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Arkansas Teachers' Perspectives and Experiences Implementing STEM in Kindergarten Classrooms

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This is to certify that the doctoral study by

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Walden University
2023

Abstract

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MSE, Arkansas State University, 2006

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Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Kindergarten teachers in one large district in Arkansas are inconsistently implementing science, technology, engineering, and mathematics (STEM)-integrated lessons into their curriculum despite a systemic plan for increasing equitable access to high-quality STEM-focused education for all students by the state department of education. While researchers suggest that barriers for lower elementary teachers in implementing STEM include low STEM content and pedagogical efficacy, few studies explore how kindergarten teachers implement STEM lessons with their students. Hence, the purpose of this descriptive-interpretive study was to explore Arkansas teachers' experiences with and perspectives on implementing STEM lessons in their kindergarten classrooms within the context of the Arkansas (AR) STEM Model Program. This study, framed by Bandura's social cognitive theory and constructivism, was driven by research questions focused on exploring kindergarten teachers' perceptions of how they currently implement STEM-integrated learning and their successes and challenges in doing so. Interviews were conducted with 12 kindergarten teachers. Data were analyzed thematically with open and axial coding techniques. The results of this study indicated that various factors influence how consistently STEM lessons are integrated into these classrooms. Outside factors, such as a limited amount of curriculum, administrative support, professional training, and internal influences, such as self-efficacy and knowledge, influenced how often STEM was implemented. The results of this study could influence teacher professional development and encourage necessary shifts in curriculum development to better meet the needs of students and provide them with opportunities to develop essential 21st-century skills.

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Dedication

This study is dedicated to my daughters, Essie, and Lottie, whom I hope will never stop learning, questioning, and using their voices. I hope they both have the desire to expand their knowledge of the world around them as well as find their own unique way of making the world a more beautiful place.

I also dedicate this to the hundreds of little learners who have spent their earliest years of education in my classroom. I hope you all never forget your power. I will never forget you.

Finally, this study is dedicated to the teachers who continue to show up to educate, to the teachers who diligently fight for what is fair and just for all learners, and to those who endure the politicization of education during our current educational climate. Never stop using your teacher's voice for what is right and best for students.

Acknowledgments

I want to thank my family and friends who have stood by my side as I journeyed toward completing this study over the past several years. My husband, Travis, whose belief in me ignited my desire to work toward a doctoral degree. He took on many of my implied “mom” roles which allowed me to focus on my educational advancement. My daughters, Essie and Lottie, whose love and encouragement kept me fueled and focused. My parents, Dale and Judy never doubted my success in my ventures. Melissa, who started this doctoral adventure alongside me, and Becky, who gripped my hand and weathered the journey right alongside me the entire journey. Nathan, who could always speak reason and logic (along with a touch of humor) into my emotions, helped me navigate many of the challenges completing a doctoral degree brought into my world.

I want to acknowledge Dr. Sarah Hough and Dr. Lynn Varner, my first and second chairs, who have been so consistent throughout this process and helped guide this study to completion. I also want to acknowledge my URR, Dr. Mary Howe, for her guidance and feedback as well.

Finally, to all the educators who have left an imprint on my journey…your impact is everlasting and constant. You are more powerful than you realize.

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Chapter 1: Introduction to the Study

Policymakers, educational leaders, and researchers have called for integrated approaches to science, technology, engineering, and mathematics (STEM) education across all grade levels to help prepare students for the 21st century through the development of growth mindsets and essential skills such as communication, collaboration, and critical thinking (National Research Council, 2011). Just as the industrial revolution made it essential for all children to learn to read, the technological revolution has made it critical for all students to understand STEM (McClure et al., 2017). In 2011, the National Research Council established three goals for STEM-focused K-12 instruction in the United States: expand the number of students pursuing STEM-related careers, increase science literacy for all students, and expand the STEM-related workforce (Forman et al., 2015). This movement of integrating STEM and the development of a multidisciplinary framework for learning were the driving forces behind the development of the Next Generation Science Standards (NGSS; NGSS Lead States, 2013). However, despite the national push toward science instruction reform, there exists a vagueness regarding the conceptualization of STEM education among teachers, administrators, and curriculum developers (el Nagdi et al., 2018). John et al. (2018) asserted that while there is evidence that rigorous, integrated STEM curriculum promotes curiosity and cognitive development in kindergarten-aged children, very little STEM or engineering-based instruction occurs in kindergarten classrooms. Furthermore, the role that lower elementary, specifically kindergarten, teachers embody as STEM teachers in their classrooms is unclear.

Although there is an awareness of the importance of STEM education in classrooms, kindergarten teachers tend to be less familiar with integrating STEM into their current curriculum (Tao, 2019). This minimal familiarity could be due to several factors such as (a) inadequate professional development in STEM integrated curriculum (Pendergrast et al., 2017), (b) the potentially challenging implementation of STEM learning by kindergarten teachers in the elementary classroom because literacy and mathematics dominate the elementary curriculum at the expense of science (Isabelle, 2017); and (c) teachers' own personal sense of inadequate skills or low self-efficacy in STEM integration (Johnson et al., 2021).

Current researchers have stated the minimal efficacy that some lower elementary teachers feel in implementing STEM, but there is minimal research showing how successful elementary STEM teachers implement integrated STEM in their classrooms (Hammack & Ivey, 2017). Young learners are often natural scientists and engineers (Samara et al., 2018), and basic STEM concepts are best learned at an early age because they are essential prerequisites to college readiness, career and technical training, and an overall increase of technical skills in the workplace (National Science and Technology Council [NSTC], 2018). Although there is a widespread movement toward integrating STEM within K-12 education, few studies explore teachers' experiences implementing STEM at the kindergarten level. Limited attention has been paid to teaching STEM in early childhood and kindergarten classrooms (Park et al., 2017). In this study, I explored kindergarten teachers' perspectives on STEM integration with their students and considered how kindergarten teachers in one large school district are implementing STEM in their current classrooms, including their successes and struggles as they do so.

This study is significant as it provides valuable insight into teacher perspectives, potential challenges, and opportunities for the implementation of STEM education in Arkansas. The results of this study could influence the professional development and curriculum development at the early elementary level that could better align instruction to the demands of the 21st-century workforce and NGSS.

Background

National Background

Over the past few decades, STEM education has evolved from a set of overlapping disciplines to a more integrated, interdisciplinary approach to teaching academic concepts through real-world applications and problem-solving (NSTC, 2018). In 2018, the NSTC, along with the U.S. Department of Education, developed a strategic 5-year plan, C*harting a Course for Success: America's Strategy for STEM Education*, that detailed the federal government's strategy to expand and improve the capacity for STEM education for all students (NSTC, 2018). This strategic plan details three overarching goals: (a) build solid foundations for STEM literacy so that every student can master basic STEM concepts; (b) increase diversity, equity, and inclusion in STEM; and (c) prepare the STEM workforce for the future (NSTC, 2018). This White House-led initiative was adopted in 2018 and details the vision, goals, and benefits of STEM education in the United States. However, the NSTC did not outline a consideration for teacher confidence in or attitudes toward implementing integrated STEM learning or the plan for teacher training for such implementation. Additionally, researchers in recent studies indicated that, nationally, very little time within a day in K-3 classrooms is dedicated to STEM education because approximately 89 minutes a day is focused on language arts, 54 minutes is focused on mathematics, and only 19 minutes is dedicated to science (Tippett & Milford, 2017). Teachers often feel constrained by the current school structures and policies to consistently implement STEM-integrated learning (McClure et al., 2017).

Local Background

Many states have utilized the national strategic plan, *Charting a Course for Success: America's Strategy for STEM Education*, to develop state-wide STEM initiatives and plans for integration of STEM education locally. Arkansas developed the AR STEM Model Program Timeline, which closely aligns with the national model. The goals of this timeline include (a) increasing STEM opportunities for Arkansas students; (b) recognizing model STEM schools across the state; (c) developing and strengthening partnerships with business, industry, and community; and (d) supporting growth and diversity of ARSTEM teacher pipeline (Division of Elementary and Secondary Education, n.d.-b). Arkansas's plan was created with state-wide stakeholder input and outlines the development of STEM committees, identification of best practices, development of a rubric to establish model STEM schools, and a plan to offer STEM-focused professional development. However, much like the national plan, the state plan does not mention teacher implementation or training consideration.

I consulted with an elementary curriculum coordinator of a local, large school district. She reported that the curriculum team has met with approximately 50 kindergarten teachers each year for the past 3 years to discuss curriculum needs and successes. Records from those meetings showed that STEM learning was only mentioned seven times over those 3 years, and records indicated that three teachers felt they were successful in implementing STEM, whereas four statements indicated that teachers wanted to implement STEM but struggled to do so. The remainder of the curriculum discussion focused primarily on literacy and mathematics content. As stated above, one of the reasons kindergarten teachers may inconsistently implement STEM-integrated curriculum is a primary focus on core content areas of literacy and mathematics, and teachers feel there is not enough time in the day to integrate STEM learning activities.

Due to the COVID-19 pandemic, the last available standardized test data are from the 2018-2019 school year because tests were not administered during the 2019-2020 school year. Additionally, kindergarten students are not administered a cumulative standardized assessment; therefore, data were pulled from third and fourth-grade level bands from the ACT Aspire assessment. According to these data for third graders during the 2018-2019 school year, 61.47% of students scored *ready* or *exceeding* in mathematics, while 39.11% scored *ready* or *exceeding* in science (Arkansas Department of Education, 2020). Data results for fourth graders were 53.37% scored *ready* or *exceeding* in mathematics, while 41.97% scored *ready* or *exceeding* in science (Arkansas Department of Education, 2020). The low science and mathematics scores may further indicate that STEM is implemented inconsistently in the lower grades across the district.

Officials at a local educational cooperative responsible for most of the professional development opportunities for the teachers in this large district indicated that STEM-focused training had been offered only seven times within the past 5 years for the K-6 grade bands. As indicated in the literature, minimal teacher training and preparation could lead to inconsistent implementation of STEM content in the kindergarten classroom (Tao, 2019).

Problem Statement

The problem that was addressed in this qualitative study is that kindergarten teachers in one large district in Arkansas inconsistently implement STEM-integrated lessons into their curriculum. Although the Arkansas Department of Education, in collaboration with state-wide stakeholders, has established a systemic plan for increasing equitable access to high-quality STEM-focused education for all students, the lack of consideration of current implementation, barriers that might exist to proper implementation, and teacher training could impede the successful adoption or implementation the AR STEM Model Program.

The two most proximal influences on student achievement of the STEM goals are effective instruction and establishment of a culture of learning that supports STEM-focused education (Forman et al., 2015). To be effective, educators must possess multidisciplinary content knowledge along with the pedagogical expertise of integrating STEM content (NGSS Lead States, 2013). It is essential that educators understand the foundational concepts, philosophy, and purpose for an integrated STEM curriculum prior to implementation in the classroom (Kelley & Knowles, 2016); therefore, teachers who do not feel properly trained in STEM integration may possess a low academic self-efficacy. According to Bandura (1977), self-efficacy beliefs lie at the core of educator functioning and possessing a low self-efficacy may prevent educators from completing tasks or accomplishing goals.

Purpose of the Study

The purpose of this qualitative study was to explore kindergarten teachers' perspectives on STEM integration with their students and to consider how kindergarten teachers in one large school district are implementing STEM in their current classrooms including their successes and struggles as they do so. The problem that was addressed in this study is that kindergarten teachers in one large district in Arkansas inconsistently implement STEM integrated lessons into their curriculum and the intent of this study is to explore those teachers' perceptions of STEM integration as well as consider how they are currently implementing STEM into their classrooms.

Research Questions

RQ1. What are kindergarten teachers' perspectives on implementing STEM integration at the kindergarten level within one large school district in Arkansas?

RQ2. How do kindergarten teachers in one large school district in Arkansas integrate STEM learning activities in their curriculum?

Conceptual Framework

Bandura's social cognitive theory (SCT) provides the foundation for this study. This theory states that people are not just shaped by their environment and inner forces, but rather, people also actively shape their environment and inner forces as well (Nabavi, 2011). Self-efficacy along with other key social-cognitive factors influence motivation and performance actions. Self-efficacy and outcome expectations can influence behavior.

SCT asserts that high self-efficacy for performing a behavior alone is often unlikely to produce a behavior if a person has a low outcome expectancy. Teachers can potentially possess a high self-efficacy in STEM implementation, yet, if they do not believe that integration of STEM into their classroom would pose a positive impact or outcome on their students, they may hesitate to implement the curriculum changes (Ku et al., 2015).

This study is founded in the constructivist theory to explore the implementation of STEM learning within the kindergarten classroom because it supports the experiential nature of learning and allows for individual perspectives. Social constructivism and educational constructivism tend to have the greatest impact on curriculum design and instruction as educators tend to draw upon their own experiences and perspectives when making educational decisions (Kyere, 2017).

Nature of the Study

A basic qualitative research design with interviews was used to complete this study. This approach is derived philosophically from constructivism and presented insight into the perspectives, experiences, and implementation practices for educators (Ravitch & Carl, 2016). For this study, I conducted 12 individual interviews gathered from kindergarten teachers within one large school district Arkansas. I selected kindergarten teachers who teach within one school district to ensure student demographics, availability of resources and professional development opportunities, and curriculum remain similar. Individual interviews were conducted via the digital platform Zoom (https://zoom.us). As a fellow kindergarten teacher within this local school district, I believe that participants felt comfortable sharing their perspectives regarding STEM implementation with me for the purpose of this study. Although I completed this study within my own school district, I did not use my own school building, nor did I hold any supervisory position over any of the participants.

Definitions

AR STEM Model Program: A statewide program that connects Arkansas's STEM education system to Arkansas careers and career training opportunities with the goals of (a) increasing STEM opportunities for students K-12; (b) recognizing model STEM schools across the state; (c) developing and strengthening partnerships with business, industry, and community; and (d) supporting growth and diversity in the AR STEM teacher pipeline (Division of Elementary and Secondary Education, n.d.-b).

Digital divide: The gap between those who do and do not have access to technology or the internet (Muller, 2022).

Early childhood education: In the state of Arkansas, early childhood education is often considered pre-kindergarten to kindergarten. Classroom teachers must hold an early childhood education degree (PK-4) to teach kindergarten (Division of Elementary and Secondary Education, n.d.-a).

Efficacy: The level of confidence educators have in their ability to guide learners to success (Bandura, 1977).

Evidence-based reasoning (EBR): Utilizing logic and evidence to support claims and ideas (National Research Council, 2012).

Integrated STEM: The seamless amalgamation of content and concepts from multiple STEM disciplines (Nadelson & Seifert, 2017).

Makerspace: A collaborative workspace designed for making, learning, and sharing that utilizes a variety of technology (Makerspaces.com, 2022).

Outcome expectations: The anticipated results from a specific activity (Bandura, 1977).

Project-based learning (PBL): A teaching method in which students learn by actively engaging in real-world and personally meaningful projects (Buck Institute of Education, 2022).

Service learning: An educational approach that combines learning objective with community service in order to provide a pragmatic, learning experience while meeting societal needs (Reinking, 2018).

STEM: The widely accepted acronym for science, technology, engineering, and mathematics (NSTC, 2018).

Assumptions

Certain aspects of public education in the study state were assumed. It was assumed that all participants hold either a standard or nontraditional teaching license. All participants were expected to teach the same state standards as well as have access to the same science and mathematics curriculum since all participants are from the same school district. Additionally, it was assumed that there would be kindergarten teachers willing to participate in this study who would respond honestly during the interview process.

Scope and Delimitations

This study began from my own experiences as a kindergarten teacher as well as my experiences of visiting other classrooms around the state during my year as state teacher of the year. I often witnessed STEM integration in middle and secondary schools but rarely in elementary. Not once did I observe STEM-integrated learning in a kindergarten classroom during my year of service. In this study, I explored kindergarten teachers' perspectives on and experiences implementing STEM-integrated lessons as those areas are often overlooked in literature (Hammack & Ivey, 2017; Tao, 2019). Much of the literature available focuses on the benefits of STEM integration (Kyere, 2017; Linder et al., 2016) as well as the barriers that might exist that prevent kindergarten teachers in implementation (Pendergrast et al., 2017). I identified the challenges or barriers that exist in implementation as well as highlighted the successes as I considered the individual perspectives of kindergarten teachers in one large district.

This study focused on the perspectives of kindergarten teachers who teach within one large school district. This district houses nine elementary campuses and employs between 30 and 35 kindergarten teachers. I requested participants from schools other than the one where I teach personally to avoid any conflict within my own local setting. Any teacher that I know personally or have interacted with professionally was excluded from this study.

Bandura's SCT provides the foundation for this study since the purpose and research questions focus on teacher perspectives and experiences with STEM. Many studies focused on STEM utilize frameworks based around STEM such as the STEM education theoretical framework or focused on 21st century skills frameworks such as the P21 Framework. However, since this study focuses predominantly on teacher perspectives and beliefs, Bandura's SCT was chosen as the foundation.

Although this study focuses solely on the experiences of kindergarten teachers, the results of this study could be transferred to similar populations of early childhood or elementary teachers as much of the literature utilized in this study blends into those areas as well. Transferability will be promoted by including detailed descriptions of both the data and the context so that readers can make comparisons and connections to other contexts or complete their own similar studies.

Limitations

One of the greatest anticipated challenges was the global COVID-19 pandemic. I addressed this barrier by utilizing digital tools such as Zoom to gather data. Another limitation is that I only used one data source, therefore, I could not triangulate my findings via more than one data source. However, I used thematic analysis to analyze my data and presented a thick description of the write-up of the study to help establish credibility. Member checking was also utilized to promote validity and credibility of the study. The small sample size could also have limited transferability.

Significance

This study is significant as it provides valuable insight into teacher perspectives, potential challenges, and opportunities of implementation of STEM education in a local district. The results of this study could influence the professional development and curriculum development at the early elementary level that could better align instruction to the demands of the 21st-century workforce and NGSS. The local site could utilize the results of this study to engage educators in dialogue focused on STEM integration. Additionally, the results of this study could provide the state department of education insight into what might hinder or enhance the implementation of the AR STEM Model Program to accomplish the program goals (Division of Elementary and Secondary Education, n.d.-b). This study addresses a gap in practice at a local setting as well as a gap in literature as it focuses on the implementation of STEM in the kindergarten setting—an area that is often overlooked in research (Hammack & Ivey, 2017).

Summary

This qualitative study allowed for individual educators' perspectives on implementing STEM-integrated learning in kindergarten classrooms which provides much richer insight than quantitative data. The goal of this study was to explore kindergarten teachers' experiences with and knowledge of STEM integration, including their successes and struggles as they do so. The results of this study could influence professional development for teachers as well as encourage necessary shifts in curriculum change to better meet the needs of students and provide them with opportunities to develop essential 21st century skills. In Chapter 2, I provide a critical review of the literature as well as key concepts such as STEM in kindergarten, benefits of STEM education in kindergarten classrooms, STEM and how it enhances the development of 21st century learning skills, considerations of an integrated approach versus disciplinary approach to STEM integration, and barriers that may prevent the implementation of STEM such as teacher perceptions and self-efficacy as well as teacher training and preparation.

Chapter 2: Literature Review

As discussed in Chapter 1, the problem that was addressed in this qualitative study is that kindergarten teachers in one large district in Arkansas inconsistently implement STEM-integrated curriculum into their curriculum. Although the Arkansas Department of Education, in collaboration with state-wide stakeholders, has established a systemic plan for increasing the equitable access to high-quality STEM-focused education for all students, the lack of consideration of current implementation, barriers that might exist to proper implementation in this context, and teacher training could impede the successful adoption or implementation the AR STEM Model Program. The purpose of this qualitative study was to (a) explore kindergarten teachers' perspectives on STEM integration with their students and (b) consider how kindergarten teachers in one large school district are implementing STEM in their current classrooms including their successes and struggles as they do so.

The current literature on the topic of STEM integration is wide and varied as the push for integration of STEM learning has been an educational focus for the past few decades. Research regarding the benefits and effectiveness of STEM education across K-12 grade bands is plentiful and demonstrates why STEM should be taught across various grade bands. Some of the benefits include but are not exclusive of increasing 21st century learning skills, preparing students for STEM-based careers, and promoting the development of science literacy.

The current research also focuses on the barriers that might prevent the implementation of STEM-integrated learning into classrooms such as teacher self-efficacy, teacher training, and a focus on mathematics and literacy consuming much of the school day. Much of the research focuses on implementation at the secondary and post-secondary level and there are few studies that explore teachers' experiences implementing STEM at the kindergarten level. Little is known about how current kindergarten teachers are implementing integrated STEM lessons into their classrooms as well as what successes and struggles current kindergarten teachers may experience (Early Childhood STEM Working Group, 2017), and Hrywic (2017) stated that while research has been completed regarding the implementation of STEM in secondary education, further investigation needs to be completed about the implementation of STEM learning at the early elementary level and how that implementation impacts the development of 21st-century skills.

Literature Search Strategy

I searched for literature from the Walden Library primarily. In the Walden Library, I used databases such as EBSCOhost, Education Source, and SAGE Knowledge. I searched ProQuest for past dissertations and Thoreau for theories. I searched for literature using keywords and their combinations such as *kindergarten*, *STEM*, *social cognitive theory*, *self-efficacy*, *STEM and early elementary*, *early childhood STEM*, *teacher attitudes and perceptions*, and *21st-century skills*. For information about Arkansas, I searched the keywords *Arkansas, Arkansas and STEM*, and *Arkansas and kindergarten*. I also utilized search engines such as Google and Google Scholar. Due to the minimal about of literature focused on STEM integration specifically in kindergarten, my literature search was broadened to early childhood (pre-kindergarten), elementary, and secondary education. Some assumptions can be made that generalizations found in these articles can be applied to kindergarten as well.

Conceptual Framework/Theoretical Foundation

Bandura's SCT provides the conceptual lens for this study both in terms of the necessity of the research question themselves and the methods by which the data will be analyzed and interpreted. This theory states that people are not just shaped by their environment and inner forces, but rather, people also actively shape their environment and inner forces as well (Nabavi, 2011). Self-efficacy along with other key social-cognitive factors influence motivation and performance actions. Self-efficacy and outcome expectations can influence behavior.

A major component of SCT is self-efficacy. Bandura defined self-efficacy as the drive that is operational when an individual perceives a task is achievable. This perception of achievement may alleviate the threat of failure, therefore increasing an individual's confidence in succeeding (Bandura, 1977). An individual gauges their self-efficacy from their prior performance accomplishments, modeled experiences, forms of social persuasion, and physiological indexes (Bandura, 1977). An individual's performance accomplishments tend to be the most consistent information to assess self-efficacy as they are concrete indicators of one's skills. Successful performances increase self-efficacy, whereas negative performances (or perceived failures) lower self-efficacy. Bandura also argued that individuals avoid tasks or activities whose requirements demand skills that the individuals perceive as beyond their capabilities. This assertion motivates RQ1 as it considers the individual perceptions of kindergarten teachers within the district and may provide insight into how those perceptions influence performance.

SCT asserts that high self-efficacy for performing a behavior alone is often unlikely to produce a behavior if a person has a low outcome expectancy. Teachers can potentially possess a high self-efficacy in STEM implementation, yet, if they do not believe that integration of STEM into their classroom would pose a positive impact or outcome on their students, they may hesitate to implement the curriculum changes (Ku et al., 2015). SCT then illustrates the necessity of obtaining teachers' own perception of the efficacy of STEM integration at the kindergarten level and influences the research questions in this study.

This theory has been used as a framework in numerous studies to help explain teacher actions, perceptions, and beliefs. Some examples of studies that utilized this theory as a framework include a study completed on teacher commitment to teaching (Raymond et al., 2020), preservice teacher instructional competence and capacity (Moses et al., 2019), and elementary teachers' level of self-efficacy in teaching science (Bursal, 2012). In all three of these studies, Bandura's SCT provided the foundation and framework for the study to provide insight into why educators do what they do. The purpose of this study is to explore how kindergarten teachers in one large school district currently implement STEM integrated lessons as well as examine what barriers kindergarten teachers face as they implement STEM into curriculum. The components of SCT could be utilized to help explain why teachers do or do not implement STEM as well as provide insight into the role that self-efficacy plays in implementation of STEM.

SCT is also rooted in constructivism, which also provides the conceptual framework for this study. The constructivist theory asserts that learners actively create or construct their own knowledge (McLeod, 2019). The principles of constructivism are that learning is active, social, and personal (Olusegan, 2015). The teacher's role in a constructivist classroom is to provide a collaborative environment so that students can problem solve as active participants in their own learning (McLeod, 2019). This theory aligns closely to a STEM-integrated classroom as STEM learning is often collaborative and problem-solving based. During STEM lessons, teachers often take on the role of a facilitator and scaffold learning so that students can construct their own meaning while they engage in the task at hand, which also aligns to constructivism.

To answer the research questions posed in this study, both the SCT and constructivism provide the framework and lens through which the data were analyzed, interpreted, and presented. Both theories align to the STEM education model as well as focus on the roles that teachers and students each play in the classroom. SCT asserts that self-efficacy along with other key social-cognitive factors influence motivation and performance actions and can influence behavior of teachers.

Literature Review Related to Key Concepts and Variables

STEM Education in Early Childhood and Kindergarten Classrooms

The earlier that educators support young children's natural curiosity and wonder and provide opportunities for children to engage in STEM focused learning, the more successful they will be in all aspects of learning throughout their life (Pawilen & Yuzon, 2019). According to the NSTC (2018), basic STEM concepts are best learned at an early age through the teaching of academic content integrated into real-world applications and problem solving. This approach to learning where content standards are integrated with real-world lessons allows students to apply science, technology, engineering, and mathematics skills and make connections to their own lives. These interdisciplinary experiences should be founded in STEM and based on student interests, cultures, and experiences (Scarola et al., 2022). Young children who have opportunities to engage in STEM learning activities often develop a foundation of knowledge across disciplines and greater socio-emotional and health outcomes (Murray, 2019).

Young children are often inquisitive, observant, open-minded and have a natural curiosity that drives a pursuit of knowledge (Pendergast et al., 2017). Concepts at the core of STEM such as curiosity, creativity, collaboration, and critical thinking are in high demand and should therefore be addressed as early as possible (Park et al., 2017). Upon entering kindergarten, students are primed to engage in scientific exploration and inquiry; therefore, science phenomena can be explored at an early age. According to the NGSS (2013) standards for kindergarten, the crosscutting concepts of patterns; cause and effect; systems and system models; interdependence of science, engineering, and technology; and influence of engineering, technology, and science on society and the natural world are called out as organizing concepts for these disciplinary core ideas. Students are expected to demonstrate grade-appropriate proficiency in asking questions, developing, and using models, planning and carrying out investigations, analyzing and interpreting data, designing solutions, engaging in argument from evidence, and obtaining, evaluating, and communicating information. Kindergarten students are expected to use these practices to demonstrate understanding of the core ideas, such as understanding variations and patterns as they relate to weather, developing an understanding of what animals need to survive and applying that knowledge to explain why animals live in certain ecosystems, and applying an understanding of force and motion to design and analyze a design solution.

Kindergarten students have a natural ability to investigate and learn from their environment. Everyday activities such as talking with peers, participating in hobbies, and play help them learn about the world around them (National Research Council, 2012). The capacity of young learners from all backgrounds and socioeconomic levels to reason is significantly greater than what has been historically assumed. Kindergarten teachers can build upon this knowledge through scientific and engineering practices and help students develop a deeper, more complex understanding of science concepts. It is crucial for young students to see the application of science in real-life situations, to participate in hands-on learning experiences that involve STEM concepts, and to engage in decision making and problem-solving to increase their interest and motivation in science, technology, engineering, and mathematics (Pawilen & Yuzon, 2019).

Science education involves both learning science concepts as well as scientific reasoning. Authors of a recent study (Graaf et al., 2016) found that by engaging kindergarten students in the process of scientific reasoning that students developed a greater scientific vocabulary and were able to participate in scientific discourse. Through this discourse, kindergarten children were able to independently master science concepts if they utilized scientific reasoning appropriately.

One unique aspect of STEM integration is the inclusion of engineering concepts into science curriculum. Tank et al. (2018) completed a study focused on the implementation of engineering design-based instruction in the kindergarten classroom. The authors asserted that developmentally appropriate engineering can incorporate multiple aspects of engineering design, be scaffolded by teachers to promote student discourse, include interdisciplinary content, and take place over an extended period of time. Kindergarten students are able to engage in solving multilayer problems that require them to revisit ideas, make connections, and suggest a variety of solutions (Tank et al., 2018). The results of this study suggested that kindergarteners can demonstrate a high level of understanding and engagement in long-term, multipart engineering and integrated STEM lessons.

Authors of another study (Rynearson et al., 2017) also explored engineering practices in the kindergarten classroom with a focus on argumentation, which is one of the eight essential practices in science and engineering (National Research Council, 2012). Argumentation allows students to design solutions based on evidence and is often referred to as *evidence-based reasoning* (EBR). Rynearson et al. (2017) sought to investigate whether kindergarten-aged students could utilize EBR to design solutions rather than just “tinkering” until they found the solution. The results of this study demonstrate that kindergarten students can utilize EBR to complete engineering practices in the classrooms. The most important aspect of incorporating engineering in the classroom is the inclusion of the question “Why?” so that students cannot just simply make a claim but rather support their claims with evidence (Rynearson et al., 2017).

Argumentation, and more specifically EBR, is an important skill for students to learn at an early age so that they begin to build habits of utilizing evidence to support their claims (National Research Council, 2012).

Malone et al. (2018) studied the effects engineering practices had on student cognition and interest in STEM in kindergarten classrooms. The authors approached the integration of STEM by incorporating engineering practices into dance, visual arts, and physical education which often are part of the kindergarten daily schedule. They found that when engineering practices were built into these units, students demonstrated an increase in a conceptual understanding of technology and engineering by 55% as well as demonstrated an increase in interest in future STEM careers. Additionally, a study by Toma and Greca (2018) also found that students who were engaged in STEM-integrated learning were more likely to possess a positive attitude toward science than peers who were not exposed to STEM. Therefore, consistent access to STEM-based learning could influence student interest in STEM but also impact student self-efficacy as related to careers in STEM-related fields (Malone et al., 2018; Toma & Greca, 2018).

Additionally, Marcus et al. (2018) found that one way to support children's learning and transfer of knowledge in hands-on, problem-solving lessons is through the utilization of engineering instructions that help guide students to apply knowledge to new situations. Scaffolding student learning by teaching specific engineering principles such as cross-bracing and structural integrity by using age-appropriate vocabulary such as wobbly and sturdy was found to be an effective strategy that fostered transferability of knowledge from STEM into other content areas (Marcus et al., 2018). While all these studies focused on different aspects of engineering education within the kindergarten classroom, all found that incorporating engineering principles to be developmentally appropriate and foster positive effects on student learning and engagement.

Benefits of STEM Integration

STEM lessons often require more time than an isolated mathematics or science lesson; however, more learning standards are addressed during integrated STEM lessons than when disciplines are taught separately, and the integration of the disciplines allows students to explore a concept or topic in a meaningful way (Linder et al., 2016). Students who participate in integrated STEM learning can make connections between content areas and their own world and learning transcends the classroom walls and becomes relevant to students' lives (Kyere, 2017). Through real life scenarios, teachers can provide learners with prior knowledge, which helps to scaffold and model lessons and often leads to rich discussions among young children (Sundararajan et al., 2018).

Additionally, students who participate in STEM-integrated learning often possess a more positive attitude toward science, technology, engineering, and mathematics and are more likely to pursue a career in the STEM field (Malone et al., 2018; Toma & Greca, 2018). Jiang (2022) added that the practice of early science education is a highly effective strategy for the future development of kindergarten children's scientific literacy. Children who are exposed to STEM-integrated lessons early develop strong scientific vocabulary as well as learn essential scientific concepts (Jiang, 2022).

There are major benefits to hands-on STEM-integrated learning experiences: development of students' critical thinking and problem-solving skills, facilitation of concept development, a greater retention of content knowledge, and access to a stimulating learning environment (Kyere, 2017). Project-based learning models founded in STEM require design-thinking skills such as designing, prototyping, and evaluating outcomes. These activities can prove to be valuable as authentic, real-world lessons that allow even the youngest students to demonstrate complex problem-solving processes often used in business and industry (Falloon et al., 2020). Hands-on STEM-integrated learning has the potential to create active learners, promote a higher level of participation and motivation, increase student understanding, and provide a greater retention of content knowledge. Students who are actively engaged in learning science concepts through integrated lessons are more likely to ask questions, make connections, and apply their knowledge to problem solve (Linder et al., 2016; Reinking, 2018).

The results of a study completed by Şahin (2021) considered the impact that STEM-focused learning had on the problem-solving skills of five-year-old children. This study focused on a group of 37 kindergarten-aged children with students divided into two groups: one group received instruction in a disciplinary approach learning environment and the other group received instruction in an integrated STEM-based program. The same standards were taught to both groups with only the instructional method varying. The results of this study indicated that STEM-based learning had a significant impact on the problem-solving ability of students. The students who engaged in STEM learning scored significantly higher in problem solving than the students who received instruction without the STEM focus (Şahin, 2021). John et al. (2018) also found an increase in problem-solving skills of kindergarten-aged students through STEM integrated curriculum. This study asserts that when students engage in an engineering-based curriculum, they demonstrate an increase in engagement and a persistence in completion of assignments (John et al., 2018).

One of the greatest benefits of integrated STEM instruction is the fostering of the development of essential 21st-century skills such as collaboration, creativity, communication, and critical thinking. These skills have been identified as necessary and essential for students to become globally competent and able to adapt the continually changing workforce environment (Falloon et al., 2020; Nicola et al., 2018). As Michael Fullan asserted, the moral purpose of education is to equip students with the skills necessary to become productive citizens (Fullan, 2011) and the development of 21st-century skills enable students to succeed as individuals, citizens, and workers (Kivunja, 2014).

STEM and 21st-Century Skills

In our current society, information is being updated and changed at an incredible speed and to keep up with the demands of the modern society, children need to be able to process information and think critically, creatively, and flexibly (Averin et al., 2020). The Partnership for 21st-century skills has developed the P21 Framework that describes the skills and knowledge that students should master to succeed both academically and in life in general (ReMake Learning, 2016). This framework suggests that students will gain essential 21st-century skills by integrating core content and interdisciplinary themes and engaging in active learning that promotes development of the 4C's: creativity, critical thinking, communication, and collaboration. Combining the ideas of STEM integration with the importance of the development of the 21st-century skills, specifically the 4C's, is a driving force behind the push toward an interdisciplinary approach to teaching science, technology, engineering, and mathematics content (Reinking, 2018).

Chalkiadaki (2018) presented a synthesized review of current literature based on the development of 21st-century skills in the context of primary education. This study categorizes 21st-century skills into four broad sets of skills: personal skills, interpersonal and social skills, knowledge and information management, and digital literacy. For the purpose of this study, the 21st-century skills I have chosen to focus on are creativity, collaboration, communication, problem solving and critical thinking. Creativity and collaboration are skills that fall within the personal skills category while communication is found in social skills. Critical thinking lies within the knowledge and information management category and problem solving can be found in both sets of skills as students can work independently or collaboratively to develop the skill set (Chalkiadaki, 2018).

Üret and Ceylan (2021) define creativity as the ability to hold different perspectives, push boundaries, be unconventional, and innovate. Children who are between the ages of 3 and 6 fall within the prime age of creativity development and educational environments can only support the further development of creativity if they are designed in a manner in which students are allowed to work to problem solve in a variety of ways. The authors suggest a classroom founded in the constructivist theory that utilizes aspects of STEM integrated throughout the curriculum as one of the most beneficial ways to increase the development of creativity in kindergarten-aged children (Üret & Ceylan, 2021). The results of this study by Üret and Ceylan (2021) indicated that

STEM education had a significant positive effect on student creativity. Additionally, a similar study also indicated that students who received explicit STEM-integrated learning opportunities demonstrated the ability to think creatively, produce original ideas, and think flexibly at a much higher rate than their peers who did not have the same STEM based learning opportunities (Somwaeng, 2021).

The demands of our highly technological society require that students be independent critical thinkers who can work collaboratively with each other (Falloon et al., 2020; Isabelle, 2017). These demands require a fundamental shift in instructional practice that allows teachers to present core content material that will promote critical thinking, problem-solving, creativity, collaboration, and communication along with maintaining content standards (Kivunja, 2014). When kindergarten teachers challenge students to complete tasks that require them to utilize scientific reasoning and apply science and mathematics, they are promoting the development of 21^{st}-century skills such as critical thinking, communication, creativity, and collaboration as well as content standards (Brusic & Shearer, 2014; Somwaeng, 2021). Scientific reasoning is relevant in the development of critical thinking which is a key component of 21^{st}-century skills (Graaf et al., 2016) and should become a part of science curriculum in primary classrooms.

Learning activities related to STEM are appropriate in kindergarten classrooms and provide opportunities for students to develop creativity, critical thinking, problem-solving, collaboration, and communication skills (Tao, 2019). Pawilen and Yuzon (2019) added that STEM based learning opportunities not only promote the establishment of foundational knowledge but promote the development of critical thinking and life skills that are essential to helping students learn how to cope with daily life challenges and experiences. An interdisciplinary approach to STEM curriculum allows students to make connections among science and other core subject areas, establishes essential 21^{st}-century skills, and also helps establish habits of mind such as attitude and mental discipline that could impact life-long learning (Pawilen & Yuzon, 2019). Strong STEM programs are critical for students to develop essential 21^{st}-century competences, yet educators often lack a cohesive understanding of STEM education and how to implement STEM within their classroom practices (Mpofu, 2020).

Integrated Approach Versus Disciplinary Approach

One of the greatest challenges teachers face integrating STEM education is that the current educational system is discipline-based rather than problem-based and shifting to a more problem-based system would require restructuring of curriculum and great shifts in instructional methods (Nadelson & Seifert, 2017). The focus of much of school taught science is often focused on content acquisition rather than scientific reasoning (Graaf et al., 2016). Knowledge of content dominates scientific reasoning and therefore, science concepts are often taught in isolation. Furthermore, early childhood educators often perceive STEM to be comprised of lessons within the separate disciplines of science, technology, engineering, and mathematics instead of an interdisciplinary, integrated approach (Simoncini & Lasen, 2018).

Furthermore, kindergarten teachers may find the implementation of STEM learning in the elementary classroom challenging because literacy and mathematics dominate the elementary curriculum (Isabelle, 2017). Although mathematics is one component of STEM learning, it is often taught in a manner that does not integrate science, technology, or engineering concepts (DiFrancesca et al., 2014). The focus on core content instruction such as literacy and mathematics may lead to inconsistent implementation of STEM learning activities at the kindergarten level. Authors of a recent study indicated that nationally, very little time within a day in K-3 classrooms is dedicated to STEM education because approximately 89 minutes a day is focused on language arts, 54 minutes is focused on mathematics, and only 19 minutes is dedicated to science (Tippett & Milford, 2017).

A recent case-study conducted by Peters-Burton et al. (2019) was completed at a nationally recognized STEM focused elementary school to determine what aspects of STEM education are most effective. This study found that when STEM lessons were integrated into core content areas, teachers could offer more STEM learning opportunities without taking time away from core instruction. The results of this study indicated that when science concepts were integrated into other subject areas such as mathematics, literacy, or social studies that students not only mastered content standards, but they increased their 21st-century skills as well (Peters-Burton et al., 2019).

Mpofu (2020) provided a model of a continuum approach to STEM integration that outlines four levels of integration with the lowest level being disconnected disciplines and the most advanced being fully integrated across all STEM disciplines: Level one (S-T-E-M) includes separate teaching of each content area, Level 2 (STEM) includes a focus on teaching mathematics and science with one area becoming a base subject with some interconnections, Level 3 (E/T S-T/E-M) includes a focus on engineering and technology integrated into science and mathematics, and Level 4 (STEM) where all four disciplines are integrated into one hybrid system. This continuum could be utilized as a reflection tool for educators to use to determine where they currently are implementing STEM integration into their curriculum as well as provide a systemic path for further implementation.

Several studies have been completed that focus on how teachers can integrate STEM learning into their classrooms. Campbell and Speldewinde (2022) stated that young children learn during play in an integrated way they apply their knowledge and understanding from their own personal experiences to new situations and therefore already possess some of the key ideals of STEM skills and processes. To further promote the development of these skills, teachers should promote inquiry-based learning and scientific reasoning, encourage learner-centered lessons, and foster critical thinking and problem-solving skills (Campbell & Speldewinde, 2022). The researchers found that incorporating child-centered play helped to establish sustainable STEM learning environments in kindergarten classrooms. Through play, students in this study were able to solve real-world problems and demonstrated empathy with living things in their own environment. Play is essential for all children and play in the classroom promotes learning that spans across content areas (Zosh et al. 2021). Furthermore, playful learning (both self-directed and guided activities) can help foster culturally relevant learning opportunities for all students (Loewenstein et al. 2022).

Hollenstein et al. (2022) also supported the role that play has in the integration of STEM learning within the kindergarten classroom. Learning through play is essential and is recommended as an innovative way to foster skills for problem solving; specifically digital problem solving (Hollenstein et al., 2022). Rapid technological advancement has occurred over the past two decades and it is vital to identify how young children need to learn in order to navigate the digitalized world and use digital technology (Hollenstein et al., 2022). The technology (T) portion of STEM is often the most challenging to integrate into kindergarten classrooms and this study indicated that guided pretend play could potentially be an effective way to address the digital piece of STEM. Guided pretend play, where the kindergarten teachers directly participated in the play, demonstrated great potential for problem solving. During pretend play, digital problem-solving practices with teacher involvement were significantly more engaging in reasoning as to how digital technology operates; therefore, the classroom teacher has an important role both as a participant and facilitator of learning (Hollenstein et al., 2022). Although research demonstrates the educational merit of playful learning, some educators find that incorporating STEM integrated play into their classrooms difficult as leadership can deem play as a wasteful use of curricular time that does not meet content standards.

Hryciw (2018) and Zendler et al. (2018) suggested utilizing inquiry based instructional strategies such as project-based learning, science fairs, and science competitions to help students develop 21st-century skills through STEM integration. Hussin et al. (2019) suggested that robotics project-based learning as a method of integration of STEM skills into classroom lessons. Robotics project-based learning typically is founded in constructivism and involves an integrated curriculum and hands-on learning. The authors suggested that robotics project-based learning can be utilized as an effective way for teachers to integrate STEM at all grade levels to promote the development of 21st-century skills (Hussin et al., 2019). Poonsin and Jansoon, (2021) also studied the effect of project-based learning as a method for STEM integration. They suggested that integrated STEM with project-based learning could improve creative thinking skills of student significantly. The implementation of integrated STEM with project-based learning enhanced students' higher level thinking skills such as analyzing data through various points of view, creating solutions, and helped to develop an understanding of cause and effect (Poonsin & Jansoon, 2021).

Another option is to utilize Makerspaces as a method of integrating STEM learning into classrooms. A Makerspace is a collaborative workspace for making, sharing, and learning that can utilize a variety of technologies (Makerspaces.com, 2022). Strawhacker and Bers (2018) found that the utilization of Makerspaces in classrooms helped to balance the human aspect of learning with the integration of technology. Digital learning experiences need to also support children's social and emotional growth as well as their cognitive development (Strawhacker & Bers, 2018; Zendler et al., 2018). Hachey et al. (2021) also suggested the utilization of Makerspace pedagogy as a method of integrating STEM into kindergarten classrooms. Makerspaces can provide opportunities for unification of STEM and literacy practices as well as stimulate early STEM identity development in students. This STEM academic identity could influence student achievement, growth mindset, and impact future STEM engagement (Hachey et al., 2021).

Service-learning opportunities are another option for teachers who want to begin to implement STEM integration that addresses content standards in an authentic, real-world manner. Students can engage with partnerships within local communities such as community garden initiatives or local restoration projects (Collins et al., 2019; Reinking, 2018). Allowing student input in authentic, service-learning projects can promote student choice and a learner-centered environment. An effective STEM focused, learner-centered environment capitalizes on students' early interest and experiences, builds upon pre-existing knowledge, and helps to sustain interest (National Research Council, 2012). A STEM-infused curriculum inspires students to become creative scientists, engineers, and mathematicians (Reinking, 2018). Students who engage in service-learning projects often demonstrate a positive attitude toward science and report being able to see how science can positively impact their communities (Collins et al., 2019).

Teacher Perception and Self-Efficacy

Margot and Kettler (2019) presented a synthesized review of current literature based on teacher perception of STEM integration in education. The authors used thematic analysis to determine themes within 25 empirical studies to determine teacher perception and determine what challenges might prevent the implementation of STEM education into curriculum. The results of this analysis indicated that teachers often value STEM education but report barriers such as concerns about students, lack of teacher support, and curriculum and pedagogical challenges could all hinder implementation (Margot &

Kettler, 2019). Overall, this review concluded that STEM initiatives require substantial shifts in teacher training, support in curriculum and assessment and that teacher perceptions of these barriers could prevent consistent implementation of STEM into classrooms. Lestari and Kurniati (2021) also completed a study that highlights the important role that teacher perceptions and beliefs play in implementation of STEM. In this study, 50 kindergarten teachers were surveyed about their perceptions regarding STEM as well as how they implemented it into their classroom. The authors found that 70% of the kindergarten teachers surveyed reported that they never taught STEM lessons in their classrooms and teachers identified lack of training, content knowledge, and support as reasons why they had not attempted to integrate STEM yet (Lestari & Kurniati, 2021). Both studies demonstrate that teacher perception plays an important role in curriculum change and should be considered when studying why teachers make curricular decisions (Margot & Kettler, 2019).

Another challenge to STEM integration is teacher STEM knowledge, mindset, and sense of self-efficacy (Nadelson & Seifert, 2017). Research indicates that teachers' self-efficacy significantly contributes to their instructional quality and job satisfaction (Yang et al., 2021) and teacher performance, commitment, persistence, and motivation in implementing new or innovative curriculum practices (Chen et al., 2020). Yang et al. (2021) developed a STEM Teaching Self-Efficacy Scale (STSS) that provides the framework for the self-efficacy questionnaire utilized in this study. The STSS utilized two lenses to examine teacher STEM self-efficacy: (a) pedagogical self-efficacy and (b) content self-efficacy. Teachers who don't feel confident in either STEM content knowledge or pedagogical content knowledge might avoid integrating STEM learning activities or provide low-quality STEM lessons (Hammack & Ivey, 2017). Teachers' beliefs about their readiness and ability to integrate STEM learning into their curriculum greatly impacts the quality of instruction and the outcomes of student learning (Park et al., 2017), therefore it is important to consider teacher attitudes toward and confidence in implementation of STEM learning when implementing a systemic plan to improve STEM education.

Self-efficacy is often described as a task-specific self-confidence. Teachers' self-efficacy across content areas might vary for a variety of reasons such as access to resources, a teacher's own comfort level with the content, professional training within the content area, and their own educational experiences (Gerde et al., 2018). Gerde et al. (2018) recently reported that domain specific self-efficacy for early childhood was highest for literacy and lowest for science. To enhance science outcomes for students, teachers could integrate science into their mathematics and literacy content since their confidence in teaching those areas is greater.

Researchers in a recent study (Geng et al., 2018) in Hong Kong found that very few educators reported being well-prepared for teaching STEM integrated lessons. Teachers reported having significant concerns about incorporating STEM into their curriculum and reported a low self-efficacy related to STEM integration. Additionally, the study highlighted other barriers to implementation of STEM including lack of resources, administrative support, and professional development. The results of this study highlight a vital need to provide teachers with resources, support, and training to empower them in implementing STEM education (Geng et al., 2018).

John et al. (2018) found that active participation in curriculum development helped increase teacher self-efficacy and content knowledge of kindergarten teachers. This study focused on 13 early childhood educators who were involved in designing a STEM based curriculum to implement in their classrooms. The results of this study indicated that when teachers took on an active role in curriculum design, they felt more empowered and had more sustained implementation of the STEM integrated lessons (John et al., 2018).

According to DeCoito and Myszkal (2018), in order to teach STEM effectively, teachers need proficiency in STEM content knowledge as well as an increased self-efficacy in teaching that content. For their study, they utilized the Teacher Efficacy and Attitudes towards STEM (T-STEM) survey to gauge teacher self-efficacy and beliefs. The results of this survey indicated that while teachers reported a high degree of confidence in their understanding of and ability to teach STEM, there was a disconnect between teachers' confidence in and actual implementation of STEM education in their teaching practices. This disconnect suggests that there are other factors that hinder implementation of hands-on, inquiry-based STEM learning into their classrooms. One of these factors was teachers felt more confident in teaching STEM subjects in a disciplinary approach instead of an integrated approach. Additionally, elementary teachers were more likely to lack sufficient preparation in STEM integration or have deficits in their content knowledge that could affect implementation (DeCoito &

Myszkal, 2018). Therefore, teachers could report a high self-efficacy while struggling to consistently integrate STEM learning. Teacher training and curricular support are also requirements for effective implementation that will maximize student learning.

Overall, an increase in teacher self-efficacy is often associated with positive classroom outcomes and teacher retention (John et al., 2018). Teachers who possess a high self-efficacy are more willing to try new techniques and present a more positive attitude toward STEM implementation (Thibaut et al., 2018) and teacher attitudes directly impact their classroom practices. Chen et al. (2020) found that pre-service teachers who have STEM teaching experience or participated in explicit training focused on STEM integration held a much higher self-efficacy toward implementing STEM learning into their classrooms; therefore, more attention should be placed on teacher training and preparation as related to STEM.

Teacher Training and Preparation

Although there is a national push toward STEM integration, comparatively, very little attention has been given to the increasing need for teacher preparation and training to implement STEM-integrated learning, especially at the elementary level (Rinke et al., 2016). This lack of teacher preparation and training in STEM integrated curriculum and practices is another challenge to consistent implementation in kindergarten classrooms. Teacher training (whether for pre-service or existing teachers) is essential to promoting teacher outcomes and student achievement. Authors of one study (Polly et al., 2015) found that targeted and explicit learner-centered mathematics training greatly impacted student achievement as well as teacher self-efficacy in implementing more integrated mathematics lessons into their curriculum.

New standards and curriculum endorse not only science and mathematics content but also content integration with an inclusion of engineering and technology as a set of core skills that students must master (National Research Council, 2011; Rinke et al., 2016). Teacher preparation programs must shift to prepare teachers for intentionally integrating STEM across content areas (Linder et al., 2016) as elementary teachers are often prepared to be educational generalists and often lack the confidence in teaching STEM versus other subjects such as literacy and mathematics (Johnson et al., 2021). To foster consistent, effective STEM integration within classrooms, it seems there is a meaningful role for explicit STEM preparation of pre-service elementary teachers (Rinke et al., 2016).

Several recent studies have been completed that focus on pre-service teachers' content knowledge, perspectives, and personal experiences with STEM. Zdybel et al. (2019) completed a study that focused on assessing preservice teachers' perspectives regarding STEM integration. The authors of this study found that most preservice teachers surveyed held a superficial and loose knowledge about the goals and core of STEM (Zdybel et al., 2019). Most of the participants held a basic awareness of STEM education but did not fully understand the basic scientific concepts, processes, and objectives of STEM. Over 90% of participants reported that they did not believe that STEM education could help foster scientific thinking in young children. The authors asserted that this study indicated a significant gap in preservice teachers' preparation and readiness to integrate high-quality STEM focused lessons that foster student success and highlights the urgent need for teacher prep programs to focus on developing preservice teachers' knowledge about STEM (Zdybel et al., 2019).

Ryu et al. (2018) completed a study on pre-service teachers' experiences with a STEM integration college course and highlighted the challenges that those teachers faced. The researchers found that the pre-service teachers approached integrated STEM lesson development in a variety of ways that was often driven by personal experiences, interests, and backgrounds (Ryu et al., 2018). The students reported challenges to STEM implementation including existing school culture, lack of STEM role models, lack of self-efficacy, and teachers' limited content knowledge. The authors recommended that teacher education programs should establish strong partnerships with community partners to help support integrated STEM education, provide training in STEM content areas as well as training in how to integrate learning activities across disciplines, and provide opportunities for self-reflection to consider personal experiences and beliefs regarding STEM (Ryu et al., 2018). In a similar study, Balint-Svella and Szoldos Marchiș (2022) also focused on pre-service teachers' opinions and knowledge about STEM. The results of this study also highlighted the importance of teachers' own personal experiences with STEM as well as the necessity providing pre-service teachers with explicit STEM professional development prior to entering the workforce (Balint-Svella & Szoldos Marchiș, 2022). Additionally, Zdybel et al. (2019) completed a study that focused on assessing preservice teachers' perspectives regarding STEM integration. The authors of this study found that most preservice teachers surveyed held a superficial and loose knowledge about the goals and core of STEM (Zdybel et al., 2019). Most of the participants held a basic awareness of STEM education but did not fully understand the basic scientific concepts, processes, and objectives of STEM.

Yildirim and Sahin Topalcengiz (2019) developed a STEM Pedagogical Content Knowledge Scale (STEMPCK Scale) to measure preservice teachers' STEM pedagogical content knowledge. The STEMPCK Scale consisted of six factors: 21st century skills, pedagogical knowledge, mathematics, science, engineering, and technology. In their study, the scale was administered to 655 preservice teachers to analyze its reliability and validity. The results of this study indicated that this scale was both reliable and valid for assessing pre-service teachers' STEM content knowledge and could be a useful resource for teacher education programs to identify gaps in teachers' knowledge. This information could be used as guidelines for planning more effective professional development programs for teachers before they enter the classroom (Yildirim & Sahin Topalcengiz, 2019).

The literature also indicates that explicit STEM training can impact teacher self-efficacy as well as their ability to successfully integrate STEM learning. Authors of a study conducted in South Carolina considered the impact on classroom implementation of integrated STEM lessons and teacher self-efficacy of teachers who participated in an integrative STEM education institute (Havice et al., 2018). This intensive, explicit training helped teachers develop the knowledge and skills necessary to design and implement integrated STEM lessons into their curriculum through project-based learning and problem solving. The purpose of the study was to consider both the long-term and short-term effects the training had on both implementation of STEM and teacher self-efficacy. Havice et al. (2018) found that teacher training focused on STEM had a significant impact on both sustainable implementation as well as teacher self-efficacy.

The adoption of integrated STEM requires adapting current science instruction toward a more inter-disciplinary approach which requires teachers to possess an adequate understanding of STEM concepts as well as pedagogical methodologies for integration (Radloff & Guzey, 2016). The authors of one recent study (Parker et al., 2015) conducted at a large urban elementary school found that a sustained, reform-oriented professional training that includes instructional coaching is more effective when preparing teachers to shift toward a more STEM integrated approach to instructional practice. The authors found that grade-level team collaboration and planning, modeling by instructional coaches, access to quality materials and technology, and protected time were all key components to helping teachers shift their instruction to a more STEM integrated focus.

Additionally, there exists a need to improve the understanding of what educators' conceptions of integrated STEM are (Ring et al., 2017) so that appropriate training and education can occur. It is essential to establish what preconceived ideas about STEM integration educators possess as well as evaluate how those conceptions shift after explicit STEM training and collaboration with other STEM educators. According to SCT, individuals develop more advanced conceptual ideas when working collaboratively with others and suggest that a reflective, collaborative professional development would have a positive impact on the teachers' conceptions and could potentially impact implementation of STEM-integrated learning in the classroom (Ring et al., 2017).

Mumba et al. (2019) stated that little is known about elementary teachers' understanding of science process skills which may impact how effectively STEM lessons are taught in elementary classrooms. Basic science process skills include observing, measuring, classifying, inferring, predicting, and communicating. Integrated science process skills include interpreting data, identifying and controlling variables, graphing, formulating models, hypothesizing, and experimenting (National Research Council, 2012). It is important to know how familiar teachers are with these skills as it may impact how well science-inquiry based lessons are taught. The results of this study indicated that elementary teachers reported high levels of familiarity with both the basic and integrated science skills, however, they demonstrated low to moderate conceptualization of these skills during a performance test (Mumba et al., 2019). This study demonstrated the importance of both theory and practice as the disconnect between what teachers report understanding and analyzing the skills in practice was quite significant. When considering STEM integration, teacher preparation should focus on both theory and practice in real-world situations.

Equity and Inclusivity in STEM

One theme that consistently emerged throughout literature as a barrier to consistent implementation of STEM learning opportunities was a lack of equitable access for all students. There are disparities in access and opportunities in STEM for racial and ethnic minorities, students who live in high-poverty regions, students from low socioeconomic homes, girls, and students with differing abilities. This gap in access is essential to address and acknowledge as there is a growing demand for diversity in STEM fields (Fuller et al., 2021). The earlier that educators ensure equitable access to STEM education for all students regardless of race, socioeconomic status, and gender, they can begin to foster a passion and genuine interest in STEM for all students. It is well established that the experiences that children have in the early stages of life have a critical impact on their long-term development (Fuller et al., 2021), therefore, it is essential that kindergarten students have equitable access to quality, consistent STEM learning opportunities.

Fuller et al. (2021) presented a study on the inequality in access to STEM learning for students of color. The purpose of their study was to highlight the systemic barriers that hinder equity in STEM achievement for students of color (especially Black and Latinx students) during their early education. They asserted that by offering children of color opportunities to engage in STEM-related learning early in kindergarten, teachers can help establish a solid foundation of STEM knowledge and help to foster an interest and confidence in pursuing careers in STEM fields (Fuller et al., 2021). This is significant as Black and Latinx students are underrepresented in STEM-related undergraduate majors and careers and the diversification of the STEM field should be addressed through access and inclusion. Fuller et al. (2021) recommended that to help ensure equitable access for all students, pre-service and active teachers should engage in equity-based STEM training, that teachers have curriculum and materials that represent minority groups in STEM, and communities should collaborate to ensure access to materials and to address the digital divide if necessary.

Students with disabilities are another group who might not have equitable access to high quality STEM learning opportunities. Research provides several explanations for why students with disabilities are often not included in or given access to STEM-integrated learning opportunities such as lack of accommodations, teacher perception of student ability to comprehend, and lack of training (Schneiderwind & Johnson, 2020). A study by Mere-Cook and Ramanathan (2022) addressed this disparity by attempting to implement STEM learning into an early childhood classroom that contained several students with disabilities. For children with Individualized Education Programs (IEPs), teachers addressed their goals by intentionally offering STEM integrated activities that leveraged a child's strengths and interests during playful learning with other children. The teachers utilized the engineering design process as a framework to include all students in STEM-focused learning. This design process allowed the teachers to scaffold lessons for different abilities, play on student strengths and interests, and promote inclusion for all students (Mere-Cook and Ramanathan, 2022).

Women and girls, especially those of color, are underrepresented in STEM disciplines (Hughes et al., 2020). A recent report claimed that women hold less than 30% of all STEM jobs (National Science Foundation, 2021). For women to be equally represented in STEM, young girls (especially those in underrepresented minority groups) should be provided with opportunities to develop strong STEM identities (Hughes et al., 2020). Girls should have opportunities to interact with female STEM role models, make connections to their own lives, address female stereotypes in science, and be empowered to develop growth mindsets. Educators have a responsibility to provide a safe and inclusive learning environment where girls feel that they belong and that empowers girls by respecting and incorporating their interests and identities into the learning process (Hughes et al., 2020). Through intentional gender and culturally responsive teaching methods, educators can help to bridge the equity gap that prevents many students from engaging in and pursuing STEM.

Summary and Conclusions

There is a wide base of literature focused on the benefits of STEM integration, the challenges that may exist that prevent consistent implementation, as well as the impact of STEM integration has on the development of 21st-century skills. The literature presented asserts there are numerous benefits to implementation of STEM in early elementary as well as the developmental appropriateness of such instruction. Students who have access to high quality STEM-integrated learning during their early elementary years (specifically kindergarten) learn how to problem solve, communicate, and critically think. Although the benefits of STEM instructions are widely understood, barriers such as teacher self-efficacy, lack of resources or school constructs, and lack of teacher preparation prevent consistent implementation in kindergarten.

Additionally, much of the research focuses on implementation at the secondary and post-secondary level and there are few studies that explore teachers' experiences implementing STEM at the kindergarten level. Little is known about how current kindergarten teachers are implementing integrated STEM lessons into their classrooms as well as what successes and struggles current kindergarten teachers experience which is what this study is intended to explore.

Chapter 3: Research Method

The purpose of this qualitative study was to (a) explore kindergarten teachers' perspectives on STEM integration with their students and (b) consider how kindergarten teachers in one large school district are implementing STEM in their current classrooms including their successes and struggles as they do so. To explore teacher perspectives, a descriptive-interpretive design was used. In-depth interviews were conducted to collect data on how kindergarten teachers in one district currently implement STEM-integrated learning as well as provide opportunities for teachers to share their perceptions, challenges, and successes. Participants were recruited on a voluntary basis. The local setting for this study currently has between 30 and 35 kindergarten teachers, and I interviewed 12 of them via the online platform Zoom.

Research Design and Rationale

This study was completed using a descriptive-interpretive design. This design is rooted in constructivism and is useful in understanding the participants' perspectives in relationship to STEM education in the early elementary years. The use of exploratory, open-ended questions that guide the study to answer the research questions, the careful, systemic analysis of responses, and the descriptive-interpretive understanding of personal experiences justify this approach to this study (Elliott & Timulak, 2021). Qualitative research is driven by the idea that meaning is socially constructed by individuals through their personal interaction with the world and that there are multiple constructs or interpretations of reality that can shift and change (Merriam, 2002). As a qualitative researcher, I am interested in the viewpoints and experiences of a group of educators in a specific time and context. The interpretive aspect of this design focuses on understanding how individuals experience and interact within their own reality and understanding the meaning those interactions have for them. Considering that the purpose of this study is to examine how kindergarten teachers currently implement STEM-integrated learning into their classrooms, this design is appropriate. Further, this design aligns to Bandura's SCT, which provides the conceptual framework for this study as I consider teachers' own perceptions and experiences so that I can make inferences based upon those individual perspectives. I utilized participants' own words to provide a rich description of their experiences to support the findings of this study.

Role of the Researcher

My role as the researcher in this qualitative study was to attempt to access and understand the feelings and ideas of the participants. I sought to discover and understand the individual perspectives of the participants involved. Additionally, the role of the researcher was to participate in data collection personally as the instrument (Merriam 2002). The researcher selects and often designs the data collection tools such as the interview questions in this study. Qualitative researchers must plan and anticipate potential ethical issues that might arise during the study (Ravitch & Carl, 2016) so that the study is not compromised. The researcher also analyzes the data by looking for themes, patterns, and categories to gain a more precise understanding of the participants' perspectives. Every researcher has a set of roles and identities that must be considered when designing research. Positionality and social location are key elements to the researcher's role in this study. Additionally, the researcher must consider any relationship, either private or personal, with participants that could interfere with data collection and should not be in a supervisory position of any participant.

Methodology

The sole data source for this research was interviews via the digital platform Zoom. Interviews provide deep, rich, and individualized data. Through interviews, researchers can explore the experiences and opinions of others and form a deeper understanding of the construct by engaging in the perspectives of others (Rubin & Rubin, 2012). Using a self-designed interview tool, questions focused on the research questions and designed using the conceptual framework of Bandura's SCT. Additionally, the protocol for interview questions was viewed through the lens of Bandura's SCT. Interview questions were developed, in consultation with my committee chair and methodologist, using the notion that participants' self-efficacy and subsequent STEM teaching behaviors are shaped or influenced by perceptions toward implementing STEM in kindergarten, their expected outcomes for their students, and the prior experiences they have had implementing such lessons with their students. Furthermore, the themes found in the literature, which center on the benefits of STEM integration, teacher preparation and training, development of 21^{st}-century skills, and approaching instruction from an integrated versus disciplinary approach, guided the interview questions as well. Data collected from the interviews were analyzed thematically to uncover themes and patterns as well as tabulate, classify, and summarize the data (see Ravitch & Carl, 2016).

Participant Selection

The local setting for this study encompasses a large school district in Arkansas. This district houses nine elementary campuses and employs between 30 and 35 kindergarten teachers. I requested participants from schools other than the one where I teach personally to avoid any conflict within my own local setting. I emailed all the kindergarten teachers in the district to allow participants to volunteer to participate in the study. Teachers who have experience and knowledge of STEM integration were purposefully selected from interested participants to help answer the research questions of this study. Participants were further purposefully selected from the pool of volunteers to allow for maximum variation across years of experience and gender. All kindergarten teachers in this district are required to hold a current, standard early childhood education license that covers teaching grades Pre-Kindergarten through fourth grade. This is a different certification than a standard elementary license, which does not include kindergarten. A gift card in the amount of $25 was offered to each participant as an appreciation of their time.

Instrumentation

The instrumentation utilized in this study consisted of a semi structured interview tool (see Appendix) to guide the interview process. This researcher-created tool aligns to the research questions and provides opportunities for participants to share demographic information that might further help me understand viewpoints and experiences. This tool was used in each Zoom interview session but did allow for questioning for clarification if necessary to fully understand the participant’s viewpoint. Some examples of interview questions are (a) "What are your perceived benefits of STEM-integrated learning?" (b) "How confident are you in implementing STEM learning into your classroom?" (c) "What are some things that have either previously or could potentially impact your confidence in STEM implementation?" These interview questions (see Table 1) consider and address self-efficacy as well as perceived outcomes which are both important aspects of SCT, which provided the conceptual framework for the study.

Table 1

Interview Questions as They Align With Research Questions and Conceptual Framework

Research question	Interview question	Conceptual framework constructs
RQ1: What are kindergarten teachers' perspectives on implementing STEM integration at the kindergarten level within one large school district in Arkansas?	Q2: Please start by telling me what comes to mind when you think of STEM education in elementary school. a. What are the purposes of STEM education? b. How do you see your role in implementing STEM at the kindergarten level? c. In your opinion what are the benefits to integrating STEM in kindergarten for students? What are the drawbacks?? Q3: How confident do you feel integrating STEM into your current instruction? a. What do you believe makes you feel that way? b. What are some things that might have either helped develop your confidence OR c. What are some things that would impact your confidence in STEM instruction? Q7: What are some of the challenges you have experienced in implementing STEM integrated instruction? a. What do you believe were the source of these challenges? b. In your opinion, how might those challenges be overcome? Q4: Have there ever been times you wanted to integrate STEM but couldn't? a. If so, what prevented you from that implementation? b. What support would have allowed for this implementation?	a. self-efficacy b. outcome expectations c. perceived failures d. prior performance e. personal accomplishments f. modeled experiences g. forms of social persuasion h. physiological indexes
RQ2: How do kindergarten teachers in one large school district in Arkansas integrate STEM learning activities in their curriculum?	Q5: Please tell me about a STEM integrated lesson that you implemented that stands out to you. a. What was successful about it? b. What was not successful? c. How did your students perform? Q6: In general what are some of your successes you have experienced implementing STEM integrated instruction? a. What factors do you believe aided these successes? b. Can you provide me any examples of student impact or growth related to STEM integration?	a. self-efficacy b. outcome expectations c. perceived failures d. prior performance e. personal accomplishments f. modeled experiences g. forms of social persuasion h. physiological indexes i. teacher as facilitator j. active learning environment k. content focused on problem solving

By mapping the interview questions and aligning each question to the research questions and the conceptual framework, Table 1 illustrates the sufficiency of the interview questions to address the research questions of the study.

Procedures for Recruitment, Participation, and Data Collection

Once permission from the research site was secured, I sent a detailed recruitment email to all kindergarten teachers who teach within the district. This email outlined the purpose for the study, potential impact of the study, how the data will be collected and utilized, how identities will be coded to ensure confidentiality, time requirement of the interview, and what data will be collected. Additionally, informed consent forms were attached in this email that participants had to sign prior to the interview. Out of the 30 kindergarten teachers who could potentially participate in the study, 12 completed the interest survey and were offered a $25 gift card for their time in participating in the study. Considering my initial goal was to interview between 10-15 teachers, I reasoned that 12 teachers would be enough to gather the data I needed for the study.

Once participants were identified, I contacted each participant via email to schedule a Zoom interview that would take 30–60 minutes. Participants chose from a variety of time slots that best fit their schedules. I sent each participant a copy of the interview protocol prior to the interview to promote a higher quality interview since participants could take time prior to the interview to think and gather their responses and allow the interview to be completed within the timeframe agreed upon (see Rubin & Rubin, 2012). The interview was conducted in a semi structured format, which means that although the interview guide was followed with each participant, iterative interaction was utilized as needed to further understand a participant's point of view (see Rubin & Rubin, 2017). If I was unable to clearly understand a participant's viewpoint or experience, follow-up questions were posed to help gain a clearer understanding if necessary. Overall, I utilized open-ended questions that allowed participants to share their stories, beliefs, and experiences. Some examples of these questions were as follows:

- Tell me what comes to mind when you think about STEM education.
- What are the purposes of STEM education?
- Please provide me an example of a STEM integrated lesson.
- Tell me about a time you wanted to implement a STEM lesson and didn't.
- What do you feel are the impacts of STEM integrated lessons on elementary students?

At the conclusion of the interview, I informed participants that they may be selected to participate in member checking after the initial interview to ensure that I represented their thoughts and beliefs accurately. I also thanked them for their time and willingness to participate in this study.

To complete the member checking process, participants were randomly selected to participate. A copy of the transcript and initial coding were sent to them for approval along with a summary of the findings for them to check for accuracy of their data. If necessary, a follow-up interview or email was utilized to further clarify any questionable data and to allow participants to provide feedback as needed.

During the Zoom interview, my role as the researcher was to listen to responses and prompt as needed. The interviews were recorded, with participant permission, to allow time to revisit participants answers during data analysis and interpretation.

Data Analysis Plan

In alignment with this study design, thematic analysis was used to identify, analyze, and organize meaning from the interview transcripts. Thematic analysis involves the process of identifying relationships within the data (see Ravitch & Carl, 2016) and was an appropriate approach for this study as the goal was to identify how STEM is currently being integrated within classrooms as well as any challenges that might exist that prevent the implementation of STEM.

Although there was only one data source (i.e., interviews), the data were analyzed through multiple viewings and analyzation of the data including pre-coding, coding, and generating themes (see Ravitch & Carl, 2016). There are five stages of thematic analysis:

1. Prepare the data.
2. Generate initial codes.
3. Search for and review themes.
4. Define and name themes.
5. Write up results.

One of the benefits of utilizing a digital platform (e.g., Zoom) to conduct interviews is that the service provides an automated transcript at the end of each session. This transcript was cleaned and organized and then this data was manually coded with computer-assisted qualitative data analysis software (CAQDAS), which was used to manage and store the data. Once the transcripts were obtained and organized into a digital spreadsheet, precoding was completed. Precoding allows the researcher to engage, read and question the data to become more familiarized with it prior to the coding process. I completed this simple process using CAQDAS software to manage and store the data. This process allowed for potential codes to emerge as well as guide the next steps in the analysis of the data.

The next step in this data analysis plan includes immersive engagement with the data through multiple readings and implementation of strategies such as coding and generating themes. A digital spreadsheet was used during this stage of analysis. Transcripts were uploaded into a spreadsheet and initial pre-coding completed. Columns were added to the spreadsheet for preliminary and final codes. Both inductive and deductive coding processes were utilized. The inductive coding process was completed from the data itself and inductive coding was completed that connected to the literature outlined in the study. I looked for the key concepts from the literature such as self-efficacy, teacher preparation, 21st-century skills, and equity. Codes were assigned to the data using key phrases and terms that emerged during the analysis. These codes were outlined in a code list to further keep the data organized.

Once codes had been established, axial coding was completed to group codes together into themes (see Saldana, 2016). Themes relate the data to the overall purpose of the study and research questions. Themes help to tell the story of the data through patterns and allow for a broader understanding of the experiences and perceptions of the study participants. Themes were continuously revised and refined throughout the analysis process.

Trustworthiness

The trustworthiness in qualitative research is often questioned since validity and reliability often cannot be addressed as in a quantitative study within the naturalistic, constructive paradigm of qualitative studies (Shenton, 2004). However, there are ways that qualitative researchers can achieve trustworthiness in their studies. Williams and Morrow (2009) suggested that there are three categories that qualitative researchers must attend to: integrity of the data, balance between reflexivity and subjectivity, and clear communication of findings.

To promote integrity of the data, I adhered to standards in credibility, transferability, dependability, and confirmability (see Ravitch & Carl, 2016). To promote credibility of my study, I utilized thematic analysis to analyze my data and presented a thick description of the write up of the study. Additionally, I utilized member checking to further enhance credibility by sending a summary of themes from my initial analysis to a subset of participants so that they could review them as well as either verify or refute my interpretation of their comments. Participants were given a summary of my findings that they could check for accuracy of their data. Member checking allows participants an opportunity to correct any errors or challenge any of my interpretations (Stahl & James 2020). Transferability was promoted by including detailed descriptions of both the data and the context so that readers can make comparisons and connections to other contexts. Dependability is the stability of data. Providing a clear rationale for decisions made throughout the study promotes dependability. Confirmability was promoted with structured reflexivity practices such as keeping a reflexive journal. This journal was utilized to record personal reflections and detail decisions and rationales throughout the study.

Ethical Procedures

Prior to participation in this study, all participants were provided and asked to sign an informed consent. To promote informed consent, participants were provided a written explanation via the initial email of the purpose of the study and all ethical procedures that are in place, including confidentiality. Additionally, the consent form outlined the goals, timeline, and methodology of the study, provided a statement that participation is voluntary, and participants can withdraw at any time, listed any potential risks and benefits, and described how the results will be utilized and disseminated. Permission to record and transcribe the interview was obtained prior to the interview.

One of the ethical procedures necessary to a study involves maintaining confidentiality for participants, therefore, during coding, each participant was assigned a number from 1 to 12. All identifiable information such as name, gender, and years of experience, was kept separate from the interview transcript and only the participant numbers was used in the dissertation. Digital data were secured via password protected computer and any physical data were secured inside a locked cabinet in my home.

Summary

The purpose of this chapter was to outline the research methods used in this study. This study was completed using a descriptive-interpretive design. My role as a qualitative researcher was to utilize exploratory, open-ended questions to understand the ideas and feelings of the 12 kindergarten teachers who participated in this study. A semi structured interview tool (see Appendix) was used to guide the interview process, which were conducted via Zoom and transcribed. Thematic analysis was used to analyze the data to identify codes, categories, and themes to help answer the two guiding research questions of this study. The results of the study were presented clearly to help ensure trustworthiness of the study.

Chapter 4: Results

The purpose of this qualitative study was to (a) explore kindergarten teachers' perspectives on STEM integration with their students and (b) consider how kindergarten teachers in one large school district are implementing STEM in their current classrooms including their successes and struggles as they do so. The guiding research questions in this study were as follows:

- RQ1. What are kindergarten teachers' perspectives on implementing STEM integration at the kindergarten level within one large school district in Arkansas?
- RQ2. How do kindergarten teachers in one large school district in Arkansas integrate STEM learning activities in their curriculum?

This chapter is divided into six sections beginning with the introduction and setting of the study. I then describe how my data were collected, recorded, and analyzed. To conclude the chapter, I provide evidence of trustworthiness and a summary of the findings.

Setting

My data collection occurred within one large school district in Arkansas. This district houses nine elementary schools and employs approximately 35 kindergarten teachers. To avoid conflict, I chose to exclude teachers who work with me in my building, which removed five teachers from the participant pool. This left 30 teachers who teach in eight elementary schools who could potentially participate in this study.

To ensure that I had the most up-to-date list of kindergarten teachers in the district, I emailed each building principal individually to explain the purpose of my study, share that study approval had been granted by both Walden's IRB (Approval No. 11-08-22-0979911) and local setting administration, and to request a list of current certified kindergarten teachers. Once I received teachers' email addresses, I composed a master list of kindergarten teachers that included teacher names, email addresses, and building location. This tool was then used to note whether participants demonstrated interest in participating in the study by completing the Google survey that I included in an initial email sent to teachers.

I sent an initial email to all kindergarten teachers that included the informed consent form approved by Walden's IRB and a link to a Google survey that teachers would complete if they were interested in participating. This survey included basic demographic information such as gender and years of experience as well as a clarification that teachers should only participate if they have knowledge of or experience in implementing STEM in their classrooms. Out of the 30 kindergarten teachers who received the invitation, 12 completed the Google survey to indicate interest in participating in this study. I had initially planned to interview 15–20 participants; however, since my pool of participants was smaller than I was initially told, I chose to interview all 12 teachers. All 12 teachers indicated that they had either knowledge or experience in implementing STEM into the kindergarten classroom. The years of experience of the volunteers also varied from 4 to 21 years; therefore, I determined that I had allowed for maximum variation of years of experience and did not need to seek further participants.

Once participants completed the survey, I sent them printed copies of the informed consent form through interdepartmental school mail. Each participant received two copies of the form, one for their personal records and one they signed and returned to me through interdepartmental school mail. A second email was sent to the teachers who had completed the Google survey to select a date and time that worked with their schedule to conduct the interview. Once participants selected their interview date and time, I sent each participant a Google calendar invitation that also contained the link to the Zoom interview.

Data Collection

The 12 kindergarten teacher participants were assigned a number from 1 to 12 as shown in Table 1, which outlines their total number of years of teaching experience and number of years of teaching experience at the kindergarten level. All participants held a standard teaching license.

Table 2

Participants by Years of Teaching Experience

Participant ID	Years of teaching experience	No. of years teaching kindergarten
1	13	13
2	9	7
3	10	8
4	10	8
5	12	12
6	21	18
7	20	8
8	6	6
9	4	4
10	14	14
11	7	4
12	7	5

Interviews were held after school hours over a 3-week time frame. Participants were provided with several date and time options and were asked to select the interview time that best fit their schedule. Prior to conducting my interviews, I held a practice run with a colleague to test the transcription program on Zoom and to determine how accurately it would transcribe our audio. From this trial run, I determined that the transcripts were accurate representations of the interviews.

Each interview was recorded and transcribed by Zoom. During the interviews, I used my Interview Protocol (see Appendix), which was provided to each participant prior to the interview so that they could familiarize themselves with the questions. I followed the interview guide verbatim except when several participants shared that they had little experience implementing STEM. I adapted or excluded a few questions to help guide the interview process. For example, Participant 2 stated that while she had never implemented STEM in kindergarten, she had previously implemented it when she taught another grade at a different district. I adapted my questions to include her prior experiences in implementing STEM as well as what her perceived benefits would be if she were to implement them in kindergarten. Another example of this was when Participant 4 shared about a grant that she wrote to purchase STEM materials for her classroom. I chose to inquire further about the grant to allow the participant to share more about her reasons behind seeking out the grant as well as any successes she might have seen while implementing the STEM materials in class.

Since the Zoom software automatically transcribed the audio of the interview, I took notes during the interviews of participants' body language as well as any notes that might help data analysis. At the conclusion of each interview, I uploaded my notes and reflections into my interview reflection log. This log was used during the interview and the coding process and provided additional insight into my analysis of the data.

Data Analysis

Once all the interviews were completed and my reflections were added to my interview reflection log, my next step was to begin to analyze the data. Since I conducted a trial run of the interview process to test the accuracy of the Zoom transcription process, I knew that there would be some level of misrepresentation that would need to be corrected. The Zoom software provided me with a transcript of each interview; however, the transcripts needed to be edited because my Southern accent was incorrectly recorded by the software. To accurately represent the data given by participants, I listened to each interview recording and compared it to the Zoom transcription. Through this process, I could ensure each transcript was an accurate representation of the interview. I then edited transcripts to remove any information that was considered an aside and words commonly used in informal speech. I removed common filler words such as “like,” “yeah,” and “um.” I also deleted any occurrence of dialogue that did not pertain to the study. For example, during an interview, the participant’s child interrupted, and the participant had to address her for a few moments. In another interview, there were microphone issues so that dialogue was deleted as well. This took several readings of each transcript, and I became familiar with the data through this precoding step.

I researched options for what to use as CAQDAS to store my data. I decided to purchase the ATLAS.ti software. I uploaded the 12 cleaned transcripts into the ATLAS.ti software, and then began the open-coding process in the program. In Table 3, I outline the codes, categories, and themes that aligned to RQ1: What are teachers’ perspectives on implementing STEM integration at the kindergarten level within one large school district in Arkansas? In total, I identified 31 codes, which were then sorted into five categories: knowledge of STEM, teacher as facilitator, STEM as outside responsibility, 21st-century learning skills, and other perceived benefits. The codes and categories were then sorted into three themes that helped to answer this research question: teacher knowledge of STEM, teacher view of the role of the teacher, and perceived benefits of STEM integration.

Table 3

Teacher Perspectives: Themes, Categories, and Codes

Category	Codes	Examples from coded text
	Theme 1: Teacher knowledge of STEM	
Knowledge of STEM	Uncertainty Lack of knowledge	"I feel like with STEM, I don't not know a whole lot about it." "And it really is just that the fact that it's such a foreign concept for us, because it's not something we do and it's not something that's focused on in our district and I think is there are districts that do a lot."
	Theme 2: Teacher view of the role of the teacher	
Teacher as facilitator	Student led vs teacher led Teacher as facilitator	"I think my role would be just like in every other subject to facilitate the learning implement all of the core concepts, and you know, assess if they have it." "I think it's more of a facilitator, role be there to kind of you know help and guide if they get stuck."
STEM as outside responsibility	GT Media specialist	"I kind of almost think of it, and I almost think of it too, is kind of like GT Enrichment, kind of category of Education, and in general education, we don't really do it. It's not pushed on us a whole lot." "Well, when you said what comes to mind what I thought of STEM, education, and elementary schools, it sounds like science activity days, or specific things, that the librarian will do, or the media specialists will do."
	Theme 3: Perceived benefits of STEM implementation.	
21st century learning skills	Collaboration Creativity Critical thinking Curiosity Communication Work force preparation Growth mindset Higher order thinking skills Technology Engineering Tenacity Problem solving	"This means they're going to continue to keep that for a little bit, they're, going to question they're going to experiment. They're going to try and they're going to figure out why things work. They'll explain how things, work that's what I like about STEM." "I think one of the things about STEM is so wildly successful is that it shows people that they can make mistakes and still not be wrong in the same sense."
Other perceived benefits	Reaches all learners Hands on learning Independence Outside the box thinking Real-life experiences Foundations of Science Knowledge Social and emotional learning Student confidence Student engagement Student enjoyment Student leadership Understanding "why"	"I think STEM education is a good way to reach all your learners. All your various types of learners." "I think it really helps them kind of figure out a role or have a leadership role and see that you can lead in different ways and respond to different leadership in that group."

In Table 4, I outline the codes, categories, and themes that aligned to RQ2: How do kindergarten teachers in one large school district in Arkansas integrate STEM learning activities in their curriculum? In total, I identified 38 codes which were then sorted into eight categories (STEM integrated into core curriculum, supplemental instruction, STEM viewed as supplemental instruction, external barriers, self-efficacy/internal barriers, science not considered core content, successes that benefit students, and successes that benefit teacher). The codes and categories were then sorted into three themes that helped to answer this research question: current implementation of STEM in classrooms, barriers to STEM implementation, and successes of STEM implementation.

Table 4

Current Implementation Successes and Struggles Themes and Codes

Theme	Categories	Codes
Theme 1: Current implementation of STEM in classrooms	STEM integrated into core content	Integrated into literacy Integrated into math
	STEM as supplemental instruction	STEM bins Center play
Theme 2: Barriers to STEM implementation	STEM viewed as supplemental instruction	Gifted & Talented (GT) Center play STEM bins Library/Media specialist MakerSpace Mystery Science
	External barriers	Focus on literacy and math Grant writing Lack of curriculum Lack of resources Lack of district or administrative support Lack of state standards Lack of teacher training Lack of time Money Politicization of science Science is not tested
	Self-efficacy/Internal barriers	Lack of guidance and support Lack of knowledge of STEM Lack of experience Self-efficacy
	Science not considered core content	Focus on literacy and math Science is not tested Science time not protected
Theme 3: Successes of STEM implementation	Successes that benefit students	Fully engaged New experiences Student enjoyment Independence Transferability of knowledge Higher test scores
	Success that benefit teachers	Different perspective of students Higher test scores Fully engaged students Observation time Facilitation of learning

The ATLAS.ti software streamlined the coding process so that I could easily select important quotes and identify codes as I read through the transcripts again. I completed a total of three rounds of initial inductive coding during this process. Each time, I read through the transcripts while marking quotes and identifying code words that emerged from the data. After this round of open-coding, I had a total of 64 codes identified in my code lists; however, as I began to move to the next step of categorizing my codes into groups, I realized that I had neglected to identify codes that related to part of the second purpose of this study. While I had identified numerous codes that related to the barriers or struggles of implementation, I had overlooked the successes of implementation. Considering all the teachers interviewed stated that they did not implement STEM to a degree in which they were satisfied, most of their responses were focused on what prevented implementation. However, there were several teachers who shared some successes so I analyzed the transcripts again and focused on identifying codes that aligned with the successes and would help to answer my second research question. During these last few rounds of coding, I found five new codes and deleted a few codes that were outliers. My final total of codes was 69 codes (see Tables 3 & 4).

My next step was to search for themes that emerged from the codes by completing axial coding. The software was used to confirm themes by frequency of occurrences of codes across transcripts. This software allowed me to identify which codes were occurring most often throughout the interviews as well as determine what codes were relative to the research questions. From the axial coding, I sorted my codes into categories. Again, in the ATLAS.ti software, I created code groups to organize my codes into categories. For example, when looking at the codes that addressed the barriers that prevented teachers from implementing STEM, the codes were sorted into several categories such as external barriers, self-efficacy/internal barriers, STEM not considered core content, and STEM viewed as supplemental instruction. From these categories, I identified themes that emerged from the data that would help me understand the individual perspectives of my participants.

In addition to the themes outlined above, two superordinate themes emerged from the data that addressed both research questions. The first theme was a desire to implement more STEM into current instruction, and the second was an acknowledgment that STEM was not being implemented consistently. Every participant verbalized a desire to do more and acknowledged that they were not integrating STEM in a way that they felt satisfied with. Although the reasons given by the participants varied somewhat about why that implementation was inconsistent, it was evident that every participant held the desire to integrate STEM more. Participant 3 stated, “I feel like there could be a whole lot of benefits, because I know I’ve been wanting to put it in my classroom more because I know it’s good especially for kindergarten.” Additionally, Participant 9 added, “I am very strong advocate for STEM in the classroom, STEM in kindergarten, not just as a pull out, not just to something that the library media specialist does once a week, or once a month, we need more.” These two superordinate themes are closely related to the six themes identified in Tables 3 and 4. In Chapter 5, I will provide a detailed description of both superordinate themes as well as the other six themes identified as they align to the research questions.

Results

Through analysis of the data that related to each of my research questions, I identified six themes that helped to provide insight into these teachers' perspectives and practices. Those six themes will be discussed in depth in the following sections as they relate to each research question.

Themes Related to RQ1

The first set of three themes addressed RQ1: What are kindergarten teachers' perspectives on implementing STEM integration at the kindergarten level within one large school district in Arkansas?

Theme 1: Teacher Knowledge of STEM

The first theme that emerged connected to teacher perspectives on implementing STEM integration was the level of knowledge that teachers possessed about such integration. Only two teachers (Participants 1 and 9) expressed that they held a high level of STEM knowledge and that they felt very confident in implementing it in their classrooms. Participant 9 shared that he had an extensive background in engineering and science and that he felt very confident to incorporate STEM in his classroom. His knowledge of STEM and his previous experiences were discrepant in his responses that aligned to the first research question. However, he stated that he did not integrate STEM to a level he was satisfied with, and his responses to how he currently implemented STEM as well as the challenges he faced were similar to the other particpants in his reponses that aligned to the questions related to the second research question.

Beyond those two teachers, the rest of the teachers stated that they either did not fully understand what STEM was or that they were uncertain what consistuted STEM lessons. Participant 4 stated,

> and it really is just that the fact that it’s such a foreign concept for us, because it’s not something we do and it’s not something that’s focused on in our district and I think is there are districts that do a lot.

Additionally, there seemed to be a level of uncertainty of what consituted STEM by several teachers. For example, Participant 3 stated,

> I do not feel confident with it at all, but I will say I was doing a lesson yesterday, and I was like I wonder if this might be STEM because I’ve been thinking about your questions and everything, and getting prepared.

This same sentiment was expressed by others who initially stated that they didn’t believe that they integrated STEM at all but with further questioning discovered that they did implement it in some ways. During the member checking process, I found that several teachers who initially stated that they did not implement STEM at all, realized after our interview that some of the things they did in their classroom were STEM related. For example, Participant 11 initially stated that she did not feel that she integrated STEM at all. After our interview, I sent her the transcript of our interview along with some of the initial codes I identified with a few follow-up questions that she could respond. In my email to her, I asked her to tell me more about the STEM bins that he used for her student morning work. In her responding email, she explained that when students arrive in the mornings, she has a variety of building tools on their tables along with a challenge or prompt for them to complete. Students work together to construct a solution. For example, around Christmas time, her students used gumdrops and toothpicks to build and design three-dimensional shapes. This uncertainty with STEM could indicate a lack of understanding of what STEM is as well as might indicate some misconceptions of what constitutes a STEM lesson.

Theme 2: Teacher View of the Role of the Teacher

Teachers either believed that the teachers role in a STEM classroom was as a facilitator of knowledge or that the responsibility of teaching STEM fell under the oversight of an outside teacher such as the library media specialist or the Gifted and Talented (GT) teacher. Participant 3 stated, “I think my role would be just like in every other subject to facilitate the learning implement all of the core concepts, and assess if they have it.” Most other participants also supported the idea of the teacher as a facilitator in STEM learning and that STEM learning was also more student led versus teacher led. Of the 12 interviewees, 11 specifically stated that the role of the teacher in a STEM lesson was “as a facilitator.” One discrepant case (Participant 9) mentioned that a STEM teacher should have mastery over content knowledge. He said,

> in a classroom that does implement STEM, the teacher’s role would be to have mastery over the subject matter, being content specific so I don’t want to not know what the science concept before I teach it. So the teacher should be a master or near to it and be able to guide students into the subject matter, whether that be technology, engineering mathematics, so on so forth.

Participant 9 also shared that he had an extensive background in engineering and science and that he felt very confident in his ability to incorporate STEM in his classroom, however, his administration prevented him from implementing it.

There were also a few responses that stated that the role of the teacher in STEM fell outside of the general education classroom. Participant 12 stated, "I kind of almost think of it as a kind of GT Enrichment kind of a category of education. And in general education, we don't really do it. It's not pushed on us a whole lot." Additionally, Participant 7 stated, "Well, I, think in the past we've done MakerSpace with our library media people, so that's, kind of what we've done before." Those teachers who responded that the responsibility of STEM implementation fell outside the general education classroom also reported that when they approached their administrators about integrating more STEM were told by those administrators that STEM education was the responsibility of either the GT teacher or library media specialist.

Theme 3: Perceived Benefits of STEM Implementation

Every participant stated that they believed that STEM-integrated learning could benefit their students in a positive manner. After analyzing participants' responses, I found that many of the codes identified fell under the theme of perceived student benefits. I sorted those codes into two categories: 21^{st} century learning skills and other perceived benefits. Given that a large amount of the research utilized in this study focuses on how STEM impacts 21^{st} century learning skills, I reasoned that separating those skills from the other perceived benefits could help me to connect interview responses to the literature. The skills that fall within the category of 21st century learning skills include collaboration, creativity, critical thinking, communication, and problem-solving.

As stated in the literature review, the demands of our highly technological society require that students be independent critical thinkers who can work collaboratively with each other (Falloon et al., 2020; Isabelle, 2017) and several participants expressed similar beliefs that STEM could affect the development of these skills. Participant 5 stated,

> We are forming these kids for jobs that don't even exist and that they need to have that ability to problem solve, to work with different kinds of diverse groups and really work outside the box since these jobs that they're going to be graduating into don't even exist.

Participant 8 adds,

> STEM is getting them to think outside of the box and getting them to problem-solve. So if they try one thing, and it doesn't work, they try something different, taking feedback from the people that they're with in their table group, or at their center. Listening and peer interaction is also super important.

There were several other perceived benfits to students mentioned during the interviews that fall outside of the 21st century skills category and I categorized those as "other perceived benefits." Included in this category were skills such as the development of student leadership, student enjoyment and engagement, and the development of foundational science knowledge. Participant 3 stated,

> I wish we did have more time for STEM, because they enjoy that. At the end of the year a lot of times whenever we do the what was your favorite part

> questionaire. Or ask what's your favorite subject? A lot a lot of kids will say science, and it's like I wish I would have done more with that.

Student enjoyment was another topic found in the literature review. Students who participate in STEM-integrated learning often possess a more positive attitude toward science, technology, engineering, and mathematics and are more likely to pursue a career in the STEM field (Malone et al., 2018; Toma & Greca, 2018).

In addition to being asked what they believe the benefits of STEM integration are, I also asked each participant if they believed if there were any drawbacks to integrating STEM in the kindergarten classroom. All 12 stated that they did not believe that there were any drawbacks to integrating STEM as it pertained to students. However, Participant 3 stated,

> I'm not sure about any drawbacks other than for me for a drawback would be just like getting materials, and that kind of stuff like I know it can be just hard to get all of that stuff together, and I think that's why it's taken me so long to do it.

So while there were not perceived drawbacks to STEM that related to students, there could be some drawbacks that relate to teachers and the time requirement of STEM. In the next section of this data analysis, I will go into more detail about the time requirements of STEM and how it affects implementation.

The guiding research question for this section RQ1: "What are kindergarten teachers' perspectives on implementing STEM integration at the kindergarten level within one large school district in Arkansas?" Through data analysis of the responses of these 12 teachers, it seems that all those who participated in the study hold STEM in a high opionion All 12 stated that they wanted to implement STEM integration more and the perceived benefits they shared were numerous and vast. There were no perceived drawbacks for students identified. There seems to be variation in knowledge of STEM integration at the kindergarten level with some teachers reporting having a deep knowledge of STEM while the others reporting having some level of knowledge. The role of the teacher was viewed mostly as a facilitator of knowledge, however, some believed that the responsibility of STEM education fell under the GT or library/media content areas. Since all the participants stated that they wanted to implement STEM more and that they did not feel they integrated it consistently or enough in their classrooms, the next section of this analysis will focus on the successes of implementation as well as the barriers they have faced in integrating STEM into their classrooms.

In the next section, I present the themes that emerged from data that directly relate to the current implementation or lack of implementation in these teachers' classrooms which aligns to RQ2: How do kindergarten teachers in one large school district in Arkansas integrate STEM learning activities in their curriculum? The themes for this section are current implementation of STEM in classrooms, barriers that prevent implementation, and successes that teachers have experienced in implementation. Since all the teachers interviewed acknowledged that they did not implement STEM integration as much as they would like to, most of the codes identified support the theme of barriers of implementation. To organize the data, those codes were then sorted into the following categories: STEM is viewed as supplemental instruction, external barriers, self-efficacy and internal barriers, and science not considered core content. Although most teachers shared about their struggles of implementation, there were several teachers who shared some successes as well. Codes that aligned to the successes of implementation were sorted into two categories: success that benefited students and successes that benefited teachers.

Themes Related to RQ2

In the following subsections, I present the themes that emerged to address RQ2: How do kindergarten teachers in one large school district in Arkansas integrate STEM learning activities in their curriculum?

Theme 1: Current Implementation of STEM in Classrooms

Although none of the teachers interviewed said that they consistently implemented STEM, several teachers shared several different ways that they did include STEM in their classrooms either by integrating STEM into existing core content lessons or through supplemental instruction. One of the supplemental instruction methods that teachers identified as how they implement STEM was by implementing STEM bins. Two of the teachers, Participants 4 and 11, both stated that they used STEM bins in their classroom occasionally. STEM bins are typically small boxes filled with manipulatives such as Legos, pattern blocks, base ten blocks, and other small items that students can use for creative exploration. Participant 4 expressed that she wrote a grant to purchase items for STEM bins for her classroom this year because she wanted to include more creative, explorative learning but did not have the materials. She used grant funds to purchase Legos, magnetic blocks, and various other building items that her students use during their center or free-play time. Another teacher, Participant 11, also uses STEM bins but her students use these as a morning activity when they arrive at school. Students use a variety of manipulatives to solve a problem or construct a solution to a problem. For example, her students used building materials to build a way for the Gingerbread Man to cross the river during their literacy study about the various tales of the Gingerbread Man.

Teachers also shared ways that they occasionally integrated a STEM lesson into their literacy and math blocks. Participants 1, 5, and 8 shared how they incorporated STEM into their literacy study focused on the tales of The Gingerbread Man. Participant 1 shared how his students designed, built, and tested bridges that helped the fictional character cross the river safely. Students worked together to complete the process and tested their products in a water trough to see if their design kept the cookie safe from water while getting him across. Participant 5 shared a similar lesson she completed with her students but rather than building a bridge, her students designed and constructed houses to hide the Gingerbread Man. Students had to work together and their creations had to abide by a set of rules such as the house had to have both an entrance and an exit.

Several teachers shared about STEM integrated into mathematics lessons. Both Participants 3 and 6 shared how they integrated STEM into their three-dimensional shape unit of study. Both teachers used manipulatives such as gumdrops and toothpicks or modeling clay and coffee stirrers to have students recreate three-dimensional shapes. Overall, teachers shared that STEM was often an isolated lesson or a supplemental activity that students could engage in during center time. None of the teachers stated that STEM was consistently integrated into their classrooms.

Theme 2: Barriers to STEM Implementation

Although teachers shared some level of success with implementing STEM, a majority of the interview time was focused on the barriers that prevent teachers from implementing it more consistently. The codes that emerged within this theme were so numerous that I sorted them into four categories and will present the results broken down into those categories as well. The categories outlined in this section include: STEM viewed as supplemental instruction, external barriers, internal barriers and self-efficacy, and STEM not viewed as core content.

Several teachers shared statements that suggest that STEM is viewed as supplemental instruction. Participants 7, 9, and 12 all shared experiences when they approached school administration about implementing more STEM lessons into their curriculum. However, their administrators suggested that STEM was the responsibility of either the GT teacher or the Library/Media Specialist. Additionally, several examples that teachers provided of how they currently integrate STEM were through STEM bins or center play stations. These instructional methods are both supplemental to the core curriculum instruction. This suggests that one barrier to implementation is that STEM is viewed as supplemental rather than essential.

External barriers were discussed often and in-depth throughout these interviews. Participants identified several external barriers that prevented them from implementing STEM at a level that they felt satisfied with. These barriers include: lack of curriculum, lack of administrative support, lack of standards, lack of time, lack of training, lack of resources, money, testing requirements, and the current political climate as it pertains to science. These factors were considered to be external as the educators had little or no control over how these factors impacted their classroom. Most of these factors were mandated at the district or state level and impacted how teachers could teach in their classrooms. Since all these teachers teach within the same school district, utilize the same curriculum and pacing guides, and have access to the same resources, it was not suprising to hear the same barriers were expressed repeatedly.

Lack of curriculum was a complaint shared by every single educator interviewed. This district does not have a science curriculum. Instead teachers use a pacing guide that outlines the essential science standards that must be covered each nine weeks. Teachers are provided access to an online science focused program called “Mystery Science” that aligns with some of the standards, however only offers a few STEM focused lessons. Several teachers reported using Mystery Science as their main resource to teach science, however, they mentioned it was not consistent and they often found they were creating and researching materials on their own.

Time was another barrier that all educators shared. All these teachers have basically the same daily schedule which only allows 30 minutes to teach science and social studies. Most teachers shared that they often rotate science and social studies each day and use Fridays for catch-up or assessment. Therefore within a week, only 1 hour of time is dedicated to science. This amount of time compared to the 12.5 hours dedicated to literacy, 5 hours dedicated to math, and 4 hours dedicated to writing per week indicates a significant barrier to science instruction. This also aligns to the belief that literacy and mathematics are the main focus of instruction and that science is not considered core content. Additionally, most teachers also shared that the 30 minutes of science and social studies time was placed at the very end of the day which often is the time that students are packing up to go home and dismissal. Therefore, teachers felt that they were not using the full 30 minutes alotted for science.

Lack of resources and money were also suggested as additional barriers. Most teachers shared that if they wanted to teach STEM, they had to create or purchase the materials necessary. One teacher shared how she wrote a grant to buy STEM materials while another shared how she uses her own personal children's discarded toys to implement STEM in her classroom. Another teacher said that she has asked the Parent Teacher Organization to purchase items before but that often takes several weeks to acquire approval and is inconvenient to purchase the materials needed.

Lack of administrative or district support was another barrier that several teachers shared. Participant 9 spoke in depth about an experience he had when he asked district curriculum administrators if he could integrate more STEM. He shared,

> This was brought up at that time when our curriculum coordinators visited our school. This was the first time, because it was my first year teaching, and I was a young guy, they kind of laughed it off and said that's what the media specialist is here for but that's, one woman for 400 students, all grade levels. It isn't working. My principal told me we don't have time to teach it and every time I bring up STEM or the technology part I get immediate shutdown or pushback.

Another teacher shared how her principal told her to focus on teaching math and literacy since those subjects were tested in kindergarten while science is not tested until third grade.

Another category of barriers of STEM implementation includes internal barriers and self-efficacy. This category aligns to Bandura's SCT, which provides the lens for which this study is conducted and results are presented. Self-efficacy and other key social-cognitive factors influence motivation and actions and could provide insight to how teachers integrate STEM. Teachers were asked how confident they felt in implementing STEM into their current classrooms. Only two teachers (Participants 1 and 9) stated that they felt very confident. The remaining teachers' responses varied from not confident at all to a medium level of confidence. I inquired what factors influenced their confidence levels and received responses such as minimal training in STEM, lack of knowledge of how to integrate STEM, and a lack of guidance and support. Participant 3 stated,

> I know it is beneficial, so it's me I need to take the time to do that, but I want to know more about it because I don't want to just throw something in place. I may not understand what I'm even doing with it.

Participant 4 shared, "Well, I'm not very confident, because I don't know enough.I think I've maybe went to one STEM training, and it was probably 6 years ago, and I don't really know that much about it." Another influencing factor was found in Participant 6's response,

> To feel more confident about it, I would definitely need maybe some more training on it. So that there's more of a purpose behind it. Also you know when you're watching others, and you see them, and you're like oh, my gosh, you know why did not think of that?

There are many factors that affect teacher self-efficacy in teaching STEM and this barrier is important to consider as it could explain teacher behavior.

The final external barrier that I address is training focused on STEM that is provided to these teachers. The district where these teachers work dictates what professional training they receive each year, therefore, these teachers receive the same professional development. None of the teachers could recall any recent training focused on STEM or even science. Several teachers mentioned that they thought they might have attended a training several years prior but could not recall any specific details. All the teachers interviewed expressed a desire to attend more science and STEM focused training and asserted that the majority of their recent training were focused on literacy and mathematics only.

Theme 3: Successes of STEM Implementation

As I analyzed the codes within this theme, I noticed that teachers tended to share successes that they felt as teachers as well as those that they saw affect their students. Both Participants 5 and 8 shared how their STEM lessons allowed them to view their students with a different perspective. In her interview, Participant 5 stated how she was able to see a different side of a student who was typically disengaged and hyperactive. She stated,

> It was was really cool to see he was just like really creative, really into it and he's a kid that has ADHD and doesn't normally listen. He can't sit still to save his life, and it was just really cool to know that he is actually paying attention and he's actually retaining information.

Participant 8 mentioned something similar in her interview. She shared, "and then somebody (usually it's that, you know, quiet, inconspicuous little person) thinks bigger and creates this really cool thing, and they're like oh, my goodness!" Participant 1 shared a similar sentiment, however, he added that often STEM lessons allow students to see each other differnently. He said,

> and what's funny is some of these kids that might not necessarily be your high-level thinkers that come up with some really good ideas. I often see like certain kids that are normally your timider ones take on leadership roles in these activities and they'll kind of step up to plate and the rest of the class sees them with different eyes when they see that they can do.

Additionally, teachers shared that STEM lessons offer an opportunity for students to be take charge and become fully engaged in the learning which allows them to observe and monitor without having to lead the lesson.

Several examples of successes that benefited students were shared during these interviews as well. Most of the codes that fit within this category were also found in the perceived benefits category in the section outline above such as student enjoyment, student engagement, and student independence. However, there were two other codes that emerged during my analysis: transferability of knowledge and new experiences.

Participant 1 shared how he sees that STEM impacts how students approach learning in general. He stated, “STEM helps students become different types of learners, and after students have figured out why is this happening with certain experiments then a lot of times they were more motivated to ask questions later on.” STEM can also provide students to access to new experiences. Participant 2 stated,

> I mean engineering isn’t even in our curriculum. So it’s definitely something they like to explore different avenues that they might not ever have otherwise been exposed to unless they’re going to like the Museum of Discovery. They’re not going to see anything like that anywhere else.

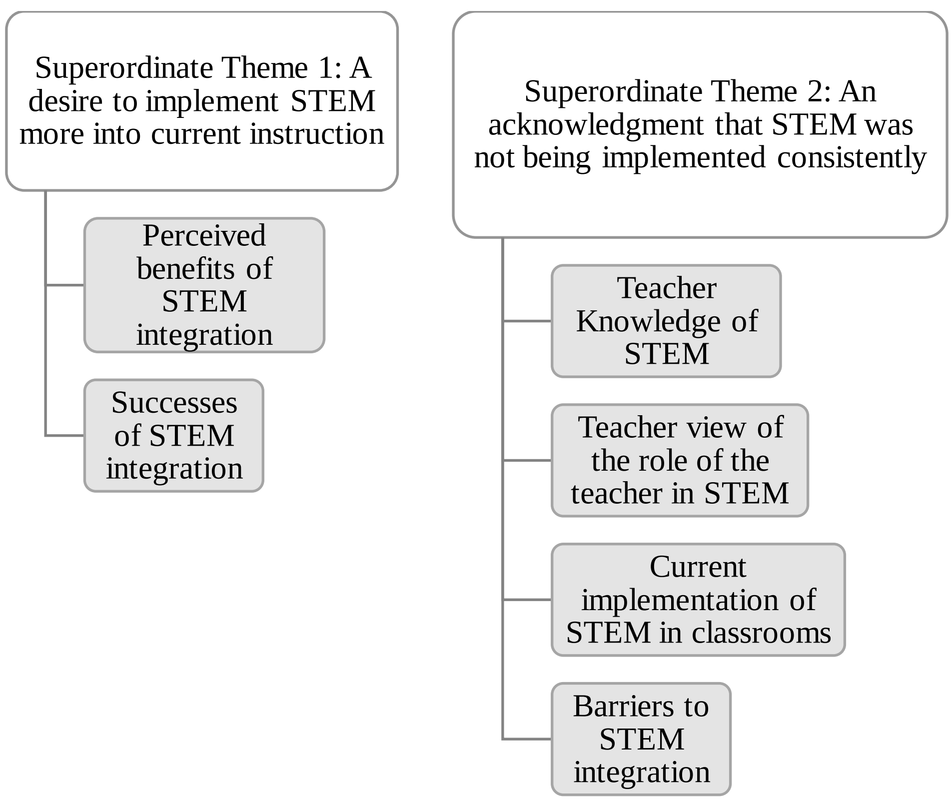
The data in this section help to answer the second research questions of this study. While teachers shared some examples of successes in implementing STEM, it was evident that STEM was being taught in isolated or supplemental methods. Science overall is not considered a core content area in this district as there is little curriculum or resources provided to teachers, there is very little time allocated to teach science standards daily, and administration seems to focus mostly on literacy and mathematics. Since literacy and mathematics occupy most of the daily schedule and are the main focus of instruction, some teachers shared successes of having integrated STEM into their existing literacy and mathematics units of study.

Superordinate Themes

In addition to the six themes outlined above, two superordinate themes emerged from the data that spanned both research questions. The desire to implement STEM into current instruction and an acknowledgment that STEM was not being implemented consistently were themes that emerged from every interview conducted. In the sections below, I will provide a detailed description of those two themes as well as outline how the six other themes support and align with the superordinate themes. I found that often the codes and categories that were sorted into the six themes helped to provide justification for the subordinate themes. For example, the categories and codes within the themes of perceived benefits of STEM integration and successes of STEM integration (Tables 3 & 4) help explain why all the teachers interviewed expressed a desire to integrate it more. In Figure 1, I outline the relationship between the six themes and the two superordinate themes.

Figure 1

Superordinate Themes and the Supporting Six Themes



Superordinate Theme 1: A Desire to Implement STEM Into Current Instruction

Every educator interviewed stated that they felt that they wanted to integrate STEM more into their classrooms. When asked what the purpose of STEM was or what they felt the benefits of STEM were, participants also shared their desire to implement it more. Their responses are outlined below.

- Participant 1, "I've always wanted to do more STEM. In my opinion, the more STEM throughout the day, the better."
- Participant 2, " If we were given the tools we needed to implement it, I think it would be great to add STEM in."
- Participant 3, "I've been wanting to put it [STEM] in my classroom more because I know it's good especially for kindergarten, because they have such big imaginations, and that's one reason why, I love teaching kindergarten so much. They can do a lot of things that people do not think they can do at all."
- Participant 4, "I want there to be more of a focus on STEM in elementary school. There is such a big focus on it in secondary school, and even middle schools and I want to do it more."
- Participant 5, "I love STEM and I would love to do it more."
- Participant 6, "I see STEM ideas and I think, oh, I wish I could do that."
- Participant 7, "And I'm like yes! Let's blow something, up but you know let's do some fun stuff!"

- Participant 8, "I said like specifically, building a time into our schedule, if that was possible, even like once a week, if we could have a STEM time you know, even if it was 30 minutes would be great."
- Participant 9, "I am very strong advocate for STEM in the classroom. STEM in kindergarten, not just as a pull out, not just to something that the library media specialist does once a week, or once a month, we need more."
- Participant 10, "I'll love science and would love, to do more but just having the time, to be able to fit it in."
- Participant 11, "The time is just not there, right now, so yeah, I've definitely, wanted to but time is my biggest factor keeping me from doing it."
- Participant 12, "That would be cool like we could integrate a STEM activity with that or something."

Although all but two of the participants stated they they either were unclear about STEM or did not possess enough knowledge of STEM to integrate it completely, they all shared the belief that STEM could have a positive impact on their students in some way. Many teachers justified their desire to incorporate STEM more by the perceived benefits that they felt it would have for their students. Therefore, the perceived benefits theme that was outlined above in RQ1 directly supports this superordinate theme. For example, Participant 1 stated that he wanted to integrate STEM more because "I think STEM is a great way to reach all your learners." Participant 6 added, "STEM helps the kids to be creative and to problem solve and that's why I would like to do more of it in my classroom."

The theme of successes of STEM that were outlined in RQ2 also directly related to this superordinate theme. Many of the teachers shared the successes that they had experience through implementation and those successes further drove their desire to integrate it more. Participant 4 shared how the STEM bins and centers she used as supplemental instruction helped her students stay engaged. She said,

> They’re happy and those [STEM centers] are the only centers or stations that honestly my kids will work at at a reasonable noise level because they’re thinking. But it’s not like when I would do the other stations where there was a lot of them arguing, and they would get bored very easily.

The successes that she had observed with these STEM stations, increased her desire to integrate STEM more to increase her student engagement during free exploration time.

Superordinate Theme 2: Acknowledgement of Inconsistent STEM Implementation

Another theme that emerged from every interview I held was that each teacher acknowledged that he or she did not integrate STEM in a manner in which they were satisfied with. When participants were asked if they felt they integrated STEM consistently or enough, these were there responses:

- Participant 1, “There have been times where it’s been suggested that we need to teach what will be tested like reading and math and the STEM stuff will not be tested so we don’t do it as much I would like to.”
- Participant 2, “ If you wanted to implement STEM. You couldn’t at this point. It’s just a to lack of time and a lack of resources.”

- Participant 3, “I try my best to get in the mystery sciences when I can, because the kids really do love those. But I barely even have time to do the activities that go along with them because it’s at the end of the day when we’re packed up, and then they’re about to be walking out of the classroom”
- Participant 4, “I don’t have the resources. I don’t have the training. I don’t have the time because of the other curriculum pressures, and when I think it was last year I wrote the grant for STEM toys and that’s just a toy it’s not even teaching them. I’m just giving it to them so I don’t even know if that’s considered STEM.”
- Participant 5, “No, there’s no time, I can’t even get through what reading and math right now, and that’s required. And so right now science is the last 30 min of our day. And it’s one thing takes us a week because it’s done in little pieces all week long.”
- Participant 6, “We don’t necessarily have it [STEM] embedded in our curriculum right now, so I think that kind of you know hinders being able to do more”
- Participant 7, “We’re busy and time is limited. So if that kind of stuff [STEM] was already kind of planned out or paced out that would be really awesome. So that would mainly be the main thing that keeps me from teaching it.”
- Participant 8, “No I mean the most that I’ve done in my classroom would be like some center activities.”

- Participant 9, "We are struggling to do science right. There's not enough content for what our standards cover."
- Participant 10, "I have not taught STEM or had certain lessons that I followed, or anything like that in my classroom."
- Participant 11, "There's a lot more that I could be doing I think but I don't do all that much STEM integration into my classroom, except for science things that we're already doing."
- Participant 12, "Last year and this year, and I'll be honest I haven't taught STEM in my classroom at all it hasn't really been on my horizon it hasn't been brought up to me in any way or shape or form and I haven't really done it."

The problem that this study addressed was that STEM was being implemented inconsistenstly within kindergarten classrooms across this district. The responses provided by the teachers interviewed provide evidence of that problem as well as insight into potential reasons why STEM in being taught inconsistently. The themes of teacher knowledge of STEM and teacher view of the role of the teacher in STEM outlined in RQ1 align and support this superordinate theme. For example, 10 out of the 12 teachers interviewed stated that they were either uncertain about STEM integration or needed to learn more. Several teachers stated that the reason they did not integrate STEM was because of their lack of knowledge. Additionally, teacher view of the role of the teacher in the STEM classroom was another reason that was suggested as to why STEM was not being implemented, especially if the teachers held the viewpoint that the responsibility of integrating STEM fell outside of their general education classroom.

Two themes that were outlined in RQ2 also support this superordinate theme. The theme of current implementation of STEM in classrooms provides further evidence of the inconsistency and provides insight into how STEM is being implemented within these classrooms. The theme of current implementation of STEM in classrooms provides insight into exactly how STEM is being taught in classrooms whether it was through integration into core content areas or through supplemental instruction. Throughout the interviews, the barriers of implementation seemed to be the main focus of what teachers wanted to share. Those barriers included external barriers such as minimal curriculum and support to internal barriers such as teacher confidence and self-efficacy. The theme of barriers to implementation provides a variety of evidence of what might be preventing teachers from implementing STEM more.

Evidence of Trustworthiness

Trustworthiness was established in this study by excluding any potential participants who would present an ethical conflict of interest. To prevent this, I did not interview any teachers that work within my school or whom I know personally. I also do not hold any supervisory position to any of the participants. I used thematic analysis to analyze my data into codes, categories, and themes to better understand the perspectives of the participants. A thick description of the results has been presented throughout this chapter including direct quotes from participants that help to provide further insight into the themes that emerged throughout the analysis.

I also completed several rounds and variations of member checking during the data analysis step of this study. After my initial round of coding, I contacted three teachers to provide them with a copy of their transcripts as well as to ask a few follow-up questions that arose during the coding process. For example, I wanted to learn more about the STEM bins that one teacher shared so I asked her to provide me with more information about this instructional method. This allowed me to gain further insight into her practices. After I finished with the coding process and had identified categories and themes, I also sent a coded copy of the transcript along with the codes, categories, and themes I identified to two other participants so that they could each have an opportunity to make suggestions or provide rebuttal to any of my findings. Both participants agreed with my analysis and did not provide any additional information.

I also used a reflexive journal throughout the interview and analysis steps where I wrote down reflections and additional information gained through the member checking process. During the interviews, I wrote down my observations and reflections on paper and then uploaded that to a Google document that served as my reflexive journal. Additionally, I kept a coding audit online that outlined initial codes as well as how and when codes were edited or deleted. This audit proved to be especially useful during the first round of the member checking process as I gained new insight.

Summary

The purpose of this study was to explore kindergarten teachers' perspectives on STEM integration with their students and consider how kindergarten teachers within one large district are currently implementing STEM into classrooms including their struggles and successes as they do so. 12 kindergarten teachers were interviewed, and a thematic analysis was utilized to identify themes that occurred throughout the teacher's responses to help answer the research questions that guided this study. Two superordinate themes emerged from the results. One theme was that all 12 teachers acknowledged that they did not integrate STEM into their classrooms consistently, and the second theme was that all 12 teachers stated that they wanted to integrate STEM more. Six additional themes were discussed in this analysis as well. These themes include: the perceived benefits of STEM integration, teacher knowledge of STEM, teacher view of the role of the teacher, the current implementation of STEM in classrooms, the barriers that prevent implementation of STEM, and the successes of STEM implementation as well. These themes support and provide insight into the two superordinate themes of a desire to implement STEM more and the acknowledgement that STEM is not being taught consistently. Overall, themes that emerged from the data helped me understand the individual perspectives of my participants while addressing my two research questions. The teachers who participated in this study all reported having a high opinion of STEM and identified many benefits to STEM implementation. However, they also shared barriers that prevent them from teaching STEM consistently. These barriers included many external factors such as lack of curriculum, minimal administrative support, and lack of time. Self-efficacy and internal barriers such as minimal guidance or support and a low level of knowledge of STEM also influenced their classroom practices.

Chapter 5: Discussion, Conclusions, and Recommendations

The purpose of this study was to explore kindergarten teachers' perspectives on STEM integration with their students and consider how kindergarten teachers within one large school district are implementing STEM in their current classrooms including their successes and struggles to do so. A basic qualitative research design with interviews was used to complete this study. I held 12 individual interviews with kindergarten teachers within one large school district Arkansas. The results of this study provide insight into how STEM is currently being integrated in these classrooms as well as what these teachers believe about STEM in general. I found that all the educators who participated believe that STEM is appropriate and beneficial to teach at the kindergarten level. All 12 participants shared a desire to implement more STEM learning opportunities into their classrooms as well as an acknowledgment that they do not currently implement STEM consistently or to a level that they are satisfied. The teachers shared many perceived benefits of STEM learning to students such as the development of 21st century learning skills. Additionally, these teachers shared how STEM is currently being implemented which was mostly through isolated or supplemental learning opportunities. Barriers that prevented further implementation were also shared, including external factors such as minimal curriculum, time, and support, as well as internal factors such as self-efficacy. Overall, it was evident that STEM (and science in general) was not considered a core content area in this district and teachers felt there was not enough time, resources, or support to integrate it more consistently although they expressed how much they believed it would help their students.

Interpretation of the Findings

The purpose of this study was to consider kindergarten teachers' perspectives as well as how they currently implement STEM in their current classrooms. From the data I collected and analyzed thematically, several themes emerged that helped to answer the two research questions that guided the study:

- RQ1. What are kindergarten teachers' perspectives on implementing STEM integration at the kindergarten level within one large school district in Arkansas?
- RQ2. How do kindergarten teachers in one large school district in Arkansas integrate STEM learning activities in their curriculum?

The themes that emerged to help answer RQ1 all related to what participants believed to be true about STEM implementation, what the perceived and observed benefits of STEM were, and highlighted the desire of teachers to implement STEM into their classrooms more consistently. The themes that emerged that helped answer RQ2 related to how these teachers currently implement STEM in their classrooms including their successes and struggles. In the following section, I will interpret those themes and connect the data from this study to the literature in Chapter 2.

Two superordinate themes that emerged from these data also helped me understand the participants' experiences and beliefs. Overall, teachers stated that they did not implement STEM consistently and that they wanted to incorporate it more. The codes, categories, and themes that I identified in the results in Chapter 4 helped me to better understand why teachers wanted to implement STEM as well as what barriers were preventing that implementation. For this study, it was important for me to understand what teachers believe to be true about STEM, what they believe their role in STEM is, and what they believe the benefits or drawbacks to STEM integration are.

One theme that emerged from the data was that the role of a teacher in STEM-integrated lessons is more that of a facilitator of knowledge than the provider of knowledge. Teachers reported that, during STEM lessons, teachers should provide support, scaffold, and guide but that students should be the ones to lead the lesson. STEM should be student-led rather than teacher-led. This constructivist view of the role of the teacher is relative to the perceived benefits of STEM integration as participants reported numerous benefits that they believed STEM could potentially have for their students. These benefits were sorted into two categories: 21st century learning skills and other perceived benefits such as building student confidence, establishing a solid foundation of science content knowledge, and student enjoyment. STEM and 21st century learning skills have been closely related in the literature outlined throughout this study. Averin et al. (2020) stated that to address the demands of modern society, children need to process information and think critically, creatively, and flexibly. Combining the ideas of STEM integration with the importance of the development of the 21st-century skills, specifically the 4C's, is a driving force behind the push toward an interdisciplinary approach to teaching science, technology, engineering, and mathematics content (Reinking, 2018).

Although teachers reported that they believed STEM could have a variety of positive outcomes for students, all the teachers in this study reported not utilizing STEM lessons consistently. To better understand why this phenomenon was occurring, I first considered how these teachers reported using STEM in their classrooms. While most participants stated that they did not use STEM-integrated lessons often, some teachers did report integrating STEM into their classroom through sporadic, supplemental lessons and activities. Teachers reported integrating it occasionally into their existing mathematics and literacy lessons or with STEM bins or centers that students could utilize during free-play or center time. As outlined in the literature review, kindergarten teachers often integrate STEM into core content due to time constraints as well as familiarity with the content (Isabelle, 2017). Integration into child-centered play and free-exploration are also described as effective ways to incorporate STEM in a sustainable way (Campbell & Spedlewinde, 2022).

Teachers reported that they did not have adequate time to teach STEM (or science) in their daily schedules since they only have 30 minutes to teach science and social studies combined. This dedicated 15 minutes of science time is even less than what was reported in the study completed by Tippett and Milford (2017) where they stated that approximately only 19 minutes of a kindergarten daily schedule is dedicated to science. According to the participants' schedules, only one hour is dedicated to science each week. This amount of time compared to the 12.5 hours dedicated to literacy, 5 hours dedicated to mathematics, and 4 hours dedicated to writing per week indicates a significant barrier to science instruction. Participants reported that administrators urged them to not focus on teaching science since it is not tested at the kindergarten level. It appeared that STEM (and even science) is considered supplemental instruction, rather than essential or core instruction.

After I considered how STEM was implemented, it was important to focus on what these teachers reported as barriers that prevented them from including STEM in their daily classroom instruction. Through my data analysis, I sorted the reported barriers into two categories: external barriers and internal barriers. The external barriers that teachers reported were vast. These included lack of curriculum, lack of support, lack of training, and a lack of money, resources, and supplies. Since all the participants teach within the same school district and have access to the same pacing guides, training, and curriculum, it was not surprising that these barriers were reported by each participant. The internal barriers that emerged were relative to the conceptual framework, Bandura's SCT, which provides the lens through which this study is conducted and results are presented. Self-efficacy and other key social-cognitive factors influence motivation and actions and could provide insight to how and why teachers integrate STEM. In this study, teachers were asked how confident they felt in implementing STEM into their current classrooms. Only two teachers stated that they felt very confident, whereas the remaining teachers' responses varied from not confident at all to a medium level of confidence. The factors that influenced their confidence levels were minimal training in STEM, a low level of knowledge of how to integrate STEM, and minimal guidance and support. These results mirror the results found by Lestari and Kurniati (2021) in their study of 50 kindergarten teachers who were surveyed about their perceptions and integration of STEM. In that study, teachers also identified lack of training, content knowledge, and support as reasons why they had not attempted to integrate STEM yet.

The literature presented throughout this study suggests that explicit STEM training can positively influence teacher self-efficacy and STEM implementation. According to the teachers in this study, they have received little or no STEM training and the educational cooperative responsible for this district's professional development also states that relatively few STEM training have been offered for kindergarten teachers within the past five years. There are many factors that affect teacher self-efficacy in teaching STEM and this barrier is important to consider as it could explain teacher behavior. Teachers who possess high self-efficacy are often more willing to try new techniques and possess a more positive attitude toward STEM implementation (Thibaut et al., 2018). Although the teachers in this study all report having a positive attitude towards STEM implementation, both the external barriers, such as a lack of curriculum, time, and resources, and the barrier of low self-efficacy impacts how STEM in currently taught in their classrooms.

Limitations of the Study

In Chapter 1, I noted limitations to this study including that I am only using one data source; therefore, I could not triangulate my findings via more than one data source. However, I used thematic analysis and presented a thick description of the write-up of the study to help establish credibility. Thematic analysis provided a way to analyze the data methodically and thoroughly. Member checking was also utilized to promote validity and credibility of the study. The small sample size of this study could also have limited transferability. My initial plan was to interview 15–20 teachers, however, once I received the official list of kindergarten teachers in the district, I had a much smaller pool of participants than I was initially told. I had to further reduce that pool by excluding a handful of teachers who work within my building so that the credibility of the study would not be impacted. In total, there were 30 teachers who could have participated in the study, and I interviewed 12 for my study. I chose to interview all who volunteered to participate since they expressed either an understanding of STEM integration or had integrated STEM previously. However, saturation was achieved through this sample size as a variety of perspectives were considered and thoroughly analyzed. Participants' years of experience varied from 4 years to 21 years, which provided insight into perspectives of veteran and novice teachers.

Recommendations

Although I answered my research questions in this study, I wonder if a similar study held within a different district would provide similar or different results. Considering that all the educators who participated teach in the same school district and have access to the same curriculum, training, and support, it could be assumed that those factors would surface in the results of this study. In this case, these teachers expressed identical external barriers that prevented them from successfully integrating STEM into their classrooms. These barriers such as lack of curriculum, time, and support were identified as big hurdles that these teachers face when implementing something new or different such as STEM. It was evident that within this district, science or STEM were not considered core content areas. I cannot help but wonder if a study was conducted in a school district that does value STEM if the results would be vastly different.

I recommend that further studies be conducted at the kindergarten level that could hopefully identify strategies that help teachers successfully integrate STEM into their classrooms. Perhaps a multi-case study across different regions of the state would provide insight into other resources or strategies for implementation or an intrinsic case study held within a district that fully supports STEM integration could provide different insights of teacher perspectives. Hopefully results from future studies could help address the barriers that arose in this study and STEM would begin to be more consistently implemented within kindergarten classrooms.

A recommendation for practice for teachers who face many of the challenges presented in this study would be to focus on the successes that were shared by the participants in this study. Although inconsistent, the examples of STEM integration were great examples of how teachers can address barriers creatively. Through integration of STEM into literacy and mathematics, teachers were able to teach science beyond the 15 allotted minutes in their schedule and by integrating STEM into those familiar content areas, teacher self-efficacy was increased. Grant writing is another way that teachers found ways to purchase materials necessary for STEM bins or learning centers.

Implications

This study provides valuable insight into teacher perspectives, potential challenges, and opportunities for implementation of STEM in a local school district. The results of this study could help influence future professional development opportunities and curriculum development as the kindergarten level that could better align to the demands of 21st century workforce and NGSS. The local site could use the results of this study to engage in dialogue with teachers about STEM integration and how it can be improved within the district. The literature outlined in Chapter 2 and the participants' perceived benefits of STEM integration outlined above both support the idea that STEM integration at the kindergarten level could have a positive impact on student achievement and development. Considering the low science test scores of students in this district that were outlined in Chapter 1, the district leaders could utilize this study to justify a shift in curriculum and instruction. Additionally, the results of this study could provide the state department of education with valuable insight into what might hinder or enhance the implementation of the AR STEM Model Program. This could help the department of education accomplish the goals of the program and consider teachers' perspectives, which could impact how the program is put into effect at the kindergarten level.

I believe that although the implementation of STEM was inconsistent, this study indicates that kindergarten teachers value STEM enough to find ways to incorporate it despite the challenges they faced. Through integration into the core content areas of mathematics and reading, teachers fit STEM into their daily schedules despite the minimal amount of time allocated to teach science by the district. The resourcefulness of the teachers' use of grant writing to purchase STEM materials also demonstrates how teachers can persevere and address the challenge of lack of resources.

As outlined in Chapter 2, there are disparities in access and opportunities in STEM for racial and ethnic minorities, students who live in high-poverty regions, students from low socioeconomic homes, girls, and students with differing abilities. This gap in access is critical to address as there is growing demand for diversity in STEM fields (Fuller et al., 2021). The earlier that educators ensure equitable access to STEM education regardless of race, socioeconomic status, and gender, the earlier they can begin to foster a passion and genuine interest in the field. It is essential that kindergarten students have equitable access to quality, consistent STEM learning opportunities and hopefully this study can provide a bit of insight into the current challenges and successes that some kindergarten teachers face.

Conclusion

Although the benefits of STEM integration at the kindergarten level are widely known and accepted, implementation of STEM in kindergarten classrooms is inconsistent. From the research findings, there are many factors that influence the implementation of STEM at the kindergarten level. These include external influences such as minimal curriculum, lack of time, lack of resources, science not being considered core content, and a lack of training. Internal factors such as self-efficacy and knowledge of STEM also play a role in implementation. Teacher confidence levels were influenced by a lack of training in STEM, lack of knowledge of how to integrate STEM, and a lack of guidance and support.

According to SCT, outcome expectancy along with self-efficacy, influences behavior (Ku et al., 2015). Although most of the teachers interviewed expressed a low self-efficacy, the high expected outcomes and perceived positive impact that STEM would have on their students influenced their classroom instructional choices. The teachers who participated in this study shared a positive attitude toward STEM. They shared a common desire to include it in their daily curriculum and instruction and believed that STEM could provide positive outcomes for their students. Although the teachers who participated in this study expressed a great deal of challenges they faced in implementing STEM, they also shared some great examples of how they addressed those challenges and found creative ways to incorporate STEM in their classrooms. Whether it was designing and building a raft for the Gingerbread Man to cross the river, constructing three-dimensional shapes with toothpicks and gumdrops, or engineering a bridge strong enough to hold The Three Billy Goats Gruff, students in these teachers' classrooms were provided with hands-on, constructive lessons that allowed them to collaborate, create, and critically think. As Participant 1 shared,

> STEM helps students become different types of learners, and so, after students have figured out why is this happening with certain experiments then a lot of times they were more motivated to ask questions later on. They realize that questions are part of learning. It's okay to question stuff and that you don't have to just take everything for what it is. I've always enjoyed that moment where you see this kid where all of a sudden he's a curious learner and I think a lot of those moments happen within STEM. It's phenomenal.

References

Arkansas Department of Education. (2020). *Office of Information Technology: District report card*. https://myschoolinfo.arkansas.gov/SRC

Averin, S., Murodhodjaeva, N., Romanova, M., Serebrennikova, Y., & Koptelov, A. V. (2020). Continuity in education in the implementation of the STEM education for the children of preschool and elementary school age modular program. *SHS Web of Conferences*, *79*, 01002. https://doi.org/10.1051/shsconf/20207901002

Balint-Svella, E., & Szoldos Marchiș, I. (2022). Pre-service teachers' knowledge and opinion about STEM education in preschool. *Studia Universitatis Babeș-Bolyai Psychologia-Paedagogia*, *67*(1), 113–123. https://doi.org/10.24193/subbpsyped.2022.1.07

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*(2), 191–215. https://doi.org/10.1037/0033-295x.84.2.191

Bonisteel, I., Shulman, R., Newhook, L. A., Guttmann, A., Smith, S., & Chafe, R. (2021). Reconceptualizing recruitment in qualitative research. *International Journal of Qualitative Methods*, *20*. https://doi.org/10.1177/16094069211042493

Brusic, S., & Shearer, K. (2014). The ABCs of 21st century skills. *Children's Technology and Engineering*, *18*(4), 6–10.

Buck Institute for Education. (2022). *What is PBL?* PBLWorks. Retrieved September 4, 2022, from https://www.pblworks.org/what-is-pbl

Bursal, M. (2012). Changes in American preservice elementary teachers' efficacy beliefs and anxieties during a science methods course. *Science Education International*, *23*(1), 40-55.

Campbell, C., & Speldewinde, C. (2022). Early childhood STEM education for Sustainable Development. *Sustainability*, *14*(6), 3524. https://doi.org/10.3390/su14063524

Chalkiadaki, A. (2018). A systematic literature review of 21st century skills and competencies in primary education. *International Journal of Instruction*, *11*(3), 1–16. https://doi.org/10.12973/iji.2018.1131a

Chen, Y.-L., Huang, L.-F., & Wu, P.-C. (2020). Preservice preschool teachers' self-efficacy in and need for STEM education professional development: STEM pedagogical belief as a mediator. *Early Childhood Education Journal*, *49*(2), 137–147. https://doi.org/10.1007/s10643-020-01055-3

Collins, M. A., Totino, J., Hartry, A., Romero, V. F., Pedroso, R., & Nava, R. (2019). Service-learning as a lever to support stem engagement for underrepresented youth. *Journal of Experiential Education*, *43*(1), 55–70. https://doi.org/10.1177/1053825919887407

DeCoito, I., & Myszkal, P. (2018). Connecting science instruction and teachers' self-efficacy and beliefs in STEM education. *Journal of Science Teacher Education*, *29*(6), 485–503. https://doi.org/10.1080/1046560x.2018.1473748

DiFrancesca, D., Lee, C., & McIntyre, E. (2014). Where is the "E" in STEM for young children? - Engineering design education in an elementary teacher preparation Program. *Issues in Teacher Education*, *23*(1), 49–64.

Division of Elementary and Secondary Education. (n.d.-a). *Educator effectiveness and licensure*. Arkansas Department of Education. Retrieved September 4, 2022, from https://dese.ade.arkansas.gov/Offices/educator-effectiveness/educator-licensure

Division of Elementary and Secondary Education. (n.d.-b). *Learning services*. Arkansas Department of Education. Retrieved September 4, 2022, from https://dese.ade.arkansas.gov/Offices/learning-services

Early Childhood STEM Working Group. (2017). *Early stem matters, providing quality stem experiences for all young learners: a policy report by the early childhood stem working group*. Erikson Institute. https://stemecosystems.org/wp-content/uploads/2019/09/earlystemmatters.pdf

Elliott, R., & Timulak, L. (2021). *Essentials of descriptive-interpretative qualitative research: A generic approach*. American Psychological Association. https://doi.org/10.1037/0000224-000

el Nagdi, M., Leammukda, F., & Roehrig, G. (2018). Developing identities of STEM teachers at emerging STEM schools. *International Journal of STEM Education*, *5*(1), 1–14. https://doi.org/10.1186/s40594-018-0136-1

Falloon, G., Hatzigianni, M., Bower, M., Forbes, A., & Stevenson, M. (2020). Understanding K-12 STEM education: A framework for developing STEM

Literacy. *Journal of Science Education and Technology*, *29*(3), 369–385. https://doi.org/10.1007/s10956-020-09823-x

Forman, J., Gubbins, E. J., Villanueva, M., Massicotte, C., Callahan, C., & Tofel-Grehl, C. (2015). National survey of STEM high schools' curricular and instructional strategies and practices. *NCSSS Journal*, *20*(1), 8–19.

Fullan, M. (2011). *Change leader: Learning to do what matters most*. Jossey-Bass.

Fuller, J. A., Luckey, S., Odean, R., & Lang, S. N. (2021). Creating a diverse, inclusive, and equitable learning environment to support children of color's early introductions to stem. *Translational Issues in Psychological Science*, *7*(4), 473–486. https://doi.org/10.1037/tps0000313

Geng, J., Jong, M. S.-Y., & Chai, C. S. (2018). Hong Kong Teachers' self-efficacy and concerns about STEM education. *The Asia-Pacific Education Researcher*, *28*(1), 35–45. https://doi.org/10.1007/s40299-018-0414-1

Gerde, H. K., Pierce, S. J., Lee, K., & van Egeren, L. A. (2018). Early childhood educators' self-efficacy in science, math, and literacy instruction and science practice in the classroom. *Early Education and Development*, *29*(1), 70–90. https://doi.org/10.1080/10409289.2017.1360127

Graaf, J. van der, Segers, E., & Verhoeven, L. (2016). Scientific reasoning in Kindergarten: Cognitive factors in experimentation and evidence evaluation. *Learning and Individual Differences*, *49*, 190–200. https://doi.org/10.1016/j.lindif.2016.06.006

Hachey, A. C., Song, A. A., & Golding, D. E. (2021). Nurturing kindergarteners' early stem academic identity through makerspace pedagogy. *Early Childhood Education Journal*, *50*(3), 469–479. https://doi.org/10.1007/s10643-021-01154-9

Hammack, R., & Ivey, T. (2017). Examining elementary teachers' engineering self-efficacy and engineering teacher efficacy. *School Science and Mathematics*, *117*(1/2), 52–62. https://doi.org/10.1111/ssm.12205

Havice, W., Havice, P., Waugaman, C., & Walker, K. (2018). Evaluating the effectiveness of integrative STEM Education: Teacher and administrator professional development. *Journal of Technology Education*, *29*(2), 73–90. https://doi.org/10.21061/jte.v29i2.a.5

Hollenstein, L., Thurnheer, S., & Vogt, F. (2022). Problem solving and digital transformation: Acquiring skills through pretend play in Kindergarten. *Education Sciences*, *12*(2), 92. https://doi.org/10.3390/educsci12020092

Hryciw, K. J. (2017). *The influence of globalization, economics, and educational policy on the development of 21st century learning and education in the sciences, technology, engineering, and mathematics in schools of Ireland* (Publication No. 10801550) [Doctoral dissertation, University of Southern California]. ProQuest Dissertations and Theses Global.

Hughes, R., Schellinger, J., Billington, B., Britsch, B., & Santiago, A. (2020). A summary of effective gender equitable teaching practices in informal stem education spaces. *The Journal of STEM Outreach*, *3*(1), 1–9. https://doi.org/10.15695/jstem/v3i1.16

Isabelle, A. D. (2017). STEM is elementary: Challenges faced by elementary teachers in the era of the Next Generation Science Standards. *Educational Forum*, *81*(1), 83–91. https://doi.org/10.1080/00131725.2016.1242678

Jiang, L. (2022). Development and implementation path of kindergarten stem educational activities based on Data Mining. *Computational Intelligence and Neuroscience*, *2022*, 1–10. https://doi.org/10.1155/2022/2700674

John, M.-S., Sibuma, B., Wunnava, S., Anggoro, F., & Dubosarsky, M. (2018). An iterative participatory approach to developing an early childhood problem-based STEM Curriculum. *European Journal of STEM Education*, *3*(3). https://doi.org/10.20897/ejsteme/3867

Johnson, J. E., Sevimli-Celik, S., Al-Mansour, M. A., Tunçdemir, T. B. A., & Dong, P. I. (2019). Play in early childhood education. *Handbook of Research on the Education of Young Children*, *3*(3), 165–175. https://doi.org/10.4324/9780429442827-12

Johnson, T. M., Byrd, K. O., & Allison, E. R. (2021). The impact of integrated STEM modeling on elementary preservice teachers' self-efficacy for integrated STEM instruction: A co-teaching approach. *School Science and Mathematics*, *121*(1), 25–35. https://doi.org/10.1111/ssm.12443

Kelley, T. R., & Knowles, J. G. (2016). A conceptual framework for integrated STEM education. *International Journal of STEM Education*, *3*(1). https://doi.org/10.1186/s40594-016-0046-z

Kivunja, C. (2014). Do you want your students to be job-ready with 21st century skills? Change pedagogies: A pedagogical paradigm shift from Vygotskyian Social

Constructivism to critical thinking, problem solving and Siemens' Digital Connectivism. *International Journal of Higher Education*, *3*(3), 81–91/ https://doi.org/10.5430/ijhe.v3n3p81

Kivunja, C. (2014). Teaching students to learn and to work well with 21st century skills: Unpacking the career and life skills domain of the new learning paradigm. *International Journal of Higher Education*, *4*(1), 1–11. https://doi.org/10.5430/ijhe.v4n1p1

Ku, K. Y. L., Phillipson, S., & Phillipson, S. N. (2015). Educational Learning Theory. *International Encyclopedia of the Social & Behavioral Sciences: Second Edition*, 238–245. https://doi.org/10.1016/B978-0-08-097086-8.92150-0

Kyere, J. (2017). *The effectiveness of hands-on pedagogy in STEM education* (Publication No. 10239707) [Doctoral dissertation, Walden University]. ProQuest Dissertations and Theses.

Lestari, M., & Kurniati, E. (2021). STEM flexibel model in kindergarten. *Jurnal Penelitian Pendidikan*, *24*(2). https://doi.org/10.20961/paedagogia.v24i2.53774

Linder, S. M., Emerson, A. M., Heffron, B., Shevlin, E., & Vest, A. (2016). STEM use in early childhood education: Viewpoints from the field. *Science, Technology, Engineering, and Mathematics in Early Childhood Education*, 71(3), 87–92.

Loewenstein, M., Sturdivant, T. D., & Thompson, J. (2022). Learning Through Play in Teacher Education. *YC Young Children*, *77*(2), 44-50.

Makerspaces.com. (2022). *What is a Makerspace? Is it a Hackerspace or a Makerspace?* Retrieved February 21, 2022, from https://www.makerspaces.com/what-is-a-makerspace/

Malone, K. L., Tiarani, V., Irving, K. E., Kajfez, R., Lin, H., Giasi, T., & Edmiston, B. W. (2018). Engineering design challenges in early childhood education: Effects on student cognition and interest. *European Journal of STEM Education*, *3*(3). https://doi.org/10.20897/ejsteme/3871

Mano, H., Molina, K., Lange, A., & Nayfield, I. (2019). Planting the seeds of engineering: Preschoolers think about, talk about, and solve a real problem in the garden. *Science and Children*, 57(2), 80-84. https://www.ecstemlab.com/uploads/4/0/3/5/40359017/plantingtheseeds-ee.pdf

Marcus, M., Haden, C. A., & Uttal, D. H. (2018). Promoting children's learning and transfer across informal science, technology, engineering, and Mathematics learning experiences. *Journal of Experimental Child Psychology*, *175*, 80–95. https://doi.org/10.1016/j.jecp.2018.06.003

Margot, K. C., & Kettler, T. (2019). Teachers' perception of stem integration and education: A systematic literature review. *International Journal of STEM Education*, *6*(1). https://doi.org/10.1186/s40594-018-0151-2

McClure, E. R., Guernsey, L., Clements, D. H., Bales, S. N., Nichols, J., Michael, N. K.-T., & Levine, H. (2017). *STEM starts early: Grounding science, technology, engineering, and mathematics education in early childhood*. www.joanganzcooneycenter.org

McLeod, S. (2019, January 1). *Constructivism as a theory for teaching and learning.* Simply Psychology. Retrieved August 27, 2022, from https://www.simplypsychology.org/constructivism.html

Mere-Cook, Y., & Ramanathan, G. (2022). Promoting inclusive teaching and learning using the engineering design process. *YC Young Children*, *77*(2), 78-87.

Merriam, S. B. (2002). Introduction to qualitative research. In *Qualitative research in practice: Examples for discussion and analysist*, 1(1), 1–17.

Moses, I., Admiraal, W., Berry, A., & Saab, N. (2019). Student-teachers' commitment to teaching and intentions to enter the teaching profession in Tanzania. *South African Journal of Education*, *39*(1), 1-15. https://doi.org/10.15700/saje.v39n1a1485

Mpofu, V. (2019). A Theoretical Framework for Implementing STEM Education. In (Ed.), Theorizing STEM Education in the 21st Century. IntechOpen. https://doi.org/10.5772/intechopen.88304

Muller, C. (2022, July 11). *What is the digital divide?* Internet Society. Retrieved September 6, 2022, from https://www.internetsociety.org/blog/2022/03/what-is-the-digital-divide/

Mumba, F., Miles, E., & Chabalegnula, V. (2019). Elementary education in-service teachers' familiarity, interest, conceptual knowledge and performance on Science Process Skills. *Journal of STEM Teacher Education*, *53*(2), 21–42. https://doi.org/10.30707/jste53.2mumba

Murray, J. (2019). Routes to stem: Nurturing science, technology, engineering and mathematics in Early Years education. *International Journal of Early Years Education*, *27*(3), 219–221. https://doi.org/10.1080/09669760.2019.1653508

Nabavi, R. T. (2012). Bandura's social learning theory & social cognitive learning theory. *Theory of Developmental Psychology*, *1*, 24.

Nadelson, L. S., & Seifert, A. L. (2017). Integrated STEM defined: Contexts, challenges, and the future. In *Journal of Educational Research*, 110 (3), 221–223. https://doi.org/10.1080/00220671.2017.1289775

National Science Foundation. (2021). (rep.). *Women, Minorities, and Persons with Disabilities in Science and Engineering*. National Center for Science and Engineering Statistics. Retrieved September 6, 2022, from https://ncses.nsf.gov/pubs/nsf21321/report.

National Research Council. (2011). Successful K-12 STEM Education. In *Successful K-12 STEM Education*. https://doi.org/10.17226/13158

National Research Council. (2012). A framework for K-12 science education: Practices, crosscutting concepts, and core ideas. In *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. National Academies Press. https://doi.org/10.17226/13165

National Science and Technology Council. (2018). *Charting a course for success: America's strategy for STEM education.*

NGSS Lead States. (2013). *Next generation science standards: for state by states*. The National Academies Press.

Nicola, S., Pinto, C., & Mendonca, J. (2018). *The role of education on the acquisition of 21st century soft skills by Engineering students*. 1–4. https://doi.org/10.1109/cispee.2018.8593495

Olusegen, B. S. (2015). Constructivism Learning Theory: A Paradigm for Teaching and Learning. *Journal of Research Method and Education*, *5*(1), 66–70. https://doi.org/10.9790/7388-05616670

Park, M. H., Dimitrov, D. M., Patterson, L. G., & Park, D. Y. (2017). Early childhood teachers' beliefs about readiness for teaching science, technology, engineering, and mathematics. *Journal of Early Childhood Research*, *15*(3), 275–291. https://doi.org/10.1177/1476718X15614040

Parker, C., Abel, Y., & Denisova, E. (2015). Urban elementary STEM initiative. *School Science and Mathematics*, *115*(6), 292–301. https://doi.org/10.1111/ssm.12133

Pawilen, G. T., & Yuzon, M. R. (2019). Planning a Science, Technology, Engineering, and Mathematics (STEM) Curriculum for Young Children: A Collaborative Project for Pre-service Teacher Education Students. *International Journal of Curriculum and Instruction*, *11*(2), 130–146.

Pendergast, E., Lieberman-Betz, R. G., & Vail, C. O. (2017). Attitudes and beliefs of prekindergarten teachers toward teaching science to young children. *Early Childhood Education Journal*, *45*(1), 43–52. https://doi.org/10.1007/S10643-015-0761-Y

Peters-Burton, E. E., House, A., Peters, V., & Remold, J. (2019). Understanding STEM-focused elementary schools: Case study of Walter Bracken STEAM Academy.

School Science and Mathematics, *119*(8), 446–456. https://doi.org/10.1111/ssm.12372

Polly, D., McGee, J., Wang, C., Martin, C., Lambert, R., & Pugalee, D. K. (2015). Linking professional development, teacher outcomes, and student achievement: The case of a learner-centered mathematics program for elementary school teachers. *International Journal of Educational Research*, *72*, 26–37. https://doi.org/10.1016/j.ijer.2015.04.002

Poonsin, T., & Jansoon, N. (2021). Integrated Stem with project-based learning implementation to enhance students' creativity. *2021 2nd SEA-STEM International Conference (SEA-STEM)*, 112–115. https://doi.org/10.1109/sea-stem53614.2021.9668085

Radloff, J., & Guzey, S. (2016). Investigating preservice STEM teacher conceptions of STEM education. *Journal of Science Education and Technology*, *25*(5), 759–774. https://doi.org/10.1007/s10956-016-9633-5

Ravitch, S. M., & Carl, N. M. (2016). *Qualitative research: Bridging the conceptual, theoretical, and methodological*. Sage Publications.

Reinking, A. K. & Martin, B. (2018). Strategies, research, and examples for elementary teachers to integrate STEM. *K-12 STEM Education*, *4*(4), 413–419.

Raymond, R. D., Sharp, L. A., & Piper, R. (2020). Developing Instructional Capacity and Competence among Preservice Teachers: Voices of Literacy Teacher Educators. *Excellence in Education Journal*, *9*(2), 29-54.

Remake Learning. (2016, April 29). Demystifying Learning Frameworks: The P21 framework [web log]. Retrieved August 27, 2022, from https://remakelearning.org/blog/2016/04/29/demystifying-learning-frameworks-the-p21-framework/.

Ring, E. A., Dare, E. A., Crotty, E. A., & Roehrig, G. H. (2017). The evolution of teacher conceptions of STEM education throughout an intensive professional development experience. *Journal of Science Teacher Education*, *28*(5), 444–467. https://doi.org/10.1080/1046560X.2017.1356671

Rinke, C. R., Gladstone-Brown, W., Kinlaw, C. R., & Cappiello, J. (2016). Characterizing STEM teacher education: Affordances and constraints of explicit STEM preparation for elementary teachers. *School Science and Mathematics, 116*(6), 300–309. https://doi.org/10.1111/ssm.12185

Rubin, H. J., & Rubin, I. S. (2012). *Qualitative Interviewing: The art of hearing data* (3rd ed.). Sage Publications.

Rynearson, A. M., Moore, T. J., Tank, K. M., & Gajdzik, E. (2017). Evidence-based reasoning in a kindergarten classroom through an Integrated STEM Curriculum *American Society for Engineering Education*.

Ryu, M., Mentzer, N., & Knobloch, N. (2018). Preservice teachers' experiences of STEM integration: Challenges and implications for integrated STEM teacher preparation. *International Journal of Technology and Design Education*, *29*(3), 493–512. https://doi.org/10.1007/s10798-018-9440-9

Şahin, H. (2021). The effect of STEM-based education program on problem solving skills of five year old children. *Malaysian Online Journal of Educational Technology*, *9*(4), 68–87. https://doi.org/10.52380/mojet.2021.9.4.325

Saldana, J. (2016). *The coding manual for qualitative researchers* (3rd ed.). Sage Publications.

Sarama, J., Clements, D., Nielson, M., Romance, N., Hoover, M., Staudt, C., Barrody, A., McWayne, C., & McCullough, C. (2018). *Considerations for STEM Education from PreK through Grade 3 What Does STEM Mean?* https://go.edc.org/earlylearning-resources

Scarola, K., Wallace, N., & Precht, C. (2022). The STEAM circle: How an interdisciplinary program connects children, schools, and a local community. *YC Young Children*, *77*(1), 78-83.

Schneiderwind, J., & Johnson, J. M. (2020). Disability and invisibility in STEM education. *Journal of Higher Education Theory and Practice*, *20*(14), 101–104. https://doi.org/10.33423/jhetp.v20i14.3854

Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information*, *22*(2), 63–75. https://doi.org/10.3233/EFI-2004-22201

Simoncini, K., & Lasen, M. (2018). Ideas about stem among Australian early childhood professionals: How important is stem in early childhood education? *International Journal of Early Childhood*, *50*(3), 353–369. https://doi.org/10.1007/s13158-018-0229-5

Somwaeng, A. (2021). Developing early childhood students' creative thinking ability in STEM education. *Journal of Physics: Conference Series*, *1835*(1), 012009. https://doi.org/10.1088/1742-6596/1835/1/012009

Stahl, N., & King, J. (2020). Expanding approaches for research: Understanding and using trustworthiness in qualitative research. *Journal of Developmental Education*, *44*(1), 26–28. https://doi.org/10.4135/9781483329574

Strawhacker, A., & Bers, M. U. (2018). Promoting positive technological development in a kindergarten Makerspace: A qualitative case study. *European Journal of STEM Education*, *3*(3) 1-21. https://doi.org/10.20897/ejsteme/3869

Sundararajan, N., Adesope, O., & Cavagnetto, A. (2018). The process of collaborative concept mapping in kindergarten and the effect on critical thinking skills. *Journal of STEM Education*, *19*(1) 5-13.

Tank, K. M., Rynearson, A. M., & Moore, T. J. (2018). Examining student and teacher talk within engineering design in kindergarten. *European Journal of STEM Education*, *3*(3) 1-15. https://doi.org/10.20897/ejsteme/3870

Tao, Y. (2019). Kindergarten teachers' attitudes toward and confidence for integrated STEM education. *Journal for STEM Education Research*, *2*(2), 154–171. https://doi.org/10.1007/s41979-019-00017-8

Thibaut, L., Knipprath, H., Dehaene, W., & Depaepe, F. (2018). The influence of teachers' attitudes and school context on instructional practices in integrated STEM Education. *Teaching and Teacher Education, 71*, 190–205. https://doi.org/10.1016/j.tate.2017.12.014

Tippett, C. D., & Milford, T. M. (2017). Findings from a pre-kindergarten classroom: Making the case for STEM in early childhood education. *International Journal of Science and Mathematics Education*, 15(1), 67–86.

Toma, R. B., & Greca, I. M. (2018). The effect of integrative STEM instruction on elementary students' attitudes toward science. *EURASIA Journal of Mathematics, Science and Technology Education*, *14*(4), 1383–1395. https://doi.org/10.29333/ejmste/83676

Üret, A., & Ceylan, R. (2021). Exploring the effectiveness of STEM education on the creativity of 5-year-old Kindergarten Children. *European Early Childhood Education Research Journal*, *29*(6), 842–855. https://doi.org/10.1080/1350293x.2021.1913204

Williams, E. N., & Morrow, S. L. (2009). Achieving trustworthiness in qualitative research: A pan-paradigmatic perspective. *Psychotherapy Research*, 19(4–5), 576–582. https://doi.org/10.1080/10503300802702113

Yang, W., Wu, R., & Li, J. (2021). Development and validation of the STEM Teaching Self-efficacy Scale (STSS) for early childhood teachers. *Current Psychology*. https://doi.org/10.1007/s12144-021-02074-y

Yildirim, B., & Sahin Topalcengiz, E. (2019). Stem pedagogical content knowledge scale (STEMPCK): A validity and Reliability Study. *Journal of STEM Teacher Education*, *53*(2). https://doi.org/10.30707/jste53.2yildirim

Zdybel, D., Pulak, I., Crotty, Y., & Fuertes Camacho, M. T. (2019). Developing STEM skills in kindergarten: Opportunities and challenges from the perspective of future teachers. *Edukacja Elementarna w Teorii i Praktyce*, *14*(54), 71-94.

Zendler, A., Seitz, C., & Klaudt, D. (2018). Instructional methods in STEM education: A cross-contextual study. *EURASIA Journal of Mathematics, Science and Technology Education*, *14*(7), 2969–2986. https://doi.org/10.29333/ejmste/91482

Zosh, J. M., Gaudreau, C., Golinkoff, R. M., & Hirsh-Pasek, K. (2022). The power of playful learning in the early childhood setting. *YC Young Children*, *77*(2), 6-13.

Appendix: Interview Protocol

Instrumentation: Interview Guide

Date:

Time:

Interviewee Code #:

Zoom Interview

Parts of the Interview	**Interview Questions**
Introduction	Hi, this is Mrs. Randi House. The purpose of this interview is to explore your personal experience in implementing integrated STEM learning within your classroom. This interview should take no longer than 30 minutes. After our interview, I will examine your answers to identify themes and some of your answers will be shared within my research study. However, I will not identify you in my documents, and you will not be identifiable by your answers. You can choose to stop this interview at any time. I also need to let you know that this interview will be recorded for transcription purposes.
Introduction	Do you have any questions?
Introduction	Are you okay with me recording this interview for transcription purposes? Are you ready to begin?
Question 1:	I will start with some basic demographic data. These data will not be published in a manner that can identify you and your name will not be utilized. I am using a coding system to protect your identity and ensure confidentiality in your responses.

	a. Where do you teach? b. How many years have you taught? c. How many of those years were taught in kindergarten? d. Did you obtain your license in a standard or non-traditional manner?
Question 2:	Please start by telling me what comes to mind when you think of STEM education in elementary school? d. What are the purposes of STEM education? e. How do you see your role in implementing STEM at the kindergarten level? f. In your opinion what are the benefits to integrating STEM in kindergarten for students? What are the drawbacks?
Question 3:	How confident do you feel integrating STEM into your current instruction? d. What do you believe makes you feel that way? e. What are some things that might have either helped develop your confidence OR f. What are some things that would impact your confidence in STEM instruction?
Question 4:	Have there ever been times you wanted to integrate STEM but didn’t? If so, what prevented you from that integration? a. What could have changed to allow integration?
Question 5:	Please tell me about a STEM integrated lesson that you implemented that stands out to you. a. How did your students perform? b. What was successful about it?

	c. What was not successful? If you were to reteach that lesson, what could you do to make it a successful one?
Question 6:	In general what are some of your successes you have experienced in STEM integrated instruction? a. What aided these successes? B. Please provide me any examples of student impact or growth related to STEM integration?
Question 7:	What are some of the challenges you have experienced in using STEM integrated instruction? a. What do you believe were the source of these challenges? c. In your opinion, how might those challenges be overcome?
Closing	Thank you for your answers. Do you have anything else you’d like to share?