepresented in STEM fields (Carmichael, 2017).

Women and Minorities in STEM

Even though some progress has been made in recent years regarding graduation rates, there still seems to be an extreme disconnect in STEM disciplines. The low number of students who are STEM literate, majoring, graduating and working in STEM fields, particularly women and minorities, continues to be a national concern (Early Childhood STEM Working Group, 2017). The word minority refers to a group of people or things that comprise a smaller part (Minority, n.d.). In 2011, half the children born in the US were minorities, and minorities make up almost 40% of the population (U.S. Census Bureau, 2017). If current trends continue, by 2060 more than half of the U.S. population will be non-white (Kent, 2005). As the population of ethnic minority groups increases simultaneously, STEM grows as millions of STEM field jobs are created each year outnumbering non-STEM jobs three-to-one (Langdon, 2011). These prospects create an opportunity for this new majority to become a significant part of the workforce.

However, the nation is currently in a state of crisis when considering the demographics of those currently entering STEM professions. According to their research, Jacob (2017) found that underrepresented minorities in our country earned only 18.6% of all undergraduate degrees from a four-year college/university in 2010. Of those degrees, only 16.4% (of the 18.6%) were in the
science fields. To have a competitive and diverse workforce needed for STEM sustainability in the future, the inconsistency that exists in the U.S. education system cannot be ignored. For this reason, women and minorities have become fundamental in STEM education policy initiatives.

**Underrepresentation.** Content analysis of state’ goals and aspirations with STEM education revealed that 56% of states in the United States wanted to improve minority groups participation in STEM fields (Carmichael, 2017). Similarly, one of the first objectives of the National Research Council (2011) when looking for ways to advance K–12 STEM education was to increase the number of women and minority students who were involved in STEM areas. They explained that no child should be denied high-quality education in STEM because of their race, language, sex, or economic circumstances (Park, 2017).

Within the United States, girls and students from minority groups have been neglect and overlooked when it comes to STEM due to biases and stereotypes that limit their success as STEM learners (Early Childhood STEM Working Group, 2017). Culturally diversity approaches are needed when attempting to engage underrepresented groups that recognize their unique attributes, skills, and knowledge. In their policy report, the Early Childhood STEM Working Group explain that building self-efficacy in adults and children regarding their competence in STEM is indispensable. Changing the attitudes and beliefs of women and minorities about their ability to excel in STEM disciplines will change the landscape for how subjects are taught.

McClure et al. (2017) found that even though parents and teachers were enthusiastic about early STEM learning, they required additional knowledge and support to follow through with providing quality educational opportunities for their children. Part of the knowledge and paradigm shift requires the intentional inclusion of girls in every aspect of STEM learning and teaching (McClure et al., 2017). Blömeke and Delaney (2012) explained that girls in western
countries have had a significant disadvantage compared with boys in the mathematics achievement which can be linked to motivational differences and differences in the amount of prior knowledge between girls and boys. Educators perceptions of the children in their classrooms determine how supported children feel, so encouraging young children especially those under-represented will lead to better quality STEM education for many years to come (Early Childhood STEM Working Group, 2017).

**Summation.** A growing gap continues to exist when considering the number of students majoring and graduating in STEM fields compared to the vast demand for STEM workers here in the United States. As a result, many will not have the opportunity to benefit from the growing STEM industry unless early childhood leaders invest in STEM. Students need to be afforded early learning opportunities that boost creative critical-thinking and decision-making skills in order to change the trajectory of the current STEM workforce. A student’s success in STEM should no longer depending on their gender, family income and education, ethnicity or language background. Instead, early experiences and exposure with STEM disciplines can ensure that every child has a foundation in STEM literacy and possess 21st Century skills.

**Importance of ECE STEM**

**Child Development**

In their conceptual framework for STEM integration, Kelley and Knowles (2016) posited without program-wide strategic planning, STEM integration is insignificant and less effective. They add that planning should not only include curriculum development but should also include opportunities for ECE educators to grow in their knowledge of child development. In comparison to other teachers, preschool educators have a huge responsibility of providing a safe and nurturing environment for children all while molding the brains of young children from birth.
According to Zambo (2008), both practical knowledge and knowledge concerning child
development and child psychology are essential for ECE practitioners. They explain that those
who understand the Developmentally Appropriate Practices (DAP) associated with healthy brain
growth are better equipped to care for children and found that teachers get their information from
multiple sources with a mean of 3.7 sources per participant. Workshops (76%), magazines
(61%), and the Internet (59%) had the highest rating while courses (44%), television (36%) and
the source least marked was radio at (3%). This research demonstrated that though teachers had
more tacit knowledge from their experience in classrooms, they knew significantly less about the
specifics of the brain and its development or scientific knowledge about brain research.

Early Brain Development Research. The above study confirms that brain development
in children is a complicated process that takes place through interactions “with adults who talk to
them, hold them, and nurture them in a loving and natural way” (Zambo, 2008, p. 572).
Furthermore, the experiences children have from birth determine whether they build the
necessary skills that support higher-level functions, including memory, emotional and behavioral
regulation, and language (Stone & Lindsey, 1998). From the time an infant is born, 700 new
neural connections are formed every second; this means that during the first few years a baby’s
brain will create approximate 1,000 trillion synapses (Center on the Developing Child, Harvard
University, 2019). As the brain develops, the neurological circuits that are regularly used are
strengthened, while those that are not used are pruned away (Kuehn, 2014). Hence, birth to age
five is the most critical time to invest efforts for child development and cognition because of the
rapid growth of the human brain (Kok et al., 2015). One of the best ways to stimulate children’s
natural curiosity is through the use of STEM learning (Chesloff, 2013). Ironically some
educators, as well as parents, don’t believe teaching STEM is essential or developmentally
appropriate for preschoolers (Park et al., 2017). Children who attend preschools can attain higher levels of understanding in STEM when they are engaged in well-planned, stimulating and developmentally appropriate activities (Aldemir & Kermani, 2017).

**Poverty.** As confirmed by brain research, the first few years in a child’s life (the most significant window of opportunity) need to be filled with moments of healthy relationships and quality experiences with parents, caregivers, and communities that shield children from toxic stress (Stone, & Lindsey, 1998). Children who grow up in high poverty tend to face incredibly high levels of stress, are in constant fight or flight mode, and cannot learn if their psyche is bombarded daily by stress. Toxic stress is chronic unmitigated stress or repeated adverse experiences, such as physical or sexual abuse, neglect, and malnutrition (Kuehn, 2014). Early exposure to this type of pressure leads to social-emotional delays and higher rates of disruptive behavior problems well into the adult years (Woltering & Shi, 2016). Recent research confirms that toxic stress during the early years contributes to higher risks of cardiovascular disease and other physical ailments. Toxic stress also increases the likelihood that a child will fall behind developmentally and require special education (Kuehn, 2014).

So then, the likelihood of children from minority groups achieving success in STEM may be out of reach if they have not had high-quality ECE and have the odds stacked against them. Children who come from less economically privileged backgrounds are more likely to attend lower performing schools which do not adequately prepare them for basic math and science skills and the schools they attend are many times denied the resources they need (Gorski, 2013). These children are said to be 25% more likely to drop out, 50% more likely to require special education services, and 70% more likely to be involved in violent crime (Kuehn, 2014). As can be seen through these statistics, children who grow up in poverty benefit from positive early
experiences that pique their curiosity and interests through hands-on experiential learning as early in life as possible. Early STEM exposure will yield better results for all children and families and is beneficial to society in general.

**Developmentally Appropriate Practices**

**Foundations of DAP.** DAP in ECE lay a foundation for what high-quality teaching should encompass to yield positive outcomes for children between the ages of zero through eight irrespective of discipline (Kemple, 2017). Additionally, DAP is rooted in Piagetian and Vygotskian principles that mirror tenants of the progressive education movement. Lucy Sprague Mitchell, a student of John Dewey, was an advocate of providing children with opportunities to experience learning in the real world so that students could ‘touch’ and ‘feel’ the content before a teacher would teach it (Kemple, 2017). When creating a social studies curriculum, her curriculum did not resemble those of the current time, which typically focused on memorizing facts. Instead, she advocated that:

1) The younger the child, the greater the need for first-hand sensory experiences
2) One experience, fact, or idea needs to be connected in some way to another; two facts and a relationship joining them are and should be an invitation to generalize, extrapolate, and make a tentative intuitive leap…even to build theory
3) what children learn must be useful to them in some way and related to daily life and 4) play, and active learning are necessary (Kemple, 2017, p. 626).

Mitchell’s philosophies were consistent with the ideologies of developmentally appropriate practice later developed by NAEYC and are indispensable, especially if integrating STEM. Unfortunately, classrooms today still embrace methods that were viewed as ineffective almost a century ago (Kemple, 2017).
NAEYC. In the 1980s NAEYC discovered that many children who attended preschool programs were not kindergarten ready and preschool instruction was increasingly becoming more like the direct instructional practices typically used in elementary school (Brown & Lan, 2013). Practitioners, teachers, and educators of young children were utilizing kindergarten strategies to teach concepts children, so NAEYC adopted guidelines for developmentally appropriate practices (DAP). The first position statement was published in 1987, then revised in 1997 and revised for a second time in 2009 (Kim & Buchanan, 2009). The 1997 changes considered the influence of the environment (home and community) on a child’s development in addition to the inclusion of children with special needs. The 2009 revisions addressed three issues: 1) “reducing learning gaps and increasing the achievement of all children; 2) creating improved, better-connected education for preschool and elementary children; and 3) recognizing teacher knowledge and decision making as vital to educational effectiveness” (NAEYC, 2009, p. 4, as cited in Brown & Lan, 2013). All these factors impact DAP within various learning environments including teachers’ interpretations of these changes. Using quantitative survey data Kim and Buchanan (2009) found the Teacher Beliefs and Practices Survey (TBPS) to be an effective and reliable tool for examining teachers’ beliefs about DAP. This tool was specially designed to correlate to the new NAEYC guidelines for DAP in 1997 (Kim & Buchanan, 2009). The most recent position statement (NAEYC, 2009) makes it very clear that NAEYC is committed to excellence and equity in educating children and will revise and refine their understanding of how children learn and develop as needed (Carol Copple & Sue Bredekamp, 2009).

Characteristics of DAP. When considering DAP, it is important to note that DAP is not a checklist for a particular type of teacher to use with certain types of students (Brown & Lan,
Brown, Feger, and Mowry (2015) explained that DAP is a process of working with all children in a way that stimulates their thinking, provide opportunities for hands-on experiences and connect learning to children’s lives. They further explained that DAP should be utilized for all children and are not specific to a location or socio-economic status (Brown, Feger, & Mowry, 2015). DAP can be adapted to meet the needs of diverse communities (cultural, ethnic, and racial diversities) and young children with a range of disabilities, including those with severe cognitive, motor, emotional, and behavioral disabilities benefit tremendously from DAP (Filler & Xu, 2006). In their research, Brown, and Lan (2013) noted several challenges being faced by teachers when attempting to balance the specific needs of their students with the program goals. Yet, they recommended new research explore how DAP are impacting students instead of teachers.

So then, Alford, Rollins, Padrón, and Waxman (2016) used classroom observations to explore student engagement when teachers used developmentally appropriate instructional practices (DAIP). It was discovered that students in the classes of teachers with higher DAIP scores were more likely to be actively engaged in class activities and discussions. They were involved with exploration and hands-on learning that stimulated multiple senses. Students in classes with teachers who had lower scores were more likely to not be focused on learning activities. The findings advocate for the switch from “teach to the test” direct instructional methods where teacher use scripted lesson because these methods had adverse effects on student outcomes (Alford et al., 2016). Even with evidence to support DAP, a variety of factors cause teachers to merely concentration on direct instruction including accountability measures, pressure from parents and pressure from other teachers (Abu-Jaber, Al-Shawareb, & Gheith, 2010). A study of kindergarten teachers found that teachers who were embracing a more child-
centered style felt pressure from 1st-grade teachers who were more teacher directed (Parker & Neuharth-Pritchett, 2006).

An international study (Hegde & Cassidy, 2009) of a preschool in India documented unique data regarding DAP through the use of three different tools: 1) Teacher Belief Scale (TBS-B), 2) Instructional Activities Scale (IAS), and 3) Classroom Practice Inventory (CPI). Hegde and Cassidy (2009) determined that though teachers may have appropriate beliefs about DAP, teachers’ beliefs and DAP practices did not always align. They also found that DAP did not decrease as students went to the next grades and that teachers’ education levels did not significantly impact teachers’ use of DAP as assumed here in the United States. Lastly, teachers who were considered congruent (DAP beliefs matched DAP practices), had lower classroom ratios. This research confirms that positive beliefs backed-up by effective practices along with smaller class sizes are beneficial in creating higher-quality experiences for children.

In their examination of the beliefs of Jordanian kindergarten teachers toward DAP, Abu-Jaber et al. (2010) found that teachers had high beliefs toward DAP. However, the teachers struggled to maintain shared relationships with families. Research results also noted that older teachers’ beliefs were more developmentally appropriate than younger teachers. Without an understanding of DAP, teachers, as well as parents, can misconstrue what learning experiences should be in ECE uphold inappropriate expectations. Researchers recommend the use of in-service training on DAP to help teachers plan activities that actively engage children (Abu-Jaber, Al-Shawareb, & Gheith, 2010).

**DAP Lessons.** Brown, Feger and Mowry (2015) suggested lesson plans that interest children and provide the right amount of rigor requires teachers to monitor students closely and involve multiple modalities such as large group activities (whole group, in-door & outdoor),
small group instruction (teacher-led, student-led, center-based instruction) and loud and quiet spaces. They also explain that in ECE, standards should be revisited often so that young children have time to build on content (Brown, Feger & Mowry, 2015). When appropriately applied, DAP brings about individualized support to children all while still maintaining the high expectations that parents and teachers want to see. Findings from Brown and Lan’s (2013) meta-synthesis demonstrated teachers use of DAP such as the ones listed above have a positive impact on children’s cognitive development.

**Play and Rigor.** When children are having fun playing, there is often the assumption that they are not learning and need more challenging work. On the contrary, children can perform at even higher capacities when the learning environment incorporates activities that encourage play (Bodrova and Leong, 2001). Furthermore, critics of play in ECE confuse academic difficulty with the academic rigor of preschool years. Play and rigor are not mutually exclusive, and can both coexist within ECE classrooms where children are excited about learning. A study (Nikolopoulou, & Gialamas, 2015) of 190 early childhood teachers in Greece examined the link between early childhood teachers’ beliefs about information and communications technology (ICT) and play in ECE. Research results proved ICT play was a valuable mode of learning for young children and should not only be considered a free play activity (Nikolopoulou, & Gialamas, 2015). Young children should have various opportunities to engage in traditional play while also embracing new digital tools (Verenikina et al., 2010).

**Developmentally appropriate software.** Employing the use of technology in a meaningfully way to deliver instruction is critical at the early childhood level especially when integrating STEM. Potter, Johnson, and Hutinger (2006) explained developmentally appropriate software as software that allows for:
1) Exploration,

2) Provides engaging problem-solving opportunities,

3) Allows for student control of their own learning,

4) Stimulates interest in the content,

5) Encourages active involvement, and

6) Provides practical and non-threatening feedback (Potter et al., 2006).

When technology use bleeds into formal learning activities (such as above), students receive a more enhanced experience with the curriculum.

Researchers, Ntuli and Kyei-Blankson (2011) conducted a mixed method study using an online survey and interviews to examine early childhood teacher views on developmentally appropriate software and other factors related to technology integration. Results found all teachers (n=56) viewed educational content, ease of navigation, the ability of the software to allow for active involvement and maintain children’s interest as essential factors. More than 80% of the teachers viewed exploration and problem solving as very important. Conversely, in another research study, Ihmeideh (2009) found that teachers felt software related issues negatively impacted technology use. Teachers had software programs that were not age-appropriate, and most of the software was in English. Jordan preschools needed more Arabic software that also incorporates children’s culture, religion, and habits (Ihmeideh, 2009). It is imperative when considering the developmental appropriateness of software to check the curriculum alignment and the software’s ability to echo diversity (Ntuli & Kyei-Blankson, 2011). Ntuli & Kyei-Blankson (2011) also pointed out that software on classroom computers and iPads should not contain violence because exposure to violence can ultimately affect social-emotional
development. Evidently, numerous elements need to be considered in regard to the developmental appropriateness of software and technology tools for preschool children.

**Summation.** Children should love learning and enjoy the benefits of using available DAP technology as they learn STEM concepts through play. Without enriched experiences in STEM disciplines, many students lack the confidence or the competence to choose careers in STEM fields. Teachers also need to be well supported to create engaging opportunities for children. Early childhood programs that provide DAP, hands-on and child-centered experiences offer children a chance to gain crucial skills required to succeed regardless of their race, language, sex, or economic circumstance. The earlier in life children are gain educational practices that are appropriate and challenging enough to pique their curiosity and interest, the better the results are long term.

**ECE STEM Leadership Development**

**Organizational Challenges**

With an increased emphasis on STEM integration in Higher Education and K-12, ECE administrators have the immense task of orchestrating school-wide implementation of STEM (Vasquez, 2015). At the same time, specific organizational factors within ECE pose significant threats to STEM integration. Aldemir and Kermani (2017) supposed that some of those challenges specific to ECE include:

1) Inconsistency between various funding models (e.g., profit, non-profit, federally funded, state-funded)

2) Children’s participation in ECE is voluntary (based on each family’s choice)

3) Lower pay and credentialing of teachers in comparison to K-12, and

4) Lack of relevant classroom-based STEM training (p. 1694).
Insufficient professional preparedness or training can cause ECE teachers to lack self-confidence in teaching STEM areas, feel increased pressure and anxiety towards STEM and can create discomfort with STEM subject matter (O’Brien, 2010). Also, other factors including teacher-child ratios, curriculum practices and the design of the learning environment contribute to the quality of experiences children will receive in their preschools (Aldemir & Kermani, 2017).

**Challenges in ECE Profession**

**Turnover.** Russell, Williams and Gleason-Gomez (2010) also conducted a related study in order to determine the degree to which several factors such as teachers’ ages, pay, benefits, and administrative support predicted the longevity teachers work at a preschool. Results found low salaries/wages and inadequate benefits being predictors of teacher turnover in ECE. At first glance, turnover and STEM integration seem like two unrelated subjects; however, dealing with turnover can be expensive as it requires new employee training and buy-in from staff. Devoting countless hours and dollars on training an employee that later leaves the organization can be very frustrating for many ECE administrators. Turnover disrupts the continuity of care of young children, and places added stress on current teachers (Russell, Williams, & Gleason-Gomez, 2010).

**Lack of Technology.** Though the lack of financial and human resources could be challenging for many in ECE, without proper support training and guidance, STEM is ineffective. Nikolopoulou and Gialamas (2015) investigated barriers to the integration of computers and other similar technology tools in early childhood settings, from the perspective of Greek early childhood teachers. A 26-item questionnaire administered to 134 early childhood teachers in Greece identified four overarching factors. The four factors were “lack of support,” “lack of confidence,” “lack of equipment,” and “class conditions.” Researchers found that in
Greece as in many other parts of the world, there is insufficient funding for purchasing technology or fully funding initiative and insufficient support for teachers. Teachers attributed insufficient technical, financial and administrative support together with the lack of funding as key reasons to why their use of technology reduced (Nikolopoulou & Gialamas 2015). Though challenges exist that create barriers to STEM integration, leadership and various models of professional development can create spaces for STEM integration to thrive in ECE.

**Professional Development**

**STEM Integration.** The successful integration of STEM that increases retention (1) focuses on innovation, (2) consists of a curriculum where students can productively discuss ideas, and (3) allows students to create their own ideas using existing technologies (Kelley & Knowles, 2016). When reviewing lesson plans of 39 third- to fifth-grade teachers who attended a week-long summer PD focusing on STEM integration, Sias et al. (2017) found that teachers were more inclined to use moderate levels of innovations in their lesson plans even though student-centered and project-based learning were among the most represented in the results. They explain that problem- and project-based learning was taught implicitly, and lesson plans rarely included family involvement in learning. The authors suggest that PD needs to be offered to help teachers provide a higher level of educational innovations that support 21st-century skills and to bridge the gap between classroom and community.

Aldemir and Kermani (2017) also found that with support PD, ECE teachers gained an understanding of how to purposefully integrate STEM into early childhood classrooms. The two lead teachers in the 10-week intervention group received a total of 10 hours of professional development in STEM integration and noted that they felt more fulfilled regarding their teaching abilities when they saw the enthusiasm children had for STEM concepts. The creation of such an
environment required teachers to use child-centered learning, active engagement, peer interaction, teacher scaffolding, and a variety of materials (theme-related science kits, iPad technology for each classroom and building hardware and construction toys for engineering projects) (Aldemir & Kermani, 2017). Additionally, with the majority (83%) of the children in their study (Aldemir & Kermani, 2017) being African-American, Hispanic and multiracial, the authors advocated that STEM integration in ECE in developmentally appropriate ways help to close the achievement gap that places minorities children at a disadvantage.

To integrate STEM successfully in ECE would require an improvement in the quality of education provided for children so that they have the skills needed to compete globally (Aldemir & Kermani, 2017). High-quality teaching and learning is a challenging task for many who hope to produce positive outcomes in STEM education. Ring, Dare, Crotty, and Roehrig (2017) found that sustained PD endeavors (i.e., three weeks), and allowed teachers to be reflective and collaborative made a significant impact. This type of PD improved teachers’ views of STEM as their conceptions became more detailed and complex each week. Due to the time and effort required from teachers, they must see integration as a significant component of teaching STEM and believe in its benefits. They also point out that teachers and administrators need to collaborate often, have shared goals and an understanding of what classroom models should look like within their schools (Ring, Dare, Crotty, & Roehrig, 2017).

In their research on Elementary Engineering Teacher Professional Development (EETPD) Boots (2013) found teachers defined a successful implementation of Teacher Professional Development (TPD), critical opportunities for teacher buy-in, a nurturing environment for professional growth, and strong partnerships with engineers were necessary. On the other hand, in Singapore two STEM school teachers (Teo & Ke, 2014) found that having a
laser focus specialization in STEM can cause teachers to become an anomaly, having STEM skillsets that exceed their current work environments. They caution that teachers should be able to transition to mainstream schools if they are not able to teach at a specialized STEM school.

When studying adaptive teaching strategies used by a novice teacher, Allen, Webb, & Matthews (2016) recommend that teachers have:

1) an established Pedagogical Content Knowledge (PCK);
2) a constructivist paradigm of teaching and learning and
3) the ability to draw on a vision while reflecting on and during teaching to help negotiate challenges in their teaching contexts are well positioned to engage in the process of adaptive teaching (Allen et al., 2016, p. 218).

The case study proved that novice teachers could become more adaptive and use constructivist and inquiry-based teaching when supported through professional development and mentoring. Another characteristic of developing PCK was the emotional aspects of becoming and being a STEM teacher which comes through reflective thoughts. The teacher in this study said multiple times that she envisioned herself as the teacher she wanted to be (Allen et al., 2016). Self-reflecting and developing a healthy attitude is an indispensable quality for educators especially those involved with STEM integration.

**Teacher Self-Efficacy.** Educators feelings about their abilities to integrate STEM will either have a positive or negative impact. Maier et al. (2013) described self-efficacy as a teacher’s confidence in our judgment of their teaching ability to produce positive student outcomes. The findings revealed that teacher comfort, child benefit, and challenges affect the quality of science instruction. There was a positive correlation between teacher attitudes, beliefs, and the activities used in the classroom. Other factors such as lack of knowledge, materials, and
time took a toll on the quality and quantity of science instruction (Park et al., 2017). Whether or not teachers feel supported by their leaders influences a teacher’s self-efficacy and impacts the amount of time teachers dedicate towards science. A pre-k teacher shares her experiences:

We are departmentalized, so I do not get to teach science very often. In Pre-K–2 much emphasis is placed on learning to read, write, and comprehend. Math instruction is also emphasized. Our administration is very adamant that we only teach reading, writing, and math in first grade. She said our only focus should be getting all children reading on grade level and scoring proficient on MAP [Measures of Academic Progress] testing. Unfortunately, that leaves little to no time to teach all the components of STEM education in my classroom. (p. 284)

Unfortunately, the issue of time is a struggle for many schools. Early childhood teachers have felt the pressure to place more emphasis on literacy and math skills and neglect other content areas in order to make children ‘ready’ for kindergarten entry (Parette et al., 2010). Despite reform efforts, there is an overall lack of STEM teaching at the Pre-K level because the majority of academic learning time is being devoted to language arts and mathematics, “Pre-K teachers seldom teach science, and exploring engineering ideas is rarely part of Pre-K learning” (Parette et al., 2010, p. 68). Furthermore, Dossani (2016) noted that currently less than 5% of the time in formal ECE settings is devoted to STEM learning due to the importance placed on numeracy and literacy. There is no excuse for neglecting STEM any longer. Canadian researchers, Tippett and Milford (2017) explained that the core elements of STEM are synonymous with ECE fundamentals such as questioning, exploring and observing, developing skills and processes, communicating, and playing. Early experiences are vital for brain development, and exposure to
STEM in ECE can promote growth in a variety of skills including literacy development (Early Childhood STEM Working Group, 2017).

**Technology Integration.** A qualitative study designed by Keengwe, Kidd, and Kyei-Blankson (2009) to examine factors affecting ITC implementation found overarching themes associated with successful ITC adoption as organizational support, leadership, training and development, and resources. Participants of the research were faculty, instructional designers and a variety of staff. Findings from this study provide insights on how administrators and technology leaders could help their faculty and staff to implement appropriate ICT tools and practices to improve student learning. There were the three factors that came up: 1) better leadership to clearly articulate the mission, vision, and goals of technology initiatives; 2) faculty training and development that provided guided practice, examples, and remedial support in using the tools; and 3) organizational support in the form of peer support, cross-collaboration with other faculty using technology, or even rewards programs to attract and motivate faculty. Furthermore, without aligning student learning outcomes and objectives with the technology, it becomes more difficult to enhance teaching practices efficiently (Keengwe, Kidd, & Kyei-Blankson, 2009).

Leadership is a significant part of affecting positive change when wanting to integrate any form of technology. It is necessary for the entire school to understand the significance of the change and for well-built structures to be put in place to support the new initiatives. Sugar (2005) explored an alternative method to instruct public school teachers on how to integrate technology in their classrooms through a situated professional development technology program. One technology coach was paired with nine teachers and results from this study show that in order to be successful teachers need personalized training (such as this coaching model) focused on their
technology skills and classroom environment. Also, training should effectively address their confidence (or lack of) in using these technology skills. The benefits of this coaching model were extraordinary and could be a model that can be replicated in various ECE classrooms.

In addition to coaching, Keengwe et al. (2009) suggested a need for cross-collaboration amongst faculty. Though that study was conducted amongst the faculty of Higher Education Institutions, incorporating that strategy could prove to be very beneficial for ECE teachers as well. A Hong Kong study (Ho, Lee, & Teng, 2016) done to investigate the relationship between teacher qualifications and school-based professional learning community (PLC) practices in ECE proposed that there be a significant relationship between school-level teacher qualifications and teachers' perception of school-based PLC practices. Overall, the researchers found that the higher the level of education teachers had, the more they were willing to participate in PLC activities. Even though ECE teachers may have lower qualifications than public school teachers, the study provided focused on how PLCs contribute to school improvement because they provide a professional community among teachers and organizational learning (Ho, Lee & Teng, 2016). Whether through coaching and mentoring or PLCs, schools should invest time into creating and providing a technology policy for early childhood teachers that lays out how to appropriately incorporate technology into their curriculum and throughout the school (Blackwell et al., 2014).

**Distributive and Pedagogical Leadership for STEM**

Because of the uniqueness of ECE, leaders in childcare centers often try to make the best use of what they have while using creative ways to reach teachers, parents, and other community stakeholders. Though more recent researchers (Heikka et al., 2013) have suggested the incorporation of distributed leadership (DL) within early childhood settings, many leaders are unaware of how to successfully use a distributed approach to leadership in the ECE setting. One
goal of ECE is the provision of quality education for young children. Lin and Lee (2013) conducted interviews with preschool staff and found that before decisions can be made about how to implement a curriculum effectively, leaders must first have a clear mission and understand prior instructional methods. The way systems have been developed in the past can have a significant impact on whether new strategies are embraced. Lin and Lee (2013) also recommend carefully selecting a group to help organize, lead and evaluate the progress of curriculum programs.

Nicholson and Kroll (2015) explained that leaders with the ability to echo sound judgment to tackle everyday adaptive challenge (Nicholson & Kroll, 2015; Kangas et al., 2016) act in wiser ways. They are more likely built trusting relationships and encouraged leadership approaches that reflected improved social justice for those in the ECE community. PD towards distributed leadership in Finland suggest the need to lessen centralized, top-down controlled leadership and develop concrete changes in practical work for all staff which emphasizes staff expertise, guidance, and counseling (Kangas et al., 2016).

Constructing a system for assigning responsibilities to those within and outside preschools takes intentionality and strategic planning (Heikka & Waniganayake, 2011). Focus groups findings in Finland reported that the more administrators, teachers, and leaders connected, DL improved, however time allocation for knowledge sharing, planning and dialogue was problematic. Prioritizing tasks into numerous categories served as a foundation for effectively disseminating task. In addition, careful analysis of strengths and weakness help in determining how roles are assigned even in teaching assignments. Ryan, Whitebook, Kipnis, and Sakai, (2011) highlighted the need for considering leadership in the hiring process as well. They found schools how ranked very well hired administrators with competitive credentials in ECE.
Ho and Lin (2011) recommend that teachers with diverse styles be purposefully grouped with the intention of cooperation and communication among teachers to maximize learning outcomes. Armstrong, Kinney, and Clayton (2009) found novice teachers were more willing to participate in leadership if they had the backing of their principal through mentorship and have re
given a chance to lead. When healthy relationships support additional leadership roles and mentoring opportunities (especially for beginning teachers or new staff) a culture of leadership practice is more readily embraced and generates a sense of ownership in many, including the

students (Shin et al., 2004). Distributed leadership (DL) provides an opportunity for a culture of growth and development within preschools where the expertise of stakeholders is acknowledged, appreciated and applied (Heikka et al., 2013).

**Summation.** Throughout various studies in ECE, DL has been found to be a practical approach to increase program quality and to effectively spread leadership roles to include all who work and engage with preschools programs. Information gained from the literature expressed the complexity and fluidity needed from leaders and followers within ECE contexts due to the uniqueness of ECE in comparison to K-12. In examining the evidence, professional development that is ongoing and provides hands-on learning experiences for teachers is significant for increasing teachers content knowledge and build their confidence STEM. The literature examined provided insight into how preschools can focus on their own specific situations and circumstances and shift from traditional leadership practices that promoted top-down structures. Instead, they can embrace ones that include clear school-wide objectives for STEM, opportunities for collaboration and critical reflection, and promotes strong school culture amongst teachers, administrative staff as well as children and their families.
Literature Review Summary

ECE as a profession faces some unique challenges. However, unless schools, communities, and countries, work together to promote STEM integration, many children between the ages of zero to five will lose out on meaningful experiences. To better understand the significant elements of STEM in ECE I have explored several topics in the literature review: 1) the various way in which STEM is defined including examples of various studies related to the disciplines, 2) the need for increasing the number of women and minorities in STEM, 3) the critical role DAP play in providing high-quality STEM experiences for young children (regardless of their background), and 4) the use of effective PD and distributed pedagogical leadership. The information from the literature reveals that many preschools are already utilizing a useful way to incorporate STEM disciplines.

What is not noted within these studies is how teaching practices regarding STEM integration are supported by school leadership. Due to the limitation in existing literature, it is essential and urgent that we explore how to keep the integration of STEM relevant and robust in preschools because this can potentially increase the number of STEM proficient workers, STEM literacy in all citizens, and the development of scientists and engineers. Furthering the exploration of STEM integration in ECE will challenge the current system where children from underprivileged backgrounds and those who are typically underrepresented in STEM miss out on high-quality learning experiences. However, this will require the collaborative efforts of teachers, support staff, local and state governments, parents as well as community leaders. Additional research should focus on determining how school leaders in ECE prioritize and plan for STEM integration within the context of their unique school setting. This is of high
importance and can contribute vital information concerning the gap of STEM leadership in ECE.

The next chapter will discuss the methodology of this study.
Chapter Three: Methodology

Introduction

Early sciences, technology, engineering, and mathematics (STEM) experiences allow young children to create, problem solve and explore, which can ultimately spark enthusiasm for STEM learning (Mcclure et al., 2017; Tippett & Milford, 2017). However, STEM (particularly engineering design) can be a complicated process for various reasons including; teacher certification, professional development, and the limited number of curriculum developers that have the pedagogical knowledge and engineering experience (Pinelli & Haynie, 2010). Therefore, it is essential to understand how the process of STEM integration takes place in an ECE setting despite common barriers to STEM integration existing in preschools today. This study explored the pedagogical and leadership practices of ECE educators when integrating STEM throughout a preschool as well as explore how these practices impact children and families. This case study determined how and in what ways STEM integration can be improved in preschool environments. Specifically, the following research questions were explored:

1) How do teachers integrate STEM practices in ECE settings?
2) How do preschool directors support STEM integration within ECE settings?

The next section of this chapter addresses the research design and tradition. A description of the recruitment and sampling procedures that were followed are also included. Then, data collection, storage, and data analysis are reviewed. The chapter concludes with a discussion of the reliability, validity, and trustworthiness of the design of the study.

Research Design

Qualitative research describes and interprets experiences of participants, finding themes and patterns within the data (Ponterotto, 2005). Qualitative research can reveal how various
components of a complicated situation work together to make a whole and helps to “explain the meaning of social phenomena with little disruption of the natural setting as possible” (Merriam, 1998, p. 3). As such, this study utilized qualitative research to determine how teachers were integrating STEM into their classroom activities and examined how preschool directors managed this integration. To gain a better understanding of participants’ experiences that have been involved with STEM integration, multiple data sources (interviews, observations, and a focus group) were explored.

**Research Paradigm**

The interpretive-constructivist paradigm views knowledge as something to be constructed by people and their interactions with their social environment (Baxter & Jack, 2008). The researcher chose the constructivist paradigm for understanding educational practices used in STEM because the integration process can occur differently depending on the context. Within this paradigm, multiple truth can exist at the same time (Ponterotto, 2005), and the reality of STEM in preschool will be primarily constructed by the teachers and leaders that are going through the experience and processing it. Participants in this study had the opportunity to give voice to the experiences of teachers that implementing STEM within their school, and this provided a context for understanding the different ways they construct knowledge. The researcher’s experiences in ECE as an observer and trainer for preschool teachers provided a lens for how STEM integration should be executed. However, the researcher was aware of their own construction of knowledge and was intentional about not projecting these views onto any of the participants.
Research Tradition and Rationale for Case Study Design

The selected approach for this research project is the qualitative case study (QCS) approach which is a process that explores a bounded case over time and location (Boblin, Ireland, Kirkpatrick, & Robertson, 2013). A case study investigates a contemporary phenomenon in its real-life context using multiple sources, each with its own sampling (Pegram & Phil, 1999). Though they do not always have well-defined and well-structured protocols, case studies are one of the most frequently used qualitative research methods (Yazan, 2015) and typically focus on answering “how” and “why” questions. An exploratory single-case study approach (Baxter & Jack, 2008) was utilized instead of multiple cases because it helped to increase the understanding of the complexities involved in the STEM integration process in the context of a preschool that was already involved in the process. The single-case allowed for more depth (Merriam, 1998) in studying the processes and relationships within the preschool. Case studies can be described as particularistic, heuristic, or descriptive (Merriam, 1998). A descriptive case study was applied to describe the experiences of participants related to STEM integration and to investigate research questions. In addition, the use of “thick descriptions” (Brown, 2008, p. 3) revealed the complexities of STEM integration in preschool settings through diverse sources and various viewpoints.

Context. The case in this study is bounded by the pedagogical and leadership practices within a preschool program, ABC Preschool (pseudonym) in a large county in a Southeastern State. ABC is a non-profit preschool that has been serving children that range from the ages of two to six years old for over 25 years. This particular case study examined various elements that were integral for the STEM integration process at this particular program including teachers, parents, curriculum and school leadership. This case was chosen due to the fact that ABC’s
educational philosophy is founded on principles that promote independence, curiosity, and creativity into its daily practices, which encouraged preschool STEM integration.

**Participants**

The sampling process was guided by the need to include: 1) At least two administrators, 2) Four to six teachers that have worked at the program for at least one year and 3) Two classrooms with pre-school aged children (three to five years old) that consistently utilize STEM integration practices. Merriam (1998) recommended that a small number of participants will yield substantial opportunity to establish themes of the case. For that reason, participants were purposefully selected (Creswell, 2013) for participation in interviews, observations, and a focus group. Two administrators were selected for a semi-structured interview. Instead of analyzing separate transcripts, the researcher interviewed the two administrators together to gain a more holistic understanding of practices put in place to support STEM. Based on recommendations from the director, two teachers who display frequent use of STEM integration were selected for follow-up interviews after observations.

In addition, teachers with varying levels of teaching experience were selected to comprehend how distributive leadership practices impact teachers’ ability to integrate STEM. Participation of the following teachers was solicited for observations, one teacher with five years or less of pre-k teaching experience and the second teacher being a degreed teacher with six or more years of teaching experience. Unlike K-12 where all teachers are required to have a bachelor’s degree, this is not always the case for ECE where years of experience significantly impact teacher self-efficacy (Mansfield et al., 2012). However, with the complexities involved with STEM integration, both education and teaching experience contribute to increasing teachers' pedagogical content knowledge (Park et al., 2017). Selections of the teachers were made based
on teachers who meet the requirements and are willing to participate in the study. Two teachers participated in follow-up interviews at the end of the observations.

This homogeneous sampling (Creswell, 2013) ensured that all participants had access to the same PD throughout the year and were responsible for STEM teaching. This sample size allowed for a thorough investigation of the experiences, impressions, strategies, and knowledge of the participants. STEM integration was defined as “the approach to teaching the STEM content of two or more STEM domains, bound by STEM practices within an authentic context for the purpose of connecting these subjects to enhance student learning” (Kelley & Knowles, 2016, p. 3).

**Recruitment and Access**

Participants were recruited to understand better how the pedagogical and leadership practices at ABC influenced STEM integration through a distributive approach lens (Spillane, 2005). The researcher's past relationship with an individual at the research site was integral for increasing access to key stakeholders for this study with the understanding that participation is voluntary. Participants were recruited based on their availability and recommendations from the preschool director. The director recommended two lead teachers for observation follow-up interviews and four teachers for the focus group interview. Light refreshments were provided during the focus group and stipends of $25.00, in the form of a gift card, were offered to all the selected participants.

Immediately before interviews, chosen participants received a Statement of Consent form (Appendix A) for their review and to sign. The Statement of Consent was read aloud to participants before the interviews began. Before being asked to sign the Statement of Consent, participants’ questions were answered, and they were made aware that they were audio recorded.
The Statement of Consent outlined the purpose of the study, the role of the investigator, the potential risks, what is being asked of participants including a potential time commitment, the voluntary nature of their participation, procedures for maintaining the confidentiality of the data, and potential benefits. Participants gave consent to participate in the study by signing the Statement of Consent. Signed copies of consent forms were stored in a locked storage cabinet. Participants were made aware that they had the right to withdraw from the study at any time without penalty and that their participation did not have any effect (positive or negative) on their employment status.

Pseudonyms were used for the preschool (ABC Preschool) and study participants. Names and any other identifying information collected during interviews, focus groups, observations, and document analysis were eliminated from written transcripts in preparation for the data analysis. All transcripts were coded, data were stored on a password-protected computer, and printed materials were filed in a locked storage cabinet. Potential risks associated with participation in the study are unlikely and of low probability. Participants are going to be asked to self-report information about their experiences as part of the STEM initiative and share the ways in which STEM is currently being integrated throughout the school. These questions have the potential of minimal psychological risk if participants are upset or reluctant to share their professional or personal experiences, but there is no foreseeable harm. These procedures and protections were followed in accordance with the Northeastern University Institutional Review Board (IRB) and approval from the IRB were sought by submitting the required application, consent forms, and recruitment materials about two months prior to the start of this research study. The researcher will also seek approval from the IRB in the school district before making contact with school administrators to conduct the study.
Data Collection

Typically for case studies, data can be collected from a variety of sources such as interviews (individual and group), direct observations, and documentation (lesson plans) (Merriam, 1998). Using multiple sources of evidence highlights one of the strengths of case study data collection in comparison to other methods. However, the researcher was cautious regarding the complexities that exist with working through vast quantities of data (Baxter & Jack, 2008). The primary means of data collection for this study was three semi-structured interviews (one with school administrators and two with teachers), two direct observations, one focus group interview, and document analysis including the researcher's detailed notes, reflections, thoughts, and emotions.

**Interviews.** Interviews are the most common source of data in case study research and are defined as a purposeful conversation by Merriam (1998). Merriam (1998) also explained that interviewing is necessary when we cannot directly observe what we are interested in learning about. For this case study at ABC, interviews are useful for learning the school culture, which fosters daily STEM. The goal of the researcher was to interview the preschool administrators and teachers with engaging, open-ended questions in an unbiased friendly manner (Yazan, 2015). The Interview Protocols (Appendix F and Appendix G) addressed components of PL, DL, STEM integration, and ECE.

**Observations.** As part of this single-case study, direct observation was incorporated as another means to collect data within the natural setting of the case (Merriam, 1998). Two observations took place, one in the morning and one in the afternoon both lasting two hours in order to get an accurate reflection of a typical day at ABC. Observations of how STEM disciplines are combined as well as the developmental appropriateness of activities were
observed during small group instruction as teachers flowed from the indoor to the outdoor classrooms. Furthermore, observations focused on teachers and their instructional practices and not on students. No identifying information about students was noted or recorded such as student names or demographics. The ways in which teachers integrate STEM into their lessons and activities provided additional evidence to corroborate and triangulate other data sources such as the interviews and documents.

**Focus group.** A focus group can be defined as an “interview on a topic with a group of people who have knowledge of the topic” (Merriam, 2009, p. 93). The focus group was the preferred approach with the teachers (at least four) so that the free-flowing interpersonal discourse of the group could aid in understandings the practices utilized during STEM integration. In addition, with focus groups, teachers got an opportunity not only to respond, but also hear responses from colleagues and made additional comments beyond their initial thoughts. Because this study sought to find benefits and challenges with STEM, a focus group presented a non-threatening method for teachers to share their feelings, attitudes, and perceptions (Stewart, & Shamdasani, 2014). The researcher was aware that there was a risk of the group conversations being dominated by certain individuals and getting off script (Merriam, 2009), but took these factors into consideration and encouraged each teacher to take part in the conversation. The Focus Group Protocol (Appendix H) was used to ensure that the conversation reflected desired topics.

**Document analysis.** In addition to the data documented in transcripts from interviews, and focus groups, the researcher collected secondary sources of data in the form of documents. The documents include the school's website and a white paper which were analyzed for elements
of STEM and DAP. During each site visit, and after each visit, the researcher wrote analytic memos. Writings included descriptive notes, as well as emotions, thoughts, and reflections.

**Data Storage**

With the consent of participants, interviews and focus groups were audio-recorded, and observations were documented through field notes. Participants were identified as Administrator A and Administrator B, Teacher A through Teacher F. To ensure confidentiality all files, notes, and sources of data utilized these pseudonyms and any identifying information were removed from all documents. Materials were organized by data types (interviews, observations, focus groups, and documents) and digital files were housed on a password-protected computer, and printed materials were filed in a locked storage cabinet only accessible to the researcher. A backup of files was secured on a hard drive stored in the locked cabinet. Once the research was completed, all printed materials and computer files were deleted, excluding the informed consent documents that are kept for three years. To ensure confidentiality throughout the data collection process, the researcher was the only person with access to these files and documents.

**Data Analysis**

Merriam (1998) suggested that the goal of data analysis in the case study is to communicate understanding from multiple sources of data and she suggests that both data collection and analysis occur simultaneously in qualitative research (Merriam, 1998; Stake, 1995). There are no cookie-cutter routines and procedures for analyzing data, which makes analysis more problematic for novice researchers (Yin, 2009). Therefore, the analytical process proceeded with three separate phases of data collection and analysis to simplify the analysis process. This included conducting an administrator interview, then observing two sessions at ABC, and lastly conducting a focus group interview (with teachers). Once data was collected
during each phase, coding and analysis began through data condensation, data display, and drawing conclusions (Miles, Huberman, & Saldaña, 2014). Figure 3 shows how the researcher proceeded with the data analysis process.

**Figure 3. Data Collection and Analysis Sequence**

**Pre-Coding.** Yin (2009) suggested that researchers should have or create case study databases (to organize data) and maintain a chain of evidence. Prior to beginning the first rounds of coding during each data collection phase the researcher developed a system for organizing the data (e.g., according to the participant) and then immersed into the data reading, studying, and highlighting particularly rich passages and quotes. After acquiring a working knowledge of data, the researcher started with first cycle coding using open and in vivo coding method (Miles et al., 2014.)

**First cycle.** Through using open coding initially, primary labels were used to record significant topics that come up in data sets. Next, In vivo coding (Miles et al., 2014) was used to identify words and short phrases stated by the participants to reduce researcher bias (Creswell, 2013). According to Miles, Huberman, and Saldana (2014) when the exact words of the
participants are used, this increases validity. Codes were later refined and analyzed for frequency (Miles et al., 2014). The researcher allowed codes to emerge from the interview data rather than using a preconfigured coding system (Miles et al., 2014). During this stage, the emerging information from these two different rounds of coding, open coding followed by in vivo coding aided in the construction of the follow-up interview questions as part of the second phase of data collection. Each phase of data collection and analysis strengthened the subsequent phase.

**Second cycle.** The second cycle was a way to reorganize and reanalyze data that was coded in the first cycle coding (Miles et al., 2014). During the second cycle, the data was also analyzed for themes and patterns. Pattern coding identifies similarities, frequency, sequencing (specific order of events), correspondence (something happening in relation to another event) and causation (Miles et al., 2014). This round of coding lead to emergent themes to answer the “how” and “why,” of ECE leadership and STEM integration (Yin, 2009). Coding took place on hard copies of the transcript initially, and then computer generated charts and tables were used for coding and sorting the vast volumes of data. Nevertheless, the researcher “played with the data,” (Yin, 2009, p. 129) to determine significant patterns related to the original research questions. After themes emerged and codes were grouped by theme, the data was explored from a stakeholder perspective to explore interrelationships and variances (Miles et al., 2014).

While the initial interviews focused on discovering leadership practices that support STEM, the focus group identified themes associated with how the implementation process of STEM integration was taking place within the ECE classrooms as perceived by teachers. The purpose of analyzing both the observation fieldnotes and the focus group transcripts was to investigate how pedagogical practices impact the quality of teaching within a preschool. Audio gathered from interviews, and focus groups were transcribed by a paid service, reviewed by the
researcher for accuracy, cross-checked with participants “member checking” (Merriam, 1998), and then coded to uncover themes.

**Trustworthiness**

For this study, several measures were put into place to maintain the trustworthiness and validity of the study (Denzin, Lincoln, & Guba, 1994) in order to present a true and accurate representation of the phenomenon of STEM integration in ECE. First, the researcher utilized the strategy of triangulation in which numerous data tools are used to create a full depiction of study results (Creswell, 2013). The researcher collected data through interviews, observations with field notes, and document analysis. Furthermore, the data was also triangulated through multiple participants to authenticate study results. Next, member checking was employed to verify the accuracy of research data (including transcripts) with participants to ensure that inferences and interpretation correctly reflect participants and the researcher (Creswell, 2013). Consent forms, approvals, and proper procedures were used to followed to ensure integrity (Yin, 2009). To minimize researcher bias, In Vivo coding (Miles et al., 2014) objectively preserved the authenticity of participants comments so that more comprehensive findings emerged.

**Potential Threats to Internal Validity**

As a result of the researcher’s background as an elementary school teacher, middle-level manager/trainer in ECE and instructor in higher education, the researcher had biases about the importance of STEM integration. The researcher believed that STEM integration was essential as early as possible in order to pique student interest in fields that need STEM literate employees. The researcher also believed that STEM was a perfect opportunity to make learning fun and interesting for children of all ages especially preschool children. The description of these biases allowed the reader to understand how they might have impacted the research study. The
researcher's analytic memos (Creswell, 2013) were utilized as a tool to track the researcher’s growth and development.

**Chapter Summary**

This chapter presented a detailed description of the study design, the rationale for the selection of each of the research methods, and the sample populations for interviews, observations and focus groups. This chapter also gave an overview of the data analysis process as well as addressed validity and reliability concerns. In line with case study research, a small number of participants were selected who met the previously described criteria. Contact with the participants adhered to the procedures and protections provided by the Northeastern University IRB. The primary sources of data were one group interview with two administrators, two direct observations, one semi-structured interview with lead-teachers, and a focus group interview with four teachers. Chapter 4 will discuss the findings from the interviews, observations, focus groups, and document analysis.
Chapter Four: Research Findings

The purpose of this study was to investigate how ECE leadership practices at a South Florida preschool impact STEM integration and was guided by the following research questions:

1. How do teachers integrate STEM practices in ECE settings?

2. How do preschool directors support STEM integration within ECE settings?

This chapter summarizes the themes that emerged from the findings of direct observations and interviews with teachers and administrators at ABC Preschool (pseudonym). The participants were comprised of four teachers, two lead teachers, and two administrators, all of whom are involved in the STEM integration process. Within the research findings participants are mainly identified with the following pseudonyms Administrator 1 and 2 and Teachers A through F. In addition, several documents were analyzed to supplement information learned from the interviews and observations.

The first research question focused on the way teachers integrated STEM practices at ABC Preschool. To explore this question, the participants were observed in their natural environment as they taught and interacted with children. Within the interviews teachers and administrators were asked to describe their feelings toward STEM, how STEM disciplines were implemented, the developmental appropriateness of STEM activities, challenges faced when implementing STEM, recommendations for improving STEM integration and about the impact STEM has had on their students. The second research question focused on how preschool leaders supported teachers in their efforts to integrate STEM throughout their instruction. To better understand the ways teachers felt most supported by their leadership, the participants were asked to describe the hiring process, reasons they chose to work at ABC Preschool, and teachers were also asked to recall opportunities they have had for leadership, collaboration and personal
growth. All data were analyzed using open and in vivo coding. From these codes, four themes emerged: pedagogical leadership; freedom of choice and voice; strong school culture and identity; and home, school and community partnerships.

**Context of the Study**

In order to fully interpret and understand these findings, the context of ABC Preschool must first be examined. This preschool is a 501c3 nonprofit organization that has served families in various counties in its state for over twenty-four years. ABC Preschool was founded as a place for children and families to have a home and a community and a place to share ideas and beliefs about how young children’s curiosity, passion, and creativity could be nurtured (ABC Executive Board, personal reference, 2014). From infants to adults, ABC has a substantial parent education component, which includes a parent co-operative component which incorporates parent education and support into each daily session.

**Educational Approach and Philosophy**

The ABC approach to preschool education focuses on encouraging children’s intrinsic motivation to learning while providing opportunities for them to experiment and gain an appreciation for art, science, and nature. This approach also provides children with the tools to handle conflict resolution through good communication and empathy. Students of the program are called Seedlings, and Seedlings are given time, space, and freedom of movement to explore the world and interact with their peers and the adults around them through play. In this approach, play is regarded as a significant tool for all types of learning especially for very young children. ABC Preschool views unstructured play as a vehicle for helping young children process the world and make sense of new ideas and concepts.
School Layout/Structure

Another contextual element of importance is the structure of the learning environment at ABC Preschool. The school has three main areas where children learn and play, which are the indoor classroom, the outdoor classroom, and the nature playscape. At any given time, approximately 25 children are moving from place to place within these three areas without restriction. This learning environment is facilitated by a total of five teachers and two parent helpers, which eliminates the need for teachers to be divided into their own separate class with their students. The five teachers present move around the three spaces based on the children’s interest. The indoor classroom consists of two main areas which include but are not limited; a dramatic play area, an area with blocks and toys, tables for writing and drawing, cozy area for reading, and tables with various objects and materials. Spaces in the indoor classroom resemble many aspects of a traditional preschool class while the other two classrooms are located outdoors.

The outdoor classroom contains various areas such as: tables with materials for experiments, a water play bin, a sand table, a bird feeder, picnic tables (where children eat snack), various trees and gardening areas, a compost bin, a waterfall, and open space where children can roam, etc. The nature playscape can be described as what traditional preschools would call the playground. The playscape does have some of the objects you would find at other playgrounds such as a slide, a balance beam (made of wood), swings, blocks, and tricycles. However, the majority of the items appeared to be handcrafted and not manufactured. For instance, swings were made of various rope that hung from trees; “blocks” were actually different sizes of chopped wood (large and small); and the varying elevation levels for children provided an actual hill for students to stand and play on.
**Major Findings**

Taking into account the context of ABC Preschool and its unique structure the main findings that emerged from the coding and analysis of interviews and documents are as follows: pedagogical leadership, freedom of choice and voice, strong school culture and identity, and home, school and community partnerships. Various aspects of each theme were explored through several subthemes.

**Figure 4. Themes of Major Findings**

**Pedagogical Leadership**

The first theme that was recognized in this study relates to how teachers intentionally plan and assess STEM activities and also addresses the first research question, which explores how teachers integrate STEM in ECE settings. This theme was identified as pedagogical leadership and is defined as the way teachers understand the teaching and learning environment. At ABC there were several subthemes that emerged which had a significant impact on the
teaching and learning process. These subthemes were: flexible teaching and planning, implicit versus explicit STEM, collaborative on-demand teaching, and evaluation.

**Flexible teaching and planning.** At ABC instead of viewing activities as lessons to be taught, learning activities and materials are presented to children as invitations. These invitations are offered in the indoor classroom and outdoor classrooms where children can choose to participate and work in those areas or choose to do another activity. Teacher D said, “Most of the time we just give [children] the ingredients for things. We just give them the supplies and the tools they need, and with their curiosity, they just do things. They discover science. They just discover it all.”

For instance, during an observation of the outdoor classroom, there was a table out with beakers (short and tall), flasks, oil, funnels, food coloring, and Alka-Seltzer. Once a few children were interested and came to the table, teachers also made their way to the table. Teachers helped students put the right amount of ingredients in the beakers and commented, “Put it [Alka-Seltzer] in to see what happens,” and “Look at those pretty colors.” Students made comments such as, “Oily, very oily,” “I want to do a tall one,” and “It’s making bubble!” Teachers asked students what they thought the bubbles were for and said, “It could be air, going all the way to the bottom.” When children added the Alka-Seltzer at times, some the liquid spurt in the air and a child said, “It’s raining bubbles.” Teachers said, “Oh you feel little drops coming out?” “It’s like a tornado in there! One of the fascinating parts of watching this invitation was seeing the children light up as different children did it over and over again. One student, in particular, was extremely upset about not having a bike earlier in the day; however, during this invitation/experiment he forgot all about the bike he had wanted so badly and was so focused on the experiment. He smiled, laughed, and slapped the table with excitement and did not even
notice another child “borrowed” his bike. Teachers want to see their children engaged and excited about learning just like they were during the Alka-Seltzer experiment. Participants also explained how important it was to pay attention to the needs of the students when planning so that they do not begin to lose interest in education.

Each morning teachers get to work early and speak about which invitations/materials they will make available for children to explore. Though the variety of items can change based on what the teachers are thinking about that day and materials available, some constants are play dough, a writing table and a mixing experiment outside. Teacher A expressed that though she puts together a general lesson plan ahead of time, she’s always looking for ways to tweak or enhance the experience for the children. She recounts how she often wonders, "Oh, did they really like that? What do they need? They might need something different; they might need a change." Even though teachers have a plan on how they want to facilitate students’ learning, they value the ability flexible.

The ability to be flexible also comes from the rigorous training teachers have received in how to communicate effectively with children and their understanding of how to stimulate critical thinking skills regardless of the activity children are engaged in. Teachers at ABC also look to discover how they can diversify activities to meet the needs of students whether it would be from morning session to the afternoon session, or from week to week. Teacher B extended this notion further by stating, “Each year is really different,” and that they continually adjust activities so that they are engaging for students year-round. When explaining that things could change at any given moment, Teacher E expressed, “We always have so many changes of clothes for them because they get wet, dirty, stinky, and slimy.” She also said that if it rained teachers would be “out there getting wet with them.” This quote is an expression of the core
believes at ABC that children should be able to enjoy these things that they generally do not get a chance to do at other schools.

**Implicit versus Explicit STEM.** When asked about the best strategies for integrating STEM, Teacher E explained, activities should be “non-directive” and “you have to make it look like play, it has to be play, you can't come from a lesson plan.” This echoed a sub-theme that STEM should be taught implicitly instead of explicitly. Teacher F explains that children do not even know that they are doing science and engineering throughout the entire day at ABC. In addition, Teacher B shared comments from a parent who said, “It seems to me like every day that when the kids come here, it seems like they're going through the entire scientific process.” Teacher B continued, “Just every little thing they do, they were asking a question, they're coming up with a hypothesis, they're testing their hypothesis, and they're coming up with a conclusion, and they don't even know that they're doing that.” In the same breath, all participants believed that the best way to teach STEM was to do it implicitly because this method was more impactful and less intimidating for children. Teacher F shared how all the teachers (especially Teacher C) regularly integrate STEM “without it being taught like taught in a direct way.” She continued, “I think there's a lot of it here without it being as direct as it would be in a mainstream program,” as she described how STEM learning at ABC was integrated through fun activities that allowed her son to play, build and use his creativity.

For instance, during the afternoon observation, there were two young boys that were very serious about building. They added more and more wooden logs and boxes to their creation as time went on. One student said, “This is kinda heavy, but it’s giving me muscles.” Then a student commented, “This is lighter.” When the teacher asked what they were making the students commented, “Nothing.” They later made a barrier so that children would not run into
their creation and a teacher said, “It kind of like real construction, like when they are doing construction on a Highway they close it down. They close down lanes.” When young children get to play for extended periods of time, analyzing, measuring, building and creating, they get an opportunity to be immersed in STEM in ways that are enjoyable and not rigid.

Participants frequently expressed their discontentment with the current systems in place for teaching young children. When describing STEM in one word, Teacher D used the term anger. Referring to the way STEM is currently taught she said, “Because of the formal way, how it's taught. It's very much focused on those things, rather than many other things that are also wondrous about people, like art and creativity and all that.” Teachers recounted several initiatives throughout the country that were started with good intentions, but they noted that the execution of these programs was “too academic,” and testing had become the main priority.

When referring to STEM activities, Teacher F explained “all of us bring in activities that are STEM, but it's not like where we sit with the curriculum or bullet points of like oh this means 2.2 of a whatever.” Teacher B recalled having to shift her own thought patterns when she began working at ABC, “I used to really focus on, are they learning what they need to be prepared for kindergarten?” She later explained that the play, nature and art philosophy “doesn't just prepare you for kindergarten; it prepares you for life.” She also shared that at ABC, children “really have what they need to discover and learn on their own.” This sentiment was common amongst teachers who were all gratefully that ABC afforded them the autonomy to teach in a way that was not limited to formalized lessons and standards based on testing and accountability measures.

**Collaborative On-Demand Teaching.** During snack time, Teacher D was observed reaching for pigeon peas and eating them with children for snack. The teacher asked the students
how they liked the peas and asked about how they got the skin opened. Students tried to open the peas without the help of the teacher, and the teacher asked, “Can you open them one way or are there a lot of different ways?” As the students finished their snack, some of the children were ready to throw their pigeon peas away, and the teacher goes to the compost bin to throw the scales away with students. She explains, when they are brown, they don’t have seeds inside them anymore, they kind of dissolve.

A few feet away, another group of children decided they wanted to plant some seeds. One student said, “I am going to plant them right here.” Teacher B asked the students what they would need to plant their seeds. One child said he needed a watering container; another child exclaimed, “I have an idea; we need to dig holes. We need shovels.” Teacher B watched, listened, engaged in conversation with children asking questions such as, “Do you think it needs to be deeper? Are there some beans on the ground too? What are they?” The teacher also added, “We might need to put something around it to protect it.” Teacher B watched the students plant seeds while right next to her were a few students climbing a tree. She called out to the student furthest on the tree, “Are you on the branches that are as wide as your arm? Make sure the branches are thick enough. Make sure you look at them.” On the other end near the compost bin, Teacher D continued with the students that were eating pigeon peas and now wanted to plant snap peas.

At ABC teachers do not have walls that divide students according to class. Instead all students essentially belong to all teachers and one participant remarked, “We work together.” Children in the scenarios above were fluid, moving from one teacher to the next or the teachers moved based on where or what the students were doing. At ABC, teaching is not limited to “circle time,” but it happens in real-time as children move from one area to the next. When
speaking of how teachers facilitate areas and invitations, Teacher A shared “Sometimes it's individual, sometimes it’s all of us collaborating to put together an invitation on the table.” Invitations are set out with the mindset of allowing students to lead their learning. However, a focus group participant explained how a parent assumed that teaching at ABC was a breeze because all she had to do was “sit around.” The parent quoted, "This must be nice, to just get to sit here and relax…But you don't have to be doing stuff with them." In contrast, Teachers expressed that the teaching approach at ABC was all but easy:

- “it forces us to be on our toes constantly,”
- “it's a little bit mentally tiring ... constantly trying to guide them through these things instead of even more structured setting,”
- “if you switch on autopilot something is going to explode, or someone is going to get hurt,”
- it takes “massive brain power.”

It takes skill and understanding of child development to be able to contribute to children of various ages, interests, and developmental levels. Teachers at ABC do not stand around passively watching children but are intentionally listening for preschoolers’ questions and thoughts about what they are working on so that teachers provide the appropriate level of assistance. This critical feedback stretches children’s thought processes and helps them problem solve. When describing children who played together in the Nature Playscape, a participant described how the play, nature and art philosophy connected to STEM:

I just really feel like that whole inquiry process is happening, and they're becoming those kinds of kids and lifelong learners that are going to ask those questions that you need to ask, in science and technology and math, you may need that higher-level type questioning
that takes you to that engineering. I think you just need to kind of develop that curiosity
and that critical thinking.

**Evaluation.** ABC uses formal and informal methods to assess and evaluate the growth of
children including an online tool named Storypark. Though ABC is mostly a screen-free zone,
teachers make use of a technology tool named Storypark to enhance the documentation process.
Teacher B explains the tool;

> We document a lot. But now, we have a system; we have a specific documentation
> system called Storypark. So, we're doing a lot of photos stories, where basically each
> child has a digital portfolio, so we're able to kind of go through the year and see how that
> individual child has grown.”

Based on information from their websites, Storypark is an interactive community where
teachers can easily share pictures, videos, and audios of children’s development. This tool
provides a way to support and track child outcomes. Parents have instant access to stories being
added by teachers; they can continue activities at home and can add or share their own stories via
phone, tablet or computer. Other family members can also be invited to view the child’s story or
add one of their own about the child (Storypark, 2019).

When asked about why students are assessed this way, participants shared the importance
of documentation and reflective communication with parents. Teacher A described, “So, a lot of
our assessment and understanding of that is from an observation process rather than a testing
process.” With all teachers involved at all times with any given child, the ability for teachers to
know each child is increased and brings more individualization to tracking student growth and
progress. Teacher A explained, “We try to accommodate their needs as they need it too, which is
kind of like working individually with each child for their needs.” With this approach, multiple
teachers at ABC have the ability to recount when, where and how children met developmental milestones and can check-in with each other as they document.

When asked about if the educational philosophy at ABC was working for students, one teacher confidently stated, “I can tell you almost every child here goes to kindergarten, kindergarten ready.” Participants also explained how parents raved about how their children were school ready not only academically but also in the area of social-emotional development. She explained, “I don't know any parents that have told me, ‘Oh, my child's not really doing well at all.’ They're almost even exceeding.” In an interview with two administrators from ABC, the founder and current director explained that, “The mission is to empower children to be confident, creative, and compassionate through play, nature, and the arts.” She also added that one of the three pillars of the ABC educational philosophy is to provide hands-on experiences (experiential learning). Through collaborative and strategically planned invitations children at ABC uniquely explore STEM disciplines. This student-focused teaching is successfully preparing young children to explore STEM activities that pique their curiosity.

**Freedom of Choice and Voice**

The second theme that developed in this study relates to how teachers engage students to participate in STEM activities and also addresses the first research question, which explores how teachers integrate STEM in ECE settings. Below is a chart of some of the activities observed during two observation cycles.

<table>
<thead>
<tr>
<th>Science</th>
<th>Technology</th>
<th>Engineering</th>
<th>Math</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digging Holes</td>
<td>Pulleys</td>
<td>Making Guitar</td>
<td>Measuring thickness</td>
</tr>
<tr>
<td>Planting seeds, beans</td>
<td>Teacher use camera &amp; walkie-talkies</td>
<td>Playing with logs</td>
<td>Rubberband shapes</td>
</tr>
<tr>
<td>Experiment with oil, water &amp; Alka-Seltzer</td>
<td></td>
<td>Teacher fixes pulleys</td>
<td>Magnatile Shapes</td>
</tr>
<tr>
<td>Eating pigeon peas</td>
<td></td>
<td>Playdough</td>
<td>Counters (bears)</td>
</tr>
</tbody>
</table>
The word unique is one that many would use to describe ABC and the children that have attended the preschool even though the activities above are similar to that of other preschools. However, the uniqueness of ABC can be characterized by the way activities were experienced by children. Students at ABC were able to explore and learn through rich experiences; they were often encouraged to be independent thinkers, work cooperatively with their peers and encouraged to be leaders that spoke up.

**Learning through rich experiences.** In the administrator interview, both directors expressed that student-centered learning was a core value of ABC. Administrator 2 shared, “The kids are really following what their interests are, what they're most passionate about.” When speaking of her own son’s experiences at ABC, she especially appreciated “the fact that he was able to follow his interests and the adults in his life were facilitating that kind of passion.” When teachers were asked about the activities students enjoy, Teacher C explained, “Lots of experiments!” Teacher E quoted, “The dirtier they are, the more fun they had most likely.” Similarly, there was a consensus amongst focus group participants that children really enjoyed so many of the activities and invitations that were available to them such as making crayon art, steam art, the milk experiment, surface tension activities, cooking, baking, gardening and pretty much anything that was hands-on. Teacher F shared how Teacher C built a gutter system that fascinated students, “You can watch the kids put things in there and watch them go down.” She
further explained how students were experimenting and wondering “if I pour more water…. what does that do to the ball going down…. can I roll this down there?” She noted, “So, they're figuring all these things out, but in a very hands-on way.”

Teacher C added, “Sensory is a big part” of providing hands-on activities the children enjoyed. They spoke of how making slime should be taught in a non-formal way where children could speak and think about the way slime felt, and what would happen if certain ingredients were added. During the observation period, Teacher C was observed working with students in the outdoor classroom making guitars out of cardboard, vice grips, rubber bands, and other materials. Some children looked and observed, others enthusiastically joined in so that they could make their own guitar, but most importantly, students were not required to engage in the activity or any of the other activities that were available at that time. When thinking of what would spark children’s interests, Teacher D, expressed, “They definitely do gravitate towards the things here that feed their soul,” and that students at ABC have “found what makes them happy, what they enjoy.” When asked about preschoolers’ attention span, teachers expressed, “If they are doing things they are interested in, they would be very focused for many hours,” and that “what keeps their [students] attention is whatever they have chosen to do.”

**Independence.** When asked about what students do not enjoy, Teacher F said, “I think here, the only thing I would say they don't like is being confined,” and Teacher E added, “confined and controlled.” Teacher D proposed, “They would do anything if they think it's their idea.” At ABC Preschool young children are encouraged to be independent, and students get to choose and lead activities in most cases due to the use of invitations. Teacher B remarked that teachers were there to teach students “to be independent thinkers” and “independent doers.” Students at ABC are not forced or told to participate in activities such as circle time, seat work,
or recess for a specific amount of time. Their movement is unrestricted, and they can stay in an area for as little or as much time as they want. “They need freedom,” Teacher D said. “Give them that time and that space. They just need tools and some guidance.” Teachers at ABC felt that this approach was more suitable for STEM teaching and learning. Teacher D noted, “So, if it is science, if it is technology, if it is building things, it comes from them, and it’s not us.”

Teacher B described that at ABC “we're just the facilitators, really, of that learning in this environment.” She added that “to learn and develop as a full individual, you need a lot more than just sitting down in a chair and having rote learning,” and that “the children really need to discover on their own.” Teacher D shared that children would sometimes build things for hours, “They get very immersed in it.” The Nature Playscape can be considered what traditional preschools call their playground. There are swings, slides, hills, trikes, a sand pit, a balance beam, and so much more, yet there are no limits to the amount of time and number of children that can play there. Instead, their learning is facilitated by the teachers and/or parent helpers in that area. During an observation, a teacher was observed interacting with children who carried large wooden stumps and logs from one place to the next. Teacher B engaged children in thought-provoking conversation regarding their creation as they worked on it for a sustained period.

Children at ABC have uninterrupted play time because their play is their work. Play is when children get the opportunity to think, reason and build the confidence to be independent. This independence is manifested as children build the confidence to be reflective decision-makers and are empowered to speak up for themselves. Teacher A described, “They [students] have a voice. They don't feel threatened to tell us, ‘Well, I’m independent. I feel good about doing this here’.” Students at ABC are often very zealous about what they believe in often
stating, "This is what I want to do," however participants expressed that children learn a great deal of social-emotional skills from their time at ABC.

**Cooperative Learning.** Administrator 1 explained, “The third pillar is learning within the community,” and this was evident through observations at ABC. While in the indoor classrooms, children decided to share stories and then wrote stories down that they wanted teachers to share. One student stated, “One time one of my friends got stung by a bee.” Another student shared one time one of my friends ran over me, and I cried.” Students were allowed to talk and draw without direction or guidance, besides the teacher stepping in to let each child get a chance to speak such as when she said, “[Student Name] was waiting to tell her story.” In playing and working together in the same space, children were learning to delay the gratification of saying whatever they wanted. One student said, “I’m gonna tell you my story after you.”

Being in an environment where children are of mixed-age and mixed-ability can be a bit challenging for some students; however, mixed age groups also have benefits according to teachers. Teacher B shared, “You get one child who starts to put that play in, and then you have the other ones that come in, and I find the older ones are actually helping to teach the younger ones.” Multiple teachers expressed how younger children would watch older children play and build for days, weeks or months without interacting. These same children would later join in or act on what they had been observing. Teachers also explained that this was developmentally appropriate for children because they were afforded the opportunity to join in when they were ready and had an interest in that invitation. Teacher A shared, “They're doing so much on their own when they're at the developmental level to do that.”

It is almost expected that there will be conflict and disagreements, as is common amongst preschool children. At ABC children learn to work together as they play, and teachers were right
there in the mix guiding their learning, coaching them through conflicts, and helping them to come up with their own resolutions to issues that arise. Teacher A described, “We're also teaching them to deal with conflicts.” Teacher C added, “Even when there is a conflict situation we ask what they [students] can do, how they can get out of this. We don't give any advice; just what can you do?” Teacher C explained that instilling problem-solving skills, “This is a huge part of ABC. A very important part.” Teachers provide the language for students such as "Well what can you do? How can we solve this problem?" and recall how “You'll see the four-year-olds guiding other children to problem solve... We'll hear our own words, from the beginning of the year, from a four-year-old.” Once students learn the language of conflict resolution, Teacher E explains that teachers sometimes even play the role of referees, “There is a game happening, and we are just standing back, you know we don't want interrupt, but if there is something that you need to step in for we are there, but for the most part we are just hanging back.”

At ABC children get to say how they feel about certain things and why they feel that way. Teacher A recalls children’s words, "I'm not okay with you touching me, I'm not okay with you saying that to me. I'm not okay with you hitting me." She continues, “A lot of kids don't have that voice, but they have that voice here.” Teacher A expressed “they even challenge us” when recalling times children wanted to do certain activities. Safety stood out as a priority for teachers and administrators who expressed multiple times that children could freely explore as long as they were using caution and were kept safe. “We just keep them safe,” said Teacher C. One participant shared their conversation with a student, “Well, yeah, we are doing that, but we still need to keep you safe.” The ABC environment intentionally provides physical safety as well as emotional safety for children so that they learn skills to be unapologetic about who they are.
Students as leaders. When referring to the students, one participant stated, “They're like the leaders.” They also shared that on several occasions they planned for an invitation and were very excited about the prospects of what children would learn, however children were not interested in that invitation at that moment. Students would inquire, "Oh, can we have some glue? Or could we just have something else?" Teacher A explained, “We'll go pull it out for them because they have a vision and some of them have a vision we want to expand on that vision.” Teacher E added, “They take it in a completely different direction than we would ever imagine, and that's really fun to watch.” Children are afforded the opportunity to dictate how and when they participate in an invitation, which fosters confidence in their decision-making skills and cultivates leadership skills.

Teacher C shared that “When my son went to school they started to call him peacemaker” and that his son, “helped everybody come out from conflicts.” Teacher E confirmed this stating, “We get a lot of high praise from seedlings after they graduate and go on to mainstream schools, you know wherever they end up, we hear the praise that these children are the models.” When speaking of her daughter who entered kindergarten after attending ABC, Teacher F shared, “Her kindergarten teacher all last year would tell me ‘I'm so amazed, she's so mature’.” Her daughter’s teacher also explained, ”Well whenever there is like a conflict or something she just kind of is like ‘I have a solution, why don't you just do this? Or why don't you do this?’” As an educator and mom Teacher F explained that “I think that they develop such social skills here, that are so critical for success, in school, work, life.” Teacher E continued, “We are building this backbone in these young children to continue with that strength throughout their lives in ways that are very unique.”
Though this chart may seem ordinary, the results and positive reviews about ABC are all but ordinary. Participants all agreed that families love the school so much that they never leave. When speaking of the families of children who then move on to kindergarten one participant stated, “We never lose them.” Another participant shared that ABC is a place where families “want to continue to be a part of even once their children are no longer physically here anymore,” and compared the bonds and connections to that of a “private high school alumni association.” With numerous challenges involved in providing care and education for young children all throughout the country, it is imperative to get a better understanding of the supports that have been put in place at ABC which have produced such a positive learning environment for all those involved.

**Strong School Culture and Identity**

The third theme that developed in this study related to the ways leaders support STEM and focused on the second research question which explores how school administrators support teachers with the integration of STEM in ECE settings. Within ABC three subthemes emerged, culture, transformational learning, and collaboration. Teachers, parents, and leaders at this school worked together and learned together on a consistent basis exhibited unity and teamwork.

**Culture.** It was evident when interviewing participants at ABC Preschool that there was a common language being spoken. Sure, they all spoke English, but they also spoke the ABC language. Whether it was the administrators, lead teachers, or teachers present during the focus group, they all had a sense of ownership of the ABC philosophy. When speaking of the way things were done at the preschool, one participant explained, “I think you have to be here to feel it. So, I think you’re [student researcher] kind of getting it maybe from being here.” Administrator 1 explained a little bit further sharing that the philosophy was “developed from all
of the things that I could see [needs in the community] and from my studies, all research-based, developmentally appropriate, and focused on play, nature, and the arts.” This research-based philosophy is very comprehensive, yet teachers, as well as parents, seem to be on the same page in carrying it out. The level of coherence amongst participants displayed that a substantial amount of time was invested in educating and empowering participants in order to develop this single-school culture.

With such a comprehensive vision for ABC, Administrator 1 explained that finding the right people to join the team was of high priority. She stated that ABC has a “really specific process to really make sure that it's the best fit for that person and for us.” ABC is devoted to implementing a well thought out hiring process, which produces quality individuals who understand the school’s mission firsthand. The administrators feel that these individuals have to be able to “collaborate well amid a lot of changes,” and also added that the entire staff gets a say in deciding which candidates get hired. Administrator 2 explained that this extensive hiring process contributed to lower teacher turnover. “I would say we have pretty minimal turnover, I think, in comparison to the industry against the norm.” A thorough understanding of the school’s purpose and choosing the right people to carry out the school’s vision have contributed to creating a culture where participants felt knowledgeable, valued, and appreciated.

**Transformational learning.** A unique benefit of being part of the ABC family as narrated by participants is the countless opportunities for personal and professional growth. Participants shared that so much of what they know comes from a variety of sources including but not limited to: 1) internal and external professional development and training they received, 2) participating in book studies, 3) one-on-one mentoring, and 4) merely listening and watching each other model effective strategies. According to participants, teachers received extensive
training at the commencement of each school year and are compensated for completing additional training hours of their choosing.

Furthermore, many of the internal workshops were geared towards parents. However, teachers also attend these sessions and are able to apply some of the same techniques with children throughout the school day. At ABC, teachers were not the sole focus of professional learning. Instead, parents were consistently invited to join and participate in professional development (PD) learning activities. ABC Parents are held to a level of respect, which is not typical for all preschools; however, this lines up with the first pillar of the ABC philosophy which discusses respect for students, teachers, and parents. Teacher E remarked, “We are such an ecosystem here, where like each portion of it affects the whole, you know teaching the parents, teaching the students, teaching us. It's all a balance; it all feeds into the same thing.” This quote brings to light the fact that ABC is successfully maintaining a culture of learning as a community regardless of an individual’s role or position.

Collaboration. When asked about collaboration opportunities, Teacher B commented that “the nature of us working together in the same classroom” gave teachers an increased ability to collaborate more frequently. Teacher A quoted, “We do it formally and informally. We have weekly meetings…We're here an hour early every morning setting up. So, we'll just kind of unofficially collaborate and talk about things.” Another participant, Teacher D, spoke about the dynamics that come with working together, “You get to run your classroom the way you run your classroom when it's one of you; when it's more than one of you, then you kind of have to do it to accommodate a lot of different personalities.” She also explained that teachers had ways to resolve conflicts that arose. “We do have tools to deal with that too.” Teacher A recounted various training events earlier on in the school year. “We do a lot of the conflict resolution
things, not as just for students but for teachers too” and added that the teachers’ morning meditation centers were helpful and refreshing. Teacher D stated, “We learn a lot here; I think that's huge, it's not just my way or the highway. We have to learn to work together, and overall, I think we do it pretty seamlessly.”

Participants were undoubtedly aware of the challenges entailed with working in an environment such as ABC. One participant remarked that there was “a lot of moving parts here.” Teacher F recounted, “And we also have to deal with parents a lot more,” when referring to the way ABC partners with parents in educating children. For instance, as part of the co-operative, there are two parent helpers during the morning and afternoon sessions. In addition, parents who have new or younger children might decide to stay at the school to provide their child with comfort, and there is no telling when people will stop by and visit. Teachers acknowledged these circumstances with optimism with Teacher D stating that the word challenge had a negative undertone. She continued “but I like to think of them as they are all positive challenges, they are great because they drive you and they grow, and you do all of these things from challenges.”

Similarly, Teacher E stated that these experiences were “so much more challenging but at the same time makes them so much more wonderful.” Teacher F added, “I like to think of them as they are all positive challenges.” Providing more opportunities for learning and collaboration is one of the things ABC does very well. This had an impact on the way teachers interact, especially when integrating STEM disciplines. With little support and guidance, STEM integration can become discouraging for teachers who work alone and have little opportunity to collaborate with others. The leaders at ABC have also found a way to connect the dots to ensure that teachers, parents, and staff are encouraged to learn and grow together as a community, therefore, contributing to the sustainability and success of ABC’s school model.
Home, School, and Community Partnerships

The fourth and final theme that developed in this study also related to the ways leaders supported STEM and focused on the second research question which explored how school administrators support the overall integration of STEM in ECE settings. Within ABC three subthemes emerged, parent support, parent educators, and community impact. Teachers were not the only ones impacting the integration of STEM within this school. As a result, leaders prioritized activities that involved parents and the community in the education process.

Parent Support. Data from interviews and document analysis revealed that ABC preschool is a school that is “not just about the children,” but focuses on “the whole family.” Administrator 1 shared, “The parents are so much a part of things, and we support them...” Administrator 2 added, “I think that first and foremost, the communication and the collaboration that happens with families, the support that is offered to and created for families to me is incredibly differentiating between other programs.” Teacher F recounted how at the beginning of the year parents participate in an orientation meeting with teachers and staff where they do activities together “modeling the language of ABC.” In addition, all throughout the year parents are invited to participate in various meetings such as share and learn meetings at the park, book clubs; they receive one-on-one interviews/mentoring, and have their own space at ABC to destress. When at ABC, meetings were observed being held in the parent room where there was a comfortable space where parents could sit down for a cup of tea and/or work on their devices while their child was in school. Parents are incredibly involved in every aspect of the program, to the point that parents eventually become teachers or administrative staff. Besides the director who started the program, three of the other seven research participants were parents of ABC children. Their involvement is what led them to be either teachers or leaders in this school.
Teacher F shared, “I started off here as a parent, and then started working here part-time.”

Teacher C shared, “I started as a parent, too, actually.”

**Parent Educators.** The parent co-operative is an opportunity for parents to be involved in educating young children where two parent helpers are present and engaging in the day to day activities with children. Administrator 2 advised that clear communication between parents and teachers, especially regarding the ABC educational philosophy, was imperative. She explained that participation of parents in the co-operative “really helps support making sure that the skills that the teachers are working with the children in the program were being supported at home as well, which made for holistic learning.” When parents are equipped with the same tools teachers have, there is less disconnect between what is expected at school and what parents expect at home.

When asked about the why parents were such a substantial part of the education process, Teacher F remarked, “If we don't educate the parents then our hours have less of an impact, or [are] less meaningful.” During observations, it was difficult to tell at first who was a parent and who was a teacher based on their interactions with children. Eventually, it became more obvious because the teachers were wearing purple shirts and parent helpers wore blue shirts with the school name and logo that read, “Remember Play? We Do.” With more adults present in the indoor and outdoor classrooms, student ratios are improved, and children receive additional individualization.

Empowering parents in a variety of ways is part of the mission of ABC, and various participants shared that parents are deeply connected and satisfied with the services offered by the school. Administrator 2 explained that she was referred to the school by a friend that told her about how wonderful ABC was. She explained that many parents expressed how they initially
came to the school for their children, but later benefited so much for themselves. She quoted, “ABC was a place where not only I felt my kids were in great hands, but I also was getting things that otherwise I feel like I was stuck on the internet trying to figure out what I was supposed to do because I didn't know anybody else.” Administrator 1 attributed the high level of parent involvement to the sense of community created by all stakeholders, which is more than “just a drop-off school.” When speaking of parents, Administrator 2 remarked, “a lot of them [parents] I think really find their family, find their community, find their support here.”

**Community Impact.** The impact of ABC goes far beyond the preschool years of children who attend ABC. Teacher C explained what happened when a family moved and the child was leaving the school. The parent said, "You guys have changed her life, completely." The teacher revealed how the child cried, and he remarked, “It was very powerful.” The connections made at this school go beyond education but enable the educational endeavors of the school. ABC uses a variety of community events to spread the ABC philosophy and to keep the impact going throughout the community even after a family leaves ABC. One participant shared that there were several free community events that were open to all such as the Ice Castle event where children play, build, and sculpting ice castles. Another event is Gather in the Garden where children play outside on the play-scape, and there’s a big potluck dinner. Administrator 1 explained other events where children made creations out of recycled materials and an event where children played in a big pool of spaghetti. She shared, “We're all about community building.” At the end of the focus group teachers were asked to describe ABC in one word and their responses were: Family (Teacher C), Magical (Teacher F), Home (Teacher E) Life (Teacher D). The broad support and commitment by the community to also support the ABC philosophy is imperative for schools undertaking the task of increasing STEM integration in ECE settings.
Chapter Summary

This chapter summarized the themes that emerged from analyses of interviews, focus groups, observations, and documents collected from six teachers and two administrators from ABC Preschool. The school’s educational approach and unique structure in comparison to traditional preschools were described in detail. Based on this context, the following four findings emerged in the coding and analysis of interviews and documents: pedagogical leadership; freedom of choice and voice; strong school culture and identity; and home, school and community partnerships.

The first two themes answered the first research questions, which explored how teachers integrate STEM in ECE. The data showed that using pedagogical leadership (leadership of teaching and learning), teachers employed distinctive strategies to help encourage STEM learning such as: having flexibility when planning activities, using more subtle ways to facilitate and incorporate STEM activities (instead of explicit lessons), and working collaboratively to meet the needs of individual students. Teachers also used observations as a means of assessing student learning rather than using tests. Secondly, the data indicated that teachers integrated STEM in a way that honored students’ interests and empowered them to be independent thinkers and doers. Students’ abilities to choose activities and express themselves was consistently viewed as a priority for maximizing learning in STEM. The freedom students had to explore through rich experiences fostered a sense of independence in children all while giving them the time and space to collaborate with one another. Children also gained leadership skills through this approach where they developed an understanding of how to choose for themselves and resolve conflicts. These examples related to the first research question and demonstrated how teachers integrated STEM in their classroom with young children.
Next, when examining the second research question about how STEM integration was supported in ECE, data from ABC showed that the school's educational philosophy and connections with parents and the community had a significant impact on laying the foundations for effective STEM integration at the case study site. The participants in this study shared a common language when they spoke and interacted that reflected the research-based philosophical beliefs guiding this preschool model. These beliefs, or ABC ways of doing things, shaped a strong school culture, which was found to be very beneficial for establishing identity in teachers as well as the children and families. The culture of learning was evident when parents and teachers alike were able to learn and grow together through collaboration. Despite the challenges involved with working so closely together, participants shared positive feelings and experiences about their ability to work together to support the children at ABC. Lastly, the connection between home, school, and the community is recognized as a significant feature that set ABC apart from other schools. Parents and families were highly esteemed and well supported by a variety of professional development activities. Data showed that STEM education did not stop once children left the school; parents were a key feature in continuing STEM at home and added so much value to the school environment. ABC was found to have an even more significant impact in the community at large due to the community events and the positive relationships and bonds that families had with the school even after children left.

Overall, the elements in these themes resulted in increased knowledge, motivation, and enthusiasm for children to engage in STEM activities and topics. In addition, with the ability to learn, plan and teach together, teachers and parents were unbothered by testing and could focus on creating activities for children that stimulated their curiosity and developed critical thinking.
Data from this study reveal that significant components put in place at this preschool have a positive and considerable influence on improving STEM integration practices in ECE.
Chapter Five: Discussion of Research

Introduction

STEM industries nationally and globally are at an all-time high with paying higher salaries, yet employers are still scrambling to find skilled individuals who are proficient in STEM competencies (Langdon, 2011). Large amounts of funds have been poured into college and K-12 education to ensure students are successfully majoring in STEM so that the nation can compete globally (Merrill & Daugherty, 2010). Tippett and Milford (2017) posited that building a STEM foundation in young children goes well beyond economic gain and is very important for today’s “science and technology-driven society (p. 83).” They also share that they were unable to find reasons not to begin STEM instruction because children are naturally curious and are born explorers and scientists which makes sense to begin STEM in ECE (Kelley & Knowles, 2016). Other researchers confirm that the early years in a child’s life are the perfect time to encourage the natural inclinations of children to solve problems while setting a foundation for STEM learning in later years (McClure et al., 2017). Currently, a variety of barriers exist that hinder STEM integration within preschool settings. However, this study sought to gain a better understanding of practices that ultimately improve STEM integration in ECE programs through an examination of classroom-based practices and school leadership.

This case study examined how a preschool integrated STEM within the classroom and how leadership supported STEM integration practices. Two research questions were developed to guide this research. The first question focused on the pedagogical practices utilized by teachers to integrate STEM. The second research question focused on the role school leaders played in facilitating a learning environment that encourages STEM integration at the preschool level. In Chapter Four, the findings from multiple interviews with teachers and administrators
along with details from observations and documents were examined. Answers to the two research questions were revealed in the following takeaways: 1) early STEM exposure is a necessity not a luxury, 2) experiential learning leads to more STEM integration, 3) collaborative teaching is beneficial for ECE classrooms, and 4) a distributive approach to leadership supports STEM. This chapter will explore the significance of these findings, make connections to the literature, provide suggestions for improving STEM integration in ECE, identify areas for future research, and list the limitations of the study.

**Major Take-Aways**

**The Significance of Early STEM**

This study provided a rich description of ECE STEM experiences. As we know from the literature, the years of early childhood are the most critical periods in a child’s life and should be filled with experiences that nurture curiosity and support learning (Tippett & Milford, 2017). Through observations, the researcher witnessed young children enjoying play while they made creations, built structures, and experimented in various ways. These sorts of activities are significant during this age because developmentally-appropriate STEM teaching and learning can have a long-lasting positive impact when activities are exciting and interesting for children (Carroll & Scott, 2017; Tay et al., 2018). Also, children begin to shape their attitudes towards STEM disciplines very early, and this can be hard to change as they get older (Kermani & Aldemir, 2015). At ABC, children enjoyed activities at their developmental level and were encouraged to think creatively. Children as young as two years of age can attend ABC preschool or full-time or part-time.

**STEM Exposure for all.** Teachers at ABC frequently stated that they wanted children to be confident, independent thinkers that were not afraid to take risks. The attitude of confidence
and independence correlates with recent literature stating that the preschool environment should be the space where young children are supported to confidently develop positive mindsets about STEM disciplines (Torres-Crespo, Kraatz, & Pallansch, 2014). A remarkable aspect of watching teachers and children interact at ABC is the fact that they were doing so much STEM whether children realized it or not. Teachers and parent helpers would not explicitly say, “We are learning this or that concept,” they just did it. For instance, STEM was present in the gardening activities in the outdoor classroom, the loose parts children played within the indoor classroom, and in the Nature Playscape where children used inquiry regularly, multiple times a day. These developmentally appropriate practices are crucial for creating a healthy mindset towards subjects like math and science, especially for children that are from groups that are typically underrepresented in STEM fields (Early Childhood STEM Working Group, 2017). Study participants expressed that at ABC there was not a large number of students who were underrepresented minorities. However, they felt very strongly that students who attended their school were empowered to participate in various STEM-related invitations and experiments regardless of their gender and race.

A disparity continues to exist when considering the number of STEM degrees attained by underrepresented minority students in STEM (i.e., African American, Hispanic or Latino/Latina, American Indian, and Alaska Natives) compared with white and Asian students (Estrada et al., 2016). Additionally, in comparison to European American students, students that have various STEM-disadvantage statuses such as gender, SES, and ethnic minority believed they were less competent in their test-taking skills and had lower self-efficacy scores students (Macphee, Farro, & Canetto, 2013). One participant explained that she would like to see the ABC philosophy and concept in schools that serve a larger population of students from minority groups. The
participant added that girls needed to be empowered to engage in activities that may be geared towards young boys and the same for boys who might become discouraged to engage in activities stereotypically characterized as more for girls.

Macphee, Farro, and Canetto (2013) confirmed that women perceived themselves as academically weaker than men even though they had similar academic performance scores. Furthermore, the number of women were also much lower in technological fields such as computer science (18%) and engineering (19%) which limits their chances of succeeding in computer science and engineering careers (Master, Cheryan, Moscatelli, & Meltzoff, 2017). During observations, a study participant encouraged a female student to use her discretion as she climbed a tree in the outdoor classroom. One participant stated, “Our girls are so strong here.” This participant felt very proud that at ABC young girls were not limited. She shared her experience with her daughter attending a STEM program at a local university in middle school and felt that middle school was too late of a time to begin empowering young girls for STEM.

Another participant, Teacher F shared similar thoughts about STEM in ECE stating, “It is easier to make a bigger impact on their whole future, teaching kids at this age or guiding them than it is to teach a subject in middle school.” Teachers often have set biases towards certain students when considering who can do STEM (Jacob, 2017). Unfortunately, this mindset is passed on to children at very early ages, even as young as six (Master et al., 2017), and decreases students’ self-efficacy when participating activities that involve STEM. Study participants at ABC have demonstrated a desire to encourage and empower preschool children that may be at a STEM disadvantage due to their gender or minority groups. The years of early childhood are a good time for growing motivation for STEM all while developing other essential skills.
Literature in the field also suggests the necessity of “starting in high school if not earlier to enhance the diversity of professionals in STEM disciplines” (Macphee et al., 2013 p. 365).

**Executive functions.** Data from interviews revealed that participants viewed teaching STEM in ECE as more impactful than the teaching of STEM in later years. They explained that the foundation of exploration and inquiry are needed during the years of age of early childhood, especially before children enter kindergarten (between the ages zero through five). Researchers also agree that these are very significant times for children to develop executive functions, which are essential for STEM learning. The pre-frontal cortex of the brain develops skills such as, “organizing information, staying focused, strategizing, planning, and exercising self-control” (Smart Brief, 2013, p. 3 ). Children at ABC are continuously engaged in activities that develop their executive functions as they work on projects that cause them to persist in learning and keep them engaged for sustain periods (Diamond, 2012). These skills are at a peak and immensely develop from the time children are born but slow down after the ages of early childhood. For that reason, early stem exposure where children are encouraged to explore their environment through their interests is essential and aligns with the current philosophy of play-based programs such as ABC preschool (Torres-Crespo et al., 2014).

**Stimulating Experiences**

The second takeaway, which is related to the first research question, is that it is vital to provide stimulating experiences for children when hoping to integrate STEM. Participants in this study expressed on multiple occasions that learning requires more than listening or watching an adult teach a concept. It was clear that teachers at ABC had a distaste for limiting preschool children to a desk for the majority of the day. Tippett and Milford (2017) also explained that worksheets and rote learning are not developmentally appropriate, but found that providing
young children with the freedom to engage in critical thinking and problem-solving was beneficial. Thus, at ABC students experienced STEM through hands-on practices that involved the use of all five senses and they interacted with their environment rather than learning concepts through rote memorization (Alford, Rollins, Padrón, & Waxman, 2016). Teacher B believed that ABC’s hands-on and free-flowing learning environment is a design that should be applied to more preschools, “rather than sticking them [children] at a desk at four years old.” She further explains that the when children have experiences where they can manipulate objects and freely experiment, this allows their brain to be stimulated differently and is more rigorous than more traditional teaching methods (Bencze, 2010).

**Experiential Learning.** The tenets of experiential learning theory align closely with best practices for ECE, and much of these findings were revealed in this study. For instance, Kolb and Kolb (2009) specified that learning is a re-occurring process where students get to experiment and add on to what they already know while going back and forth between what they believed. Through observational data, children at ABC were seen playing, reading, building, experimenting, speaking up for themselves, and resolving conflict with one another. Teachers at ABC were engaged in activities and discussions to ensure that learning actively took place through interactions with the environment (Atkinson-Hamilton et al., 2017). Furthermore, service learning projects that focus on STEM are another way students can contribute to their community in meaningful ways (Vandermaas-peeler, Mcclain, & Fair, 2016). ABC currently conducts various community events within and outside the school that encourage children of all ages to enjoy play, nature, and arts. Existing literature on ECE and service learning found that preschooler children are naturally inclined to be helpers and activities such as service learning
can enhancing preschoolers’ social skills, helping them to become more compassionate and empathetic (Freeman & King, 2001).

**Inquiry before tech.** From childhood to adulthood, technology has been a considerable focus on developing 21st-century skills. Many schools have structured times for technology use and intentionally budget for the use of technology tools such as iPads, whiteboards, and labs. In contrast, ABC has decided to take a different approach to technology and explicitly state their school is a mostly screen-free zone. Though technology is available in several capacities by parents, teachers and school staff, interview and observational data revealed that the ABC philosophy is one focused more on teaching young children how to be explorers and those who use inquiry in comparison to using technology for learning activities. Participants felt that teaching inquiry before technology was crucial because of the amount of technology children would have access to later on in future years. Teacher B shared, “They cannot miss technology. I mean the next... They are either getting it at home now or the next step [grade school] it is coming. It is unavoidable. So, here they are getting the inquiry basis, and the rest will kind of catch up.”

Current literature suggests that even though society is more reliant on technology (Capraro et al., 2013), ECE settings continue to fall behind when it comes to embracing innovative technology tools for children (Kucuk & Sisman, 2017). For instance, even though robotics supports hands-on learning and has helped students learn numbers, sizes, shapes, and geometry, many teachers do not perceive robotics as a practical learning tool for teaching young children math (Khanlari & Kiaie, 2015). Also, not all experiences with technology lead to positive principles in students towards technology (Master et al., 2017). However, the inquiry skills children are gaining at ABC lay a great foundation and are useful for preschools wanting to
embrace more technology with children. Parette, Quesenberry, and Blum (2010) suggested that ECE leaders “embraces the challenge of reconceptualizing the role of technology in developmentally appropriate practice” (Parette et al., 2010, p. 341). ABC preschool is in a situation where they can seamlessly integrate more technology such as robotics. Their hands-on, inquiry first approach gives children the opportunity to learn skills such as thinking critically, making wise choices, thinking about safe risk-taking and having a voice which can translate in children’s later experiences with technology.

Benefits of Collaborative Teaching

Teaching can be a lonely job (Ord et al., 2013), especially when teaching STEM disciplines. However, teachers at ABC frequently explained how they worked together to plan and decide what activities to put out for children. Based on the researcher’s experience, preschool classrooms typically consist of two teachers. In infant and toddler classroom responsibilities are more fluid, and teachers operate as co-teachers or caregivers. However, in classes that are preparing students to enter kindergarten (ages four through five), the distinction is more evident as teachers operate in lead teacher (usually a degree holder) and teacher assistant roles. It is apparent which teacher the lead is because they spend the majority of their time leading activities with children while the assistants are engaged in managerial tasks such as attendance counts, preparing crafts, preparing meals, restroom breaks, and cleaning up. Based on observations at ABC, five teachers and two parent helpers were present with children continuously, and their behaviors were very similar as they seamlessly interacted with children throughout the three learning areas. Besides the fact that teachers and parent helpers wore certain color shirts, there was no clear way to determine which teachers were leads. As children
transition from one area to the next, teachers also moved around, co-taught or switched positions when engaging in conversation, play, experiments, gardening, building, and more.

**Increased communication between experienced and new teachers.** Based on the researcher’s experience, schools struggle to create a class list at times because teachers on a grade level or team with the more positive reputation are the teachers that are most requested by parents and families. With its unique design, ABC has eliminated this issue by allowing each teacher to impact all children and training all teachers to be that sought out master teacher. Participants in this study ranged from teachers who have been teaching for many years, those who are new to ECE, or those who have changed professions. Teachers at ABC undergo at least 10 hours of PD of their choice and participate in several other school-wide PD sessions throughout the year. Though collaboration can be difficult, sharing modeling and working together are valuable ways to improve teachers’ expertise (Li, 2015).

Based on the researcher’s experience in the field, many preschoolers do not have the capacity for robust professional development like those in a K-12 setting. Teaching STEM in a transdisciplinary manner is very different from the typical circle time routine that teachers can do without even thinking about it (Quigley & Herro, 2016). For example, teaching STEM takes intentionality in planning (Aldemir & Kermani, 2017; Sias et al., 2017) and requires teachers to understand the developmental levels of the children they work with (Parette et al., 2010). In contrast, one of the most prominent issues teachers in ECE face is lack of time which can impact their ability to provide individualization for students (Park et al., 2017). The structure at ABC provides an environment where a teacher is rarely left alone to teach, manage, or monitor the varying developmental levels of the children present. Existing literature confirms that successful teachers collaborate with their colleagues, supervisors, and the community (Armstrong, Kinney,
& Clayton, 2009). Therefore, it is crucial for new teachers seeking to integrate STEM to have the time and opportunity to speak with other veteran teachers, teach together, read books together (book studies were a norm at ABC) and teach each other based on their strength (Liao, 2016). Teachers can also benefit from interaction with experts in the field such as scientists and engineers to gain more knowledge of the long term effects of STEM teaching (Kelley & Knowles, 2016).

**Increased knowledge of others’ strengths.** As a result of working together daily, teachers can gain a greater understanding of each other’s strengths. For instance, Teacher C quoted, “I have a passion for building things,” as he explained the leadership team noticed this passion when he was a parent of ABC. Similarly, Teacher D stated, “He is an artist, and he is very creative and wondrous, but he brings so much STEM to ABC.” The teachers and administrator seem comfortable in their abilities and were aware of how each contributed to making ABC better. A participant shared:

> We all have our strengths, and our weaknesses and each person brings something to the table, and I think when the executive team figures out what you got hidden underneath your wing, they take tend to pull it out and use it to their ability to help the school to grow and help us to grow as teachers.

Several participants mentioned that the leadership was intentional about understanding each teacher’s strength or their interest so that teachers had more opportunities to contribute to the organization. Existing literature supports the delegation of leadership tasks because this “release of control builds trust among everyone in the school and enables change to flourish” (Armstrong et al., 2009, p. 15). One of the participants at ABC suggested doing even more cross-training activities than the ones done during pre-service so that individuals have a better grasp on tasks
other teachers and leaders are involved with to strengthen the organization further. This level of intentionality in task completion is an interesting concept which is described by Spillane (2005) as co-performance (Gunter, Hall, & Bragg, 2013). Through the use of a co-performance model, group members can learn more about themselves, and how each person can contribute to the whole. This way new teachers can co-construct knowledge while learning best practices. The reflective and collaborative efforts put forth by each person will determine the level of success achieved by the group (Kangas et al., 2016; Nicholson & Maniates, 2016).

**Reduce Burnout/Turnover.** Teachers in ECE often feel that they are overworked and underpaid (National Association for the Education of Young Children, 2009). McClure et al. (2017) explained that the median salary for a preschool teacher is $28,570 and teacher turnover is significantly high in many preschools throughout the nation (McClure et al., 2017). The teachers in ABC did not display these common signs. For instance, Teacher A shared confidently, “I feel really good about making a decision about working here when I did.” Other participants made similar comments, and according to Administrator 2, ABC had low turnover. Though it is not clear if the lower turnover can be attributed solely to the extensive hiring process candidates went through, participants seemed very content with their role at ABC and they demonstrated a sense of ownership of the teaching and learning philosophy at ABC. Understanding and valuing diversity while focusing on shared goals can reduce ambiguity amongst staff and build cultures of collaboration, ownership, and excellence (Nicholson & Kroll, 2015). Consequently, collaboration in itself may have had an indirect effect on reducing burnout and therefore decreasing turnover, which is very prevalent in ECE.
Supporting STEM through a Distributive Approach

The fourth takeaway that developed in this study relates to the way leaders support STEM and focuses on the second research question which explores how school administrators support teachers with the integration of STEM in ECE settings. Based on quotes from interviews, observations and document analysis, ABC Preschool did not appear to operate from a top-down leadership model, but that of a distributive approach where each group (administrators, teachers, staff, parents, community) played a role in the success of the school (Sims et al., 2017). In their study, Lahtero et al., (2017) explained that as organizations become larger and more complex, there is a need for multiple people leading and managing the day-to-day happenings. Within this study, the founding director expressed that there came a time at ABC where she was no longer able to “do it all” and that there was a need to build an infrastructure that could sustain time and growth. She quoted, “that is one of the failings of a founder/director of a nonprofit is, the founder has to realize they cannot do everything or else the organization will not be able to grow.” She also reflected:

That was kind of hard for me, but I have an amazing team. It was a team of six women including myself that brought us from that little nonprofit into this home and being able to quadruple the number of families that we are able to serve and own our own home. Though the team is much larger now, the same principles of teamwork continue to resonate at ABC within participants. A common trend at ABC was that participants felt a sense of empowerment to “help each other” all while appreciating individuality.

Aubrey et al., (2013) characterized this strong sense of collegiality as a proponent of distributive leadership (DL) and found this sort of leadership to be beneficial for ECE. Additionally, DL is grounded in interactions and relationships between people rather than
features that divide such as departments or grade levels (Gunter et al., 2013). During the researcher’s time at ABC, it was evident that teachers learned how to work together in a way that maximized learning for children. Research on DL embraces collaboration and collectivity and confirms that when relationships are strengthened in organizations, knowledge construction takes place more readily (Ord et al., 2013).

The Founding Director (Administrator 1) is the visionary and mentor for so many of the teachers and parents at ABC. Participants thoughtfully communicated how the charisma, passion, and knowledge of the founding director is an indispensable element that ultimately impacts how ABC is viewed by the community. There was no question that she is a transformational leader that serves her school and community in an altruistic way. However, Administrator 1 emphasized that she was not and is not alone in the process. This paradigm shift needs to continue where leaders find value in including multiple stakeholders in the life of the organization and embrace what Nicholson and Kroll (2015) called the concept of parallel process.

The parallel process enables early childhood professionals to be honest about where they are on their professional development journey so that they feel respected and supported. Mentors like Administrator 1 at ABC are vital in the parallel process because they engage teachers in “collaborative problem-solving, use of inquiry or strengths-based discourse” (Nicholson & Kroll, 2015, p. 22) that build a foundation for positive learning and relationship building to occur, not only amongst teachers, but also with children and families. Not all schools have a founding director that is dedicated to the mission of the organization. However, it is essential that school leaders especially in ECE, build strong relationships amongst staff and determine which approaches are best for the school community they serve. The distributive approach to leadership
is not a cookie-cutter model but encourages leaders to become the engineers that design the best structures for their particular organization (Spillane, 2005). The design aspect is crucial in ECE because the traditional methods of educating young children is becoming more rigid but not necessarily producing improved outcomes (Alford et al., 2016).

The Future of STEM Integration for All Schools

From STEM to STEAM

In recent years another discipline has commonly been added to the STEM acronym and it is one that is very familiar for ECE practitioners. The letter A (for the Arts), has been added to STEM to create STEAM, which creates a transdisciplinary space for children to learn about the world around them (Sharapan, 2012). Though this study focused on STEM, the findings demonstrate the arts played a major role in helping children at ABC engage in and process STEM concepts. Current literature confirms that adding the arts allows for more creative and imaginative play when integrating STEM with visual arts, descriptive language, music and dance. Schools wanting to integrate STEM at all levels should consider the benefits of arts for young children as it fosters creativity and innovation (Liao, 2016).

The STEM Ecosystem Culture. This case study was an example of how STEM can be cultivated in an entire community of learners; teachers, parents, school administrators, and school staff. One of the most notable quotes from the research data was from Teacher E who shared, “We are such an ecosystem here, where each portion affects the whole: teaching the parents, teaching the students, teaching us [teachers]. It's all a balance; it all feeds into the same thing.” This quote exemplifies what is needed within a school structure wanting to embrace STEM in a way that goes beyond a person or a place. STEM is best integrated when curiosity, inquiry and exploration are embedded into the culture of the learning environment. The
educational philosophy, mission and vision of the school has to align with STEM integration
efforts and all stakeholders; parents, teachers and leaders must be committed to learning, and
growing in their STEM pedagogical knowledge. Teacher B stated, “I think this is the perfect
environment for STEM type teaching to thrive,” and observation at the school confirmed that
teacher practices did indeed facilitate STEM teaching and learning. Even though this school site
did not necessary call them self a STEM school, they possessed the STEM Ecosystem Culture
which is necessary for shifting the paradigm for future STEM teaching and learning in schools
throughout the nation.

**Connecting with Community.** Another important aspect of taking STEM to the next
level is connecting with the community. To provide STEM access to all, including those in
marginalized communities, community resources need to be a significant partner in building the
STEM Culture Ecosystem. Schools at all levels can benefit from partnering with local businesses
and organizations to advance STEM initiatives, similar to the way ABC Preschool connected
with those in their community. There is no end to the amount of backing schools can obtain from
building relationships and partnerships with those in their communities. Schools that forgo this
important step in the STEM Culture Ecosystem place themselves at a disadvantage when hoping
to begin and sustain STEM Integration.

**Implications for Practice**

Based on the results from this case study, and takeaways from current literature in the
field of ECE and STEM the following implications for practice were developed and are broken
down into the following categories: Significance of Early STEM for all children, Stimulating and
Supporting Pedagogical, Knowledge Benefits of Collaboration, and Supporting STEM through a
Distributive Approach. In the figure below are implications for each takeaway.

![Distributive Approach Diagram]

**Figure 6. Implications for Practice**

**Implications for Educators working in Early STEM**

When considering STEM integration, it is essential for preschool educators to encourage STEM skills through play to make learning fun for children. Torres-Crespo et al. (2014) explained that “play is what children want to do and work is what they have to do” (Torres-Crespo et al., 2014, p. 8). Similarly, Teacher A explained, “We are making them excited about it. We are not pushing it on them, but they get excited about it. So, then they want to do it, not because you are telling them.” When activities are exciting, use a variety of modalities, and challenge children’s thinking, they are more likely to remain engaged in these activities (Mansfield et al., 2012). Teachers at ABC consistently stated that children enjoyed anything they felt that they had a part of choosing or creating. Allowing students to take part of lesson creation and delivery is not an easy task and teachers, parent-teachers and school leaders need the skills to
elicit the thoughts of students and facilitate their learning without ‘getting in the way’ as several study participants explained.

**Encourage Independence.** From birth, children depend on their caregiver for their most basic needs; however as children move into toddlerhood, they look forward to more and more opportunities to be independent (NAEYC, 2009). Even when children are young, they can think critically and make decisions (Copple & Bredekamp, 2009). When describing children, teachers at ABC used words such as powerful and strong and said that they learned so much from children. They believed that children were capable of displaying more rigorous skills and higher-order thinking if teachers would give them the time and space to discover. However, ECE teachers have a hard time relinquishing control within their class (Ritchie, Phillips, & Garrett, 2001).

Similar to the teaching philosophy at ABC, Teachstone (2019), an education service company, found three domains that are essential for preschool classrooms: Emotional Support, Classroom Organization, and Instructional Support. The first domain, Emotional Support, has a dimension referred to as Regard for Student Perspectives (Teachstone, 2019) that encourages young learners to be independent thinkers and independent doers. Throughout the nation, preschool classrooms are being assessed by Teachstone’s Classroom Assessment Scoring System (CLASS) assessments, and teachers are evaluated on their ability to attend to the following behavior markers: flexibility and student focus, support for autonomy and leadership, student expression, and restriction of movement (See Figure 6).
Based on what was observed at ABC, this type of approach can potentially give children a better opportunity to further their STEM knowledge and experiences.

**Implication for Stimulating and Supporting Pedagogical Knowledge in ECE**

**Individualization.** In teaching young children, it is essential to be flexible and remain aware of what children need at different stages in the learning process (Aguilar, 2016). Participants at ABC believed that teachers should be less rigid about standards or what children must know at a particular age or grade. Instead, they viewed individualized instruction as more useful for students tracking progress. In Exceptional Student Education (ESE) the concept of least restrictive environment is commonly used when developing an individualized education plan (Odom & Mcevoy, 1990). Likewise, preschool educators that embrace learning

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1 This was adopted from the Pre-K Classroom Assessment Scoring System
opportunities that encourage independence are placing children in a less restrictive atmosphere where they feel comfortable taking risks.

**Focus on the Process.** Educators should focus on the process children go through as they engage in playful activities, not the product (Kelley & Knowles, 2016). Participants of the study shared how the children had cooking experiences that involved anything from cooking, baking, or making simple products such as a lemonade or salad dressing. At first thought, these items would seem very simple to make. However, the process and the conversations that take place with students as they talk about lemons, where they come from, how they taste and why is where the magic happens. Squeezing the lemons, measuring and adding the ingredients all build a child’s understanding and confidence. When considering how children at ABC made salad dressing from herbs they grew in the garden, the next time they go to the store and see salad dressing, they have a whole new perspective about the process that took place before the product arrived on the shelf of the grocery store. Several teachers used the exact words, “focus on the process.” They insisted that the process led to more positive results where children were intrinsically motivated to keep trying in comparison to phrases such as, “good job.” The Early Childhood STEM Working Group agrees with this ideology and suggests that the focus should not be on whether children are ‘good at or not good at something but rather than on their effort and persistence. Experiential learning experts also agree that “Learning is best conceived as a process, not in terms of outcomes” (Kolb & Kolb, 2009, 194).

**Technology.** According the Office of Early Learning (2017) technology goes beyond computers, tablets and smart phones and should not be used as a way to keep children busy. Technology in ECE should focus on the impact technology has on students’ lives for example helping children understand how many people use technology in their work (doctors, dentist
cooks, game designers and discussing the advantages or disadvantages of technology such as taking the stairs in comparison to taking an elevator, walk or driving, solar cooking and conventional ovens.

**Implications for Collaboration: Collaborative Teaching and Learning**

Based on the researcher’s experience, providing time for teachers, parents and other school leaders to engage in collaborative teaching and learning has gone beyond the typical team teaching approach that generally takes place in ECE classrooms. Opportunities for teachers to reflect on their practice while providing support in the context of classroom teaching can help close the gap and move STEM teaching forward (Quigley & Herro, 2016). Critical friends groups, communities of practices and professional learning communities are all vehicles for improving communication and collaboration amongst teachers (Davison et al., 2013). Likewise, children also need to be allowed to learn collaboratively with their peers, through discussion, joint decision making, and collaborative problem solving (Aldemir & Kermani, 2017). These techniques can aid students in developing skills that will help them to persist in more difficult tasks in the futures (Honey et al., 2009).

**Implications for Distributive Leadership**

Schools can benefit from a DL model, which challenges the idea that one person can lead an organization. Schools need to have a way to identify other potential leaders so that the skills and abilities of these leaders are recognized. One way to do this is through the co-operative model that ABC uses where parents are participating in the education of their young children instead of being outside observers. Besides, when multiple individuals are approached to contribute to the organization, are shown respect, and professionalism, this can lead to a positive effect on the efficiency of teachers and other personnel. Teachers, parents, administrations, and
staff come with varying experiences and may feel ambiguity towards STEM teaching. However, DL is a diagnostic and design tool for schools to reflect on what practices are working and what practices are not working within the school so that leadership practice are improved daily (Nicholson & Kroll, 2015).

Additionally, improved relationships with those in local communities can benefit schools that may not have as many resources as those in more affluent communities. Schools can choose to partner with local businesses for donation of loose parts children can use to build, old computers children can take apart, or items that can be recycled or repurposed. Schools can also partner with STEM related clubs and organizations within local high schools or colleges in service learning projects that can teach children concepts such as gardening and agriculture, solar or sustainable energy, and robotics. Literature also suggests collaborating with STEM experts Engineers, Scientist to increase STEM knowledge.

**Implications for Future Research**

After being part of the ABC family for the brief of this study, I am still curious about the concept of invitations verses lessons. More specifically, future studies can explore children’s perceptions of STEM when they made aware the fact that they will participate in a lesson on a specific concept versus the use of invitations. For instance, does less explicit STEM teaching lead to more interest by students and improved understanding of STEM concepts? Studies which seek to understand these nuances in STEM teaching and learning can significantly add to the body of work concerning STEM integration in ECE. Also, future qualitative and quantitative research can explore STEM-centered collaborations between teachers in ECE look like and determine whether collaborative teaching has an impact on reducing teacher burnout and turnover in ECE. Data from this study suggests that teachers from various backgrounds (novice
and veteran) can benefit from collaboration for STEM integration in ECE such as participants at ABC who were either new to ECE because they served as parents, had a career change, or recently graduated.

**Scholar-Practitioner Reflection**

When switching careers from being a teacher in K-12, I thought I had the secret to “help” those in ECE. I remember speaking with my principal about the required 90 minutes children played in centers and felt that this time could be better spent working on academic lessons. Many years later, everything that I have learned confirms that I could not have been more wrong in my thinking. My years of working in ECE in addition to this study have given me a better understanding of the intricacies of early childhood, which dramatically differs from K-12 education. I have come full circle where I now view play as such a precious commodity that needs to be protected. My focus has shifted from standards-driven approaches to an experiential approach where teachers, as well as students, are learning in non-traditional ways that promote STEM through critical thinking and play.

As a life-long educator, I hope to continue to learn and grow in my understanding of how to best support education at all levels and become an even greater advocate of young children while empowering educators, parents and community leaders. Professionally, through my new position within the ECE field, I will have the opportunity to be part of a team of specialists who mainly focus on improving the quality of education in infant, toddler and preschool classrooms. My goal is to utilize knowledge from my years of research in the doctoral program and knowledge gained from this study to build awareness of STEM integration in ECE as well as challenge the traditional methods of teaching STEM in preschool. My priority is to partner with
ABC in various capacities to continue the pedagogical and distributive practices evident at ABC to schools that serve children from groups underrepresented in STEM.

**Limitations**

This descriptive case study was limited to eight participants who worked at a non-profit preschool in a southeastern state. Data from interviews, observations, and document analysis revealed the perspectives and opinions of only these individuals. Therefore, the results cannot be generalized to all teachers or administrators who work at the preschools or who are employed in other preschools with similar philosophies. Many factors influence STEM integration including the ability to collaborate, learn as a community, and partner with parents. Study participants were selected based on their knowledge and experience at ABC preschool and their use of STEM integration, yet their perceptions, beliefs, and STEM integration practices cannot be generalized to all teachers at ABC or all preschool teachers.

**Conclusion**

Preschools face a variety of challenges including high turnover, lack of funding, and providing safety and care for our most precious children. The concept of STEM learning in ECE can bring apprehension to those unfamiliar with child pedagogy; however, ABC’s educational philosophy and distributive approach to leadership activities have given the preschool an advantage when it comes to STEM integration. Results from this study illustrate that STEM can be integrated daily in preschool environments when intentionally planned for with the ability to follow the students lead in real-time. As participants in this research recalled their experiences with children, they acknowledged the implicit use of STEM teaching where children went through the scientific process several times a day and were involved in engineering design all while they engaged in play, nature, and the arts. The pedagogical knowledge teachers displayed
was supported by professional development, modeling, mentoring, and opportunities for teachers to collaborate before, during, and after working with children. The initial problem of practice explored in this research study addressed challenges teachers and leaders face in providing high-quality STEM experiences for young children. Findings of this research study indicate that STEM integration could be improved by focusing on how to 1) reduce the pressure of regimented lessons that are standards-driven, 2) increase the number of student-led inquiry-based activities, 3) increasing the amount of time teachers have to collaborate and 4) use more distributive approaches of leadership to sustain a learning environment.
Appendix A1: Administrators Statement of Consent Form

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<thead>
<tr>
<th>Name of Investigator(s)</th>
<th>Corliss Brown Thompson Ph.D., Ruth Floreal</th>
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<td>Title of Project:</td>
<td>STEM Leadership for Early Childhood Programs</td>
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Informed Consent to Participate in a Research Study

We are inviting you to take part in a research study. This form will tell you about the study, but the researcher will explain it to you first. You may ask this person any questions that you have. When you are ready to make a decision, you may tell the researcher if you want to participate or not. You do not have to participate if you do not want to. If you decide to participate, the researcher will ask you to sign this statement and will give you a copy to keep.

Why am I being asked to take part in this research study?

We are asking you to be in this study because you are an administrator and was part of the leadership during the STEM initiative at ABC.

Why is this research study being done?

The purpose of this study is to gain a better understanding of what practices ultimately improve STEM integration in early childhood education programs.

What will I be asked to do?

As a participant of this research study, you will engage in a group interview with me and one other administrator from ABC.

Where will this take place and how much of my time will it take?

The interview will be for no more than 60 minutes and will during a time and place that is convenient for you and the other administrator at ABC. The interview will take about 45 minutes.

Will there be any risk or discomfort to me?

Potential risks associated with participation in the study are unlikely and of low probability. Participants are going to be asked to self-report information about their experiences as part of the STEM initiative and share the ways in which STEM is currently being integrated throughout the school. These questions have the potential of minimal psychological risk if participants are upset or reluctant to share their professional or personal experiences, but there is no foreseeable harm.

Will I benefit by being in this research?
Participants in this study cannot expect any benefits from involvement in this research study. However, the information gathered from this research study could benefit teachers and preschools hoping to integrate STEM in meaningful ways that involve multiple stakeholders.

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<th>Who will see the information about me?</th>
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<tr>
<td>Your identity as a participant in this study will not be known. That means no one, not even the researchers, will know that the answers you give are from you. Participants in this study will be identified as Administrator A and Administrator B, Teacher 1 through Teacher 6 (if applicable), and Classroom A and Classroom B. To ensure confidentiality all files, notes, and sources of data will utilize these pseudonyms and any identifying information will be removed from all documents. Materials and digital files will be stored on a password-protected computer, and printed materials will be filed in a locked storage cabinet that is only accessible to the researcher.</td>
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<th>If I do not want to take part in the study, what choices do I have?</th>
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<th>What will happen if I suffer any harm from this research?</th>
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<td>No special arrangements will be made for compensation or for payment for treatment solely because of my participation in this research.</td>
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<th>Can I stop my participation in this study?</th>
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<td>Your participation in this research is completely voluntary. You do not have to participate if you do not want to and you can refuse to answer any question. Even if you begin the study, you may quit at any time. If you do not participate or if you decide to quit, you will not lose any rights, benefits, or services that you would otherwise have as an employee.</td>
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<th>Who can I contact if I have questions or problems?</th>
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<td>If you have any questions about this study, please feel free to contact [Ruth Floreal, <a href="mailto:floreal.r@husky.neu.edu">floreal.r@husky.neu.edu</a>], the person mainly responsible for the research. You can also contact [Corliss Brown Thompson Ph.D., <a href="mailto:co.brown@northeastern.edu">co.brown@northeastern.edu</a>], the Principal Investigator.</td>
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<th>Who can I contact about my rights as a participant?</th>
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<td>If you have any questions about your rights in this research, you may contact Nan C. Regina, Director, Human Subject Research Protection, 490 Renaissance Park, Northeastern University, Boston, MA 02115. Tel: 617.373.4588, Email: <a href="mailto:n.regina@neu.edu">n.regina@neu.edu</a>. You may call anonymously if you wish.</td>
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Will I be paid for my participation?
You will be given a $25 gift certificate to Target as soon as you complete the study.

Will it cost me anything to participate?
N/A

Is there anything else I need to know?
N/A

I agree to take part in this research.

____________________________________________
Signature of person [parent] agreeing to take part

____________________________________________
Printed name of person above

____________________________________________
Signature of person who explained the study to the participant above and obtained consent

____________________________________________
Printed name of person above

Depending upon the nature of your research, you may also be required to provide information about one or more of the following if it is applicable:
1. A statement that the particular treatment or procedure may involve risks to the subject (or to the embryo or fetus, if the subject is or may become pregnant) which are currently unforeseeable.
2. Anticipated circumstances under which the subject’s participation may be terminated by the investigator without regard to the subject’s consent.
3. Any additional costs to the subject that may result from participation in the research.
4. The consequences of a subject’s decision to withdraw from the research and procedures for orderly termination of participation by the subject.
5. A statement that significant new finding(s) developed during the course of the research which may be related to the subject’s willingness to continue participation will be provided to the subject.
6. The approximate number of subjects involved in the study.
Appendix A2: Teachers Statement of Consent Form

Northeastern University, College of Professional Studies
Name of Investigator(s): Corliss Brown Thompson Ph.D., Ruth Floreal
Title of Project: STEM Leadership for Early Childhood Programs

Informed Consent to Participate in a Research Study

We are inviting you to take part in a research study. This form will tell you about the study, but the researcher will explain it to you first. You may ask this person any questions that you have. When you are ready to make a decision, you may tell the researcher if you want to participate or not. You do not have to participate if you do not want to. If you decide to participate, the researcher will ask you to sign this statement and will give you a copy to keep.

Why am I being asked to take part in this research study?

We are asking you to be in this study because you are a preschool teacher and took part of the STEM initiative at ABC.

Why is this research study being done?

The purpose of this study is to gain a better understanding of what practices ultimately improve STEM integration in early childhood education programs.

What will I be asked to do?

As a participant of this research study, you will provide a lesson plan that reflects STEM integration and will be observed teaching this lesson large group activities or small group activities. A portion of the observation time will be in the STEAM lab. After the observations are completed, you will participate in a one-on-one follow-up interview with me.

Where will this take place and how much of my time will it take?

You will be observed for no more than three hours and will be interviewed at ABC during a time and place that is convenient for you. The interview will take about one hour.

Will there be any risk or discomfort to me?

Potential risks associated with participation in the study are unlikely and of low probability. Participants are going to be asked to self-report information about their experiences as part of the STEM initiative and share the ways in which STEM is currently being integrated throughout the school. These questions have the potential of minimal psychological risk if participants are upset or reluctant to share their professional or personal experiences, but there is no foreseeable harm.
**Will I benefit by being in this research?**

Participants in this study cannot expect any benefits from involvement in this research study. However, the information gathered from this research study could benefit teachers and preschools hoping to integrate STEM in meaningful ways that involve multiple stakeholders.

**Who will see the information about me?**

Your identity as a participant in this study will not be known. That means no one, not even the researchers, will know that the answers you give are from you. Participants in this study will be identified as Administrator A and Administrator B, Teacher 1 through Teacher 6 (if applicable), and Classroom A and Classroom B. To ensure confidentiality all files, notes, and sources of data will utilize these pseudonyms and any identifying information will be removed from all documents. Materials and digital files will be stored on a password-protected computer, and printed materials will be filed in a locked storage cabinet that is only accessible to the researcher.

**If I do not want to take part in the study, what choices do I have?**

N/A

**What will happen if I suffer any harm from this research?**

No special arrangements will be made for compensation or for payment for treatment solely because of my participation in this research.

**Can I stop my participation in this study?**

Your participation in this research is completely voluntary. You do not have to participate if you do not want to and you can refuse to answer any question. Even if you begin the study, you may quit at any time. If you do not participate or if you decide to quit, you will not lose any rights, benefits, or services that you would otherwise have as an employee.

**Who can I contact if I have questions or problems?**

If you have any questions about this study, please feel free to contact [Ruth Floreal, floreal.r@husky.neu.edu], the person mainly responsible for the research. You can also contact [Corliss Brown Thompson Ph.D., co.brown@northeastern.edu], the Principal Investigator.

**Who can I contact about my rights as a participant?**

If you have any questions about your rights in this research, you may contact Nan C. Regina, Director, Human Subject Research Protection, 490 Renaissance Park, Northeastern University, Boston, MA 02115. Tel: 617.373.4588, Email: n.regina@neu.edu. You may call anonymously if you wish.
**Will I be paid for my participation?**
You will be given a $25 gift certificate to Target as soon as you complete the study.

**Will it cost me anything to participate?**

N/A

**Is there anything else I need to know?**

N/A

**I agree to take part in this research.**

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*Depending upon the nature of your research, you may also be required to provide information about one or more of the following if it is applicable:*  
7. A statement that the particular treatment or procedure may involve risks to the subject (or to the embryo or fetus, if the subject is or may become pregnant) which are currently unforeseeable.  
8. Anticipated circumstances under which the subject’s participation may be terminated by the investigator without regard to the subject’s consent.  
9. Any additional costs to the subject that may result from participation in the research.  
10. The consequences of a subject’s decision to withdraw from the research and procedures for orderly termination of participation by the subject.  
11. A statement that significant new finding(s) developed during the course of the research which may be related to the subject’s willingness to continue participation will be provided to the subject.  
12. The approximate number of subjects involved in the study.*
Appendix A3: Focus Group Statement of Consent Form

Northeastern University, College of Professional Studies
Name of Investigator(s): Corliss Brown Thompson Ph.D., Ruth Floreal
Title of Project: STEM Leadership for Early Childhood Programs

Informed Consent to Participate in a Research Study

We are inviting you to take part in a research study. This form will tell you about the study, but the researcher will explain it to you first. You may ask this person any questions that you have. When you are ready to make a decision, you may tell the researcher if you want to participate or not. You do not have to participate if you do not want to. If you decide to participate, the researcher will ask you to sign this statement and will give you a copy to keep.

Why am I being asked to take part in this research study?

We are asking you to be in this study because you are a preschool teacher and took part of the STEM initiative at ABC.

Why is this research study being done?

The purpose of this study is to gain a better understanding of what practices ultimately improve STEM integration in early childhood education programs.

What will I be asked to do?

As a participant of this research study, you will participate in a focus group interview in which you will bring one artifact from your class that represents STEM integration.

Where will this take place and how much of my time will it take?

The focus group will be for no more than 75 minutes at ABC conference room during a time and place that is convenient for the group. The interview will take about one hour.

Will there be any risk or discomfort to me?

Potential risks associated with participation in the study are unlikely and of low probability. Participants are going to be asked to self-report information about their experiences as part of the STEM initiative and share the ways in which STEM is currently being integrated throughout the school. These questions have the potential of minimal psychological risk if participants are upset or reluctant to share their professional or personal experiences, but there is no foreseeable harm.

Will I benefit by being in this research?
Participants in this study cannot expect any benefits from involvement in this research study. However, the information gathered from this research study could benefit teachers and preschools hoping to integrate STEM in meaningful ways that involve multiple stakeholders.

**Who will see the information about me?**

Your identity as a participant in this study will not be known. That means no one, not even the researchers, will know that the answers you give are from you. Participants in this study will be identified as Administrator A and Administrator B, Teacher 1 through Teacher 6 (if applicable), and Classroom A and Classroom B. To ensure confidentiality all files, notes, and sources of data will utilize these pseudonyms and any identifying information will be removed from all documents. Materials and digital files will be stored on a password-protected computer, and printed materials will be filed in a locked storage cabinet that is only accessible to the researcher.

**If I do not want to take part in the study, what choices do I have?**

N/A

**What will happen if I suffer any harm from this research?**

No special arrangements will be made for compensation or for payment for treatment solely because of my participation in this research.

**Can I stop my participation in this study?**

Your participation in this research is completely voluntary. You do not have to participate if you do not want to and you can refuse to answer any question. Even if you begin the study, you may quit at any time. If you do not participate or if you decide to quit, you will not lose any rights, benefits, or services that you would otherwise have as an employee.

**Who can I contact if I have questions or problems?**

If you have any questions about this study, please feel free to contact [Ruth Floreal, floreal.r@husky.neu.edu], the person mainly responsible for the research. You can also contact [Corliss Brown Thompson Ph.D., co.brown@northeastern.edu], the Principal Investigator.

**Who can I contact about my rights as a participant?**

If you have any questions about your rights in this research, you may contact Nan C. Regina, Director, Human Subject Research Protection, 490 Renaissance Park, Northeastern University, Boston, MA 02115. Tel: 617.373.4588, Email: n.regina@neu.edu. You may call anonymously if you wish.

**Will I be paid for my participation?**
You will be given a $25 gift certificate to Target as soon as you complete the study.

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Depending upon the nature of your research, you may also be required to provide information about one or more of the following if it is applicable:

13. A statement that the particular treatment or procedure may involve risks to the subject (or to the embryo or fetus, if the subject is or may become pregnant) which are currently unforeseeable.
14. Anticipated circumstances under which the subject’s participation may be terminated by the investigator without regard to the subject’s consent.
15. Any additional costs to the subject that may result from participation in the research.
16. The consequences of a subject’s decision to withdraw from the research and procedures for orderly termination of participation by the subject.
17. A statement that significant new finding(s) developed during the course of the research which may be related to the subject’s willingness to continue participation will be provided to the subject.
18. The approximate number of subjects involved in the study.
Appendix B: Letter to Principal

Principal ***
(Month) (Day), 2018

Dear **** Principal,

As a doctoral candidate in the College of Professional Studies at Northeastern University, I am conducting a study on the leadership and pedagogical practices that promote STEM integration in early childhood. More specifically, I am interested in exploring the experiences of administrators and teachers implementing STEM in preschool settings. This study seeks to ask questions about school culture, STEM content knowledge, distributive leadership and the promotion of 21st Century skills in students.

The intention of the study is to recruit two administrators and at least six teachers who were part of the initial STEM Initiative. Interviews will be held with the administrators and two teachers who agree to participate in observations. One focus group will be held with teachers at a location of convenience to staff. Complete confidentiality will be maintained during and after this study.

The results of this study will help produce practical and applicable suggestions for preschools wanting to enhance STEM teaching and learning. I will share the results with you when I complete my study.

I am writing to you to request permission to attend a staff meeting to speak with the staff about the details of the study and hand out informational flyers.

Thank you for your support.

Best regards,

Ruth Floreal
Doctoral Candidate, College of Professional Studies
Northeastern University
Appendix C: Recruitment Flyer

Teachers Wanted!

You are invited to participate in a focus group. The purpose of this focus group is to gain a better understanding
1) How teachers are integrating STEM
2) How teachers are best supported for STEM integration

Details of the Study:
We are seeking participants who:
(1) Are currently teaching in a pre-k class (ages 3-5)
(2) Were employed at ABC for at least one year
(3) Incorporate STEM into daily instruction

If you would like you to participate in the focus group, we would need you to provide one artifact (lesson, project, etc.) related to STEM that students enjoyed in your class. Your time commitment would be no greater than 60 minutes at a location of your choice. Food and drinks will be provided at the focus group.

If interested, please contact Ruth Floreal at Northeastern University, College of Professional Studies at floreal.r@husky.neu.edu.
Appendix D: Email to Interview Participants

Dear [Name],

Thank you for your interest in the STEM for Early Childhood Programs study. At this time, I invite you to participate in this research study and to review, sign and return the attached Statement of Consent Form, which provides details about this research study and your role. As you may recall, the purpose of this study is to gain a better understanding of what practices ultimately improve STEM integration in early childhood education programs. By learning about your experiences with STEM integration, I hope to produce practical and applicable suggestions for preschools wanting to enhance STEM teaching and learning.

As a participant of this research study, you will be observed teaching STEM and will engage in a group interview with me after observations. You will be compensated with a $25 gift card at the completion of your involvement.

To confirm your participation, please respond to this email. I look forward to working with you.

Kindly,

Ruth Floreal

Florealr.r@husky.neu.edu
Appendix E: Email to Focus Group Participants

Dear Teachers,

Thank you for your interest in the STEM Leadership for Early Childhood Programs study. At this time, I invite you to participate in this research study and to review, sign and return the attached Statement of Consent Form, which provides details about this research study and your role. As you may recall, the purpose of this study is to gain a better understanding of what practices ultimately improve STEM integration in early childhood education programs. By learning about teachers’ experiences with STEM integration, I hope to produce practical and applicable suggestions for preschools wanting to enhance STEM teaching and learning.

As a participant of this research study, you will be asked to engage in a 60-minute focus group interview with me and to share an artifact that relates to STEM that your students have enjoyed. You will be compensated with a $25 gift card at the completion of your involvement.

To confirm your participation, please respond to this email with your signed Statement of Consent which can be scanned and emailed back to me. I look forward to working with you.

Kindly,

Ruth Floreal
Florealr.r@husky.neu.edu
Appendix F: Administrator Interview Protocol and Questions

Administrator Interview Protocol Form
Institution: Northeastern University
Interviewee:
Interviewer: Ruth Floreal
RESEARCH QUESTIONS: 1) How do teachers integrate STEM practices in ECE settings? 2) How do preschool directors support STEM integration within ECE settings?

Part I:
Introductory Session Objectives (5-7 minutes): Build rapport, describe the study, answer any questions (under typical circumstances an informed consent form would be reviewed and signed here).
Introductory Protocol
You have been selected to speak with us today because you have been identified as someone who can share a great deal about your experiences with the STEM initiative taking place at this school. My research project focuses on the STEM integration process in Early Childhood settings. Through this study, we hope to gain more insight into the practices that support and promote STEM teaching in early childhood.
Because your responses are important and I want to make sure to capture everything you say, I would like to audio tape our conversation today. Do I have your permission to record this interview? [if yes, thank the participant, let them know you may ask the question again as you start recording, and then turn on the recording equipment]. I will also be taking written notes. I can assure you that all responses will be confidential and only a pseudonym will be used when quoting from the transcripts. I will be the only one privy to the recording which will be eventually destroyed after they are transcribed. To meet our human subjects requirements at the university, you must sign the form I have with me [provide the form]. Essentially, this document states that: (1) all information will be held confidential, (2) your participation is voluntary, and you may stop at any time if you feel uncomfortable, and (3) we do not intend to inflict any harm.
Do you have any questions about the interview process or how your data will be used? This interview should last about 45-60 minutes. During this time, I have several questions that I would like to cover. If time begins to run short, it may be necessary to interrupt you in order to push ahead and complete this line of questioning. Do you have any questions at this time?

Part II:
Interviewee Background (5-10 minutes)
Objective: To establish rapport and obtain the story of the participant in general along the lines of the research topic. This section should be brief as it is not the focus of the study.
A. Interviewee Background and History of STEM Initiative
   1. Tell me about your career journey that led you to Sunflower Creative Arts (SCA).
   2. A few years ago, SCA re-located to Delray Beach. Tell me more about how the decision to relocate came about.
B. Questions about leadership experiences with STEM integration
School Background Information
   1. Tell me about the educational philosophy that guides the teaching and learning at SCA?
      a) Who made the decision to adopt this approach and when?
b) Whom were the main people involved in the creation of the play-based philosophy?
   a) How is this approach different from what other preschools are currently doing?
   b) Are there any other schools using this approach that you are aware of?
   c) Most preschools are either private pay or publicly funded. How would you categorize SCA? How have you been able to sustain such a unique school for so long?
   d) Do you have any articles or documents about the school that I can take a look at?

STEM Integration
For the purpose of this study, STEM Education is defined as- “The approach to teaching the STEM content of two or more STEM disciplines within an authentic context for the purpose of connecting these subjects to enhance student learning.”

2. What role does STEM integration having on SCA overall?
3. How does STEM impact teachers and staff? How do they feel about STEM?
4. How are STEM disciplines (Science, Technology, Engineer, Mathematics) implemented within teaching practices?
5. What developmentally appropriate practices are being used within classrooms for STEM integration?
6. How are students impacted by STEM practices here at SCA?

Leadership in Early Childhood
7. What do you believe are the significant components of early childhood classrooms?
8. After the hiring process, how were teachers introduced to the play, nature and arts-based educational philosophy?
9. How do you ensure that teachers are using high-quality teaching practices within their instruction?
10. What do teachers do when they need assistance with integrating subjects such as Literacy and Math?
11. Describe how you currently collaborate with teachers? In what ways do teachers collaborate with one another? Has this collaboration changed in any way in the past years?
12. How do you involve teachers in the leadership process?
13. What role has professional development played in developing the school culture?
14. What types of professional development opportunities have been offered to instructional and non-instructional staff?
15. In what ways have parents and community members been involved with STEM integration at SCA?
16. Tell me a little bit more about your programs for babies and toddlers. Do you feel that STEM teaching is appropriate for them as well?
17. What are some of the challenges you’ve faced with implementing STEM?
18. Is there anything else you would like to add?

Ask participant if they have any questions and thank them for their participation.
Appendix G: Observation Follow-Up Teacher Interview Protocol and Questions

Observation Follow-up Interview Protocol Form
Institution: Northeastern University
Interviewee: 
Interviewer: Ruth Floreal
RESEARCH QUESTIONS: 1) How do teachers integrate STEM practices in ECE settings? 2) How do preschool directors support STEM integration within ECE settings?

Part I:

Introductory Session Objectives (5-7 minutes): Build rapport, describe the study, answer any questions (under typical circumstances an informed consent form would be reviewed and signed here).

Introductory Protocol
You have been selected to speak with us today because you have been identified as a teacher that can share a great deal about your experiences with the STEM initiative taking place at this school. My research project focuses on the STEM integration process. Through this study, we hope to gain more insight into the practices that support and promote STEM teaching in early childhood.

Because your responses are important and I want to make sure to capture everything you say, I would like to audio tape our conversation today. Do I have your permission to record this interview? [if yes, thank the participant, let them know you may ask the question again as you start recording, and then turn on the recording equipment]. I will also be taking written notes. I can assure you that all responses will be confidential and only a pseudonym will be used when quoting from the transcripts. I will be the only one privy to the recording which will be eventually destroyed after they are transcribed. To meet our human subject’s requirements at the university, you must sign the form I have with me [provide the form]. Essentially, this document states that: (1) all information will be held confidential, (2) your participation is voluntary, and you may stop at any time if you feel uncomfortable, and (3) we do not intend to inflict any harm. Do you have any questions about the interview process or how your data will be used? This discussion should last about 45-60 minute. During this time, I have several questions that I would like to cover. If time begins to run short, it may be necessary to interrupt you in order to push ahead and complete this line of questioning. Do you have any questions at this time?

Part II:

I’m interested in finding out about your experiences as a teacher integrating STEM into your teaching practices. To do this, I am going to ask you some questions about some of your experiences here at Sunflower Creative Arts (SCA). If you mention other people, please do not mention names. You can say that you are giving the person a pseudonym.

1. When did you begin teaching at SCA? How did you decide on teaching at this school?
2. What is your understanding of the educational philosophy of play, nature, and arts-based teaching?
3. How do you feel this connects with STEM?
4. What do you believe STEM integration should look like in a preschool?
5. How do you decide on when and what subjects to teach?
6. What developmentally appropriate practices are used within your classroom?
7. How do you use art to support STEM integration?
8. How do you feel women and minority students are impacted by STEM integration?
9. How do you know that you have successfully taught a concept or lesson?
10. As a teacher, what opportunities for leadership do you have?
11. Describe how you currently collaborate with your peers (other teachers).
12. What type of professional development or teacher-training have you received? Are any of these STEM-related?
13. Regarding the observation today, how do you feel it went? Was this a reflection of a typical day for your students?
14. Can I share some of my thoughts and observations with you?
15. Over the past year, how have children responded to the play, nature and arts-based activities?
16. How has the use of STEM practices impacted students in your classes?
17. How are parents involved in SCA?
18. What are some of your greatest challenges when integrating STEM practices?
19. What recommendations do you have for improving teaching practices in preschools?
20. Is there anything else you would like to add?

Thank you for your time. For our focus group, I would like for you to bring an artifact that displays some of your students' favorite STEM activities.
Appendix H: Focus Group Interview Protocol and Questions

Focus Group Interview Protocol Form
Institution: Northeastern University
Interviewee:
Interviewer: Ruth Floreal

RESEARCH QUESTIONS: 1) How do teachers integrate STEM practices in ECE settings? 2) How do preschool directors support STEM integration within ECE settings?

Part I:

Introductory Session Objectives (5-7 minutes): Build rapport, describe the study, answer any questions (under typical circumstances an informed consent form would be reviewed and signed here).

Introductory Protocol
You all have been selected to speak with us today because you have been identified as teachers who can share a great deal about your experiences with the teaching and learning taking place at this school. My research project focuses on the STEM integration process. Through this study, we hope to gain more insight into the practices that support and promote STEM teaching in early childhood.

Because your responses are important and I want to make sure to capture everything you say, I would like to audio tape our conversation today. Do I have your permission to record this interview? [If yes, thank the participant, let them know you may ask the question again as you start recording, and then turn on the recording equipment]. I will also be taking written notes. I can assure you that all responses will be confidential and only a pseudonym will be used when quoting from the transcripts. I will be the only one privy to the recording which will be eventually destroyed after they are transcribed. To meet our human subjects requirements at the university, you must sign the form I have with me [provide the form]. Essentially, this document states that: (1) all information will be held confidential, (2) your participation is voluntary, and you may stop at any time if you feel uncomfortable, and (3) we do not intend to inflict any harm. Do you have any questions about the interview process or how your data will be used?

This discussion should last about 60-90 minutes. During this time, I have several questions that I would like to cover. If time begins to run short, it may be necessary to interrupt you in order to push ahead and complete this line of questioning. Do you have any questions at this time?

Part II:
I’m interested in finding out about your experiences as a teacher integrating STEM into your teaching practices. To do this, I am going to ask you some questions about some of your experiences during your time here at Sunflower Creative Arts (SCA). If you mention other people, please do not mention names. You can say that you are giving the person a pseudonym.

1. Before we begin talking about STEM, tell me a little bit more about Sunflower Creative Arts.
2. When you hear the word STEM, what’s the first word or phrase that comes to mind?
3. I asked each of you to bring something that represents STEM in your classroom. At this time, I would like for each of you to talk about the artifact you brought with you.
   a) Please explain the artifact you brought with you and why you decided to bring it.
b) What about it represents STEM integration? (multiple disciplines)
c) How it is developmentally appropriate?
d) What did your students enjoy about this activity?

4. How do you use art to support STEM integration?

5. As you know STEM is particularly important given the need to increase the number of students, who are proficient in STEM fields. Based on your previous experiences with teaching STEM:

6. What is the potential of STEM in ECE (preschool)? If money, space, or time were not an issue, what would STEM education look like?

7. How do you feel STEM integration impact students?

8. Earlier, we talked about what the students enjoyed. What have you noticed that they didn’t enjoy about STEM?
   a) What doesn’t work when integrating STEM?
   b) What challenges do you see in ECE (preschool)?
   c) Which of the disciplines Science, Technology, Engineering, or Mathematics is the most difficult to integrate, why?

9. How does your leadership support or collaborate with you?

10. How does your leadership support your growth as an educator?

11. What recommendations do you have for improving the STEM integration process in preschools?

12. Is there anything else you would like to add?

Ask participants if they have any questions and thank them for their participation.
References


Aguilar, N. A. (2016). Examining the integration of science, technology, engineering, and mathematics (STEM) in preschool and transitional kindergarten (TK) classrooms using a social-constructivist approach (Doctoral dissertation, Mills College).


https://doi.org/10.1007/978-94-6209-143-6


tid=12826


programs serving children from birth through age 8. Retrieved from


Creswell, J. W. (2013). Writing a qualitative study: Qualitative inquiry and research design:
Choosing among the five approaches. Los Angeles: Sage.

Distributed leadership: Building capacity for interdisciplinary climate change teaching at
four universities. International Journal of Sustainability in Higher Education, 15(1), 98-
110. https://doi.org/10.1108/IJSHE-10-2012-0091

Denzin, N. K., Lincoln, Y. S., & Guba, E. G. (1994). Paradigmatic controversies, contradictions,
and emerging confluences. Handbook of Qualitative Research, 643.
https://doi.org/10.1111/j.1365-2648.2005.03538_2.x

Current Directions in Psychological Science, 21(5), 335–341.

organisation for the twenty-first-century knowledge-based economy: The case of Singapore.
https://doi.org/10.1080/13632434.2010.546106

https://en.wikipedia.org/wiki/Distributed_leadership

early-childhood-education


*STEM experiences for all young learners*. Retrieved from 
http://d3lwefg3pyezlb.cloudfront.net/docs/Early_STEM_Matters_FINAL.pdf

Estrada, M., Burnett, M., Campbell, A. G., Campbell, P. B., Denetclaw, W. F., Gutiérrez, C. G., 

engineering design practices. *International Journal of Technology and Design Education*, 
27(1), 107–129. https://doi.org/10.1007/s10798-015-9328-x

programs: Individualizing developmentally appropriate practices. *Childhood 
Education, 83*(2), 92-98.

Freeman, N. K., & King, S. (2001). Service learning in preschool: An intergenerational project 
involving five year olds, fifth graders, and senior citizens. *Early Childhood Education 
Journal, 28*(4).

Gorski, P. (2013) *Reaching and teaching students in poverty: Strategies for erasing the 

423-451.


Keengwe, J., Kidd, T., & Kyei-Blankson, L. (2009). Faculty and technology: Implications for faculty training and technology leadership. *Journal of Science Education and*


https://doi.org/10.4135/9780857021038.n3


https://doi.org/10.1080/13632434.2017.1293638


https://doi.org/10.1007/s10643-014-0674-1


National Association for the Education of Young Children. (2009). *Developmentally appropriate practice in early childhood programs serving children from birth through age 8, 1–31*


https://doi.org/10.1080/03004430.2014.903939

https://doi.org/10.1080/09575146.2015.1080667


https://doi.org/10.1177/027112149001000205

February 28, 2019 from
http://flbt5.floridaearlylearning.com/details.html#p=resources/VII/four_year olds/H/1&d=VII&a=four_year_olds


https://doi.org/10.1016/j.procs.2013.09.317


https://doi.org/10.1080/00220671.2016.1253539


https://doi.org/10.1177/1741143217714254


Talan, T. N., Bloom, P. J., & Kelton, R. E. (2014). Building the leadership capacity of early


https://doi.org/10.1177/0162353217745159


https://doi.org/10.1080/00405841.2014.862116


