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Leadership Perceptions of STEAM Curriculum Implementation from Educational Leaders in an Elementary Setting

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by
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Dedication

I dedicate this dissertation to my boys. All five of you. To the twins, Matthew and Trevor, you have blessed me with the perspective of a bonus mom, allowed me to love you, teach you, and grow with you. I am forever grateful I was blessed to be a part of your life and for you to be part of mine. As for the littles, Brian and Bo, you have had to endure the countless weekends of being quiet and finding ways to busy yourselves as I worked. What you don't know is that in the wee hours of those oh so early mornings, I would peek into your rooms and say I love you from the doorway because I knew the day would get away from me after you awoke. And to my last boy (man rather), my husband, Scott. There are no words for the way you support, encourage, and love me. You took everything you could off my plate so I could work and even when I was at less than my best, you never let me give up. More than anything, you have modeled a great example for our boys in the way you put others before yourself. I am so happy "we" have finished this season of our lives and are moving on to the next adventure!

I also dedicate this dissertation to my parents. Your expectations of me have always been high, and, although I never understood why, I see it now for my own children. You pushed, supported, and never wavered in your love—this example has shaped me into the person I am today. Thank you for all you did for me growing up to instill a firm foundation of faith, family, and education.

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Lastly, I would like to acknowledge the most important of all, my Lord and Savior, Jesus Christ. He is the one who makes all things possible.

Abstract

The purpose of this qualitative case study was to understand the perceptions of administrators toward the process of STEAM curriculum implementation using a curriculum change lens. The study centers on the qualitative data gathered through the views and experiences of principals who work toward addressing the needs of a future workforce through the STEAM method. Research questions included: (1) What are administrators' perceptions of implementing the STEAM curriculum approach to instruction within an elementary school? (2) What are characteristics of administrators who have guided STEAM curriculum implementation? Data were collected through questionnaires, interviews with individual leaders, and artifacts. The gathering such information aided in providing a clearer illustration of the thoughts of administrators implementing STEAM curriculum.

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Chapter I: Introduction

As the needs of the world continue to change, evidence of more than 9 million projected new STEAM jobs by the year 2022 has been reported by the U.S. Bureau of Labor Statistics (Schwab, 2017). Further indications from Schwab (2017) predicted the needs of future job markets have shifted into a Fourth Industrial Revolution (4IR) and have blurred boundaries of physical, biological, and digital fields of study. The combination of future jobs and blending of the metasciences set a need for curricula surrounding areas concentrated around integration of science, technology, engineering, the arts, and mathematics (STEAM) fields. STEAM curricula explore the creative avenues of arts integration and design thinking by connecting expression, communication, creativity, perception, and ideas, as discussed by Bucheli et al. (1991). Arts integration within the more widely known science, technology, engineering, and mathematics (STEM) practices have been regarded as essential to the development of cognitive skills.

Background of the Problem

A STEAM curriculum program is an individualized approach that considers a balanced integration of all areas within the STEAM acronym, including science, technology, engineering, the arts, and mathematics. Dating over 100 years ago to recommendations from educator and philosopher Dewey, STEAM approaches were used to engage students with authentic problems relevant to current economic trends by using each content area and a design thinking process. First coined in 2001 as STEM by the director of the National Science Foundation's education and human resources division, Judith Ramaley, the curriculum has grown into a globally renowned program of study (Christenson, 2011). The inclusion of the arts, by the Rhode Island School of Design, initiated a national movement to marry STEM and arts curricula to benefit students (Piro, 2010). The National Art Education Association (NAEA) regarded the curriculum as infusing art and design techniques and concepts into STEM (Liao, 2016).

The purpose of STEAM curriculum is to inform research policy, integrate art into traditional state and local curricula, and stimulate innovation among students (Rolling, 2016). Since the Every Student Succeeds Act (ESSA) was passed in 2015, STEAM education has been implemented in the United States in a differentiated manner, as it is facilitated in a variety of ways with regard to geographical location, economic development, and stakeholder participations, according to state and local decision makers (The White House, Office of the President, 2015). Contrary to the No Child Left Behind Act (NCLB), the amended Elementary and Secondary Education Act of 1965 (ESEA), achieved under ESSA, acknowledged the role of the arts as eligible for grants and support (Mathis & Trujillo, 2016). This shift in policy gave equal regard to all content areas including the Arts. Formal standards associated with the arts were devised for each grade level. Additionally, STEAM curriculum is centered around the learner and may include instructional pedagogy such as problem-based learning (PBL) and inquiry-based learning where teachers serve as facilitators rather than providers of information. Herro and Quigley (2016) asserted PBL and inquiry-based learning opportunities incorporate investigative thinking and creativity regarding an authentic problem. The autonomy associated with students being able to choose a collaborative manner by which to think through solutions to a problem integrates the use of arts in a variety of ways. Sketching with brainstorming ideas, formulating model replicas, and reenacting processes are but a few arts integrations that connect the often–siloed content areas. Scientific inquiry involves specific steps containing engaging activities to model scientific process. Activities include observing, defining a problem, forming the question, investigating the known, articulating the expectation, carrying out the study, examining the results, reflecting on the findings, and communicating with others (Harwood, 2004). The two domains included in STEAM curriculum models are: (a) instructional content used in PBL disciplines and (b) the learning context used in instructional approach, assessment, and participation (Herro & Quigley, 2016). Students make multidisciplinary connections using collaboration, critical thinking, creativity, and communication from the two domains (Jolly, 2014).

Statement of the Problem

A problem exists in the world of education as curricula are not adequately preparing our students to enter tomorrow's workforce (Crumpler & Lewis, 2019). A great deal of support for building the future workforce has been focused on the STEM fields (Bencze, 2010; Riley, 2014). However, these shifts have been primarily in upper grade curricula, not in elementary. Currently, students are taught standards for skills and concepts necessary to compete in today's workforce; however, many jobs that are common today are quickly becoming automated with no need for human presence (Johnson et al., 2014). This problem impacts all students, primarily elementary students, because of the length of time spent in school prior to graduating and embarking on careers (Cook, 2012). Upper grades have options to participate in programs including Career Technical and Agricultural Education (CTAE), vocational tracks, and Advanced Placement content courses (Cevik, 2018). These options are not present in the elementary grade levels of most public schools in the United States, as standards at that level focus on building foundational knowledge. However, most comparable to CTAE programs are magnet, arts, and international baccalaureate programs. Current state curriculum models fail to prepare students for 21st century workforces simply due to the projected fact that most future jobs have not yet been created (Schwab, 2017). The significance of this problem directly relates to implementation of a curriculum that addresses skills for application. Many possible factors contribute to this problem, including lack of knowledge from educational administrators on how to implement a curriculum to address students' future needs. This study contributed to the body of knowledge needed to address this problem by focusing on administrators' perceptions within the field of elementary STEAM education.

Purpose of the Study

The purpose of the study was to explore administrators' perceptions toward the process of STEAM curriculum implementation. The study centered on gathering qualitative, perceptual data from principals who work toward addressing the needs of the world through the STEAM method of curriculum. Questionnaires, interviews with individual elementary principals and assistant principals, and portfolio artifacts were the methods for data collection. The ultimate intention of gathering such information was to provide a clear illustration of thoughts and intentions of administrators implementing STEAM curriculum.

This study used a descriptive case study methodology with a multiple case design. The investigation of leader perceptions from elementary school levels were examined by collecting data such as interview transcripts and artifacts from four different schools within the same district. The intention was to gain further insight into leaders' opinions about what the research questions sought to answer. The catalyst behind the integration of STEAM curriculum implementation was to provide students with authentic learning experiences through project-based learning opportunities (Yakman, 2008). STEAM used as a model curriculum creates an overlap of siloed content areas affording participants a new experience with STEAM curriculum implementation. Perceptions gained from the experience of such exposure were indicative of emergent interactive models denoted by Bandura (1971). Through self-reflection of the process of integrating STEAM curriculum, administrators' beliefs can adapt regarding the impacts observed from teachers and learners (Bandura, 1971). As beliefs and perceptions are founded, further information can be gained on the overall motivation of the facilitation of instruction with the role it plays in the performance of the learner (Bandura, 1971). Profound effects from such influence directly affect the outcome of an initiative (Bandura, 1971).

Adult participants in leadership roles to include principal and assistant principals were selected from elementary schools within a rural school district in West Central Georgia. This area was selected due to the current number of Georgia Department of Education STEAM–certified elementary schools within the Harris County School District. The district has 2 of the 6 total elementary certified schools in the state. The high representation of STEAM schools within one district provided a focused administrative demographic for the collection of data on curriculum implementation.

A total of eight administrators were asked to participate in the case study. Each potential participant—principals and assistant principals—were from four respective elementary schools within the single district. All administrators would represent schools at varying levels of STEAM curriculum implementation. Referencing Barnett (2002), interviews of administrators assisted with yielding insight into whether the STEAM curriculum approach has common trends or actions that take place. A set of questions I determined previously addressed topics centered on perceptions of STEAM and observations of constructs regarding school climate and culture I collected prior to the meeting. Collection of previous College and Career Readiness Performance Index (CCRPI) data provided information on school climate data as represented by students, staff, and parents/guardians. Information from participants were also noted with their perceptions of previous years.

Participants were encouraged to disclose personal opinions and descriptions of accounts as they interpreted them to be. The procedure to collect data was in the form of a structured interview. During a 9-week period, administrators responded to a series of interview questions. Participants were required to reflect on experiences and interactions with STEAM curriculum implementation. Interview responses were digitally recorded using correspondence through emails. Email transcriptions were printed for manual coding.

Research Questions

The following questions were posed:

1. What are administrators' perceptions of implementing the STEAM curriculum approach to instruction within an elementary school?
2. What are characteristics of administrators who have guided STEAM curriculum implementation?

Theoretical Framework

The theoretical framework undergirding this study is curriculum change theory. Change theory can be classified as a framework of ideas, supported by evidence, that explains some aspect of change beyond a single initiative (Reinholz & Andrews, 2020). Advancements in educational reforms have experienced an increase in the systems and cultures of teaching and learning environments (Henderson et al., 2011). The use of change theory within the study can inform practices and reception of a change such as in a complex organization like a school district. The observation of change within a system was influenced the impact of STEAM curriculum implementation. The qualitative nature of the study allowed for abstract thinking toward understanding larger phenomena to have a current conceptual grasp, further clarifying social theories (Pope et al., 2007).

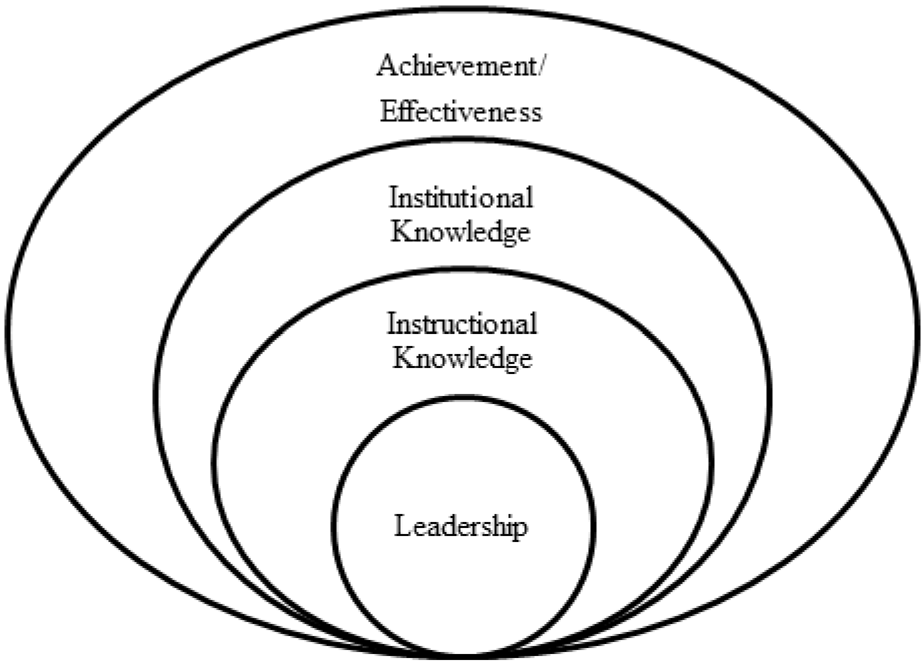
Sahlberg (2005) classified change theory to have three parts of implementation:

1. Understanding that success requires "change knowledge," and that failure is a result of neglecting it. Policymakers, education leaders, and teachers need to know more about the drivers of successful curriculum change in schools. Therefore, learning about educational change and its key features should become integral elements of any serious curriculum reform process. There is an interesting stock of literature, both research and reports of case studies, that is gradually changing the way we should view the change in education, especially in schools and at the level of teaching and learning.
2. Re-conceptualizing curriculum. Many curriculum reforms are based on how the curriculum has traditionally been organized. As a consequence, many curricula have become overloaded, confusing and inappropriate for teachers and students. Therefore, curriculum orientation should shift from a curriculum as a product model to a curriculum as a process model. This would also transform the role of the curriculum from a purely technical document into a more comprehensive idea that also serves as guidelines for school improvement.
3. Changing the way teachers teach and students learn requires specific approaches. In-service training of teachers is not enough. If curriculum reform aims at changing the ways students learn and teachers teach, more sophisticated implementation strategies are required. Therefore, helping teachers to create professional learning communities and schools to learn from each other are recommended approaches. (p. 1)

A national focus to provide students with 21st century skill sets is a growing priority (PricewaterhouseCoopers, 2016). The curriculum adopted by a growing number of elementary educators according to Herro and Quigley (2016) is that of STEAM, the implementation of which is expanding nationally and globally. Technology advancements paired with economic and 20th-century research on organizational productivity yield innovations directly related to economic progress and linked to driving educational instruction. The relationship between creativity and productivity supports the connection between creativity and innovation-based economics (Liao, 2016).

A leading force behind favorable performance conditions for implementing a new curriculum is a leader who manages taking actions while monitoring five conditions: direction, structure, context, coaching, and resources (Hackman, 1986; Voogt et al., 2016). The authenticity of each STEAM–related task provides a context for leaders to frame coaching and professional development around. Consequently, resources needed to fund and allot for increased opportunities with learning are at the center of the school's budgetary designations, collaborations with other educators, and workshops/trainings that develop knowledge base. Leaders who tackle these areas are more prone to be successful in gaining support and teacher buy-in. Understanding how administrators play a role in implementing a successful curriculum is important for achieving goals set forth by that curriculum, such as improved achievement scores and abilities to apply knowledge in a performance task. Furthermore, principals, assistant principals, and instructional coaches are viewed as instructional leaders; however, teachers can be leaders as well. Figure 1 illustrates areas where leaders support each level of STEAM curriculum implementation beginning with the instructional knowledge encompassed by the institutional knowledge, which thereby produces overall achievement and effectiveness results.

Figure 1 Preliminary Conceptual Framework for Levels of STEAM Curriculum Implementation



Components of the framework include the observational learning that took place by watching and observing outcomes of STEAM curriculum implementation and recording the modeling of these practices as they are put into place by the leader(s) of the elementary schools. Beginning with leadership at the core of the study, then observing instructional knowledge, institutional knowledge, and the resulting achievement or effectiveness of the curriculum implementation, the framework is presented as a ripple effect.

Methodology Overview

To better identify the need for further research, data from peer reviewed studies and articles were reviewed and synthesized. Collecting data on perceptions of principals and assistant principals in one elementary school district regarding implementation of STEAM curriculum was conducted primarily through questionnaires and interviews. A Google Form questionnaire was sent to participants followed by interviews. Interviews were conducted, transcribed manually, and analyzed using a manual coding process. Open–ended coding identified trends in methods of implementation and overall themes perceived by participants. Inductive and deductive coding explored the implementation process in the natural setting. Artifacts associated with the STEAM certification application were obtained and recorded to identify emergent themes that led to inductive understanding (Creswell, 2014).

The investigation of leader perceptions from elementary school levels was implemented through transcripts of interviews. The focus of this method was to gain further insight on the collective opinions of leaders related to the research questions. Perceptions gained from the experience of such an exposure are indicative of emergent interactive models, as denoted by Bandura (1971). Through self-reflection of the process of integrating STEAM curriculum, administrators' beliefs can adapt regarding the impacts observed from teachers and learners. The qualitative approach to this study directly relates to a constructivism paradigm of research as the data collected more clearly communicates administrator responses.

The sampling method was purposeful in that leaders were chosen to participate from surrounding comparable elementary schools. Adult participants who are in leadership roles to include principal and assistant principals would be selected from elementary schools within a rural group of school districts in West Central Georgia. A total of eight administrators represented schools at varying levels of STEAM curriculum implementation. During a 9-week period, administrators responded to one electronic questionnaire and one interview question session. Participants were required to reflect on experiences and interactions with STEAM curriculum implementation. Interview responses were recorded using the Zoom platform. Transcriptions of recordings were downloaded and printed.

Delimitations and Limitations

The study was conducted in the same school district where I am employed as an administrator, proving to be a delimitation for the case study. Participants have a professional relationship with me and represent four schools in the school district. The sample area represents a small portion of the Georgia educational system, and limiting the sample size to this area created a focus on the highly state-identified STEAM program of study. Participants have varying levels of authority and instructional roles within their respective schools, limiting the existence of equal knowledge and experience. Participants have 210-day and 220-day work calendars, resulting in an unequal number of contracted workdays. It is assumed study participants responded accurately and honestly to all questions in the interview process. The interview data gathered aided in developing consensus among participant experiences and actions. Limitations of this study include inability to account for the wide variance of approaches to STEAM curriculum implementation regarding accessibility to resources, professional learning opportunities, and stakeholders.

Definition of Terms

For the purpose of this study the following terms were used:

- Interdisciplinary: A combination of multiple disciplines both academic and arts within the curriculum (Herro & Quigley, 2016).
- Project-based learning (PBL): "PBL is the ongoing act of learning about different subjects simultaneously" (Wolpert-Gawron, 2015, p. 1).
- STEM: "A standards-based, meta-discipline involving academic areas of science, technology, engineering, and mathematics (STEM) curriculum (Merrill, 2009)

- STEAM: “The infusion of art and design principles, concepts, and techniques into STEM instruction and learning” (Liao, 2016, p. 45).
- Transdisciplinary: Transdisciplinary refers to a curriculum not categorized by individual areas of focus but created through student work in all subjects (Herro & Quigley, 2016).

Chapter II: Literature Review

Global competitiveness among educational institutions is inevitable with the increase of daily technological advances (Boy, 2013). In 1965, Intel co-founder Gordon Moore referred to an observation of the doubling of transistors per square inch of circuit boards (Schaller, 1997). The overarching meaning behind the observation that later became Moore's Law expressed growth in technology to be faster than the rate at which human mastery of concepts occurred. When considering this observation of the physical world, the notation could be viewed as a precursor for the types of infrastructure that need to be developed to support and use the advancements. The law suggests the world's industries are exponentially increasing in complexity and rigor, and predicts trends, pacing, and continuous competition projections for several areas while serving as a reminder that the only thing constant is change. This means the capacity for which human brains can comprehend a new concept surrounding technology will be in a state of constant lagging, unable to adequately prepare for an evolving world. The law directly correlates with the field of education in that rises in certain career fields need instructional support from the classroom to better prepare students for the workforce. The reality of what the learner experiences through the curriculum becomes the foundations from which to scaffold learning (Schaller, 1997).

Since the establishment of Moore's Law, the world has been thrust into an exponential growth of technological innovation that has left educators grasping for ways to prepare students for jobs that do not yet exist (Schwab, 2017). States and districts have also been charged with adhering to legislation that has provided autonomy to create individualized curriculums to provide a highly competitive education for our students (The White House, Office of the President, 2015). Legislation has since been introduced to address a curriculum that supports the future job market. “Social efficiency ideology” surrounding the use of STEM curriculum originated from the identification of needs and gaps in the workforce (Schiro, 2012). Social efficiency advocates base their ideology on using the scientific method to develop, implement, and evaluate curriculum in the most effective and efficient way possible to “train” students to become productive members of an ever-changing society. To understand how to identify curriculum models that prepare students for the world, perceptions of administrators who provide non-traditional curriculum methods are needed.

Theoretical Framework

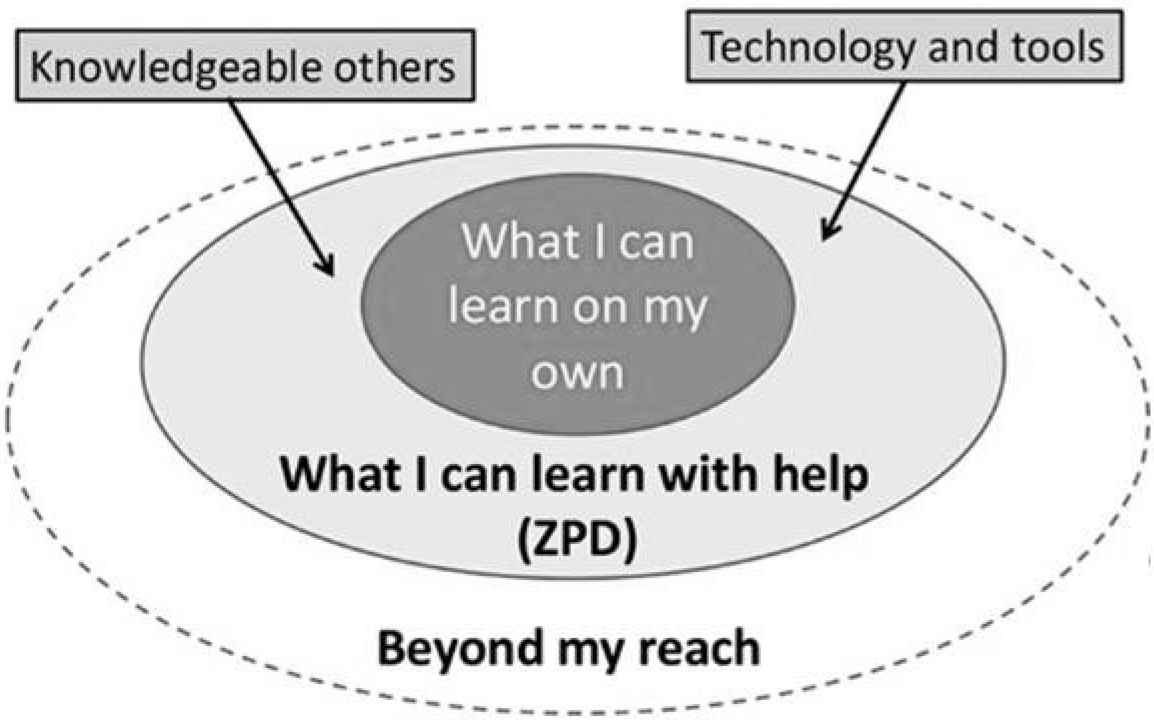
The work of this study seeks to learn how individuals make meaning of events and activities, like those presented in the implementation of STEAM curriculum, through the perspectives of administrators. Interpretations of the perspectives are meant to share participants' experiences and therefore align qualitative research methods, collecting descriptive information that describes individual experiences and their interactions with the school organization (Creswell, 2014).

Social constructivism was founded on the premise that interactions lead to cognitive development. Personal encounters are the start of the learning process through an individual's senses, language, and observations. This dialectical view is aligned with those of Marx and Hegel, who attribute learning through social experiences. Therefore, STEAM curriculum implementation can be considered as a two-fold focus of design with social constructivism and conceptual change perspective. Theoretically, it employs a constructivist-based model for instruction and practice. Vygotsky's theory of social constructivism stresses the fundamental role of social interactions between learners with consideration to the cognitive development that follows (Vygotsky, 1978). Learning is viewed as occurring through social interactions with another person who exemplifies a specific behavior or skill.

Using what Vygotsky (1978) referred to as collaborative dialogue, the learner begins to comprehend by internalizing information. The two significant principles of Vygotsky's theories present in this type of cognitive development are the more knowledgeable other (MKO) and the zone of proximal development (ZPD). MKO refers to a person who understands more of a concept or possesses a higher ability level than that of the learner. ZPD is the difference between what a student can do with and without assistance from an MKO. The relation of the MKO to the ZPD exposes the independence and potential of the learner through the interactions of the two as seen in Figure 2 (Wheeler, 2013). Vygotsky's theories also support interests with collaborative learning. Growth is maximized if social interactions occur within the ZPD. The lens of social constructivism directly correlates with the focus of STEAM curriculum and instructional practices. The roles of the administrator, experts in their field, and specialists who support educational instruction within the organization, could be viewed as that of the MKO, assisting the learner through the ZPD. Conversation and collaborative dialogues working toward gaining full implementation of STEAM align with the necessary interactions that would create a successful outcome.

Vygotsky (1978) expanded on social constructivism with four areas that align with STEAM curriculum, beginning with children constructing their own knowledge. Children have active participation with their own wants and needs and thereby shape their existence. A child’s development is synonymous with their social context. To that end, maturation and environment are the second areas that affect learning. Third, scaffolding provided by teachers or MKOs increases development, and the last area is language. Due to his views of the intertwining of language and metacognition, Vygotsky's work has deep meaning and implications for models of leadership.

Figure 2 Model of Vygotsky's Zone of Proximal Development



Similarly, the work of Bruner (1996) expanded on Vygotsky's theory to include nine tenets of education. All nine encompass constructivism and interactions in project-based learning (PBL) environments. Bruner denotes that a knowledge system is developed when learners generalize themes in their learning experiences. The culture of a classroom has a direct impact on the ability of the student to acquire discovery or inquiry-based, physiology of the discipline or spiral review.

The second frame of focus is conceptual change perspective (Piaget, 1952). The use of this theory accounts for how new information is used based on previous experiences of the participant. As administrators support the implementation of the new curriculum there is influence from personal, motivation, social, and historical factors (Pintrich et al., 1993). Specifically using the model from Pintrich et al.'s (1993) the process of curriculum implementation can be identified by the beliefs, goals, and values of the administrators. Each staff member possesses a myriad of personal experiences that could affect STEAM curriculum usage. For instance, a fine arts teacher would be equipped to integrate the arts more easily than a general education teacher with no background in the arts.

In a qualitative study conducted by DeJarnette (2018a), we see the constructivist theory employed to understand the observations gained from implementation of STEAM lessons. The constructivist theory provides authentic learning experiences reflective of the student's personal environment and involves gaining understanding through interaction and collaboration with others (Wilson, 1996). Lessons were provided by the researcher for Grades K-2 as well as a 2-hour professional development session for the two teacher participants. Students were administered lessons by the media specialist and art teacher to collaborate and design, develop, and test their engineering skills. A triangulation of data was collected with pre- and post-surveys, field notes, and interviews with each teacher participant. Reflections collected from the research were favorable for students who are from a high needs background, suggesting STEAM curriculum was impactfully delivered on the part of the teachers.

Another example case study that used social constructivism was that of Novoa et al. (2018) where a compilation of 3 years of forums was documented for changing a curriculum. The study used a scenario of water scarcity as the basis of an authentic problem whereby students, curriculum advisors, industry experts, and an external advisory committee participated in inquiry-based interactions to generate a new curriculum for industrial design that incorporated

STEAM elements. The study concluded participants' efforts were successful and altered the previously traditional curriculum.

Expanding from this study to a larger, school district approach with the emphasis on administrative influence on STEAM curriculum implementation, a qualitative survey and quantitative survey was administered to 104 elementary teachers from Massachusetts to assess professional development efforts, needs, and implementation of Next Generation Science Standards (NGSS) through a teacher development program called STEAM Go! (Love et al., 2018). The study posed questions related to leadership of initiatives with or without the employment of a STEAM coordinator, what practices and models were used to meet the needs of teachers and students, and the identification of skills and expertise from those leading the implementation. The district in the study was comparable to the one used in this study having approximately 4,200 students in one high school, one middle school, and five elementary schools. With a constructivist approach for providing professional development experiences for teachers to become more knowledgeable of STEAM content practices, the data were collected through sets of online surveys at the conclusion of 10 full-day workshops from October 2016 until June 2017. Results from the elementary analysis of the first research question yielded possibilities of teacher leaders and the assistant superintendent of curriculum for focus of implementation. They also suggested recommendations for further professional development models, particularly with teacher leaders, principals, and administrators serving in supportive roles and collaborations with other school's department heads or coordinators. The skills associated with experience of STEAM content and pedagogical knowledge were listed as essential for individuals in leadership roles.

Consequently, use of a constructivist lens has been employed by a rurally located K-8 STEAM school in Georgia. The administration, faculty, and staff work to incorporate PBL experiences through a constructivist view at the Union Point STEAM Academy (UPSA). The UPSA is the first public STEAM charter school in the state (Williams & Mote, 2013). The goals of the school align with the aforementioned framework designs through the school's promotion of authentic and experiential learning paired with meaningful design production (Mote et al., 2014). This area is demographically similar to the area within this study and is seeking to continue to gather data on the governing structure and interdisciplinary participation from all content and stakeholder areas.

Historical and Legislative STEAM Background

A revolution of sorts has been experienced recently with the integration of science, technology, engineering, arts, and mathematics (STEAM) within interdisciplinary and applied approaches to curriculum. STEM, the predecessor of STEAM, was originally conceived in 1957 after the launch of the Russian satellite, Sputnik, into space. President Dwight Eisenhower emphasized the full exploration of science and technology education. In response to the Russian development, the National Aeronautics and Space Administration (NASA) was founded. NASA became the champion of science, technology, engineering, and mathematics awareness for primary, middle, and high school age students. Space exploration publicity inspired more students to explore science and engineering-related fields. NASA also organized scientific programs and became the leader of scientific development in the nation. In the mid-1980s, the Engineering workforce Commission reported approximately 800,000 students graduated from science and engineering programs per year. In successive years, gradual reforms were made in the education system, improving the quality of the STEM disciplines, and attracting more students. However, there was a gap in the number of STEM graduates and the number of STEM-related career opportunities, necessitating reforms to better STEM education. Various research organizations reported a decline in career focused STEM performance in the United States and indicated the need for the education system to shift to the science, technology, engineering, and mathematics field. During a STEM symposium held at Capitol Hill in Washington, DC in 2013, Edie Fraser, the director of STEMconnect, mentioned 2.5 million jobs that require STEM disciplines were not filled at the time, and appointments would require computer science knowledge (Johnson et al., 2014).

Before STEAM was born, the acronym lacked the arts integration and was regarded as teaching each of the siloed subject areas of science, technology, engineering, and math. The STEM initiative was founded by the director of the National Science Foundation’s education and human resources division, Judith Ramaley. The curriculum had grown into a globally renowned program of study (Christenson, 2011). Inclusion of the arts, by the Rhode Island School of Design initiated a national movement to marry the STEM and the arts curriculums to benefit students (Piro, 2010). The relatively new curriculum of integrating science, technology, engineering, the arts, and mathematics (STEAM) was created as a response to the need for development of problem-solving skills in students by providing authentically relevant lessons. Lessons that expand the ways in which students acquire cognitive, interactional, and creative skills are necessary for future workforces (Herro & Quigley, 2016). Curriculum of this type promotes teaching with understanding due to the backwards design approach and integration of subject areas in place of isolated strands. Backwards design stems from the problem-based approach STEAM addresses through real-life problems. STEAM curriculum supports interactional skills of collaboration and communication that have suggested longer retention of content and application of the knowledge within new environments (Rivet & Krajcik, 2008).

One purpose of implementing the STEAM approach to curriculum is to enable a student to study subjects as one compulsory combination instead of studying them in fragments. The STEAM system, which is also used interchangeably with STEM, was first used in 2000 by the National Science Foundation (NSF). The movement from STEM to STEAM was championed by Maeda, who encouraged the addition of "arts" to STEM (Johnson et al., 2014). He argued art was paramount in innovation, and like the science, engineering, and technology disciplines, it needed the same priority. A combination of art and science in STEAM education is important in producing a creative workforce (Boy, 2013; Feldman, 2015). Since Maeda's (2012) original movement, there have been other acronyms that have grown to incorporate other content areas such as reading, forming STREAM. Nonetheless, for purposes of this paper, STEAM was the only construct investigated.

In 2009, approximately 1.25 million children abandoned their education without completing high school. Many people are convinced education, technology, and engineering are not essential for youth (Boe, 2010). The United States had developed increased concerns during this time that they were losing science and technology leadership at college and university level, to other countries of the world. The leading technology companies echoed the same fear that they are experiencing a shortage in homegrown STEM experts and that they are relying on foreign experts. On the other hand, the number of foreign nationals studying in the United States is increasing and has surpassed 500 million. About 30% of the students enrolled in U.S. universities were foreign nationals. Surprisingly, a 2013 study revealed only 4% of the college graduates majored in STEM courses over a 6-year time span (Chen, 2013). In comparison, there was a higher percentage of students who majored in engineering in other countries such as the United Kingdom. A report by the Asian American Business Roundtable (2017) identified, in the coming future, most scientists will come from Asia.

The U.S. National Aeronautics and Space Administration (NASA) also aided in the implementation of the STEAM curriculum. Guidance for school programs was given to advance the system to increase the number of scientists. Individual states took the responsibility of ramping up the production of graduates in STEAM subjects. The state of California began running a pilot program to learn how to implement the curriculum to increase students' success (California Department of Education, 2017). The state of Florida came next in the adoption of the program. It was the first to establish a STEAM education program. Other states across the nation later adopted the program, with some states such as Arizona, New Jersey, Virginia, Texas, North Carolina, and Ohio adopting the program.

In 2011, a report by the National Science Foundation indicated African Americans scored lower on the PISA than Hispanics, Whites, and Asian students (National Science Board, 2014). During the same year, statistics revealed Blacks made up 11% of the total workforce in the United States, and African Americans constituted only 6% of the STEAM workforce. Statistics show STEAM is still dominated by only Caucasian, although some efforts are made to increase the diversity of the workfare in the system. Critics have argued the focus on diversity in the system has lowered the academic system.

Women in the U.S. workforce make up 47% of the total workforce (Wajngurt & Sloan, 2019). However, in the STEAM system workforce, they make up only 24% of the total workforce. The data shows that women are still to embrace the science and engineering courses. Evidence suggested, introducing women to science at a tender age could help in motivating the female population to join the system and reduce the gender gap by nearly half. Some activists and groups have taken up the task of conducting campaigns on reducing the gender gap. They aimed to achieve gender balance in the STEAM programs by the year 2020 (Wajngurt & Sloan, 2019). However, in a 2017 study using the social cognitive perspective, six empirically supported factors were identified for the continued underrepresentation of females: (a) cognitive ability, (b) relative cognitive strengths, (c) career preferences, (d) lifestyle values, (e) field-specific ability beliefs, and (f) gender-related stereotypes and biases (M. T. Wang & Degol, 2017).

Still other efforts were employed to address the shortfalls in the American education system. In George W. Bush's State of the Union address in 2006, he announced the American Competitiveness Initiative. The main objective of the initiative was to address issues in the federal government to boost the development in education and the STEAM program. The Bush administration made a significant effort to improve the shortcomings of the education system by increasing the federal funding for advanced education programs, K-12. It doubled the financing of scientific research and the increase in the number of U.S. students under the STEAM program. The Texas Space Grant Consortium, through NASA, business initiative further promoted the efforts of the Bush administration to encourage and increase the population of students taking the STEAM subjects. The organization inspired college and high school students to study STEAM subjects while also motivating the professors in the field to indulge their student's scientific research (Sousa & Pilecki, 2013). The National Science Foundation developed several programs to enrich the system and to make it more interesting for learners. The programs include the one for K-12 students called the ITEST program (Avery & Reeve, 2013).

STEM academies were also used to build and increase the literacy of all students in the system. The academies were nonprofit organizations that provided an approved next-generation, high-impact education model to the students in the United States. The education model used the best practices strategies and programming to ensure that all the students acquired the stem education program (Wajngurt & Sloan, 2019). The organization was designed to improve the coverage of the STEAM system to reach the underrepresented minority and low-income students aims to succeed in closing the achievement gaps, minimizing the student dropout rates, and increasing the number of high school graduation rates. The organization is unique in that it invests in improving the teacher and principal performance and effectiveness. The STEM academy is an effective model that covers all schools and students of all levels in the nation.

Another nonprofit organization, Project Lead the Way (PLTW), provided STEAM curricular programs to all the schools in the United States. Curricula was developed for middle and high schools, with 5,200 academic programs for more than 4,700 across the 50 American states. Programs developed by the organization include high school biomedical science, the pathway to engineering, middle school technology, and engineering programs such as Gateway to technology. The nonprofit organization not only provides curriculum but also supports teacher professional development to provide evolutionary programs in schools. It received endorsement by the then-President Barack Obama and then-Secretary of Education, Arne Duncan, among other state and national leaders for its exceptional role in the STEAM program. The STEAM coalition, which has since 2008 seemed to slow, worked to support the teacher and students' program in the U.S. Department of Education (Bybee, 2011).

In the 2013 budget in Obama's administration, the STEAM program was allocated $3.1 billion to recruit and support teachers and to support implementation in schools regarding

STEAM innovations (Petty, 2013). The budget also aimed to promote advanced research projects for education and learning technologies. The importance of STEAM education was to meet the growing demand for skilled workers and the need for technological solutions that required innovations and research. By 2018, the manufacturing industry was faced with a shortage of skilled workers. Most of the jobs are science and technology work that require STEM disciplines only. The average salary for an entry-level STEM job is 26% higher than the non-STEM job at the same level (Piro, 2010). The STEM proficient workers shortage problem is also experienced in other parts of developed economies of the world, such as the United Kingdom, Germany, and France (Friedman, 2015). A report in the United Kingdom in 2018 revealed the British education system would need to graduate 10,000 STEM majors every year until the year 2020 to meet the demand of the growing STEM fields. Germany reported experiencing a shortage of 210,000 workers in the field of engineering, mathematics, technology, and natural sciences.

President Obama also started the Education to Innovate campaigns. Among the objectives of the campaign was to rally other groups and individuals to fund and support STEM education. Numerous companies have since committed their efforts and resources to support new programs that include Change the Equation. Over 100 CEOs of various companies launched the Change the Equation campaign in 2010. Primary campaign activities were to pool the finances and develop more supporting initiatives to improve STEAM. Since its inception in 2010, the campaign has made various achievements, such as developing a report called Vital signs (Catterall, 2017). The report is used in measuring the level of achievement in STEAM. It also launched a database known as STEMworks used in STEAM programs. The campaign developed a more engaging platform called iON loaded with games designed to improve interest in STEAM subjects among the young children. Recordings of interviews and presentations of successful and inspiring STEAM professionals are made available to students to inspire them to venture into STEAM disciplines.

In June 2019, H.R. 2225 was introduced to amend the 2015 STEM Education Act. The amendment included a requirement of the National Science Foundation to promote the integration of art and design in STEM education, and for other purposes (GovTrack.us, 2020). This amendment had been suggested earlier in 2017 but was not enacted under the 115th Congress. A federal STEM Strategic Plan was produced in 2018, and in 2019, The White House provided an update on the federal implementation of the 2018 STEM Strategic Plan and the alignment of other education agencies. The measurement of the progress was recorded in a variety of ways to assess each area individually. Some of the assessment items included: complex portfolio of programs, K-12 engagement outreach, STEM professional development, and supporting graduate fellowships. Collaboration among agencies has been noted as occurring frequently, as plans to achieve objectives within the STEM Strategic Plan are ongoing. Further feedback and input from stakeholders are also continuing to be gathered to achieve success with practices of integration.

At the high school level, increased focus to involve the application of the STEM subjects in real life was implemented through programs that engaged and challenged students with real-life problem-solving scenarios. Courses were introduced in the STEM fields and professional occupations. The students were prepared for higher learning and employment opportunities through the newly added course options (Langdon et al., 2011). In this sense, STEAM was multispectral in approaching learning by combining both in-school and out-of-school science, engineering, art, and technology opportunities (A. R. Clark, 2014). The system was designed to effectively attract the minority and the underrepresented population. In a workshop designed quantitative study by STEMconnect (Verma et al., 2014), it was reported that female students were more inclined to science fields such as marine biology, ecology, and environmental sciences and are less attracted to engineering courses or a college major. Males, on the other hand, were more likely to pursue engineering, mathematics, and technology courses. The male students were three times more likely to pursue STEM disciplines. The gap is gradually increasing (Johnson et al., 2014). The STEM education program seeks to address such differences and to minimize the gap to further the achievement of gender balance both in the STEM disciplines and careers.

The STEAM education critics raised an objection to the legitimacy of the program that the STEAM crisis encouraged government extravagance through the spending of millions of dollars of taxpayer's money in advocacy programs. The critics give conflicting reports from that of the STEAM proponents. They do not agree with the proponents that there will be more STEAM jobs than STEAM professionals. The opponents of the program are not convinced with the call for more STEAM workers to fill the gap. In their arguments, they say that there is no clear way to differentiate a STEAM professional and that there is no means of determining the level of education one must acquire as a STEAM professional (Beede et al., 2011). The opponents state no clear weakness in the STEAM education that needs reform, and therefore, the reforms done on the system are just like reforming the general education system. There are also various reports that suggest that STEAM's popularity has declined across the globe. Despite the negative reports and critics of STEAM education, many believe interest in STEAM disciplines in the United States will continue to increase.

The purpose of STEAM curriculum is to form research policy, integrate art, and stimulate innovation (American for the Arts Action Fund, 2013). After the Every Student Succeeds Act

(ESSA) was passed in 2015, STEAM education has been implemented in the United States in a differentiated manner according to state and local decision makers (The White House, Office of the President, 2015). Contrary to the No Child Left Behind Act (NCLB), the amended Elementary and Secondary Education Act of 1965 (ESEA), achieved under ESSA, acknowledged the role of the Arts as eligible for grants and support (Mathis & Trujillo, 2016). The efforts of the Educate to Innovate campaign continue to charge P-12 schools with the use of STEM/STEAM curriculum(s) although testing, professional learning and overall teacher knowledge base continue to impede the approach (Brophy et al., 2008).

Need for Student Success

The needs of the world have played a role in shifting educational focus from assembly line instruction to differentiated. Currently, practices that address equity in educational programs are limited when attempting to provide 21st century and future career opportunities. Arguments for creativity as the world's most abundant human resource have been made as the world's population continues to exponentially increase (Newton & Newton, 2014). To compound this need, rural schools are showing challenges meeting science and mathematics benchmarks indicating a gap among students, particularly those who are from lower socioeconomic backgrounds (Boyer, 2006). Prior research has shown socioeconomic status has had a statistically significant relationship with students embarking on postsecondary education regardless of their geographical location (Koricich et al., 2018). Antiquated school systems that provide traditional curriculum tracks are looking toward application of concepts through the integration of the siloed content areas of STEAM. In a qualitative case study conducted by Henriksen (2014), a National Teacher of the Year for the United States, was interviewed. The interview focused on understanding the significance of teaching interdisciplinary content and the distinctions between traditional and arts infused disciplines. Descriptions recorded by the researcher noted higher student motivation and achievement when arts-based strategies were implemented throughout the academic areas. Common uses of curriculum do not regard all disciplines equally, and therefore the importance of the arts is viewed as creative independent areas. STEAM aims to develop engineering skills together with other subjects and nurture engineers at a young age.

The national workforce has found the need for more employees to master skills in technology, mathematics and problem solving. Jones (2010) argued opportunities for the use of creativity may increase understanding of other subject areas. The National Art Education Association regarded STEAM curriculum as infusing art and design techniques and concepts into STEM (Liao, 2016). The definition of the curriculum reiterated the noted insight of the historic scholars, Pythagoras, and Planck (1950). The implementation of a STEAM curriculum has been recognized as a way to increase the rigor of academics, while growing the future workforce to decrease the gap in skills necessary for new occupations (Herro & Quigley, 2016; Keane & Keane, 2016). The most recent employment projections from the U.S. Department of Labor, Bureau of Labor Statistics (2020) set a growth in both STEM and STEAM related jobs to 8.8% from the present until 2028. This rate exceeds other job areas by 3.8% with STEM and STEAM jobs receiving an almost $50,000 difference in annual median wages in comparison.

In 2015, American students participated in the national Program for International Student Assessment (PISA). The United States performed poorly out of 109 participants. In mathematics, students ranked 35th, came 24th in reading and ranked 25th in science. Students also came 29th in the percentage of the number of 24-year-olds with mathematics or science degrees (Irwin et al., 2015). The need for an innovative curriculum reaches all the way to the earliest of education institutions. Beginning with preschool classrooms, the need for STEAM is necessary as it supplies hands-on, positive experiences that impact student perceptions toward the curriculum approach (Bagiati et al., 2010). In a qualitative study of preschool teachers' perceptions toward STEAM, two professional development workshops were provided to the respective teachers. The preschool teachers participated in model STEAM lessons, and the researcher recorded organically pleasant and positive dispositions from the teachers in response to the training. Data were collected through an interview process. Results of the study concluded teachers' perceptions of STEAM curriculum were enhanced by opportunities for professional development; however, the rate at which teachers implemented the lessons was nearly obsolete.

STEAM education engages students in transformative learning (Taylor, 2015). The U.S. National Academies in 2016, expressed concern about the declining condition of the STEAM. They developed recommendations to remedy the problem. They proposed several recommendations. First, was to improve the American talent population by boosting K-2 science and mathematics studies. Secondly, offering additional training of teachers to strengthen their skills in science, mathematics, and engineering. Finally, developing plans to increase the number of students entering college to take STEM courses.

Conradty and Bogner (2018) led a quantitative study funded by the European HORIZON-2020 framework grant, which sought to monitor creativity through a participant sample of 2,713 students from the United Kingdom, Greece, Sweden, Malta, Italy, and Germany. Participants completed a multilingual, Likert scale, 10-item questionnaire. Results were validated by use of a repeated factor analysis test and showed a significant link between collaboration and instruction for a framework of creative thinking. The two factors were discussed as parts of the STEAM curricula process. Integration of the arts may seem synonymous with creativity, although it has been deemed as having its own domain and required for other parts of life experiences. Benefits from combining the two areas can transfer solutions that are creative, and begin to close the creativity gap (Henriksen, 2014; Runco et al., 2017).

Furthermore, industry has produced a need for student success. As seen in a quantitative study by Root-Bernstein et al. (2008), the compilation of publishing, accolades, and achievements of scientific geniuses was used to identify what makes certain individuals more creative than others. The findings noted increased success was accompanied by the engagement of arts and crafts training. Similarly, Haller (2012) stated STEAM programs are opportunities for teachers to learn the relationship between the intertwining of art and STEM. Moreover, an extended autoethnographic study conducted by Sochacka et al. (2016) found the potential for STEAM curriculum to give students and teachers explorational connections into the components of academic disciplines. This study developed an expanded view of the pedagogical alignment of STEAM curriculum with engineering content. Results revealed two art and engineering educators found connections to materials, design, society, and environments will engage students.

Similarly, a curriculum proposal by Graham and Brouillette (2016) investigated the impact of STEAM lessons in 10 Title I schools in California. The quasi-experimental design sectioned participants into two cohorts of Grades 3–5. Findings solidified students who had been "exposed to the STEAM lessons demonstrated greater improvement on physical science benchmark assessments than students exposed to a STEM-only physical science curriculum" (Graham & Brouillette, 2016, p. 2). Suggestions for additional research in measuring student success was noted for future research as well as more content training for the teachers. There was a misleading portion of the study, as deemed by the researcher, that seemingly reported gains with the STEAM cohort alone. However, there was evidence of all students showing some improvement, but students with the nine-hour exposure of STEAM curriculum increased by 13%. The study also used teacher focus groups to ascertain observational data. Teachers shared sentiments and accounts that correlated with arts integration as a form of student engagement.

Introducing the “A” in STEAM

Arts integration has been proven to intensify cognitive abilities that promote autonomy, engagement, and other positive attributes that are conducive to a successful learning environment (Appel, 2006). Moving from STEM to STEAM means promoting creativity through the interdisciplinary instructional methods that incorporate the fine arts. Specifically, Georgia has produced a STEAM curriculum continuum for use in attaining a school or program certification (Dell'Erba, 2019; Georgia Department of Education, 2020). Acquiring such a designation is supported by studies such as one centered around establishing a basis for recognizing functions and capabilities that can be supported through secondary school student participation in arts related areas. Maguire et al. (2012) reported on five New York City high school arts-focused programs through student descriptions of arts pathway experiences. The mixed methods study by Maguire et al. provided results aligned with increasing students’ access to arts instruction as being a beneficial strategy for raising graduation rates and improving lower performing schools and noted the need for further research (Israel, 2009).

The value of arts education in public schools has trended negatively in the past, having to contend with funding reductions. Eisner (1998) argued employment of arts related programs had not been conclusively proven in the current research of the time. Eisner (2002) went on to determine arts provided stimulation to autonomously use the imagination as an origination of content. Connecting the individual siloed areas of Science, Technology, Engineering, and

Mathematics with the areas of the fine arts affords students the ability to transfer the knowledge of one content area to another, and thereby make application (Leysath, 2015) Seen in an exploratory phenomenological case study conducted at a Title I Texas secondary school, arts integration into the siloed content areas of the curriculum was explored. The perceptions of influence were noted by administrators, teachers and students as being increasingly engaged as they participated in authentic designed chemistry lessons. The findings suggested teacher and administrator commitment to innovation and flexibility increased academic success and supplied an enjoyment of the process (Leysath, 2015).

Expression of knowledge through integrated curriculum, gives teachers and students an avenue to develop a multifaceted view of the world through artistic representation (Burnaford et al., 2009). Authentic products and solutions take place when the arts and other content areas are fluid (Aprill, 2001). Even in varied case study environments integration of the arts has been recognized as yielding more engaged students (DeJesús-Rueff, 2016; Lahana, 2016; Rao, 2014) Additionally, in an article from *Art Education*, Glass and Wilson (2016) covered six design principles that support the integration of the arts. They include collaborative and cross-disciplinary teams, feedback surveys, testing and reviews of usage, standards alignment, summative and formative performance tasks, and scaffolded learning within that task. All the principles correlate with the purpose of the current research in gaining a perceptual knowledge of how to construct a program that seamlessly integrates STEAM curriculum.

Henriksen (2017) provided authentic examples for lessons with a focus on design thinking for the integration of the arts, citing teachers may not have formal training in the art field and may feel ill equipped to instruct arts centered lessons. The following account from a Spanish teacher summarizes her experience with implementing a STEAM lesson:

> Learning about design thinking came at a great moment in my teaching career. It allowed me to feel like a designer. I believe this process of design is a motivating way to promote creative thinking, collaboration, and student ownership and responsibility of their learning. There were irregularities and problems that came up along the way for me, however I felt like I was developing problem-solving skills to tackle these issues…I also think you could take many different paths through and modify this process as needed. Without it, I think I would have struggled creating this project for my students and would have been overwhelmed or frustrated. As a designer, it was exciting to see the development and changes in my project from the beginning to the end. (Henriksen, 2017, p. 9)

The reflective response of the teacher denotes her understanding of STEAM was developing to acknowledge what she knew, what she was challenged with, and her embracement of design thinking practices toward the project. This realization is a step toward full integration and away from traditional curriculum that limits the use of teachable moments that often present in the challenges of PBLs.

STEAM Design Frameworks

The STEAM system is perceived to be different from the usual science and mathematics in that the STEAM blends a learning environment with the practical application of scientific methods in solving daily life problems. STEAM education, as mentioned before, derives its success in early exposure of children to scientific, technological, and computational thinking in finding solutions to problems in the society. The system focuses on the junior-level courses while maintaining the STEM field and occupation requirements (Wing, 2017). It aims at developing interest in science, engineering, and technology disciplines in a child to provide firm roots in scientific approaches as the child advances. This aspect improves the attitude of a student on STEM courses and reduces drop out cases in schools. In the middle school level, learning becomes gradually rigorous, engaging, and challenging.

STEAM frameworks such as those presented by Passmore et al. (2009), Yakman (2008), and Schwarz and Gwekwerere (2007) involved the construction of mental models from a discovery or inquiry-based learning opportunity. Frameworks such as these have been an evident factor in education in recent decades (e.g., Johnson-Laird, 1983; Seel & Dinter, 1995) and relate to STEM programs of inquiry learning in education (National Research Council, 2011). The use of inquiry-based learning models is a direct reflection of the application of curriculum change as it is a tool that aids in providing an alternative to prior instructional methods, and is constructivist in nature (R. Miller, 2011). In the field of education, constructivism can be defined as how knowledge is acquired, a theory of classroom learning, or a worldview or an ideological position. Vygotsky emphasized understanding cognitive development with regard to social and cultural aspects was where learning took place. Students who engage with activities create understanding of their environment. As each environment provides a variation of tools that aids with supporting the learning process, STEAM curriculum would be the psychological tool guiding students to extend beyond their mental limitations. The development of cognitive skills aid in acquisition of multiple knowledge types within learning and reasoning (Kolodner et al., 1998).

The social cognitive theory framework connects with the need to understand how to provide students with skill sets that will benefit them in the future. Presently, some of the careers that will be needed in the future do not yet exist, making it difficult for teachers to prepare students. Educational leaders who use STEAM curriculum will be affording students and teachers an opportunity to prepare for future jobs by using concepts that are conducive to creative skill applications. Using the social cognitive theory, through the perceptions of administrators implementing STEAM, Bandura (1971) asserted the use of observational learning, by which observers imitate models they encounter, affords observers the opportunity to gain information faster than attempting to learn independently.

As noted by this legislation, the STEM curriculum was created to meet the needs of society. Therefore, it is of a social efficiency ideology. The principles of social efficiency defined by Schiro (2012) is to carry out the task of educating students efficiently for their clients, with the clients being the public to better serve society. Curriculum is not random and must be efficient and effective as it is shaping the behavior of students to be functioning members of society. Vygotsky (1978) concluded social interaction and a positive learning environment is crucial to a student's learning. In relation to social efficiency ideology, Vygotsky acknowledged learners need to have an environment that allows them to talk and share about different problems they encounter when learning. In this aspect, he talked about the zone of proximal development to explain the wide range of a learner’s ability to acquire knowledge about a particular experience.

According to Vygotsky (1978), the lower zone represents what a child can do independently, and the upper zone represents what a child cannot do alone or rather what the learner can do with the help. Likewise, STEAM curriculum is centered around the learner. The addition of the inherent delivery models of arts integration, PBL, and inquiry-based learning charge the teacher to be a facilitator and guide rather than a provider of information. The STEAM process is individualized to consider the student’s sex, race, socioeconomic background, interests, aptitudes, etc.

A widely adopted STEAM framework is that of Yakman (2008). Yakman's model defined the arts portion of the curriculum to go beyond aesthetics and grounded the framework with mathematical elements. The STEAM framework centers on the utilization of universal thematic units such as ergonomics, nutrition and health, transportation, communication, and power and energy to illustrate how the knowledge from core classes are applied in context (Yakman, 2012). STEAM curriculum as defined by Yakman (2012), yields to constructivist theorists such as Vygotsky, Gardner, Marzano, and Bloom because the learner is gaining knowledge through an experience that has been influenced by prior knowledge or events such as the ones within a project.

One version of the STEAM conceptual framework is based on a pyramid design that used the five concentrations of leadership, instructional, knowledge, institutional knowledge, achievement, and effectiveness. Some areas dominate others (Yakman, 2008) or all fields can be blended equally (Sanders, 2006). The instructional content for teachers includes preparation, organization, and delivery through problem-based, discipline integration, and problem-solving modes (Yakman, 2008) with scientific inquiry and PBL (Harwood, 2004). Other more recent STEAM frameworks have been identified as well as guidelines by which they are implemented. Bequette and Bequette (2012) implemented a framework to develop higher order thinking skills called studio thinking. This framework was devoid of constrictive language that allowed students to create multiple solutions and have autonomy over the learning process. Wynn and Harris (2012) also focused on a model conducive to teaching interdisciplinary collaboration, but it was Kuhn (2015) who shared the "with about in and through" (WAIT) framework that integrated more of the arts component in context with the other content areas in relation to the Next Generation Science Standards (NGSS).

PBL from the instructional content domain is used by a problem-based approach to frame an issue that could be solved using inquiry methods (Hmelo-Silver, 2004). The relevance of an issue can increase motivation and engagement in the meta-disciplines (Herrington et al., 2014). A purposeful, authentic problem can be aligned with standards to support mastery (Norman & Schmidt, 2000). Teachers' instruction should also consider the natural alignment of the content areas to contextualize the limitations of a particular field and promote student understanding (Kaufman et al., 2003). Similarly, STEAM curriculum instructional approach can consist of identification of gaps within content knowledge, emphasizing research and collaboration, and providing resources to make a coherent learning connection (Herro & Quigley, 2016). Herro and Quigley (2016) identified another instructional approach to STEAM curriculum whereby discipline integration acknowledges the multiple content areas, and integrates them on a multi-disciplinary, interdisciplinary, or transdisciplinary level. Interdisciplinary refers to the integration of subjects and collaborations among teachers to solve societal problems (Keane & Keane, 2016). Interdisciplinary and transdisciplinary development of core concepts as students look for systemic patterns, cause and effect, as well as stability and change in the dynamic ecosystem that is our world (Keane & Keane, 2016).

STEAM curriculum fosters the development of problem-solving skills in students by providing authentic relevant lessons that expand the ways students acquire cognitive, interactional, and creative skills (Herro & Quigley, 2016). Interactional skills of collaboration and communication have suggested longer retention of content and application of the knowledge within new environments (Rivet & Krajcik, 2008). Creative skills breed innovation, ideas, production, and solutions by use of art and technology integration (Kim & Park, 2012). Several institutions that use STEAM curriculum have recorded correlations between the arts and at-risk students (Catterall et al., 2012). Sousa and Pilecki (2013) found integration of the arts narrowed the gap between at-risk and high socioeconomic status populations by providing motivation to students.

To implement any educational curriculum change, means to alter the philosophical underpinnings of a school organization with buy-in and intentional planning. For faculty, staff and students to be open to participating in an implementation effort, they must understand why the change is needed and how the outcome of participating will affect them. If these basic inquiries are not answered, participants' uncertainty will lead to resistance of involvement (Powers & Dickson, 1973).

Components of Successful Curriculum Change

As more preparation programs become available to teachers embarking on STEAM curriculum implementation, professional development and collaboration remains a need (Herro & Quigley, 2016; Hunter-Doniger & Sydow, 2016). Kelner (2010) asserted teachers and students benefit from professional development that centers on arts integrated instruction. The Standards for Professional Learning from the Learning Forward Standards provide a blueprint for the structure of professional learning (Learning Forward, 2011). The standards are symbolic of best practices identified in research about adult/professional learning. Successful steps that guide curriculum change through professional development begin with a focus on content, incorporation of active learning that uses adult learning theory, collaborative, job-embedded supports, effective practice models, coaching supports, reflection, and sustained duration (Darling-Hammond et al., 2017).

A yearlong study by DeJarnette (2018b) explored the impact of STEAM curriculum among an elementary school identified as high needs. The researcher collected perceptions of K-

2 teachers as they worked with students using the DeWalt method of STEAM integration. Vygotsky's (1978) constructivist approach was used by the researcher to analyze student learning and reflect on experiences from the environment. Based around the sociocultural theory, qualitative data collected resulted in an increase of teacher dispositions toward STEAM approaches to learning. Participants completed a 2-hour professional development session, and were assisted with activities, resources, and in-class support. Further discussion posed the discrepancy between furnishing professional learning for teachers and the support needed when attempting implementation (DeJarnette, 2018b).

In a longitudinal qualitative study conducted by Hunter-Doniger and Sydow (2016), the transition from STEM to STEAM was chronicled over a 3-year period at Lily Island Middle School. The focus of the study reviewed a range of participants and stakeholders who were interviewed to contribute information on the process of integrating the arts. Teachers who formed a STEAM leadership team were provided six professional development opportunities funded by a statewide arts initiative to develop integrative arts programs. At the conclusion of the study, 93% of teachers believed STEAM curriculum benefited students. The infusion of the arts revealed better differentiation of the curriculum, yet concerns were still present in terms of sufficient time allotted to work in both the arts and academic areas.

Concurrently, the Honolulu Theatre for Youth created a program named Collaborative Residency to provide intense professional development experiences for teachers to practice arts integration. Schlaack and Steele (2018) carried out a qualitative case study focused on results of an 8-year-long support program, funded by various state organizations, classroom teachers paired with teaching artists to work together. During the summer, the pair of teachers would accrue 12 hours of collaboration. Another 24 hours was gained when they participated in additional professional development learning methodologies of arts integration. Bandura's (1971) social cognitive theory was the theoretical framework for the multiple case studies of the six public schools. Information was collected and analyzed to inform and recommend changes for practices and policies related to arts integration. Six of the teachers were selected to be sampled and the findings were recorded in three categories that related to three research questions surrounding teacher perceptions of student learning, personal behavior changes, and support within the environment. The researcher noted the increase of student engagement, teacher self-efficacy, and the arts functioning as an equalizer for diverse learners. The researcher further cited an increase in frequency by which the teachers used arts integration practices and the continued conceptual learning through replication of modeled curriculum practices by the teaching artist assistants. Finally, the researcher found the teaching environment influenced the classroom teacher's learning through the addition of the teaching artist's modeling and coaching.

Darling-Hammond (2004) suggested a whole system view should be used when implementing a new change, and the relationships that are cultivated between the components within that system should share the same perspective. Having the previous focus of STEM curriculum, the shift to incorporating the arts was in response to artists, art educators, and school leaders who believed in the incorporation of design thinking when building a necessary curriculum that would aid in supplying the world's workforce (Boy, 2013). Although some professional development can be met with resistance for change, Purnell (2008) evaluated interpersonal components in a qualitative study that found overwhelming support for arts integration. The institution of such integration was not as overwhelming with indications of infrequent usage based on little emphasis by the leadership of the school.

The establishment of professional development to support curriculum changes should address six assumptions as regarded by Knowles (1980) for adult learners to understand why they may need to learn a concept. Movement from dependent to self-directed learning takes place as the adult learner encounters four themes: experience, reflection, dialogue, and context. To determine if the professional development was successful, Guskey's (2002) five levels of professional learning has been used to assess participants' reactions, learning, knowledge of skills, organization support, student learning outcomes.

Future Teachers and Evaluative Measures

Continuing with the global digital evolution, the education system is at the epicenter of changes that directly impact the workforce of the future. Skills previously regarded as frameworks for teaching have now been overshadowed by advancements in technology. This leads to teachers needing to become familiar with self-development, and self-education to keep up with the changes (Colucci-Gray et al., 2017). Likewise, innovative approaches to training for a digital society is necessary. In many advanced countries, including Australia, Great Britain, Israel, Canada, China, Singapore, and the United States, STEAM curriculum education programs are being developed. The National Research Council and the National Science Foundation recognized STEAM education as the technological foundation of a developed society.

The degree of training in the field of STEM is an indicator of a nation's ability to support its development (Frolov, 2010). The requirement for elementary teachers to educate students in all subject areas is a focus of programs that prepare preservice teachers. As so, the integration of subject areas found in STEAM curriculum serves as a base for ensuring the Next Generation Science Standards (Keane & Keane, 2016) alongside the Common Core State Standards for Mathematics (CCSSM; National Governors Association Center for Best Practices & Council of

Chief State School Officers, 2010), are taught in a way that facilitates student interests and understanding (Bequette & Bequette, 2012; Wynn & Harris, 2012; Yakman, 2012). Learning more about the support needed to aid with guiding STEAM curriculum implementation among future teachers is cultivated by understanding how administrators would evaluate teacher practices.

In a research paper by Winarti (2018), emancipatory education of future teachers was explored. Emancipatory education involves awareness of teaching and learning styles based on individual realities of daily life. By using authentic problems, teachers integrated lessons that correlated with specific learning styles. Similarly, to the focus of STEAM curriculum, Shor (1988) emphasized, to promote critical training, education should be participatory, the materials should present problems for critical inquiry, the pedagogy should be situated, dissocializing and democratic, and the course should be interdisciplinary. Using an experiential model, Winarti sought to first provide a group of elementary student teachers with the knowledge to employ lessons and activities that used 21st–century skills. The observed implementation was gathered in the form of portfolios and indicated higher order thinking skills, learning materials, and assessments were all created by the student teachers in the single course university in Indonesia. The single course focus was a limitation of the study, as it was 1 of 5 parallel classes at the Indonesian university. The outcome of the paper brought forth an example of how the design of educational curriculum can better prepare teachers for instructing a globalized society.

Like many other nations around the world, South Korea has also adopted the integration of the STEAM curriculum. A national mandate for interdisciplinary science teaching through STEAM has guided the approach to full implementation as noted in a study of the country's preservice teachers (D. Kim & Bolger, 2017). Participants were given instruction focused on

STEAM education while collaborating with peers and received feedback toward lesson refinement. In a pre- and post-survey on attitudes regarding STEAM, preservice teacher responses indicated the process was highly educative for themselves and noted the benefits of creative lesson planning. Upon further reflection, I regarded one of the most important pieces of the case study to be the confidence gained by the preservice teachers in their ability to make the change to STEAM instruction (D. Kim & Bolger, 2017).

The Korean education system mandate for STEAM led the way for the creation of "STEAM-centric" evaluation indicators for teachers. The focus of a mixed methods study conducted by Kim and Kim (2016) surrounded the aspects of teaching behaviors from educators on the enhancement of learning abilities of students based on competency of the students' pursuit of STEAM education. Through the collection of behavioral event interview data, the researchers conducted two pilot tests that served as supplements to the main survey findings and interviews. Competency elements and target points were identified as indicators after a review of literature on STEAM education and teaching competency. The study combined results and yielded 35 indicators categorized in six areas. Use of experiential teaching was considered throughout the study, and the conclusion provides educators with a guidance to raise the usability of STEAM. Another Korean quantitative study by Kong and Huo (2014) used a quasi-experimental design to determine effects of STEAM-based learning on elementary school students. Focus was particularly on their self-efficacy, interest, and attitude toward science. Two groups were formed of fourth grade students, one experimental group, and one control group. Pre- and post-tests were given before and after the groups received instruction, with the experimental group receiving instruction through a STEAM approach. Results of the experiment yielded positive gains toward self-efficacy, positive attitudes, and no significance in interest.

Collaborative efforts on the part of administrators and teachers were evident in a qualitative case study by Moon (2020). Teachers in this Oregon school developed strategies to integrate STEAM curriculum:

> First, teachers and administrators found it helpful to talk with other educators who are implementing STEAM into their teaching practice. Secondly, STEAM practitioners encourage starting with early adopters at the school to create momentum. Next, educators encourage people to take advantage of STEAM professional development opportunities. Finally, all the education stakeholders interviewed stated the importance of sharing your success stories and communicating why STEAM integration is important. (Moon, 2020, p. 118)

The strategy suggestions based on interviews provide a systematic approach to beginning to implement STEAM, noting participants at each level.

The basic premise of the integration of STEAM curriculum implementation is to provide students with authentic learning experiences through project-based learning opportunities (Yakman, 2008). The impact derived from implementation of STEAM curriculum will directly affect the perceptions of teachers, especially when working together. The need for creative arts integration, professional development, and evaluative measures of STEAM curriculum can provide an authentic insight as to teacher perceptions of a nontraditional approach to education, which lends to how an administrator may provide support. Many states do not require the elements of STEAM to be implemented within their individual curricula. However, in a study conducted by Koehler et al. (2013), the societal impacts were the focus of the need for a rigorous curriculum that encompasses the integration of technology and engineering. Findings of this analysis indicated there was an inconsistency in the incidence of engineering and technology concepts present in each state's science standard document.

According to Shillingstad and McGlamery (2019), teacher leader definitions varied in the roles, activities, and involvement in school experiences. Within their study, a group of 17 teacher leaders were given information on the classification of servant leaders and transformational leaders through a constructivist view. They gathered results from a five-question open-ended questionnaire and analyzed the findings using themes, subthemes, and assertions that included correlations between knowledge, skills, and dispositions. The personal and professional characteristics perceived by participants were identified as being developed by the roles they assumed. Assertions included a similar terminology to that discussed in the literature review, further defining a teacher leader was demonstrated with quotes from each participant. Nine of the 12 related their discussion to a servant leadership model and 3 of the 12 related to a transformational leadership model.

Continuing to define leadership characteristics and traits, a qualitative study conducted by Ellis (2018) explored the administrative practices of elementary art teachers while looking to define roles and responsibilities and the extent to which principals perceived arts education influences on student academic achievement. The study further sought to understand what successful arts education programs looked like and how they were aligned to instruction and assessments within the realms of 21st-century learning. Findings of the study referenced the need for critical components such as accessibility, engagement, and collaboration to sustain a successful program. Klar (2018) argued there is a shortage of teachers who have been trained in STEAM curriculum implementation and asserted that support from administrators in the form of a mentoring program that addressed the shifting the focus of instruction from rote memorization to strategies associated with PBL. Klar also discussed resource and time supports, as well as encouragement of a culture where taking risk is acceptable. In an Iowa school district in 2013, a mentoring program named Teacher Leadership and Compensation System (TLC) used the aforementioned items to “support teacher leaders with the goals of attracting and retaining effective teachers, promoting collaboration, rewarding professional growth and effective teaching, and improving student achievement” (Eckert & Daughtrey, 2019, p. 3). The quantitative longitudinal study spanned 3 years, collecting data at the end of every year with a 166-item survey. Findings were analyzed based on designations of school, experience, and role with descriptive and inferential statistics. One finding stated paralleling development of teachers with administrators would prove beneficial for reaching the goals established by the TLC. To ensure the reliability of the large magnitude of data and to better consolidate the responses to better communicate, Cronbach’s alpha was calculated. Eckert and Daughtrey (2019) discussed the need for focus groups and interviews to understand the issues surrounding responses but maintained the reliability of the findings was sound.

Evaluations that then monitor the application are required from the state to monitor achievement and progress. Such examinations have been regarded by Jensen (2005) as not being aligned to mastery of content knowledge or how a student can use that knowledge. As seen in the rise of the achievement gap between the United States and other nations. Qualified teachers and socioeconomic status (SES) percentages have been used to express this inequity. Typically, students from lower SES backgrounds have a lower chance of being taught by a highly qualified teacher of high-SES students and low-SES students who were taught by highly qualified teachers, who hold a certificate in the field that they teach. However, improvements have been made over the years with the institution of the NCLB Act. Darling-Hammond (2004) attributed the successes of other countries' efforts to close the achievement gap by addressing factors considered the foundation of inequity. One such factor concerns "factory model school designs that have created dysfunctional learning environments for students and unsupportive settings for strong teaching" (J. V. Clark, 2013, p. 9).

In the findings of one multiple case study four trends of mindset were identified as to how content teachers were able to transition from a traditional curriculum to a STEAM curriculum. The methodology I conducted was in the form of notetaking, interviews, transcriptions, and focus group responses with a chunking analysis to develop codes and themes. Questions of the data collection process centered around the research questions' transitioning perspective.

Principal Roles and Faculty Resistance to Change

Research has consistently shown that influences of the principal impact the change process (Berends et al., 2001; Berman & McLaughlin, 1978; Fullan & Hargreaves, 1991). Leadership has also been previously studied regarding isolated traits and behaviors (Fleishman, 1953; Stogdill, 1948) associated with different theories. Theories including contingency (Fiedler, 1967), transformational and charismatic leadership (House, 1971), have sought to identify and understand the elements of effective leadership. The school leader is often the manager of personnel and resources. The more effective leadership styles are those that build relationships while operating within preset guidelines (Fullan, 2009). For instance, the McKinsey Report examined characteristics of the "top performing systems" in the world (Barber & Mourshed, 2007).

The following areas have been noted from the McKinsey group as policies and strategies that account for differences in organizations: employ high quality teachers who collaborate, provide areas of growth for teacher leaders, and center efforts on student learning and achievement. However, guidelines that shape the policies and strategies for achieving results in these areas are not as easily agreed upon. Characteristics associated with independent factors such as geographical, demographical, socioeconomical, etc. characteristics may have contributed to the results.

However, the Interstate School Leaders Licensure Consortium (ISLLC, 2008), details six roles of a school leader addressed by standards of vision, instruction, organization, collaboration, ethics, and advocacy. In a qualitative study Muse and Abrams (2011) conducted, semistructured, face-to-face interviews were carried out to identify the roles of a principal. Participants totaled 25 principals who were asked to also complete a daylong log of activity, along with the mission statement of the schools. I used additional data sources in the form of a reflective log and memos to aid with triangulation. The ISLLC standards were incorporated within the questions that guided the interview. Several themes emerged in the findings, including leading by example, building relationships, creating a vision, understanding the community, being a manager and instructional leader, and child-centered instruction were identified within the interview responses. The multifaceted role identifications resulted in the researchers finding there was a need to build a broader leadership capacity within schools and school districts. One practical implication was to delegate tasks to form a more shared responsibilities approach. Using assistant principals and other administrative personnel cultivates leadership and embedded professional development.

Most elementary schools have one principal and one assistant principal according to a national longitudinal study that included grades Pre-K-8 (Fuller et al., 2018). The roles of each rely on their independent aptitudes and experiences. Moreover, the superintendent also institutes responsibilities that cover a myriad of duties to include that of the instructional leader. The research of Jacobs, Tonnsen and Baker (2004) denoted the importance of the principal as instructional leader to support personal and further teacher professional development. Northouse (2014) characterized leadership as a combination of ability, skill, behavior, trait, and a relationship, leading oneself to influence the decisions of others. According to Avolio et al. (2009), if the leader is focused on instruction and goal setting, teaching strategies, climate, and achievement will improve.

In a study of 75 participants, Grillo (2018) used a mixed method approach to understand the process of STEAM implementation from an organizational learning lens. Data were collected from teachers, principals, and other leadership personnel roles within a K-12 school district in New Jersey. Data collected included a semistructured interview, lesson plans, and other documents necessary for instruction, and a questionnaire on the implementation process. A constant comparative method of qualitative analysis was conducted on the narrative data, while a quantitative analysis was conducted to provide descriptive statistics, frequencies, one-way ANOVAs, and when necessary, Post HOC test pairs after a one-way ANOVA. The findings suggested the implementation process of STEAM curriculum was affected by the leadership of the school.

Boe (2010) provided an example of a case study that focused on examining the role of the leader in the STEM curriculum by posing research questions to participants in a Delphi interview model. The study synthesized the teacher, leader, and technology educator's various perspectives and yielded trends that centered around strategies of implementation. The findings suggested an integrated curriculum was best for addressing all areas of STEM. The current common approach by teachers to deliver content within siloed areas was not meeting the needs of most students, and to facilitate integrated approaches to STEM, changes in the structure of schools and districts would be necessary. Yet, there was not a consensus as to if subjects should continue to be delivered as distinctly different content areas or whether the time dedicated to each subject should be equal.

Leadership styles are an important ingredient and indicator of success when implementing change in any organization (Adeyemi-Bello, 2001; Brumley, 2011). Characteristics of leadership styles must factor for constant change (Immegart & Pilecki, 1973). Yet, amid this statement, individuals may still express hesitance and resistance. Full implementation of a new program or initiative requires an action plan and time, beginning with a vision, skills, and incentives. This ultimately means the organization often switches focus or plans when met with new information, creating a cyclic pattern of neverending change. Nevertheless, educators are encouraged to continually grow, so there must be a source of professional development that takes place to facilitate that growth.

Push back from teachers is part of a normal resistance to change process as found in a study conducted in Germany by Terhart (2013). Results of the study found generally teachers ignore, misinterpret, or misuse results of assessments that are targeted to produce information to further instructional planning. Therefore, the values, beliefs, and actions of administrators impacts how understanding is gained, problems are solved, and information is processed (P. W. Miller, 2017). Principals often rely on their current knowledge base and make connections based on their experiences (Allen et al., 2015), which makes the role of the principal crucial for carrying out any change.

Gaps in the Literature

In the reviewed literature, there remains gaps for which more empirical research is needed. Data collection from areas surrounding arts integration over an extended period of time, variations in study designs, changes in assessment measurement and tools, teacher preparation programs, extending awareness of the arts, and additional integrated course descriptions would all contribute to a more robust body of literature regarding the implementation of STEAM curriculum.

The relationship that exists when the arts are integrated into the curriculum has yet to be fully explored in a longitudinal study that would monitor the effects on achievement and instruction. Currently, the benefits of arts integration toward providing opportunities for problem solving, creativity, critical thinking and performance application within projects are mostly assumptions, lacking extensive data collection.

STEAM research is heavily qualitative in nature, indicating a broader span of data collection would prove impactful to the effectiveness of instructional methods and the body of literature. Qualitative, quantitative, and mixed method designs could further explore the evaluative aspects of STEAM implementation. To that end, a more suitable measurement tool would aid with assessment of 21st-century skill sets that appear with cognitive development (Ifenthaler et al., 2010).

STEAM certification programs at the higher education levels are minimal (Madden et al., 2013), and varied in requirements. Further research could be conducted to explore how other teachers have transitioned from traditional curriculum approaches to STEAM curriculum with the help of professional development as a source of support for the implementation. Likewise, identification of what constitutes a successful transition would aid in replicating the process and give insight toward higher education courses that could navigate best practices. However, fully comprehending the expectations of a successful program begins with extending understanding of arts integration to include focus on other disciplines aside from visual and musical arts. Herro and Quigley (2016) suggested the use of a theater arts and language arts teacher, as well as an art teacher. Yet, current research mostly centers on visual arts integration.

The examination of the perception of the administrator was productive for identifying behaviors that contributed to curriculum implementation (Mendoza Diaz et al., 2013). In a qualitative study conducted by Brown et al. (2012), a group of 172 educators were interviewed only to find half that were able to give more than a limited definition of STEM. Due to the lack of consistency with what STEM means to those who use it, there has not been a universal definition of the curriculum. Additionally, there has been an underrepresentation of female STEM/STEAM leadership. Although Ramaley was at the forefront of the curriculum movement, very few women have succeeded in their initial efforts in possessing roles of leadership in this area. In a paper by McCullough (2016), expectations of what a STEM/STEAM leadership style should look like, regarding a specific gender was explored. There was a lack of comprehensive research in this area as there were a limited number of cases with female leaders to study.

As with the purpose of this study, more data on the leadership behind implementation that could influence the frequency and duration of STEAM programs as well as their success as it pertains to student achievement and preparedness toward entering a global economy. The decisions and collaborations made at administrative levels affect the process of change and how it is accepted, practiced, and replicated. Gaining this knowledge would further the advancement of the STEAM curriculum initiative.

Summary

Chapter II summarized empirical evidence of STEAM curriculum implementation while noting the role of the principal as instructional leader. The literature review also discussed the approaches to becoming STEAM certified in relation to the designing and professional development supports needed for facilitation. Table 1 identifies the major research findings that relate to the importance of leadership within STEAM curriculum implementation in correlation with perceptions of administrators and the impact of the overall process of STEAM certification. Chapter III will provide the methodology employed in the current examination of administrative perceptions of STEAM curriculum implementation.

Table 1

Major Research Findings Related to STEAM Curriculum Implementation

Author	Study Purpose	Participants	Design	Outcomes
Bagiati et al. (2010)	Effectiveness of professional development when implementing STEAM curriculum	Preschool teachers	Qualitative – interviews	Perceptions of STEAM curriculum were enhanced by the opportunities for professional development; however, the rate at which the teachers implemented the lessons was nearly obsolete.
Boe (2010)	Provide strategies for technology education curriculum, pre-service and in-service programs as well as leadership within the technology education profession.	Teachers, Directors, and a Technology Educator	Quantitative – case study Delphi process	The current curricular and methodology trends were examined in technology education as well as the issues related to STEM education.
Conradty & Bogner (2018)	Identify gender difference with regard to STEAM creativity.	Students in EU countries (11–19 years)	Quantitative Likert Scale Questionnaire	Collaboration and instruction provide solutions that are creative, and begin to close the creativity gap and no gender differences exist. The scores of younger students' creativity were higher than those of older students.
DeJarnette (2018)	Impact of STEAM curriculum among an elementary school identified as high need	K-2 Teachers	Qualitative – sociocultural	Increase of teacher dispositions toward STEAM approaches to learning.
Eckert & Daughtrey (2019)	Teacher leadership development: Tracking one district's progress over 3 years.	Iowa school district, teachers, and administrators	Quantitative	Formative feedback gained from positive trends in improved working conditions, teaching and learning with the implementation of a TLC
Ellis (2018)	Defining the roles and responsibilities as well as the extent to which principals perceived arts education influences on student academic achievement.	Elementary principals	Qualitative	Need for critical components such as accessibility, engagement, and collaboration to sustain a successful program.

Graham & Brouillette (2016)	Effect of nine nine STEAM lessons on the physical science achievement of elementary students in Grades 3–5.	Grades 3–5 students and teachers	Quantitative quasi-experimental	STEAM can boost the scientific understanding of students in the upper elementary grades.
Grillo (2018)	The purpose of this study was to examine STEAM implementation by unveiling K-12 schools use of organizational learning mechanisms.	Principal, teacher leaders, curriculum supervisor, supervisor of fine and performing arts	Mixed convergent parallel design	Administrators were involved in all aspects of the STEAM implementation process, including monitoring and evolving the curricula, to ensure the focus remained standards by providing top-down support, and implementing practices across the district that promoted professional learning.
Henriksen (2014)	Experiential – understanding the significance of teaching interdisciplinary content and the distinctions between traditional and arts infused disciplines	National Teacher of the Year	Qualitative – case study	Increased student achievement.
Hunter-Doniger, & Sydow (2016)	Contribute information on the process of integrating the arts.	Middle school teachers and educational stakeholders	Qualitative – longitudinal	93% of teachers believed STEAM curriculum benefited students.
D. Kim & Bolger (2017)	Effects of STEAM education while collaborating with peers and received feedback toward lesson refinement.	Korean Preservice teachers	Quantitative – case study	Confidence gained by the preservice teachers in their ability to make the change to STEAM instruction
B. H. Kim & Kim (2016)	Aspects of teaching behaviors from educators on the enhancement of learning abilities of students based on competency of the student's pursuit of STEAM education.	Korean K-12 Teachers	Mixed – interviews, surveys	35 indicators categorized in six areas for the usability of STEAM.
Koehler et al. (2013)	Explores how engineering concepts are represented in secondary science standards across the nation by examining how engineering and technical concepts are infused into these frameworks.	Three researchers	Qualitative – constant comparative	Findings of this analysis indicate there is an inconsistency in the incidence of engineering and technology concepts present in each state's science standard document.

Kong & Huo (2014)	Effects of STEAM based lessons on student's self-efficacy, interest, and attitude toward science. F	Three classes of fourth graders in Jinju city, South Korea	Quantitative Quasi-experimental	Improvements for all areas except science learning interest with the experimental group exposed to STEAM lesson
Leysath (2015)	explore the perceptual influence of a full integration of the arts into core subject instruction on classroom environment and student academic achievement	Admin, students, and teachers	Exploratory Phenomenological case study	Increased overall engagement, participation, and anticipation with lesson interactions.
Maguire et al. (2012)	Examines a range of capabilities fostered through student engagement with arts education opportunities	Students of five small arts-focused high schools in New York City, US.	Exploratory mixed methods (4 years)	Indicators were found for the potential of the arts as a site or space for fostering a range of capabilities for secondary school students. Links were found between student GPAs and participation in arts learning in school and outside of the regular school day
Moon (2020)	explore how educational stakeholders (teachers and administrators) in Oregon perceive STEAM integration in a K–8 setting	Teachers, instructional specialists, and administrators	Qualitative: Questionnaires and semistructured interviews	Confirmations of STEAM definitions and leadership challenges associated with change-resulting in seven categories for STEAM implementation.
Scruggs (2019)	Identification of steps taken by teachers who transitioned to STEAM instruction while noting their processes taken and perceived challenges encountered.	Voluntary teacher participants	Qualitative: Multiple case study	Four mindset themes were derived from mindset to teach from a STEAM perspective, started small and built up, used collaboration as a resource, and participated in ongoing professional development.
Sochacka et al. (2016)	Expands views of how STEAM might enrich engineering education in ways that more closely align with the pedagogical commitments of the arts.	Two environmental engineers	Collaborative autoethnographic exploration	Generalizations for enrichment centered around engineering educators
Shillingstad & McGlamery (2019)	Identify a characteristics and a definition of teacher leaders	Teacher mentors	Qualitative – open-ended questionnaire Case study	Confirmation of definitions used in literature review and actions that are thematic among teacher leader roles.
Schlaack & Steele (2018)	Provided intense professional development experiences for teachers to practice arts integration.	State organizations, classroom teachers, teaching artists	Qualitative – case study	The teaching environment influenced the classroom teacher's learning through the addition of the teaching artist's modeling and coaching.

Chapter III: Methodology

Chapter III provides the purpose and description of the qualitative research design of this study. Following the design description, the role of the researcher was established along with information on study participants. The instrumentation, data collection and data analysis sought to gain the perspectives of elementary administrators with regard to their personal experiences with STEAM curriculum implementation. The chapter concludes with a summary of the findings and limitations of the study.

The purpose of the study was to explore administrators' perceptions toward the process of STEAM curriculum implementation. STEAM curriculum implementation as a form of curriculum change is an attempt to address a preexisting global dilemma of improper preparation of students entering a more complex workforce (Crumpler & Lewis, 2019). As topics become more related, the integration of previously separated academic areas, provides an opportunity for students to understand concepts in a less abstract manner. Therein, for this qualitative case study, my goal was to gain understanding of elementary principals and assistant principals' perceptions of STEAM curriculum. I gathered perceptual information to inform the field of education on the application of concepts in a global society. Likewise, findings from this research influenced the field of educational leadership. The information gained from this inquiry could be used to support the need of STEAM curriculum development and changes within a school.

Research Design

Generally, a qualitative methodology affords a researcher the opportunity to build theories based on participants' voices. Qualitative research is preferred to other methods when researchers are attempting to understand a particular phenomenon in an authentic context (Yin, 2003). Yin (2003) defined a case study as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (p. 13).

Qualitative research aids with identifying answers to inquiries of meaning. In particular, a case study can provide a clearer understanding of a problem or issue (Stake, 1995). A descriptive case study approach (Yin, 1981) to research allowed for examination of questionnaires, interviews, and artifacts of elementary schools that employed the use of integrated STEAM curriculum. The descriptive case study lens provided an analysis of principals' and assistant principals' values, beliefs, and understandings in addressing STEAM curriculum implementation in elementary schools. Similarly, a case study allowed me to predict results in other cases with like variables. The descriptive case study lens connected the multiple data sources to a single bound object (Stake, 1995). To examine the first research question, a case study approach was necessary. Perceptions of one's experiences were gathered through the data collection process.

I decided upon a qualitative case study to gain information from the natural setting of the study. The qualitative data gathered produced accounts of how people engage and interact in the real world is a common definition of qualitative research (Creswell, 2013; Yin, 1981). Yin (1981) regarded five features within qualitative research distinguishing it from other approaches. The features were meaning making of real-world processes, participants' perspectives, contextual attention, background experiences, and multiple data sources. For the design of this study, I followed the example of Yin where multiple data sources were established from a defined case. The sources were necessary to study the scope and features presented in a logical manner. The knowledge gained from such interviews, questionnaires, and artifacts aided in better informed decision making for the leadership involved with changes in curriculum. Patterns and trends emerged from how implementation of curriculum change is introduced, practiced, and supported the development of a process that sustains the change. Table 2 provides an overview of the three phases involved in carrying out the qualitative case study.

Table 2

Phases of Data Collection

Phases	Phase 1 Week 1–2	Phase 2 Week 3–4	Phase 3 Week 1–9
Data Collection Method	Questionnaires	Interviews	Artifacts
Process	Questionnaire Google form	Interviews via Zoom	Receipt of photographs, videos, and documents

Beginning with the research questions, the methodology is a way to study the process used by the researcher to systematically and logically study the data collected and the participants selected. The questions were:

1. What are administrators' perceptions of implementing the STEAM curriculum approach to instruction within an elementary school?
2. What are characteristics of administrators who have guided STEAM curriculum implementation?

As the administrative participants produced responses to the interviews and questionnaires, I paired those items with artifactual data. The analysis portion followed with two cycle coding methods and a summary was generated.

Role of the Researcher

For this descriptive qualitative case study, my role was that of an active participant. The active participant role assignment had direct implications on the study regarding data collection and analysis, for which I planned. Such planning considered prior studies with the role of active participants and a training program approved by the Institutional Review Board. I made specific efforts to consciously act toward removing the presence of bias and undue/unintentional influence on participants by first identifying the potential for the researcher's bias as an active participant in the study. I also added an additional coder and employed the use of member checking after each data set is collected.

In a review of a qualitative study by Scapens (2004), researchers were charged with the task of collecting study participant data with an ethical commitment to best serve the research goals. A commitment from the researcher to adhere to ethical guidelines was described with five conditions, including:

1. A participant's voluntary participation and understanding of the meaning of the study.
2. The researcher must not distort the meaning of participants' voices.
3. The researcher must protect participants' anonymity.
4. The researcher has an obligation to participants' beneficence.
5. The researcher has an obligation to nonmalfeasance to study participant(s).

I completed the Collaborative Institutional Training Initiative (CITI) Program (see Appendix A) prior to conducting the study. The CITI Program provided educational courses in research, ethics, regulatory oversight, responsible conduct of research, research administration, and more to enhance the knowledge and professionalism of those conducting research. Knowledge gained from the course was instituted during the instrumentation, collection, and analysis of the research data.

I conducted what Creswell and Poth (2016) referred to as "backyard research" because it is in the school district of the researcher's employment. I used interviews, questionnaires, and documentation of artifacts to collect data on principals' and school principals' perceptions of implementing STEAM curriculum. My status as a colleague to participants was protected against with influencing the collected data. Personal values and beliefs regarding the topic were kept to the researcher to remain a neutral party with acknowledgment of how this case study should guard against misrepresentation and misunderstanding (Stake, 1995).

I used an informed consent document (see Appendix D) to communicate the purpose, procedures, associated risks, costs, and confidentiality of the study with participants. Informing participants of the purpose of the study and the overall process gained initial interest and provided insight as to participants' expectations. My work ethic was demonstrated through the adherence to preset schedules and timely communications with each participant. Moreover, I maintained professionalism during all contacts with participants and abided by research ethics of minimizing harm, obtaining informed consent, protecting confidentiality, avoiding deception, and providing the right to withdraw from the study.

Beginning with the credibility of the study, I relied on the individual data collected from participants through digital recorded means, and, during the coding phases, a second coder was used. Participants reviewed transcripts to check for accuracy of the data to ensure dependability. I used the information gained from the study to generalize implementation practices for other comparable educational institutions or districts. Trustworthiness was maximized by incorporating credibility, transferability, dependability, confirmability, authenticity, coherence, sampling adequacy, ethical validation, substantive validation, and creativity into the study (Hays et al., 2016. I completed reflexivity journals throughout the research and analysis process. Along with triangulation, member checking, reflexive journaling, and simultaneous data collection and analysis took place (Maxwell, 2005).

Due to my previous experience as a teacher at a Georgia STEAM-certified elementary school and now as a principal as an elementary school embarking on STEAM certification, the researcher was led to support the application of STEAM curriculum. I had worked in 3 of the 4 elementary schools in the specific school district in this case study as a teacher and administrator. The background knowledge gained from these experiences served as a foundation of my research interest. Credibility, dependability, and transferability were established to increase the generalizability of the study.

Participants

According to Baxter and Jack (2008), Stake (1995), and Yin (2003), placement of boundaries within a case study averts the inquiry from being too broad. Likewise, investigation of elementary leaders in one school district provides an opportunity to reflect on how the researcher is personally related to the other participants and phenomenon (Saldaña, 2015). The small, rural, southeastern school district that served as the setting of this study has a total of four elementary schools. All four schools were implementing STEAM curriculum; however, each was at a different stage of the implementation process. Two of the district's elementary schools received STEAM certification status from the Georgia Department of Education, in 2017 and 2020, respectively. The other two schools were in their 2nd and 3rd years of implementation. Although certification for two of the schools had been completed, curriculum implementation process was ongoing. For that reason, all four elementary school administrator groups were deemed eligible for inclusion as participants in this study.

A purposeful selection of the eight administrators within this southeastern school district was used to secure perceptual data for this study based on the information and insight they have to offer (Maxwell, 2005; Patton, 2002). Study participants included elementary school leaders, four principals, and four assistant principals, who were implementing STEAM curriculum. All the contacted administrators were asked to participate in the study, and all volunteered and agreed. Their implementation of STEAM curriculum was directed by the STEM/STEAM

Georgia Continuum. If the initially pursued participants refrained from participation, I would have sought participation from previously retired leaders from within the past 5 years who served at the same schools in the study while embarking on STEAM certification. Further still, if I had not confirmed participation with those individuals, a sample of participants from surrounding areas and school districts would have been invited to participate.

Table 3

Participant Demographics

Participant Leader	Position	Gender	Age	Highest Earned Degree	Ethnicity	Total Years of Experience	Certifications
P1	Assistant Principal	Female	47	Educational Specialist in Leadership	Caucasian	24	Reading Endorsement
P2	Principal	Female	68	Specialist in Educational Leadership	Caucasian	20	Special Education
P3	Principal	Male	51	Master's in Educational Leadership	Caucasian	28	None Reported
P4	Assistant Principal	Male	34	Specialist in Educational Leadership	Caucasian	9	None Reported
P5	Assistant Principal	Female	45	Specialist in Educational Leadership	African American	20	Special Education
P6	Principal	Female	51	Doctorate in Education	Caucasian	28	None Reported
P7	Assistant Principal	Female	55	Specialist in Elementary Education	Caucasian	21	Leadership Add-on
P8	Principal	Female	36	Specialist in Educational Leadership	Caucasian	15	Gifted

Table 3 provides demographic information from each leader ranging from 34 to 68 years of age during the 9-week period of data collection in the spring of 2021. The variation of years' experience as school leaders also ranged from 2 to 12 years. School leaders' demographics were varied by sample of race, gender, and ethnicity. Additionally, principals' schools varied in socioeconomic status of population demographics, as one of the schools was designated as Title

I. Participants voluntarily accepted participation in the research study and a commitment to participate in all three phases of the research study was communicated. This study took place at one small rural school district in southwest Georgia. The total student population of the school district was 5,491 in grades Pre-K through 12 who attended in person and virtual during the time of the data collection in the spring of 2021 due to COVID-19. The population was 73.4% White, 16.6% African American, 3.4% Hispanic, 5.1% multiracial with 29.7% of the students receiving free lunch and 6.3% of the students receiving reduced-price lunch and were marked as low socioeconomic status students.

Participants who agreed to take part in the study were contacted via phone to determine if data collection sessions would take place by phone, Zoom conference, or in person. Interviews took approximately 45 minutes each. Additional precautions such as reminder emails were taken for participants who did not readily respond to showing interest in the study. If any of the initial eight participants declined or discontinued participation in the study, I would have sought participation from former leaders who have since retired from the same schools within the district. I would have only asked for the participation of leader retirees who have actively contributed to STEAM certification within the last 5 years. If those individuals had not wished to participate, I would have sought participation from surrounding area school districts.

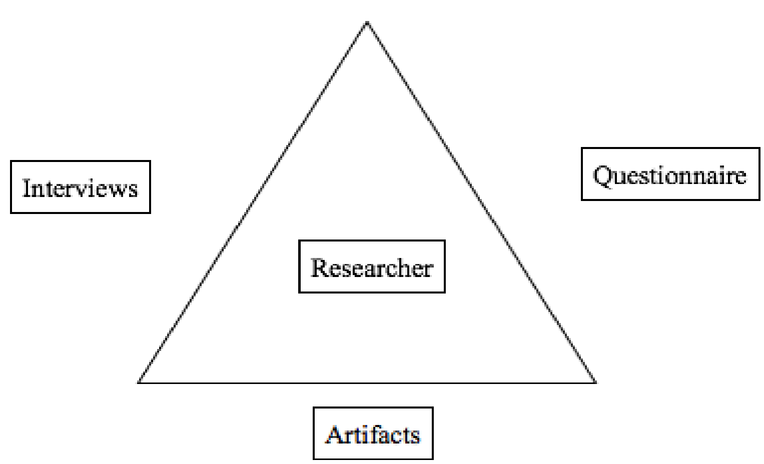
Instrumentation

I followed the recommendation of Weiss (1995), author of *Learning From Strangers: The Art and Method of Qualitative Interview Studies*, by using the “fixed-question-open-response” (p. 12) model for asking questions. I employed a questionnaire model to allow for opportunities to gather insight from participants in an in-depth and organized format. According to Christensen et al. (2011), a questionnaire used in a qualitative study encompasses a series of investigative and undefined questions. The use of a Google form questionnaire format gave the researcher the ability to construct questions and collect answers from participants (Gillham, 2008). Multiple choice and paragraph answer options were enabled, as the responses were automatically collected. All participants were asked the same questions; however, the responses were supplied from participants' own words (Weiss, 1995) instead of someone else's words as in a model of predetermined set of responses or multiple choice. Each section of questioning was created from the trending information that was supplied from the subheadings of the literature review which include: STEAM curriculum, STEAM Framework Design, Components of Curriculum Change, Future Teacher Evaluative Measures, Principal Roles and Faculty Resistance to Change. The responses better informed questions for the second phase of interviewing, and a list of questions is provided in Appendix E.

Qualitative interviewing has the purpose of capturing "how those being interviewed view their world, to learn their terminology and judgments, and to capture the complexities of *their* individual perceptions and experiences" (Patton, 2002, p. 348). Further supported by Seidman (2006), engaging in conversation with participants gives the researcher an opportunity "to find out what *their* experience is and the meaning *they* make of it" (p. 11). Consequently, individual semistructured interviews were used to address principals' and assistant principals' lived experiences in implementing STEAM curriculum. According to Brayda and Boyce (2014), the premise of qualitative interviewing starts with the idea that individual perceptions of others have meaning. With semistructured interviews, the researcher was able to provide a more in-depth inquiry into narratives and views of principals' experiences in understanding the best practices, professional development, project planning, and support roles of the leader, as well as any other trending themes that had the potential to emerge. Semistructured interviews provide flexibility within the structure and design of questions to yield substantial amounts of data (Galletta, 2013). Individual interviews provided a variety of data such as notes and transcriptions (Taylor-Powell & Renner, 2003) while giving participant principals and assistant principals opportunities to engage in dialogue that describe their levels of judgment and the impact of their beliefs on decision making. The interview protocol and question script can be seen in Appendix F. The interview questions were derived in the same manner as the questionnaire items. The questions were derived from the review of literature, summarized parts of curriculum change theory, and expanded on experiences that center around the research questions (see Appendix E).

Phase 3 included collecting artifact submissions found in the individual master schedules, lesson plans, professional development training logs/certificates, and meeting agendas from each school. I also investigated the school websites for any artifacts that may be considered relevant to the study's research questions. Artifact submissions were requested and accepted for dates that were prior to and during the timeline of the study. Figure 3 illustrates how the researcher collected the data from three separate areas. Each area accounting for the perspectives of the administrators and their experiences.

Figure 3 Data Collection Methods for Triangulation



Data Collection

Beginning with the first phase of data collection, I emailed a letter of interest to participants. Letter of interest email can be seen in Appendix C. Collection of emailed responses that confirmed or declined participation with the study were saved as a PDF and uploaded to Google Drive in a My Drive folder labeled *Dissertation Participation Emails.* If I continued to wait to hear from all eight participants, a follow-up email was sent 7 days after the original email. The follow-up letter of interest email can be seen in Appendix C. I waited for any responses for 7 additional days before forming an email distribution list that blind copied the other participants.

Prior to initiating the study, I obtained permission and approval from the district superintendent, and the informed consent (see Appendix D) of all elementary principals. After getting approval from the Institutional Review Board at Columbus State University, the consent form was given to participants in the invitation email. It is important to note, during the time of this study, health concerns surrounding the COVID-19 global pandemic had altered the protocols for suggested interactions among individuals. I abided by the guidelines of the Centers for Disease Control and Prevention (CDC, 2020) and the local Board of Education policies during all data collections to ensure participants' safety (see Appendix I).

The initial questionnaire was shared through an emailed link to the Google form. I received a notification upon each of the completed questionnaires. Each respondent was allowed to submit one response. All questionnaire data were kept confidential, though not anonymous. Survey data were kept on a password–protected computer under a password–protected database. Data collection procedures were conducted in the timeline described by Table 2 and were stored on Google Drive in a My Drive folder labeled *Dissertation Data Results.* Table 4 reflects the correlation with the items, research, and research questions. I employed analytic memos after the collection of the questionnaire data, as a means of initial analysis (Hays et al., 2016). The content validity of the questionnaire was established from the representation in Tables 5 and 6.

The second phase of data collection took place with the semistructured interview process, similar to that of Wengraf (2001). The interview time and location were agreed upon by the researcher and participant after the researcher received the participant's interest email. A secured Zoom video platform was suggested in place of face-to-face interviews. Zoom meetings were limited to 40 minutes for each session; however, I had the option to extend a longer period of time if necessary; with an additional meeting link sent to the participant through the chat feature. This would have caused the interview to be minimally interrupted with the transition to the next meeting platform. The meetings were recorded and stored in the *Dissertation Data Results* folder of my Google Drive. The Otter App was integrated into the Zoom meeting platform for transcription purposes. All participants were afforded the option to have their cameras turned on or off at the time of the interview.

To strengthen the process of triangulation, each participant was given a copy of the transcripts of the interviews. Ongoing throughout the study, I requested documents referenced in results of the questionnaires and interviews. Documents were secured in digital forms of scans, email attachments, and shared documents. Although I asked participants for these artifacts, I also searched for them on school websites and other media platforms.

Data Analysis

As noted in the review of literature, Brown et al. (2012) and C. Wang and Burris (1997) relayed the importance of reviewing and analyzing requirements of effective implementation of STEAM education. I reviewed results of the questionnaire, interview recordings, and artifacts collected to interpret perceptions of elementary school administrators with STEAM curriculum implementation. Data from each questionnaire were collected automatically and converted to a Google sheet. Zoom–interviewed participants had their sessions transcribed using a free online application called Otter App. All interview data were analyzed manually.

Table 4

Questionnaire Item Matrix

Section	Item	Research	Research Question
Demographics	1-7	Saldaña (2015) Mote et al. (2014)	2
STEAM Curriculum	8. How would you define STEAM curriculum and how it differs from other curricula approaches?	Dell'Erba (2019) Georgia Department of Education (2020)	What are administrators' perceptions of implementing the STEAM curriculum approach to instruction within an Elementary school?
	9. In what format(s) do you participate in making STEAM related professional development available? Choose all that apply.	Bagiati et al. (2010)	
	10. How much time on average are you spending planning and implementing STEAM curriculum opportunities?	Hunter-Doniger & Sydow (2016)	
	11. What drives the need for STEAM curriculum for Elementary students?	Henriksen (2014) Newton & Newton (2014)	
	12. Do you ensure development of Arts integration strategies for your teachers?	Appel (2006) Leysath (2015) Burnaford et al. (2009)	
	13. If you answered Yes to item 11 above, share when teacher trainings/professional learning took place and give a general description of it.	Henriksen (2017) Glass & Wilson (2016)	
STEAM Design Frameworks	14. Have you used a specific model or framework to guide STEAM implementation? If so, which model/framework?	Passmore et al. (2009) Yakman (2008) Schwarz & Gwekwerere (2007) Johnson-Laird (1983) Seel & Dinter (1995)	

	15. What are the elements of the model/framework(s) that you use to implement STEAM?	Yakman (2008) Sanders (2006)	
	16. Does the model/framework(s) follow an interdisciplinary approach?	Herro & Quigley (2016) Kuhn (2015) Wynn & Harris (2012) Harwood (2004)	
	17. How and by whom was this model/framework(s) chosen?	Powers & Dickson (1973)	
	18. What expectations have been communicated to your faculty and staff on STEAM curriculum professional development participation?	Darling-Hammond et al. (2017)	
Components of Curriculum Change	19. What professional learning programs do you use to aid teachers in STEAM curriculum implementation within your school?	Darling-Hammond et al. (2017) Learning Forward (2011)	What are characteristics of administrators who have guided STEAM curriculum implementation?
	20. In your journey to full STEAM curriculum implementation, has there been a timeline associated with professional development expectations for your teachers?	DeJarnette (2018) Schlaack & Steele (2018) Hunter-Doniger & Sydow (2016)	
	21. Do you personally participate in STEAM professional development through collaborations with other schools in your district as a part of a district STEAM focus?	Darling-Hammond (2004) Guskey (2002)	
Future Teachers and Evaluations	22. When looking to employee new teachers, are there particular degrees, endorsements, certifications, etc. that are helpful in STEAM curriculum integration?	Colucci-Gray et al. (2017) D. Kim & Bolger (2017) NGSS; NGSS Lead States (2013) Frolov (2010)	What are administrators' perceptions of implementing the STEAM curriculum approach to instruction within an Elementary school?
	23. In what way is STEAM curriculum integration measured in teacher evaluations?	B. H. Kim & Kim (2016) Jensen (2005)	
	24. How is feedback given to teachers who implement STEAM curriculum in your school?	Eckert & Daughtrey (2019) D. Kim & Bolger (2017)	
	25. How are teacher leaders developed to support STEAM curriculum integration?	Eckert & Daughtrey (2019) Shillingstad & McGlamery (2019) Grillo (2018)	
Principals Roles and Faculty Resistance to Change	26. What type of leader do you consider yourself to be?	Grillo (2018) Boe (2010)	What are characteristics of administrators who have guided STEAM
	27. What is your attitude toward STEAM curriculum implementation?	D. Kim & Bolger (2017) Kong & Huo (2014)	

28. What is your vision for STEAM curriculum implementation in your school?	Muse & Abrams (2011) ISLLC (2008)	curriculum implementation?
29. What kinds of instructional supports do you organize to aid your faculty in STEAM curriculum implementation?	DeJarnette (2018) Hunter-Doniger & Sydow (2016) Herro & Quigley (2016) Learning Forward (2011) Kelner (2010)	
30. Please share any experiences you had with faculty that was resistant to the changes taking place. Be specific with the experience and detailed in the recollection.	Terhart (2013) Immegart & Pilecki (1973)	
31. Do you have any certifications, formal trainings, or experience with STEAM curriculum implementation outside of your school and/or school district?	Georgia Department of Education (2020) Madden et al. (2013)	
32. If you could advise other leaders on how to implement STEAM curriculum, what would be the steps you would take in order of priority?	Barber & Mourshed (2007)	
33. What characteristics do you think a school leader needs to implement STEAM curriculum?	Fullan (1991, 2001) Berends et al. (2001) McLaughlin and Talbert (2001) Berman & McLaughlin (1978)	

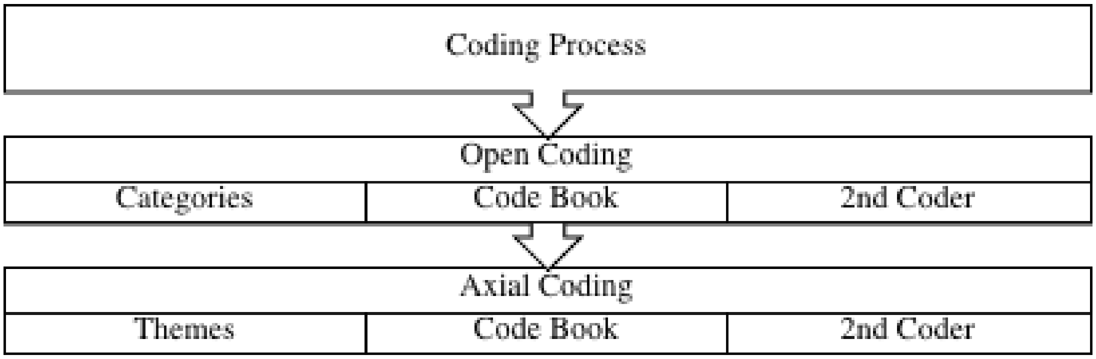
Due to the straightforwardness of the open-ended coding method, it has been commonly used by novice researchers (Saldaña, 2015) and was the first cycle of coding used for this study. Open ended coding relates to the first part of curriculum change theory as it addresses the perspectives of change knowledge. The first research question asks about the perceptions to such change which relates to the second part of curriculum change theory, reconceptualizing curriculum. A code book was created through an exploratory method of first cycle open ended coding. Open-ended coding has been more recently referred to as initial coding whereby the researcher can reflect on multiple data sources and assign quick codes after first familiarizing with the transcriptions (Saldaña, 2015). The goal of completing the first cycle of initial coding was to search for a concept or process that the researcher may further explore in the second cycle of coding. Locating key ideas, themes, and topics as they emerge from the data helped to begin the interpreting and mean making process.

Beginning with reducing the raw data to categorical paragraphs, the researcher labeled the emerging categories. From each category, I reviewed dialogue with participants line by line. Each categorical code was given a description and example to be recorded in the code book to support the reliability of the data. The book was then used to train another coder after first being modeled by the researcher. A basic orientation to the steps of coding was modeled using a calibration whereby the researcher selected a section of the data and shared it with the second coder. The second coder was asked to review the code book for basic definitions of words or phrases and subsequently code the data selection. This form of intercoder reliability was used in a paper by Burla et al. (2008). I provided a scaffolded approach as I compared the second coder's results to mine. A discussion of findings with the second coder took place to determine what evidence was seen that made the second coder use a selected code.

A second coder increased the credibility and reduced bias on the part of the researcher when analyzing the data. For this study, the second coder was the assistant superintendent of curriculum for the district that the researcher is employed. This individual was chosen due to the extensive background knowledge of curriculum development and familiarity with STEAM curriculum. The second coder has participated in the evaluation of other district STEAM certifications and has school level leadership experience as well. With IRB approval, the second coder completed CITI certification and was given defined codes for use with the raw data interview transcriptions. The second coder had access to only the raw data of the interview transcriptions that were shared through an email attachment. Participants' names were replaced with assigned numbers to protect against bias. The second coder was asked to color code the words and phrases in each of the raw data interviews. Based on the code book definitions, the researcher modeled the coding process for the second coder and asked that a table of the total number of codes found within the interviews be supplied. Miles and Huberman (1994) stated codes are tags or labels assigned to units of meaning to the descriptive or inferential information compiled during a study. Codes were attached to each portion of the data, including words, phrases, sentences, or whole paragraphs. After the initial coding, I organized the raw data into categories based on concepts and ideas.

Figure 4

Coding Process



For the second cycle of coding, axial coding was used for highlighting phrases and repeated words (Saldaña, 2009). Again, the curriculum change theory was used to guide identification of changes in the way the teachers were perceived to teach, and students were perceived to learn from the view of the leader. Research Question 2 was addressed here as the researcher noted common characteristics of administrators implementing STEAM curriculum. At that point, subcategories were identified to support generalized categories and concepts. Miles and Huberman (1994) regarded this process of analysis as a means of narrowing the data into valid and respectively exclusive codes. This step of coding helped the researcher to see patterns and deeper meaning as the concepts began to shape into broader themes.

Then assertions and propositions were generated to make connections and reflect on the findings and conclusions of the study. This process was done for each administrator response and reviewed together. Administrative perceptions were reported in a narrative format and organized to display the findings. I generated meaning from the data by noting patterns and by clustering in addition to making contrasts and comparisons to build a logical chain of evidence (Miles and Huberman, 1994). Finally, generated codes were examined against the overarching research questions and through the lens of the literature considering the three phases of curriculum change theory. A thoughtful interpretation of the data aided me in exploring the impact of the details of the implementation process, including the impact administrators had with changing curriculum.

Content Analysis

The last phase of analysis from the collection of artifacts used constant comparative analysis. The purpose of a content analysis was to analyze different kinds of data material, similar to the data found in this study with questionnaires, interviews, and artifacts. This qualitative content analysis contributed a coded and theory guided method for analyzing the questionnaire results, interview transcripts, and how they supported the artifacts. Furthermore, Hatch (2002) asserted school-based inquiry methods could include artifacts of school records, official documents, or any resources referenced in the study. The artifact analysis connected the data through the researcher's inference.

As artifacts were submitted, I documented the time, retrieval method, and description in a table that corresponded with their reference from the coded data. Artifacts were reviewed for relation to coding themes and to what extent they supported the research questions (see Table 7). Triangulation of evidence occurred as I collected data from the questionnaire and interview responses and artifact submissions. Artifact submissions requested via email (see Appendix G) were organized according to themes derived from the coding process. Likewise, artifacts were compared to the transcripts as I sought to create a comprehensive picture of participants' perspectives with regard to each research question. Artifact codes were used in conjunction with transcription codes to triangulate data and provided further evidence to support perceptions of elementary school leaders while offering future implications for curriculum change.

Table 7

Data Driven Comparative Analysis

Code	Description	Reference from interview responses	Artifact(s)
Curriculum Support	Any agencies, trainings, workshops, meetings that guide, support or further establish the curriculum change.	"So, the project-based learning activities, some of them year long, others a little bit shorter."	Schoolwide emails from grade level chairs.
Administrative Role	Leaders who carry out, schedule, plan for, and/or meet to participate in the change process	"We work with them to form a committee."	STEAM Committee meeting sign-in sheets and agendas. Calendars
Observation	Exposures through written, oral, and/or visual occurrences taking place.	"...to have that lesson plan format template and planning template really help make it all fit."	Lesson Plans
Identification of change components	Identifying aspects of STEAM curriculum implementation/curriculum change	"I mean grade level plannings each, each week that we discuss these types of teaching, as well as faculty meetings, discuss these as well."	Grade level meeting agenda Planning guide
Resources	Any item of support that facilitates the curriculum implementation.	"We've come a long way and we've involved the community a lot more."	Email correspondence. Quote Schedule
Management of Professional Development	The ability to research, organize, schedule, budget, and sustain professional development opportunities for staff.	"They've actually been able to attend workshops as well that we are more leaning towards project-based activities."	Flyer Emails of interests Certificates of Professional Development completion

Validating the Accuracy of Findings: Establishing Trustworthiness

Creswell (2013), and Guba and Lincoln (1994) identified four criteria of trustworthiness: credibility, transferability, dependability, and confirmability. Credibility was established by following the model of Guba regarding bias from the researcher and accounting for unplanned events through anecdotal noting. Following the final coding process, participants were sent the reviewed data to establish corroboration in the form of member checking. The purposive participant sampling is an intentional data collection process whereby the researcher sought to gather information to increase the probability of transferability with the findings. The literature and reviewed case studies represent a researched body of knowledge that can be extended to other cases. I recorded procedures with participants to create an audit trail. Audit trails, according to Barroso and Sandelowski (2003) and Volis, Sandelowski, Barroso and Hasselblad (2008), protect against inconsistencies and serve as a means to supply an account for all events in the data collection and analysis process. Record keeping through a journal and electronic timestamps added to the dependability of the study. To further protect the integrity of the study, I reflected on any bias that may have existed regarding participants, school district, and community. The recognition of my active participation and the second coder's affiliation with the school district was evaluated for any assumptions made toward interpretation of the data.

Working to build a relationship of trust among participants was a priority for me. Although I had a professional working relationship with participants, establishing a level of comfort for freely given lived experiences was vital to the data collection. Making early connections with participants allowed me to extend expectations and timelines of data collection. I provided an abbreviated background knowledge of the study, to aid participants in understanding the study's purpose and my intentions as the researcher. Clearly defining the criteria for participation was reiterated at the start of all communications to comfort the participant with helpful reminders. All participants were informed their participation was voluntary and could stop at any time. As the semistructured interviews were conducted, I did not plan to discuss any other topics that may interfere with the establishment of this trust. Remaining grounded in the purpose of the study and process by which the data were collected, guarded against undue bias and infringement on scheduled times. Interview conversations that took place during follow-up questioning centered around the research questions and curriculum change theory as the participant provided responses. I sought to ensure these conversations were as consistent as possible among all participants. Any questions participants may have had prior to the questionnaire and interview were answered. All participants were made aware of when the study concluded, and the paper had been completed.

Just as I attempted to maintain a trusting relationship with all participants, I also sought to increase the credibility of the study with use of a second coder. The second coder provided an additional analysis perspective other than mine. To further address the validity of the questionnaire, a panel of five individuals who have experience with curriculum change were assembled and given a list of questions from the first instrument (see Appendix H). The panel was asked to rate each item on the questionnaire as being essential or not essential to the researcher with an extent to which questions on the questionnaire measured what they were designed to measure, the Lawshe method (Lawshe, 1975) was used. Constructs measured included the concept, attribute, or variable that is the target of measurement. The Lawshe method was completed by five individuals, including teachers and other local school system personnel to assess the validity of the questionnaire. Results of this survey are displayed in Table 5. Based on the Lawshe table for minimum values of content validity ratio (CVR; Lawshe, 1975; Zeraati & Alavi, 2014), a minimum CVR of 0.99 was needed for a given item to be deemed valid. All items and the instrument as a whole were found to be valid.

Table 5

Questionnaire Assessment Validity

Item	CVR	Valid?
1	1.00	Y
2	1.00	Y
3	1.00	Y
4	1.00	Y
5	1.00	Y
6	1.00	Y
7	1.00	Y
8	1.00	Y
9	1.00	Y
10	1.00	Y
11	1.00	Y
12	1.00	Y
13	1.00	Y
14	1.00	Y
15	1.00	Y
16	1.00	Y
17	1.00	Y
18	1.00	Y
19	1.00	Y
20	1.00	Y
21	1.00	Y
22	1.00	Y
23	1.00	Y
24	1.00	Y
25	1.00	Y
26	1.00	Y
27	1.00	Y
28	1.00	Y
29	1.00	Y
30	1.00	Y
31	1.00	Y
32	1.00	Y
33	1.00	Y
34	1.00	Y

For the second instrument, interview questions were assessed in the same manner. A panel of the same 5 individuals was asked to rate each item on the interview as being essential or not essential. The Lawshe method (Lawshe, 1975) was used again to compute the validity of the instrument. Results of this survey are displayed in Table 6. A minimum CVR of 0.99 was needed for a given item to be deemed valid. All items and the instrument were found to be valid.

Table 6

Educational Leadership Perceptions of STEAM Curriculum Implementation Interview Assessment Validity Table

Item	CVR	Valid?
1	1.00	Y
2	1.00	Y
3	1.00	Y
4	1.00	Y
5	1.00	Y
6	1.00	Y
7	1.00	Y
8	0.80	Y
9	1.00	Y
10	1.00	Y
11	1.00	Y
12	1.00	Y
Instrument	**1.00**	**Y**

As evidence of trustworthiness, this type of study relies on credibility. A mechanism to demonstrate credibility or internal consistency is to show the textual evidence is consistent with the interpretation (Avolio et al., 1990). For this study, I checked with participants as to their intended meaning through the process of member check (Guba & Lincoln, 1984).

Summary

The purpose of this chapter was to analyze perceptions of elementary school administrators to produce insight as to implementing STEAM curriculum. The impact leadership has on curriculum implementation can be further understood by the evaluation of this study. The knowledge gained from identifying implementation methods could influence the other school districts that are in pursuit of STEAM curriculum implementation. The qualitative research design used exploratory analysis, open ended coding, and axial coding in conjunction with related artifacts. Chapter IV provides the findings of the data collected and analyzed.

Chapter IV: Results

The purpose of the study was to explore the perceptions of administrators toward the process of STEAM curriculum implementation. The three-phase data collection began with gathering participant results from a Google Form questionnaire, then semistructured interviews, and finally the collection of artifacts. All eight of the elementary leaders asked to participate in this study agreed to do so. To present the data in an organized manner, each of the data sources were presented with the themes that emerged from how they aligned with the research questions. Participants were introduced by the demographic information that was supplied at the beginning of each interview session.

Participants

Of the eight elementary administrators the study sought to secure as participants, all eight supplied data for the questionnaire and semistructured interview. Two participants also supplied artifactual data. Each participant was assigned a pseudonym to protect their anonymity and maintain the confidentiality agreement of the informed consent. Pseudonyms were assigned including Questionnaire Participant (QP) and Interview Participant (IP) with range from QP1 to QP8 and IP1 to IP8. All participants were employed full time by the same school district. The school district is an accredited K-12 school system based in rural west central Georgia. It serves nearly 5,400 students with four elementary schools, one intermediate school, one middle school, one high school, and one performance learning center. Only 2 of the 8 participants had experience as an administrator in schools other than elementary, and all had experience in schools serving Grades PreK–4. Demographic data for participants can be found in Table 8.

Participant 1

Participant 1 is a 47-year-old white female in her 24th year as an educator and her 4th year as an elementary administrator. She has an education specialist degree in education and a reading endorsement certification. She characterized her leadership style as an observer who looks for opportunities to support teachers.

Participant 2

Participant 2 is a 68-year-old White female in her 20th year as an educator and her 13th year as an elementary administrator. She has a PreK-12 special education degree, and an education specialist degree in educational leadership. She characterized her leadership style as available and supportive.

Participant 3

Participant 3 is a 51-year-old White male in his 28th year as an educator and his 12th year as an elementary administrator. He has a master's degree in education and has had experience with CTAE at the high school level. He characterized his leadership style as practical and realistic.

Participant 4

Participant 4 is a 34-year-old White male in his 9th year as an educator and his 2nd year as an elementary administrator. He has a bachelor's degree in elementary education, master's degree in curriculum and instruction, and a specialist degree in leadership educational leadership. He characterized his leadership style as side-by-side, setting examples.

Participant 5

Participant 5 is a 36-year-old female in her 20th year as an educator and 2nd year as an elementary administrator. She has a bachelor's degree in mental handicap, a master's degree in work community and family education, a certificate in disability policy and services, and specialist degree in leadership administration. She characterized her leadership style as democratic and team building.

Participant 6

Participant 6 is a 36-year-old White female in her 28th year as an educator and 12th year as an elementary administrator. She holds a doctorate in education. She characterized her leadership style as transactional.

Participant 7

Participant 7 is a 55-year-old White female in her 21st year as an educator and 8th year as an elementary administrator. She has an education specialist degree in elementary education and a leadership add on. She characterized her leadership style as supportive.

Participant 8

Participant 8 is a 36-year-old White female in her 15th year as an educator and 3rd year as an elementary administrator. She has a bachelor's degree in early childhood education, master's and education specialist degrees in educational leadership, and K-12 gifted certification. She characterized her leadership style as an aspiring transformationalist.

Table 8

Study Participant Demographics

Gender	
Male	2 (25%)
Female	6 (75%)
Highest Attained Degree	
Master's	1 (12.5%)
Education Specialist	6 (75%)
Doctorate	1 (12.5%)
Years of Experience as an Educator	
5-9	1 (12.5%)
10-14	0 (0%)
15-19	1 (12.5%)
20-24	4 (50%)
25-29	2 (25%)

Findings

This study explored the perceptions and characteristics of administrators who implement STEAM curriculum. Three data sources aided in understanding participants' meaning of implementing STEAM curriculum and identifying any characteristics associated with the implementation. The first data source influenced categorization of emerging themes within the semistructured interviews. Ten categories emerged to support what has been identified in the literature review as areas of recurring themes. The interview and artifact data were used to support the findings as they answer the two research questions:

1. What are administrators' perceptions of implementing the STEAM curriculum approach to instruction within an elementary school?
2. What are characteristics of administrators who have guided STEAM curriculum implementation?

The 10 categorical themes presented in the data are explored with the lens of curriculum change theory. The themes are curriculum supports, administrative roles, observations, identification of change components, personnel, teacher responsiveness, metacognition, resources, management of professional development, and environmental/facilities.

Elements of Influence

According to the perceptions of the administrator participants, the initial phase of STEAM curriculum implementation occurred with elements that influenced the progression of implementation. Each element is based on the three major tenets of curriculum change theory as they pertain to the research questions.

Curriculum Change Knowledge and Support

As stated previously by Sahlberg (2005), the curriculum change theory lens begins with understanding change knowledge. Participants recognized in both the interview and questionnaire responses that the knowledge base of STEAM curriculum was important to possess and foster in the school as part of the initial implementation process. This approach to such change was reported to be part of a district focus for helping to prepare students for their futures and was supported as participants discussed their professional growth experiences. Change knowledge on the part of the administrators were found to have taken place in four forms: curriculum supports, administrative roles, observations, and identifying change components.

Curriculum Supports. Starting with curriculum support, participants responded to how they perceived their knowledge base to be built, by working with other agencies to gain understanding. Sources of gaining change knowledge came from different areas to include the local schools, the district, and the state by “visiting other schools” through “central office staff” and Georgia Department of Education workshops. One participant shared how they gained implementation knowledge from the variety of sources as they “attend[ed] several conferences that looked at how the organization from the standpoint of the administrator was developed and how it can be organized in order to form a better framework for the teachers to be able to follow." Other sources were identified by a participant in the forms of "workshops through RESA. And also, the Georgia Department of Ed, this STEAM/STEM, science, technology workshops, there were some I think maybe in [University] but also within the state of Georgia."

Seven administrator participants noted they participated in STEAM related professional development within a hybrid model of a mixture of virtual and face-to-face platforms to gain knowledge of the curriculum. One administrator participated in face-to-face professional development only, and one other noted they additionally attend visits to other STEAM certified schools to contribute to their professional development. A participant administrator regarded gaining professional development opportunities through receiving:

> emails about upcoming resources that are available things that we can tune into we have a tab on the [school district's] website that we can click on to get, you know, ideas about upcoming events, the Georgia Department of Education actually has continued the day with some of the teachers in the school, providing some of the sessions for other teachers and to attend those professional development sessions online, it's helpful for me as administrator, not to lose touch of what the teachers are learning and what their questions are and what support they need.

Administrative Roles. Characterizing the leadership qualities needed to facilitate a curriculum change ranged in the opinions of the administrator participants but held an overall positive regard toward being supportive of the faculty through communication, flexibility, open mindedness, and enthusiastically proactive. Likewise, administrators responded to the STEAM implementation process as an opportunity to supply schools with a new culture of building applied knowledge. Administrators perceived three characteristic roles in this area, managerial,

participatory, and supportive. Administrative roles that carried out, scheduled, and planned for implementation took place within the examples of times when participants attended “grade level planning each, each week that we discuss these types of teaching, as well as faculty meetings, discuss these as well” (IP4). Another participant shared, “My part was just to attend the meetings, support the teachers, provide any resources or supplies that they needed to make sure that they had everything they needed to make sure we could get a certification.”
Administrator participant roles were found to be managerial, participatory, or supportive as they shared perceptions of themselves as different types of leaders including “practical and realistic,” “excellent,” “servant leader,” “supportive,” “servant and transformational,” “democratic,” “transactional visionary,” and “ attentive to details, analyzes things from various perspectives, organized, encourages and motivates individuals to do their best.” Providing knowledge base through their leadership characteristics was expressed with guiding teachers toward a “transactional mode again of thinking of where we want to go and put that in teachers minds and provide the roadmap to get there.” In this instance, a managerial role was employed by overseeing the implementation process with a plan. Another participant administrator offered an example of managerial experience with sharing implementation by “follow(ing) your pacing guide and you stay on course . . . it's a process”

One administrator described them self as “fully supportive and actively involved,” denoting a participatory role as they carried out a vision for STEAM curriculum implementation centered around securing certification, fully embracing a growth mindset among the teaching staff, achieving sustainability with a schoolwide culture of collaboration through PBLs, partnering with other schools, and to have complete integration in a seamless delivery model of non-traditional, student centered classrooms. Although none of the administrator participants have acquired formal certifications in STEAM curriculum implementation, one of the administrators had previously presented in a GaDOE STEAM conference prior to becoming an administrator and had also previously served as a teacher leader in a STEAM certified school. Still, the participatory roles of the administrators found five of them to have reported spending 1–2 hours per week planning implementation of STEAM curriculum opportunities for staff while the three others noted they spent 3–5 hours.

Administrators responded to the second research question with their perceptions of their own characteristics they believed to contribute to guiding the curriculum change.

Open-mindedness and willingness to support ideas were some of the perceptions shared. Giving the teachers what is needed to set up an environment that allows them to accomplish true STEAM–integrated teaching must be supported by professional development, budget, and morale boosting. At times, working alongside teachers during each of these illustrates one's personal investment with the implementation process.

Administrator participants discussed how they support steps taken to prioritize the STEAM implementation process by attending as much training and professional development as possible, researching, becoming familiar with the STEAM application process to be certified, and staying informed of the feedback from the staff. Participants shared defining a timeline through a needs assessment and determining goals that address the needs. Most advice from administrators reiterated the importance of beginning the process slowly, "taking baby steps, and not forcing it all at once."

Observation. Examples were also found of administrators' perceptual observations of student engagement through lessons that incorporated STEAM curriculum. Participants' statements were found to have specific references to students' interactions, with one participant sharing:

> I have seen it grow even more so, initially it began with some garden beds and some areas where students were looking at different projects that involved agriculture so that was our main focus. And now it has grown into more areas where gardens are available for students to collect that data and also we've branched out into chickens and chicken tractors and areas of the school that have naturally occurring problems with holding water, and students and teachers are going out to those areas because they're authentic problems and, and they're looking at the world around them and how they can take those problems and turn them into teachable moments. So, they have grown from a facility where they were looking at just the surface part of those types of lessons that they could embark on. And now, into, more, more of those.

Still, other participants found through project-based learning opportunities the students were perceived to have "far more engaged with projects [and] willingly motivated to come to school and work on those projects they're excited to see the final outcome." The inclusivity of the observations was also illustrated by another participant when the observation was made, "I have watched this develop and watched how the children and especially those children with special needs or have learning challenges, are able to learn and participate and be successful." Participants cited changes in the climate also contributed to what they perceived as increased engagement of the students, with "homey" classrooms and students "out and about, a lot more in the hallways in different areas involved in learning versus just in the classrooms with the doors closed. The environments were said to foster "more collaborative discussions with kids as they're working through projects . . . much more involvement with kids and teachers definitely facilitating."

Moreover, observations of teacher instruction were perceived to have changed in the instructional delivery models. "Before the STEAM implementation . . . the teacher would teach, she would give the students opportunities to ask questions. They did formative assessments and summative assessments. They were pretty much limited . . . because they had to basically put it on paper." Alternative methods of producing mastery of a standard included observations of "when they could show what they knew, being able to code, or when they could show how they really could take a piece of art and be so creative and work with others and show that they were really meeting a standard in that way and everybody felt like that they could contribute to the classroom." Documentation of these observations were also noted in the lesson plan examples provided by teachers with attention to STEAM curriculum.

In addition to the change in instructional delivery, participants also witnessed perceived engagement changes of the teacher whereby "they look forward to going to work, it's not a, I have a job to get money." It is important to note that at the time of the data collection, participants were navigating the COVID-19 pandemic and abiding by recommendations from the CDC (2020). Variables that may have affected instructional delivery were also part of the findings as participants shared teachers did not seem to be disengaged from delivering STEAM instruction despite the hardships of the pandemic. "I'm just amazed at how the teachers and students are still, still doing what they are doing with staying learning, even though we have the different protocols and restrictions in place."

Identification of Change Components. Lastly, components of change were found when changing curriculum approaches. Administrator participants centered their focus around components of mindset, planning, instruction, and connections. As administrators began to implement their own “growth mindsets as one of [their] themes,” they found planning for “two or three years ahead, beginning with the end in mind, and breaking it down into small doable chunks and presenting it to teachers that way and encouraging along the way” was the start of the curriculum change.

Planning for the change to take place required a STEAM Framework Design to guide implementation as noted by Passmore et al. (2009) and Yakman (2008). The most frequently used design framework was project-based learning, as it was selected by all participants. Additional framework designs used included the claim evidence reasoning, school developed models, and the scientific inquiry-based models. Participant 1 stated, “A problem is presented, students research the topic, design a solution, test the solution, refine the solution/design.” Of those models, participants shared a variety of responses as to what the elements are of their framework. Because all participants selected project-based learning, most participants regarded a design process that began with a problem being asked that then followed a design process, the four Cs of collaboration (critical thinking, collaboration, creativity, and communication), intentional planning, authentic and relevant connections. However, even with the variety of element explanations, participants agreed the model follows an interdisciplinary approach as one participant shared:

> Now it's more of an exploratory problem solving, to where they present a world problem. And then we look at all the different things that are impacted, things that we can do to help solve that problem and we allow the kids to generate those ideas, and actually then implement a plan that they come up with to help solve that problem.

Most cited the framework model was chosen by a committee of sorts, either at the district or school level. All framework models were derived from PBL and CER models and adjusted to fit the developmental needs of the students.

Administrator participants drew from their experiences to further identify components of components of curriculum change, by producing data on the use of professional development.

> Being a group of administrators across the four elementary schools that could help each other and with each other in the right direction as far as like professional development or things that have worked in their school that we could try and also the curriculum department is supportive of that. Right now, what we get emails about upcoming resources that are available things that we can tune into we have a tab on the [District] website that we can click on to get, you know, ideas about upcoming events, the Georgia Department of Education actually has continued updates with some of the teachers in the school, providing some of the sessions for other teachers and to attend those professional development sessions online, it's helpful for me as administrator, not to lose touch of what the teachers are learning and what their questions are and what support they need.

Artifacts were submitted of certificates of training completions, flyers, and sign in sheets, that all supported participants' references within the semistructured interview responses. Expectations of participation with professional development were communicated in-person, individually, in small and whole group settings through emails and calendar notifications. Participants noted teachers are encouraged to use STEAM in their classrooms as they work with the committee to participate in a minimum of two professional development experiences. Some of the options for experiences were visits to other STEAM certified schools, conferences, workshops, and teachers were encouraged to share any other forms of professional development that might target types of needs beyond what is done at the school level. Subsequently, formal expectations were communicated in the form of goals that were set forth in the teacher's evaluation platform and in school improvement plans. Several learning programs supported the expectations, including informal sessions led by local leaders and the curriculum department. During these regular teacher-led sessions, plans were developed for project-based learning opportunities. Still, the more formal manner by which participants secure professional development was reported to be by use of the Georgia Department of Education (GaDOE), West Georgia Regional Educational Service Agency (RESA), and the Professional Arts Integration Resource (PAIR) program. Only 3 of the 8 participants have not associated a timeline with STEAM curriculum implementation, and all but two of the administrators personally participated in the professional development.

Professional development that solely focused on instructional practices by administrators clearly identifying the expectation of that change component:

> I think that our teachers are aware that the concepts are thoroughly communicated and understood that that overall comprehension can then be taken and applied in any type of career so teachers that are teaching students how to integrate artistic expression into their writing, even, or how they use technology to code and make tasks that are monotonous and redundant, more efficient, and even when we look at, you know the musical aspects of it that we remember things that are put to a rhythm or rhyme or cadence. And so that, in and of itself those small pieces of functions of how the standards are communicated right now, those strategies of understanding those standards. I think that then goes on to the application process for how that will work with careers that are not yet in our world today.

Opportunities for the implementation of these expectations are afforded by scheduled times for meetings with the involved instructors.

> We have several committee meetings that take place where vertical planning is discussed, and cross curricular planning is taking place. The arts are brought in with music and the computer lab and media, and, and music in art, and all of those are opportunities for us to look at authentic ways that we can represent different lessons and different standards.

Making connections with groups of teachers, content areas, and career paths was also credited for identifying a need for the change in curriculum approach.

> I've seen a lot more of a cross discipline, instruction, with the teachers, and even in the arts, I can go into a specials classroom and see them making the connections with the academic standards as well as with the art standards as well.

Reconceptualizing Curriculum Implementation

After change knowledge perceptions were shared, three areas of reconceptualizing change were regarded with personnel, teacher responsiveness, and metacognition/reflection. Personnel comprised any individuals, groups, or organizations that aided with the training, planning, or integration through a collaborative interaction either at the school, district, state, or private agencies levels. The reactions, feedback, and observations of teachers regarding motivation and morale associated with STEAM implementation denoted the second area of reconceptualization. Lastly, the reflection or the metacognition of the administrators as they thought about observations, trainings, feedback, and personal experiences that influence the implementation practices was the last area of reconceptualization.

When asked what drives the need for STEAM curriculum for elementary students, seven responses were received that conveyed the need for students to see relationships and application of skills that would give problem solving opportunities for integration of content and thus prepare students for a more globalized job market. Six administrators agreed they ensure the integration of arts strategies as a means of fulfilling the curriculum implementation, one administrator relied on the professional development that was afforded to teachers, and one other cited the collaboration with special areas teachers.

> After I became an administrator, I received the most support from our district level personnel in the curriculum department, as well as the Georgia Department of Education, STEM and STEAM technology specialists that facilitated a lot of the professional learning opportunities.

However, areas surrounding personnel, teacher responsiveness, and the use of metacognition through reflection emerged as focal points of reconceptualizing.

Personnel. Administrator participants shared information on the staffing of their school as it related to implementing STEAM curriculum.

> I had several resources available to me in the forms of state support, with our RESA and the Georgia Department of Education, also had support at the district level with curriculum department personnel that were able to come and do individual training as well as small groups.

Most administrator participants perceived employing new teachers with degrees, endorsements, and/or certifications that support STEAM curriculum was helpful. Some asked for work experience and/or knowledge base with STEAM while during the interview process. Administrators measure the integration of STEAM curriculum in relation to the Georgia Teacher Keys Effectiveness System (TKES) Standards 1, 2, 3, 4, and 8 as they look for evidence within lesson plans, classroom observations, and participation with professional development that supports instructional planning and strategies established with previous goal settings. Evaluations take place in the planning, implementing, executing, and reflecting of a teacher’s performance. As seen in the response of one participant: “They have STEAM and plans, and also my principal we, when we are looking through TKES evaluations, we always make sure that our staff are using the STEAM engineering design process and everything that they do.”

Private agencies such as colleges or individual educational programs, were noted to feed the staffing needs of the schools as one administrator commented they have “a partnership with the high school and with Columbus State University our big goal this year was to build partnerships.”

Teacher Responsiveness. Administrators’ perceptions of teacher responsiveness surrounding attitudes associated with STEAM curriculum implementation were synonymous with seeing the benefits of the curriculum as a positive and essential means of educating students. “it's easy for them to come on board, hands down from an administrator as a mandate. It doesn't go over so well, but when it comes from a colleague, it seems to be more effective.” The administrators cited faculty buy-in as a means of achieving successful implementation. “getting the staff on board. They need a lot of persuasion, in terms of transitioning from more traditional style teaching into the STEAM approach.” To gain such buy-in, a participant shared the following approach:

> It was the end of the year, 2015 so we put a plan in place to get buy-in from the entire faculty and staff so we began by giving a questionnaire to the school leadership team. And we took it from there and got buy-in and some were really on board and started pursuing professional development for themselves, they'd actually been doing some STEAM like things in their classroom. And then others. You know what we've just had

no idea and it was kind of hard because there's, there's not a manual for it. You know, it makes it a little bit difficult. There wasn't a straight answer of how to do this, what it meant but what it was going to mean for [elementary school]. So that made it very challenging and so that I think that that piece of it caused a little bit of hesitance, say with a lot of the, with several teachers, not that they were not willing, no one ever said I don't want to. They were willing to do it.

Formation of teams or committees that are composed of teacher leaders that have bought into the initiative was another step that was shared. Further steps were to gain support from the community and work alongside the staff to show a united team approach.

We're looking at maybe a community event to work with other elementary schools. Also, I would like to see STEAM start from preK through high school to maybe look at agribusiness. I think there's a lot of opportunities for STEAM. And we are in an area where we can do a lot with staying with agriculture. It is not just about planning as a lot of things that we could do with STEAM.

Metacognition/Reflection. Additionally, experiences were submitted that denoted faculty resistance to change and how those experiences can be addressed by helping pair teachers who were bought into the change with those who were resistant. References to the process were described as "slow and difficult" by one administrator. Another administrator noted perceptions of difficulty with "keep(ing) the momentum going here and teachers on board and stay encouraged along the way." The lasting effects of STEAM implementation are not as easily identifiable, leaving teachers unable to "see the, the lingering effect of being outside of their grade level and outside of, even our school building." The overall approach was also noted as needing persuasion from the administration "in terms of transitioning from more traditional style teaching into the STEAM approach"

Moreover, reflections on the part of the administrators became part of the reactions to teacher buy-in and push back. "Took a lot of the focus in being their cheerleader and being supportive and in celebrating the baby steps that we made along the way I hope that answers." Without any clearly defined guidelines on how to complete the implementation process, administrators used their experiences and personal beliefs to help guide them:

> I feel that all students can benefit from being that I have a vocational background with John Dewey and learn by doing. I think that that's given me a different perspective of STEAM, more so than maybe a person that's a traditional academic program.

Another administrator shared:

> I was comfortable in it because I believe in the STEAM learning, project-based learning for kids. I truly believe in that kids need that that thinking to prepare them for the world of work when they graduate from high school it's so different than when I finished high school or even when I first started teaching and those kids, finishing high school. Me personally, going from a classroom where high-tech was a whiteboard and colored markers to. That's, that's not sufficient.

Further reflecting on this portion of the reconceptualizing stage of the change process, yielded insight as to the perceptions of administrators regarding their leadership characteristics for implementing the change.

> So, I think actually allowing the teachers to have an opportunity to ask direct questions of other people that have experienced it is probably the best approach and I encourage the faculty to reach out, go to these other STEAM certified schools and also attend these

conferences, so that they can ask those questions and see the implementation themselves.

Teaching Methods

The third stage of curriculum change was found in the adjustment to teaching methods participants observed. Teaching methods were affected by resources made available, management of professional development opportunities, and adjustments made to the environment. Administrators shared resources provided instructional support by offering “wish lists” for resource materials and securing state STEAM specialists to work with teacher groups within small grade-level group meetings would aid in the implementation process.

Resources. Material resources were needed from a variety of sources to aid in lessons and projects.

> We work with our district and we work with other community leaders to ensure that our teachers get what they need. We've been fortunate enough to have what we call I call a STEAM wish list this year and we've been able to get most of all of the things that we need.

More nontraditional resources were noted for the building of supportive structures:

> Oh, we were able to provide, you know, we were working on our agriculture and so we needed, you know, a lot of soil we needed to help them in building the structures, and we provided them with weather accountability so they could keep up with what the weather was doing and we provided them with the ability to collect the rainwater in order to water the flowers or vegetables. We have got chickens in our on our property, and we provided the materials to build the chicken cages, and the houses chicken houses and the feed also have had goats, and we . . . purchased for our teachers a shed for them to store all of their material that they in there for the goats and make sure that they were

secure.

Management of Professional Development. Such changes with resources were also indicated with the management of professional development. “We're also able to look at the resources that have been provided and how they may help one grade level or several.” To support the change in knowledge of the administrator, instructional support was organized through common planning times of vertical alignment and grade level collaborations, supply donations, funding of materials/events/resources, and arrangement of STEAM certified school visits.

Teachers have been given opportunities to take part in virtual training and some in person training in forms of workshops that look at different aspects of steam implementation.

> For instance, one might take place where they look at journals, and how to use those to better facilitate investigative Research Collection, or another might be where they attend the workshop that discusses how project based or problem-based learning can take place over the course of an entire year. And others may vary too but I feel that these types of engaging opportunities for teachers to learn how to better support the students, that's what ultimately builds those successful lessons.

The administrator also requested and scheduled trainings with other agencies and budgeted for teachers to attend conferences and for memberships with professional math and science organizations.

> We also do rely on experts at the DOE. And they also can refer us to other schools that are strong in certain areas to other administrators that we can contact. And there's also resources online. . . . Yes, especially our teachers, management, which is what matters.

Environmental/Facility Adjustments. To assist with supporting the instructional changes, administrators provided adjustments in the work environments, to include not only the classroom settings with "no desks and several alternative seating arrangements" but to the grounds of the school as well. One administrator shared the learning environment was evident and supported in a variety of areas.

> Outside of the four walls of the classroom for sure. Small groups out the hallway kids all over the building in the gardens by the aquarium. Just the learning took place all over the campus. Students were taking their tools and their journals and, in their Chromebooks, and videos and going on a green screen out in the hallway. Support in the outer areas was an adjustment for the mindset of the administrators. Prior to this. We would, when I went in, students would be sitting at desks in a group. Some would even be in straight lines, and some and little pods. The more we got into this I would say students up out of their desk on the floor in groups working, and some students.

Administrators revealed the overall campus was different due to the change in teaching methods from before implementation.

> School campus is a lot different because kids are out there, they're working in the gardens, they're working with their weather station in the aquaponics, so kids are out and about in the school, a whole lot more in the building like a community more than before.

Administrators also encourage teachers to share ideas and collaborate to exemplify a proficiency level on their evaluations. Teachers are also provided feedback during evaluations and observations in the form of comments, notes, recognition announcements, emails, TKES platform, and during STEAM committee meetings for the administrator "to be supportive, and to be helpful in, in the way that I mean, to help teachers get the professional learning that they need and to help them become more confident and comfortable in this way of teaching and supporting kids." Teacher leaders are then developed through this process as professional development supported by the central office, GaDOE, RESA, and STEAM committees refine leader skills. Administrators organize opportunities for the teacher leaders to redeliver information to demonstrate their leadership abilities with organizing schoolwide events, contact community support, and connect with other STEAM certified schools.

Leadership Characteristics

Participant perceptions of leadership characteristics needed to guide the implementation of STEAM curriculum were ultimately found to have common themes of support and practicality. Beginning with the implementation process, responses were noted to include characteristics of enthusiasm, motivation, persuasion, and commitment. Commonly, all characteristics found surrounded school wide culture shifts that were "lengthy processes and relied on the dedication of the leader to the initiative in order to sustain the momentum" (Participant 1). Each phase of implementation required leaders to exhibit certain characteristics and qualities to accomplish the task of facilitating curriculum change. At the start of the curriculum change, example characteristics of support were found in the leaders' ability to start by providing a clear vision and goals to teachers. "My leadership approach is just to be available, and to be supportive and also to provide them with the resources that they don't have what they need" (Participant 2). Good communication skills were also noted by leaders as they shared short term goals paired with clear attainable objectives. Participants regarded suggestions of being patient with building relationships with teachers and supporting them by practicing "open mindedness." In a specific excerpt, one participant shared of their leadership characteristics:

I would say actually observation. I think that seeing it and having an opportunity to talk

> to other people that have experienced it is the best approach, people can watch videos, but sometimes those videos are limited in information they may not necessarily apply to that particular facility. So, I think actually allowing the teachers to have an opportunity to ask direct questions of other people that have experienced it is probably the best approach and I encourage the faculty to reach out, go to these other STEAM certified schools and also attend these conferences, so that they can ask those questions and see the implementation themselves.

As participants shared characteristics regarding the executing phase, comments were made, such as the need for giving "teachers what is needed to set up an environment that will allow for them to accomplish true STEAM integrated teaching has to be supported by professional development, budget, and morale boosting." Planning and intentionality with how steps toward implementation become reality were also traits participants shared regarding being "practical and realistic" (Participant 3).

The importance of leaders modeling was found in examples of administrators "working alongside teachers [to] illustrate [their] personal investment with the implementation process." Although each leader supplied a variety of characteristics personalized to the individual schools served, a summary can be found in Table 9.

Table 9

Self-Reported Leadership Style Descriptions

Administrator Participant	Administrator Response
P1	One that is attentive to details, analyzes things from various perspectives, organizes, encourages, and motivates individuals to do their best.
P2	Excellent
P3	Practical and realistic
P4	A servant leader
P5	Supportive
P6	Servant and transformational
P7	Democratic
P8	Transactional visionary- Focused on how to support teachers, staff, and students with their performance.

Questionnaire/Interview/Artifact

All data sources were considered as a pool of information that was coded together. Each piece of data represented perceptions of lived experiences with STEAM implementation. Questionnaire data and interview data were printed and coded, and the artifactual data pieces were categorized by the same code sources. All interviews were scheduled following participants' questionnaire submissions. Each interview was conducted under the allotted 30- to 60-minute timeframe, as they averaged between 10 to 25 minutes. Transcripts were generated from each interview and read in their entirety multiple times for two reasons. The first reason was to clean up any errors in the transcription by simultaneously viewing the recording alongside the transcription. Each raw transcript had several errors that did not align with participants' actual words. I corrected the errors and formatted the document for easy identification of each speaker by labeling "Interviewer" and "Participant #." Transcripts were then housed in the researcher's google drive dissertation folder and the data then stayed unopened and unviewed for 3 days for there to be a reflection time on the part of the researcher (Clarke & Charmaz, 2014).

The second reason for reading the transcripts multiple times was to follow guidelines on line-by-line coding by Charmaz (2014). This process allowed me to reach saturation with the multiple readings (Glaser & Strauss, 1967). Simultaneously, I created a code book for the second coder to validate the initial coding. An example code book is presented in Table 10.

The affinity diagramming method was used to organize the data from participants with the semistructured interview responses. This method was employed as I recorded ideas that seemed to be related on notecards and then looked to identify the groupings of those cards. A total of 10 initial codes were generated from this method of diagramming interview data. Each of the codes related to the researcher's lens of the theoretical framework as it pertained to curriculum change theory. The three emerging categorical areas of concentration were Change Knowledge, Reconceptualizing the Curriculum, and Changing the Way Teachers Teach and Students Learn. Artifacts were any items that could be used for daily routines created or shared by participants. A total of nine artifacts were submitted through an emailed reply to the researcher's request. All artifacts were submitted with PDF attachments and were sent following the administrator participants questionnaire and interview completion. Artifacts were viewed as they were received and housed in the researcher's data collection folder to be further analyzed following the completion of the data collection process. All nine were shared from 2 of the 8 participants. Of the nine email attachments submitted, each one held multiple scanned documents that when totaled, represented 36 separate artifact documents.

Table 10

Codebook Used in Data Analysis

Code Name/Label	Full Definition	Example
Curriculum supports	Any agencies, trainings, workshops, meetings that guide, support, or further establish the curriculum change.	P1: "Mostly, those from the GaDOE with the application. And the classes, and going and visiting other schools, other schools, and actually seeing the implementation there."
Administrative roles	Leaders who carry out, schedule, plan for, and/or meet to participate in the change process	P4: "I mean grade level plannings each, each week that we discuss these types of teaching, as well as faculty meetings, discuss these as well."
Observation	Exposures through written, oral, and/or visual occurrences taking place.	P7: "More collaborative discussions with kids as they're working through projects or, or whatever they happen to be working on the task, but I would say much more involvement with kids and teachers definitely facilitating"

Categorical coding of artifacts sought to identify trends and execution of actions that were discussed in the questionnaire and interview data. I used inductive reasoning as the artifacts were viewed to delineate any similarities and differences that were stated by prior data. Artifacts were then grouped according to general categories. The categories include Meeting Agendas, Sign in Sheets, Emails, Quotes, Calendars, Certificates, Projects, Templates, Informational documents. The representation of the number of artifacts in each category is seen in Table 11.

Table 11

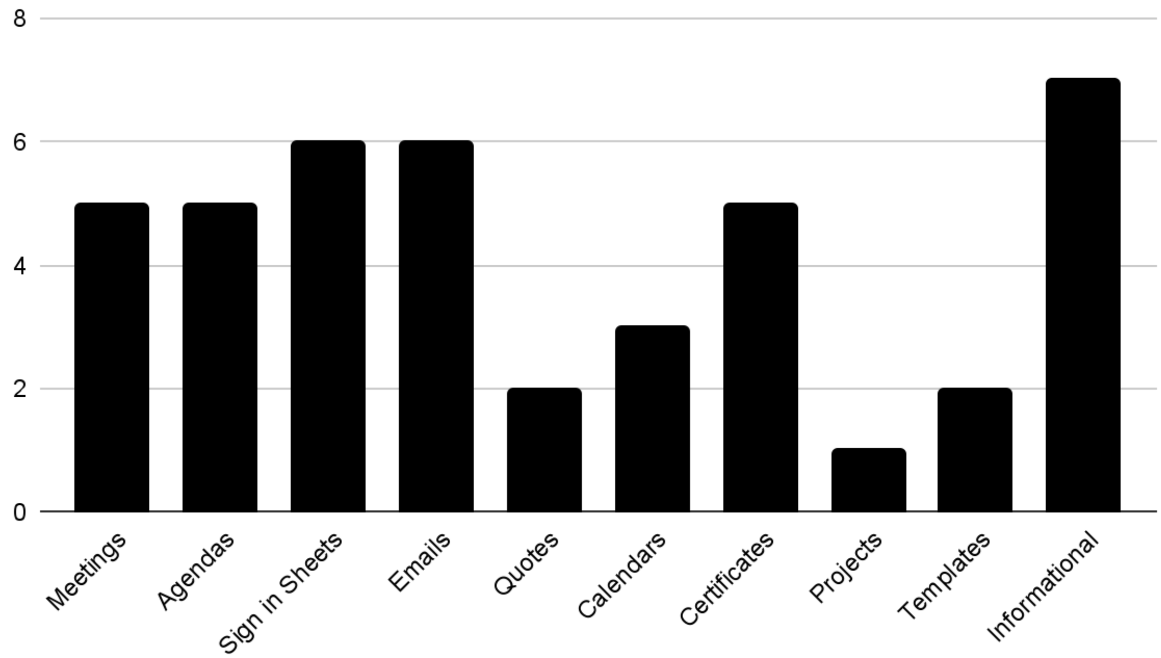
Categories and Codes by Participant

Change Knowledge Category									
	P1	P2	P3	P4	P5	P6	P7	P8	
Curriculum Supports: School	2	3	1	1	1	3	0	1	12
Curriculum Supports: District	0	3	0	0	2	2	0	0	7
Curriculum Supports: State	6	3	3	0	0	2	2	2	18
Administrative Roles: Managerial	0	2	1	0	1	2	0	0	6
Administrative Roles: Participatory	0	0	1	3	4	0	0	2	10
Administrative Roles: Supportive	0	2	1	1	5	2	0	0	11
Observations: Student Engagement/Behavior	4	2	2	1	0	2	4	3	18
Observations: Teacher Instruction	1	2	1	2	0	2	3	4	15
Identification of Change Components: Mindset	1	0	2	1	3	1	1	0	9
Identification of Change Components: Planning	2	0	1	1	5	6	1	1	17
Identification of Change Components: Instruction	2	2	1	2	2	2	1	2	14
Identification of Change Components: Connections	1	1	1	0	0	2	0	0	5
Total Coded Quotes for Change Knowledge = 142									
Reconceptualizing Curriculum									
	P1	P2	P3	P4	P5	P6	P7	P8	
Personnel: School	1	1	1	4	6	0	1	0	14
Personnel: District	1	3	1	2	1	1	2	0	11
Personnel: State	0	0	1	0	1	0	1	2	5
Personnel: Private Agency	0	0	0	0	2	0	0	0	2
Teacher Responsiveness: Push back/Resistance	2	2	1	2	0	2	1	0	10
Teacher Responsiveness: Buy in	0	1	3	1	4	2	2	0	13
Teacher Responsiveness: Initiative	1	0	1	0	1	0	0	0	3

Metacognition/Reflection: Experiences	6	2	3	0	3	3	1	1	19
Metacognition/Reflection: Reactions	3	2	2	2	3	2	5	3	22
Total Coded Quotes for Reconceptualizing Curriculum = 99									
Teaching Methods									
	P1	P2	P3	P4	P5	P6	P7	P8	
Resources: Materials	0	3	1	1	1	2	3	1	12
Resources: Connections	0	0	0	2	2	4	3	2	13
Resources: Funding	0	1	0	1	1	0	0	0	3
Management of Professional Development: Sources	0	2	1	0	1	1	0	2	7
Management of Professional Development: Organization	1	2	1	0	0	0	0	0	4
Management of Professional Development: Research	0	0	0	0	0	0	1	1	2
Environmental/Facility Adjustments: Classroom	1	1	1	0	0	1	0	2	6
Environmental/Facility Adjustments: School	0	1	1	2	1	1	0	0	6
Environmental/Facility Adjustments: Grounds	0	0	2	0	1	0	1	0	4
Total Coded Quotes for Teaching Methods = 57									

Figure 5

Artifact Categories



Summary

Findings of the study were gathered beginning April 16, 2021, and concluded May 16, 2021. The data gathered explored the perceptions of administrators toward the process of STEAM curriculum implementation from three data collection methods. I gained the perceptions of eight individual elementary leaders who were embarking on STEAM curriculum implementation within the same district and code the data to reveal a three-phase process that followed the underpinnings of curriculum change theory. The codes further organized the perceptions of the administrator participants into a logical and systematic process. Summarized results were found to have trends of implementation within the ongoing phase. Personnel have to be restrained with attrition and retirements, including nonteaching roles. Establishing schedules and monitoring progress. Planned development opportunities extended to all. Participants took time to clarify miscommunications/misconceptions and continually meet with those who ignore or resist change. Looked for opportunities to cultivate support with meetings to dispel incorrect notions of what STEAM implementation entailed. References to the process were described as "slow and difficult" by one administrator. Another administrator noted perceptions of difficulty with "keep(ing) the momentum going here and teachers on board and stay encouraged along the way." The lasting effects of STEAM implementation are not as easily identifiable, leaving teachers unable to "see the, the lingering effect of being outside of their grade level and outside of, even our school building." Administrators shared that resources provided instructional support by offering "wish lists" for resource materials and securing state STEAM specialists to work with teacher groups within small grade level group meetings would aid in the implementation process. To support the change in knowledge of the administrator, instructional support was organized through common planning times of vertical alignment and grade-level collaborations. Administrators revealed that the overall campus was different due to the change in teaching methods from before implementation. To assist with supporting the instructional changes, administrators provided adjustments in the work environments, to include not only the classroom settings with "no desks and several alternative seating arrangements," but to the grounds of the school as well. Requesting and scheduling trainings with other agencies and budgeting for teachers to attend conferences and for memberships with professional math and science organizations was another trend. The GaDOE was perceived by participants to assist with referring and connecting to other administrators in the change process. The continuous improvement stage of curriculum implementation was noted as the perceptual data supported these citings by administrators.

Each phase of implementation required leaders to exhibit certain characteristics and qualities to accomplish the task of facilitating curriculum change. Characteristics were identified by three codes with a theme of administrative roles. The managerial coding denoted leaders who manage the implementation process by overseeing the timeline. Active leaders worked alongside teachers and staff to learn the curriculum through experiencing it, and the supportive leaders identified ways to connect with those that facilitated the process by supplying feedback, resources, and encouragement. At the start of the curriculum change, example characteristics of support were found in leaders' ability to start by providing a clear vision and goals to teachers. Good communication skills were also noted by leaders as they shared short-term goals paired with clear attainable objectives. Participants regarded suggestions of being patient with building relationships with teachers and supporting them by practicing "open mindedness." Many of the shared characteristics had traits defined with transactional and transformational leadership.

Chapter V: Conclusions

Summary of the Study

The qualitative data collected from individual elementary school leaders provided perceptions of STEAM curriculum implementation and characteristic traits associated with each of the leaders by answering two research questions:

1. What are administrators' perceptions of implementing the STEAM curriculum approach to instruction within an elementary school?
2. What are characteristics of administrators who have guided STEAM curriculum implementation?

My role as the researcher and research participant was addressed to minimize bias with the results and interpretation of the findings. In this sense, serving a dual role I followed the recommendations of Scapens (2014) with adhering to ethical guidelines included five tenants:

1. Voluntary participation and understanding of the meaning of the study.
2. Not distorting the meaning of participants' voices.
3. Protecting participants' anonymity.
4. Obligation to participants' beneficence.
5. Obligation to nonmalfeasance to study participant(s).

It is believed having these practices in place protected the study from bias of the researcher. Results concluded perceptions of administrators implementing STEAM could be categorized by two phases: initial and ongoing.

Analysis of the Findings

According to the curriculum change framework, leaders must build their own knowledge base of curriculum, observe the curriculum in practice, figure out what their role is to guide the implementation process, and then work to establish mindset and planning instruction and connections. Many of these processes can be identified in the perceptions of leaders in implementing STEAM. The perceived components are:

1. Devise committees that shared goals for the school with a vision and mission statement. (Components – planning)
2. Determine questions to support the school goal and provide yearlong learning opportunities. (Build knowledge)
3. Monitor progress, needs, and monthly updates were scheduled. (Observations)
4. Contact community supporters (Roles)
5. Begin the application process (Components – instruction/planning/mindset)
6. Develop timelines of supports and check-ins (Roles)

The knowledge of the field of education as it pertains to leadership was extended as the findings contributed to the perceptions of the change process.

Change knowledge on the part of the administrators were found to have taken place in four forms: curriculum supports, administrative roles, observations, and identifying change components. Beginning with building for knowledge, the administrator worked to expand their understanding of STEAM curriculum by participating in professional development opportunities. Professional development and collaboration as a means of initiating change are confirmed by the studies of Hunter-Doniger and Sydow (2016) and Herro and Quigley (2016).

The administrator participants perceived value in growing their own knowledge, relating back to Darling-Hammond et al.'s (2017) constructs. Using their knowledge, and observations of other schools and programs led to guiding the administrators' roles as the instructional leader.

The major findings in the summary of the literature were previously organized into seven categories. The literature tells us that there is a need for students to be receiving instruction that centers around STEAM curriculum, based on the components it addresses, and that the instructional role of the leader could be better defined in terms of how the curriculum is implemented. According to Boy (2013), a global competitiveness among educational institutions is inevitable with the increase of daily technological advances. The history of STEAM curriculum was founded upon just that, a series of national and international events that involved the rapid expansion of technology. These advances gave way to legislation and plans to further the progress of education. The launch of Sputnik in 1957 gave way to the establishment of NASA in 1958, followed by the Elementary and Secondary Education Act, Project Lead the Way, and the STEM Strategic Plan, each event scaffolding the creation of STEAM curriculum as it is known today.

Along with the advances in world's technology, also comes an increase with the population. The most recent employment projections from the U.S. Department of Labor, Bureau of Labor Statistics (2020) set a growth in both STEM and STEAM related jobs to 8.8% from the present until 2028. This rate exceeds other job areas by 3.8% with STEM and STEAM jobs receiving an almost $50,000 difference in annual median wages in comparison. To that end, students must be equipped with the knowledge to compete in the future workforce, starting with the earliest of educational institutions: elementary schools.

Although prior curricula may have addressed the current workforce needs, the future needs are not specified, and in fact, may not yet be in existence (Schwab, 2017). Arts integration to STEM curriculum intensifies cognitive abilities that promote autonomy, engagement, and other positive attributes conducive to a successful learning environment (Appel, 2006). Meaning, students would be instructed through an interdisciplinary method that allowed for understanding of application of concepts across disciplines. STEAM curriculum fosters the development of problem-solving skills in students by providing authentic relevant lessons that expand the ways students acquire cognitive, interactional, and creative skills (Herro & Quigley, 2016). Findings of one qualitative study conducted by Root-Bernstien et al. (2008) noted an increase with student success when it was accompanied by the engagement of arts and crafts training. Other studies (Graham & Brouillette, 2016) found student exposure to STEAM lessons had a 13% impact on benchmark assessments.

Still, there were questions around implementation of a curriculum that could be replicated. Some examples of STEAM frameworks such as those presented by Passmore et al. (2009), Schwarz and Gwekwerere (2007), and Yakman (2008) involve the construction of mental models from a discovery or inquiry-based learning opportunity. Scientific inquiry, project/problem-based learning, studio thinking, with about in and through (WAIT), are all noted framework designs within the literature. Frameworks such as these have been an evident factor in education in recent decades (e.g., Johnson-Laird, 1983; Seel & Dinter, 1995) and relate to STEM programs of inquiry learning in education (National Research Council, 2011). The use of inquiry-based learning models is a direct reflection of the application of curriculum change from prior instructional methods (R. Miller, 2011).

The literature review also sought to better understand how STEAM implementation takes place, evidence of successful curriculum change components were identified from the case study led by Novoa et al. (2018), where a compilation of three years of forums was documented for changing a curriculum. The process of change was found to vary with each study in the literature review, but recurring components included studies that were found to incorporate teacher preparation programs and professional development supports like those noted in studies by DeJarnette (2018a) and Hunter-Doniger and Sydow (2016).

Some supports for curriculum change come in the form of innovative approaches to training, as Colucci-Gray et al. (2017) noted. Colucci-Gray et al. said this led to teachers needing to become familiar with self-development, and self-education to keep up with the changes. Likewise, Winarti (2018) chronicled the journey of preservice teachers who were becoming more prepared for STEAM curriculum instruction with the use of 21st century skills. The outcome of this study brought forth an example of how the design of educational curriculum can better prepare teachers for instructing a globalized society. J. V. Clark (2013) referred to the current curriculum models as "factory model school designs that have created dysfunctional learning environments for students and unsupportive settings for strong teaching" (p. 9). Evaluation tools that then monitor curriculum implementation are required from the state to monitor achievement and progress; however, such examinations have been regarded by Jensen (2005) as not being aligned to mastery of content knowledge or how a student can use that knowledge. As seen in the rise of the achievement gap between the United States and other nations. For that matter, the tools by which to evaluate are ineffective when considered for use with the implementation of STEAM curriculum.

As for the individuals who would organize the facilitation of the change, research consistently has shown influences of the principal impact the change process (Berends et al., 2001; Berman & McLaughlin, 1978; Fullan & Hargraves, 1991, 2001; McLaughlin & Talbert, 2001). There is evidence in the McKinsey Report (Barber & Mourshed, 2007) noting the characteristics of the top performing systems, which include policies and strategies that account for differences in organizations. Suggested roles of the principal include:

1. The employment high quality teachers who collaborate
2. The providing areas of growth for teacher leaders
3. The centering of efforts toward student learning and achievement

However, guidelines that shape the policies and strategies for achieving results in these areas are not as easily agreed upon. The Interstate School Leaders Licensure Consortium regards instructional leader as one of the six roles of a leader. Muse and Abrams (2011) found the multifaceted role identifications associated with leaders, resulted in a need to build a broader leadership capacity within schools and school districts. One practical implication gained by the study was the delegation of tasks to form a more shared responsibilities approach. Using assistant principals and other administrative personnel cultivates leadership and embedded professional development. Although change is inevitable, as noted at the beginning of Boy's (2013) literature summary, push back from teachers is part of a normal resistance to change process. Resistance was found in a study conducted by Terhart (2013) where teachers ignored the feedback of assessment results to inform instructional planning. Therefore, the values, beliefs, and actions of administrators are important to identify due to the impact it has on how understanding is gained, problems are solved, and information is processed (P. W. Miller, 2017). Principals often rely on their current knowledge base and make connections based on their experiences (Allen et al., 2015), which makes the role of the principal crucial for carrying out any change.

In 2019, Crumpler and Lewis warned of a problem existing within education regarding the use of a curriculum that prepares students for the future. Understanding the perceptions of administrators with implementing STEAM curriculum is an important part of addressing the problem of preparing students for the workforce of the future (Schwab, 2017). Traits of individuals in an administrative role further explore the leadership characteristics needed to successfully change from a previous curriculum to one that is believed to better prepare students in entering the future workforce (Cook, 2012; Crumpler & Lewis, 2019; Schwab, 2017). Findings of this study were analyzed from a curriculum change theory perspective to understand participants' lived experiences regarding the role played as an administrator during the implementation process (Darling-Hammond et al., 2017).

A deductive analysis of elements, which aligns with the practices of the scientific method. The analysis was used for the coding process and findings were derived from the 32 questionnaire items directly related to RQ1 and RQ2, as seen in the questionnaire item matrix Table 4. Using a qualitative research design, eight administrators from four elementary schools completed a 32-question questionnaire, were interviewed, and provided artifacts. These three pieces of information were used to interpret how administrators perceived the implementation of STEAM curriculum within their specific school environments. Data were also used to determine characteristics of leadership styles that are/were successful in implementing a STEAM curriculum. Responses were then linked to interview questions and artifact collections.

Initial Phase STEAM Implementation

Building Knowledge. Reinholz and Andrews (2020) classified change theory as a framework of ideas, supported by evidence, that explains some aspect of change beyond a single initiative. The theory was used to inform practices and receptions to change such as those seen in complex organizations like school districts that embark on STEAM curriculum implementation. Creswell (2014) further aligned the use of perspectives, like those found with the of administrators, to identifying emergent themes that lead to inductive understanding according to the three parts to curriculum change theory (Sahlberg, 2005). The beginning of curriculum change starts with school administrators seeking knowledge of STEAM curriculum development. They sought to do so through a variety of professional learning, collaborations with other administrators, and local and state supported observations and trainings. This gives administrators a deeper understanding of what the curriculum entails and offers examples from which to establish their own programs. This step directly relates to the theoretical framework of this study by seeking to understand what aspects of the change would have been key features in the change process. Administrators who participated in this study worked heavily with school, district, and state–level supports to aid them with gaining knowledge for the curriculum change based on their perceptions.

At the school level, the establishment of a firm knowledge base sets the leader as the foundation of the change and gives insight for the formation of a leadership committee (ISLLC, 2008). The administrators shared perceptions of identifying teacher leaders and supporters of the change and guide them to positions of leadership within the committee. Administrators perceived managerial, participatory, and supportive roles toward the implementation process. Connecting to Jacobs, Tonnsen and Baker (2004) findings in the empirical literature, he denoted the principal as an instructional leader to support the development of teachers. Further confirmation from the literature is found in Muse and Abrams's (2011) study where principals led by example to build relationships and be a manager of a child-centered institution. Transactional leadership characteristics were also seen when participants accommodated interests for professional learning and observational opportunities with other schools. One study participant considered themself to be a "transactional visionary, focused on how to support teachers, staff and students with their performance" (Participant 8). When asked what type of leader they considered them self to be. Another shared that they were "practical and realistic" (Participant 3).

The transformational leadership styles differ from the transactional leader in that characteristics are associated with altering mindsets, motivation, and ideals. They are change agents and visionaries. To confirm the knowledge of this leadership characteristic, participants shared leadership characteristic descriptions that guide STEAM curriculum implementation to include descriptive phrasing such as "servant and transformational" (Participant 6); "One that is attentive to details, analyzes things from various perspectives, organizes, encourages and motivates individuals to do their best" (Participant 1).

The roles have also been noted in previous studies including those of Bagiati et al. (2010), Grillo (2018), and Moon (2020). The leader works with the committee to grow the knowledge of other teachers by setting forth a needs assessment. A needs assessment acts as an intentional instrument that collects information on degree of mastery of a skill and establishes a baseline for a starting point with implementation by identifying targets and discussing models that would facilitate growth. This approach aligns with C. Wang and Burris (1997) as it confronts a global problem with an insufficient curricula approach and values the input of teachers who are active participants in the educational process.

Administrator participants perceived that following the establishment of a committee, action steps were needed in the following order:

1. The committee devises shared goals for the school with a vision and mission statement.
2. Grade–level questions are determined to support the school goal and provide yearlong learning opportunities.
3. Progress, needs, and monthly updates are scheduled.
4. Community supporters are contacted to bring in real world careers.

5. The application process starts.
6. Timelines of support check-ins are developed.

These actions are perceived by administrators to inform the steps that support district level collaboration mainly with the curriculum and building/facilities departments. To mirror the process by which the leader gained knowledge, the administrator begins to organize faculty opportunities with an established participation rate/requirement. For this step, administrative participants perceived that communicating with the district curriculum department would aid in coordinating the scheduling of local trainings with specialists. Developing opportunities for school partnerships with programs that support the STEAM curriculum change and align with district and state requirements were also part of what this study's participants sought to support and plan for curriculum change. Administrator and district departments budget for these recognized professional learning agencies through federal, state, and local funding sources. Financial support from other sources can also be obtained through community businesses and education partners, of which, are solicited by the teacher-led committee. Any funded projects and environmental changes are presented to the building/facilities department by the administrator. Permanent alterations to a campus are communicated to include information regarding purpose, location, construction plans, and maintenance. When asked How did your school facility, or even just the classrooms, how did they look and function before steam implementation as opposed to how they look and function now, Participant 6 shared:

> Outside of the four walls of the classroom for sure. Small groups out the hallway kids all over the building in the gardens by the aquarium. Just the learning took place all over the campus. Students were taking their tools and their journals and, in their Chromebooks, and videos and going on a green screen out in the hallway. It's just kids. It was lively.

Talking singing movements, all over the place, not just in the classroom.

The administrator perceived that learning was taking place all over the building/facility.

Participants of this study sought to increase their knowledge base even further by attending Georgia Department of Education STEAM conferences, workshops, and webinars. These learning experiences were perceived by administrators to enhance knowledge, connections, and success of program implementation. Furthermore, the state established application process notes the requirements and timeline for certification, driving the formal recognition of full STEAM curriculum implementation.

Roles. Muse and Abrams (2011) cited managerial, participatory, and supportive leadership roles as aiding with building capacity for schools and school districts through embedded professional development. To manage opportunities for embedded professional development, participants shared the perception that establishing goals within the school improvement plan as well as in the TKES goals of teachers was critical for success. A two to three-year professional development plan was created to include timelines of implementation with accountability checks for progress. Subsequently, schedules were then developed to meet with other leaders and teacher leaders in surrounding areas to gain further insight as to understanding the foundational aspects of STEAM curriculum. These meetings mirror the suggestions of Moon (2020) and Yakman (2008), whose findings noted collaboration among administrators and teachers alike impacts the perceptions of participants to align with changing knowledge.

Administrator participants who perceived their roles as managerial not only research professional development and plan for scheduling, they also participate in their own school's trainings to expand their knowledge for what STEAM curriculum implementation would look like in practice. Participation roles were primarily in the form of advisory committees that sought to plan for more STEAM curriculum/project opportunities. This type of committee participation gave the leader insight as to resources, funding, and personnel needs. Powers and Dickson (1973) backed the importance of teacher buy-in when embarking on change efforts. Working side by side with teachers as they grow in their knowledge affirms the leader is willing to put in the time and effort to make the change as well.

Participants of this study played an active and supportive role in professional development and committee meetings. When participants of this study learned how best to facilitate implementation, the plan was shared with the superintendent, central office leadership, and school leadership teams. The plan is also presented to the community in the form of PTO/PTA meetings and shared why the change was taking place, what to expect, and how to contribute. Sharing the plan of change required the administrator to be in a consistent mode of support as an encourager to teachers. Taking time to celebrate small accomplishments throughout the year and building in recognitions for those who meet certain steps within their plan are appropriate ways to deliver encouragement. Participants of this study also connect with partner agencies to give teachers a sense of shared ownership with the community and parents. The example of partnership given by all participants was that of the Professional Arts Integration Resource (PAIR). All four schools retained a working relationship with this professional development source and the administrator participants perceived the program to support STEAM curriculum.

Observations. Throughout the study, participants perceived that carving out time to observe the curriculum change taking place was an important part of the first stages of implementing STEAM curriculum. Participant 1 responded to the questionnaire item 28, which asked what kinds of supports were organized to aid the faculty in STEAM curriculum implementation. Participant 1:

> We provide common planning time, donations of supplies, financial funding for materials or events, resources such as books, organize collaboration with other experienced STEAM certified groups, collaboration with other groups that offer a STEAM product or experience, vertical planning time, and facilitation of professional development opportunities that can support their instructional.

Starting with overall student engagement, participants recognized the use of informal walkthroughs, questioning/response interactions, evidence of established routines/procedures, decreases in discipline (behavior) referrals, and project production as contributing to the perceived failures or success of the process. Participant 7 added a voluntary statement at the conclusion of the Zoom interview:

> I have seen over the last several years, a huge part of students that typically have behavior issues, just get so involved in STEAM, and working on when they have a project that they're working on long term. I just think such a huge difference in kids that are always academically strong that they can really work on the projects and have that engineering mindset. It's just been very good in my opinion to see kids like that, to see them shine in areas that they can shine and then they realize they are smart. So that's, that's been a huge part for me.

Administrators also looked for lesson plan structures that sought to develop instruction reflective of arts integration strategies and teaching methods that supported student-led and project-based learning opportunities. Participant 1 noted they "look for evidence evident in their lesson plans, in their classrooms, has the teacher documented their participation in professional development related to STEAM."

Components. A whole systems view should be used when implementing a new change (Darling-Hammond, 2004). The change, and how it is understood to be related to, effects, and influences elements within a whole was part of the mindset perceived by administrators. Making connections with designated department liaisons/chairs to coordinate across grade levels and content areas to include art, music, PE, media, technology, and theater bring the whole school together. The connections of people and content build for a shared perspective.

Fostering growth-centered mindsets through affirmations of phrases is another component of guiding change that was perceived by the study participants. Change in any form can be viewed as difficult because it is different from what has been done before, and in the case of implementing a STEAM curriculum, there is no guidebook or manual to accomplish the task. This can be an overwhelming challenge for schools, school leaders, and educators to attempt to implement. Affirmations support learning, growing, positivity, and movement toward a goal (Darling-Hammond et al., 2017). The leader can look for opportunities to give meaningful feedback both formally and informally when observing implementation. Providing feedback and further training can strengthen the facilitator's knowledge of what they are teaching, and is an approach perceived by the administrative participants to support instructional changes in the classroom environment.

A third component to the initial phase was setting aside protected periods of time for development of plans that support the learning goals in school improvement plans. Study participants sought to meet with leadership committee members to monitor progress, listen to ideas, and review data to drive planning steps on how to address needs, both present and future.

Using the school improvement plan was perceived to be a structured way to lay out the goals, timeline, resources, and strategies that guide and support the implementation process. Each participant's environment was independent of a strategic plan of actionable steps; however, it was guided by the leader of the school. In all the findings, administrator participants began with a needs assessment, identified growth target areas and discussed models that would facilitate the growth in their respective schools. This approach aligns with Avolio et al.'s (2009) suggestion that if the leader is focused on instruction and goal setting, teaching strategies, climate, and achievement will improve. Leader perceptions of support were evident in all areas of the initial phase and produced a basis for what was needed to reconceptualize a change leading to implementing the new curriculum.

Ongoing Phase STEAM Implementation

Leaders shared the perception of the importance of ongoing professional development throughout the implementation process. The need to "send as many faculty to attend STEAM opportunities as possible so everyone has a better idea of what STEAM is" (Participant 1) was a common response from leaders. As noted in a study conducted by Eckert and Daughtrey (2019), survey responses from participants provided understanding for what could be used by practitioners for improved leadership development efforts. Again, curriculum change theory aligns with this phase of implementation as the administrator's perceptions of STEAM curriculum center around re-conceptualizing the mindsets of personnel, responsiveness, and reflection of implementation. The ongoing phase of STEAM implementation was also supported by continual attention to supplying resources, professional development, and environmental/facility changes.

Personnel Development. Administrators can participate in receiving support from district level employees, who have had more extensive knowledge with implementation on a larger scale. Supported by the best practices shared via research, such as that of Muse and Abrams (2011), who noted role identifications result in building leadership capacity, administrators work with personnel to continue the established shared vision and mission in relation to the work with the curriculum department. The administrator participants shared needs for support and plans for sustainability by frequently connecting opportunities for development with staff members. State-level communications with program specialists regarding the progress of implementation and professional development opportunities are ongoing with the scheduling of planned events that support the goals of the school improvement plan and STEAM vision/mission. The perceptions of the administrator participants revealed to fully implement a change of curriculum, planned development opportunities should be extended to all facilitators involved with the process.

Teacher Responsiveness. As discussed previously in the review of literature, Terhart (2013) suggested adjusting to inherent push back from teachers by having the leader work to clarify misconceptions, misinterpretations, and meet with teachers who ignore the change. Meetings scheduled by committee members build for further teacher buy-in which is also supported by Powers and Dickson (1973) with the need for change by educating through experiences, trainings, and understanding of problems facing students for future success. The administrators in the study worked to learn about how to cultivate teacher support, with conversations and meetings that dispelled incorrect notions of what STEAM implementation entailed. Initiatives with dedications to goals and formations of committees are again supported by the literature, suggesting longer retention of content and application of the knowledge within new environments (Rivet & Krajcik, 2008).

Reflection. Studies by Bandura (1971) and Darling-Hammond et al. (2017) synthesize the importance of participant reflections of lived experiences. Leader reflections on observations, participation with training, workshops, and professional conversations, develop a holistic understanding of how those experiences can add to the building of one's own leadership. Reflecting upon reactions of those undergoing the change process in each stage is supported by the findings of Guskey (2002) whereby the assessment of professional learning can gain knowledge of how to better support from the perspective of the leader.

Resources. Reflections often yield the identification of needs (Hackman, 1986; Voogt et al., 2016). The needs that are crucial for completing an implementation process include materials, partnerships through both physical and networking means, and funding. Fullan (2009) found leadership operating in conjunction with partnerships were reflective of more effective leadership styles. Administrator participants perceive that building relationships with partners affords opportunities for resources such as materials, donations, and expertise to be lended, which ultimately assist carrying out the change in organization. Relationships built with partners further establish support of resources needed to fund projects through a variety of sources and give guidance for management of accounts through established procedures with purchases.

Professional Development Management. Management of professional development is an ongoing part of administrative responsibilities (Herro & Quigley, 2016; Hunter-Doniger & Sydow, 2016). Continuous improvement with opportunities should include: (a) observations, (b) workshops, (c) webinars, (d) university programs, (e) collaborations with specialists in the field, and (f) STEAM program specialist collaborations.

Administrators work through local Regional Educational Service Agencies, the Georgia Department of Education, Professional Arts Integration Resource, and district area teacher leaders/support personnel to coordinate and communicate professional development that matches the needs of the group. As noted in the research of Darling-Hammond et al. (2017) and Hunter-Doniger and Sydow (2016), models of professional development such as these have been proven successful with curriculum changes.

The 36 artifacts that were collected helped to contextualize participants' questionnaire and interview responses in their real–world settings. Evidence was only found for areas involving tenants of curriculum change and teaching methods seen in Table 12. There were no artifacts submitted that corresponded to personnel, teacher responsiveness, metacognition/reflection, and environmental/facility adjustments. Administrators perceived participation and endorsement of projects such as the one in Appendix J would provide reconceptualization opportunities for teachers to further their own professional knowledge and grow their abilities with the change in curriculum. PBLs have been referenced for use in the literature to support problem solving using inquiry methods (Hmelo-Silver, 2004).

Table 12

Artifact Correlation to Change Theory

Element of Influence	Artifact	Participant reference	Appendix
Curriculum Change	PBL- submissions by grade level	"Members of the curriculum department have met on a regular basis with teachers to design PBL's with alignment to the state standards."	Appendix J
	Schedules	"Local, state, and in-house- The district curriculum department works to provide supports with instructional technology integration, cross-curricular lesson and unit planning, and arts integration. State STEAM specialist are scheduled to work with groups of teachers in individual grade levels."	Appendix K
Teaching Methods	Lesson Templates	"I look for evidence evident in their lesson plans, in their classrooms, has the teacher documented their participation in professional development related to STEAM."	Appendix M
	Professional Development	"The teachers have been provided the professional developments and it is required in their lesson plans."	Appendix N
	Community Supports	"STEAM curriculum implementation, to be authentic and sustainable, takes buy in from the district leaders, teachers, parents and community. "	Appendix L

Environmental/Facility

Classroom observational evidence of STEAM implementation is supported by the findings of Bruner (1996) and Leysath (2015) as it aligns with changing the way teachers teach and students learn. Seating arrangements, materials available to students, displays of previous projects that employed design thinking, interactions with students and student-led lessons, and alternative assignments are examples of how a change is perceived to take place within the classroom environment. At the school level, Vygotsky (1978) wrote learning environments should support the learner to provide opportunities for sharing different problems encountered with learning. In this way, administrator participants worked with committees to identify building changes that needed to be made by developing proposal plans with vendor(s)/contractor(s), materials, cost, location, time of overall alteration to grounds; ensure the projects directly correlate with a learning objective. These actions further support the participant's perception of how to approach a curriculum change by noting specific components that are needed within the learner's environment.

Leadership Characteristics

Based on my interpretation of leadership characteristics ascertained from the questionnaire, interviews, and artifacts, two leadership styles were identified. Characteristics most identified within the study were transactional and transformational (Bass & Riggio, 2010; Burns, 1978).

Transactional Leadership. Kuhnert and Lewis (1987) described transactional leadership as exchanges that take place between two groups. In this study, the two entities can be identified as the leader and the teachers. As participants embarked on the initial phase of curriculum change, buy-in was needed to gain support. Supplying teachers with knowledge of the new curriculum, materials, and planning lend to the characteristic traits that are predominantly found in a transactional leader. Participant leaders gave explicit examples of setting forth expectations to teachers that included the art of building trust. Transactional leadership characteristics were also seen when participants accommodated interests for professional learning and observational opportunities with other schools. Participants shared leadership characteristic descriptions that guide STEAM curriculum implementation to include descriptive phrasing such as "servant and transformational" (Participant 6). One study participant considered I to be a "Transactional visionary- Focused on how to support teachers, staff and students with their performance." (Participant 8). Another shared their leadership style is "one that is attentive to details, analyzes things from various perspectives, organizes, encourages and motivates individuals to do their best" (Participant 1).

Transactional leaders have characteristics that provide managerial support with personnel, resources, and training. They are logical and systematic.

Transformational Leadership. Burns (1978) first described transformational leadership as having characteristics of a change agent and visionary who set forth new goals. A transformational leader alters the mindsets of followers by providing a model for, in this case the school. They promote cooperation toward a common goal. The effects of a transformational leader are seen in the culture of an institution as their actions center around a focus of teamwork regarding personal feelings and needs of others. The transformational leader grows followers by challenging them to look at current practices and rethink how they can be improved. The transformational leadership styles differ from the transactional leader in that characteristics are associated with altering mindsets, motivation, and ideals. They are change agents and visionaries. To confirm the knowledge of this leadership characteristic, participants shared leadership characteristic descriptions that guide STEAM curriculum implementation to include descriptive phrasing such as "servant and transformational" (Participant 6); "One that is attentive to details, analyzes things from various perspectives, organizes, encourages and motivates individuals to do their best" (Participant 1). Within the second phase of ongoing STEAM implementation, the characteristics of the leader were regarded as more transformational whereby organizational culture shifts were taking place with the expectations of STEAM curriculum implementation.

School and district leadership approaches can sustain the curriculum implementation process. A transactional leadership approach logically and systematically identifies the concrete execution of the change process with resources, personnel, and materials. This approach is important as the administrative participants' actions in the change process are crucial in setting the tone for change by catering to the follower's self-interests (Bass & Riggio, 2006). Scaffolding from the transactional leader's implementation approach is the transformational leader, who seeks to plan for the future of the change with professional development, growth of teacher leaders, and partnerships with stakeholders. The impact of the transformationalists' approach was considered by Burns (1978) to be uplifting and motivational, which ultimately supports the longevity of a change.

Participant leaders in the study exhibited characteristics that shifted away from transactional leadership toward transformational leadership as the implementation process continued. Leaders were working more closely with motivating and sustaining the curriculum change. More teacher leaders had emerged and were making strides to cultivate an intrinsically motivated climate.

Historically, Immegart and Pilecki (1973) cautioned leadership styles must account for constant change and transformation. In the same way, the authors found perceptions of implementation and the leadership competencies of the administrator make it possible to build capacity for changes in other areas besides curriculum approach. The nature of transactional leadership works to understand and compare changes that may be needed or beneficial, while a transformationalist wields and forges the future of the consistent change process. The potential for a successful impact relies heavily on the leadership characteristics involved with guiding implementation. If the following has not yet built a knowledge base and understanding of the curriculum, a transformational leader would not be productive because they would be too idealistic without concrete foundational understanding. However, if the following has a firm foundational knowledge of the curriculum, a transformational leader would serve as a continued support in driving and sustaining the change through planning for the constantly changing and complex future of education.

The determined model of STEAM curriculum implementation is directly tied to the leadership style of the administrator and was further seen in participant administrators' statements when asked to share advice. They denoted, "Work[ing] alongside the staff and show[ing] a team united approach. Set[ting] goals and celebrat[ing] accomplishments." (Participant 7) as well as "Take it slow. Gather interested teachers to help get buy-in. Share 'The Growth Mindset' with teachers and maybe even begin a book study to help get teachers to understand the importance of learning from mistakes. Start sending teachers to other STEAM schools to visit. Implement one or two STEAM integrated activities in the first year and then increase from there. Hold a STEAM parent night (The excitement from parents will help win teachers over.) Continue to meet with grade levels and the faculty as a whole and let them see that we are all learning this together. Work with the district level STEAM experts to meet with teachers. Work with the State Department to arrange pre-visits as they will provide valuable feedback along the way" (Participant 5). Both examples are indicative of the transformational leadership approach and where the curriculum change had been implemented for a minum of three years. However in lesser established STEAM curriculum environments, study participants shared more transactional leadership approaches as they cited advice with "Start[ing] with why STEAM, provide lots of professional development to include visiting a STEAM school in action, begin small, don't force it all at once" (Participant 4) and more reachable goals of "Research components of STEAM, visit other STEAM certified schools, send the faculty to lots of professional development opportunities in hopes that they get on board, become very familiar with the STEAM application and process to be certified" (Participant 1).

Limitations of the Study

A summative approach to qualitative content analysis has certain advantages. It is an unobtrusive and nonreactive way to study the phenomenon of interest (Babbie, 1992). It can provide basic insights into how words are used. However, findings from this approach are limited by their inattention to the broader meanings present in the data. The small sample size of eight administrators within one school district limits the transferability of the findings. When considering the research of others, small sample sizes were a side effect of studying phenomenon such as that of implementing a new curriculum. At the time of the study, there were only seven elementary–certified STEAM schools in the state of Georgia. But for the transferability, the limitation of elementary administrators could be further explored to include other districts and instructional leaders (instructional coaches, teacher leaders, curriculum supports from central office). Experience levels of the sample size participants was also considered a limitation in that they had less than 5 years of experience with STEAM.

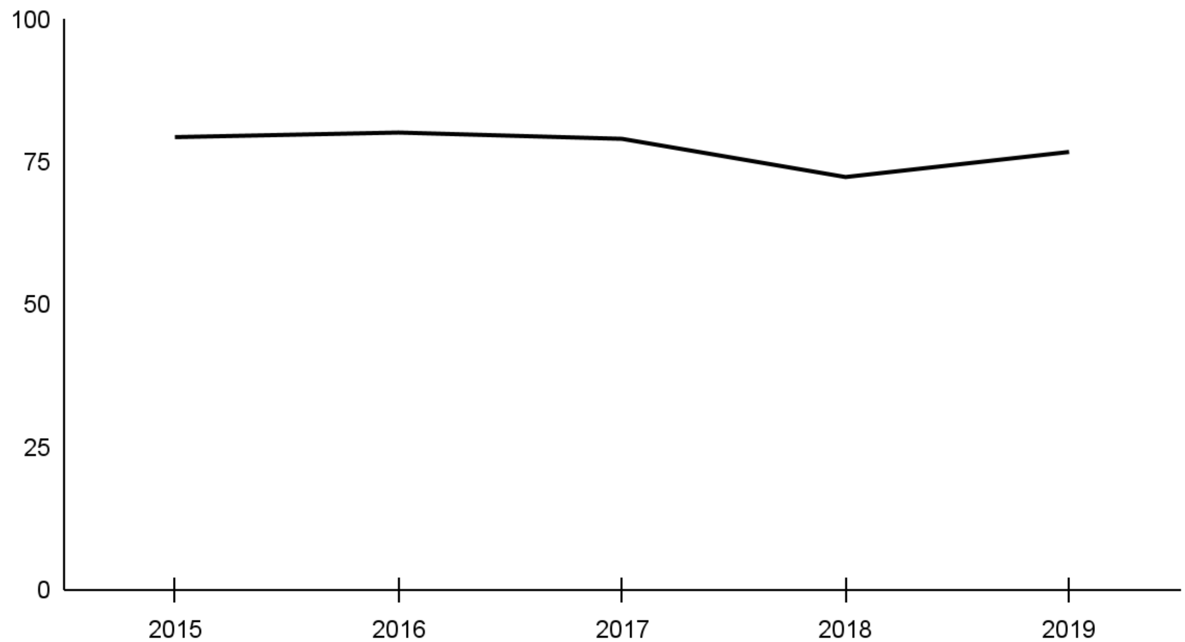
Because there is limited research in STEAM, qualitative may be best avenue to start to identify themes to study more extensively. However, findings from this approach are limited by their inattention to the broader meanings. The limitations of the study include inability to account for the wide variance of approaches to STEAM curriculum implementation regarding accessibility to resources, professional learning opportunities, and stakeholders. It is also difficult to identify causality as this study is exclusive to individual perceptions and opinions of implementation. The narratives are subjective to the interpretation of the researcher and can innately produce researcher bias. Likewise, participants' experience levels with elementary STEAM curriculum implementation were limited to no more than 5 years for each individual participant.

In Section 3 of the questionnaire, participants were asked for the elements of the framework models that they used to influence implementation. Further refinement of this question may have yielded clearer results from participants as the data gathered from the responses reflected highly varied answers. Participant responses were paired with artifactual submissions. Only two participants submitted artifacts, attributing to supporting data being submitted from only 2 of the 4 schools, thereby leaving areas that were referenced in the questionnaire and interviews unable to be triangulated. This issue posed an especially challenging problem for the researcher as an active participant. The role of the researcher as a participant in the study innately yields a bias although the protocol for data collection was strictly adhered to. The researcher gave particular attention to reporting on only the information that was supplied by the other participants and a second coder was purposely used to mitigate bias as was the use of recorded procedures to generate an audit trail of electronic timestamped collections. As the researcher produced an analysis of the findings, assumptions were not disclosed on the part of the researcher, even if the researcher had outside knowledge of the information.

The far reaching and varied approaches to STEAM curriculum are individualized to each school environment and therefore would have to be differentiated with their respective implementations. One study could not account for all the varieties of approaches; however, regarding outside factors that may have been affected with the implementation of STEAM curriculum, a comparison of college and career readiness index was reviewed for the elementary schools within this district between 2015 and 2019. A 7.8% decrease between the 2016 and 2018 scores. Although there are considerations for other variables to be at work during this time, it may be implied that this dip in scores is attributable to implementation of STEAM curriculum. The presence of other limitations surrounding COVID-19 protocols challenged the study as well, with specific regard to lessening the face-to-face collaborative process. Schools were subjected to following social distancing and refraining from sharing materials. They were also limited with their overall movements in the building. For the teachers, professional development opportunities were only available through virtual platforms.

Figure 6

College and Career Readiness Index Elementary Overview



Recommendations for Future Research

It is important to recognize the variety of data sources from participants as well as artifacts that can be used to improve the design of this study. When seeking to increase the generalizability for others, this study yields actionable steps to guide schools with the implementation process. More research is needed in STEAM curriculum implementation within the elementary setting, and although administrators from the study seemed to have a common perception of the importance of STEAM, how the implementation occurred varied.

Recommendations that would aid for future research collection are:

1. Professional development plans
2. Student achievement correlations
3. Longitudinal studies
4. Collections of teacher perceptions

Strategies to further support the establishment of specific timelines that address professional development would aid with providing teachers a clearer plan of scheduled implementation. District or schoolwide calendars that reflect these benchmarks would illustrate the timeline of goals.

In this study, student achievement data was not collected. Further exploration of how the perceptions of STEAM implementation correlate with rates of student achievement would either support or oppose the use of the curriculum. Gaining achievement data from schools that employ the use of non-STEAM curricula and comparing it to others that use STEAM curricula would be another step toward understanding the effects on student performance.

The study was conducted within a 9-week period. However, artifacts and participant responses confirm that the implementation process spanned years. Future research could focus on longitudinal data to discuss time allotments for each phase of implementation. From this research, benchmarks could be established for achieving certain aspects of the curriculum change. More broadly, a longitudinal study may provide guidance for shifting to any program or practice.

To expand on the role of the administrator, a case study of teacher perceptions and experiences with STEAM implementation may provide an insight and comparison to a more participatory role, rather than leadership role. Future studies can focus on the more specific parts of curriculum design regarding teaching methods and learning experiences.

Brumley (2011) discussed leadership styles being indicators of successful change. School districts could prepare their school leaders to implement change by first defining their own leadership styles and school level roles. An interest inventory would give a baseline for how to move forward with structuring change and planning for individual leadership styles. As the leader is more aware of their own characteristics, they may more successfully identify their own roles within the implementation process.

Implications of the Study

Previous research did not directly address the perceptions of administrators with their individual approaches that guided the change. With knowledge gained from the perspectives of others who have worked with implementing a curriculum change, one can use their lived experiences to guide and inform their own practices of curriculum change. Because we have these results, we now have an empirical foundation for things that we need and things that are useful. There are now perceptual and characteristic implications for the field of education with attention to how administrators guide the curriculum change process in their respective schools. By building a growth mindset within the faculty for accepting change as part of addressing the problem of current curriculum methods administrators may begin the change process. Knowing that what has previously been used is not preparing students for the future administrators can foster a "why" or purpose for supporting a shift from current practices. In this study, administrators noted collaboration was a significant part of implementing STEAM curriculum. Prior to building for a change in curriculum, leaders must ensure teachers are prepared for the highly collaborative nature of STEAM implementation.

Administrators also possess leadership styles that affect the change process and because of the characteristic findings, an appropriate step might be to create an administrative cohort as an educational practice. Establishment of a leadership cohort that pairs administrators at the initial stages of implementation and those who have accomplished certification status. Administrative cohorts could better inform the time, resources and support needed when embarking on a curriculum change. Throughout the study, the data cited meetings and discussions that took place with the other school leaders. They planned, researched, and shared practices, making the change process one of collaboration. In this sense, leaders as the change agents, exhibit characteristics of:

- Management – Providing the time, resources, and professional development support needed as an essential part to any curriculum change.
- Participatory – actively learning the curriculum components and creating opportunities for applying reconceptualization of the new approach
- Motivation – buy-in, expectations, support through feedback, observations, encouragement of changing teaching methods, and building relationships of trust

A pacing guide for district implementation (all had mentioned following a timeline—the result could be having a 2-/3-year plan with a formal planning process would be beneficial). The creation of a pacing guide would unite the shared experiences of administrators as they worked to change a curriculum. The district in this study would benefit from such a document because it would deliver instructions for how to institute the process at other schools, thereby saving time and resources during the trial-and-error phases of change.

When seeking to increase the generalizability for others, this study yields actionable steps to guide leaders with the implementation process. Now we know if an individual or organization sought to begin a curriculum change process, they would first start with building for a growth mindset, cultivate buy-in and building of knowledge of the curriculum. They would then move to guiding opportunities for collaboration and provide resource management.

The research of this study has shaped the field of STEAM curriculum implementation by sharing historic accomplishments that led to establishing a foundation for the change in curriculum and providing perceptions from those who have embarked on its implementation.

Previous research did not directly address the perceptions of administrators with their individual approaches that guided the change. With the data collected, one can conceptualize the constructivist experiences that are available to students.

Unconnected to the journeys of the administrators, it was noted that at the time of the full implementation of the curriculum change process, there was a district wide focus for Google Classroom Certification. Integration of technology and technology instructional supports became a vital part of the daily expectations of teachers and administrators. This was in part in response to COVID-19 and school closures; however, it's implied benefits of technology integration can be noted for support of STEAM curriculum implementation. As of August 2021, 76 of the reported elementary staff were Google Level one certified.

Dissemination of the Findings

It is the intention of the researcher to share the findings of this study through a summary presentation that will be submitted to the researcher's curriculum department and local school board of education. The findings were shared with participants in the same manner, but individually from the curriculum department and board of education presentations. I was accessible to answer questions from the groups following dissemination of the findings. Likewise, the summary presentation was shared with participants and the second coder. I plan to submit conference proposals for areas related to this field of study.

Conclusion

Administrators who participated in this study were frequently involved with the district–wide focus of the curriculum change process. They sought to learn components of STEAM curriculum and use that information to support an initial shift within their respective schools. The administrators favored the importance of this shift as they observed firsthand the benefits of creating a learning environment that guided authentic learning while providing the staff teaching autonomy.

Research Question 1 gathered administrators' perceptions of implementing the STEAM curriculum, which indicated teachers and students are directly impacted by the organized support of the leader. The impact of this question revealed administrators saw relevance in the need to transition from traditional to STEAM–based curricula. The transition took place in two phases that included initial and ongoing. Although perspectives shared were varied in actionable steps, the presence of managerial support was prevalent. Based upon findings of this study, administrative experiences guide and shape the success of transitioning from one curriculum to another. From their shared opinions, they can alter the trajectory of how, when, and to what extent changes take place as they are directly tied to management, resources, personnel, and morale of the staff. The implementation process is further guided by seeking the collaboration of others who have successfully completed full STEAM integration and not solely relying on the intuition of their own leadership abilities.

Research Question 2 yielded the types of characteristics that are possessed by administrators who guide STEAM curriculum implementation. Regarding the two phases of implementation, administrators viewed themselves as transactional leaders within the first phase and transformational leaders within the second phase. Moreover, characteristics of administrators who have guided STEAM curriculum implementation were grounded in relationship building. Relationships were built with teachers, community members, other administrators, and outside agencies to provide a strong foundation for beginning the change process. Data gathered from the administrators indicated positive trends associated with leadership skills that foster support while managing the resources and environments.

Ultimately, assertions from this study were founded on evidence of what type of perceptions are made as curriculum changes occur and to what guiding characteristics are needed to guide such change. As a district, the elementary schools are leading the way with the implementation of STEAM curriculum. The state department contracts the use of teacher leaders within the certified schools to facilitate ongoing professional learning. The recognition from the state in this manner is yet another affirmation of the success of the district's initiatives toward implementing a full STEAM curriculum. With STEAM curriculum offering an innovative approach to the problem of preparing students for the future workforce, the research of how to support this implementation remains to be imperative.

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Appendices

Appendix A

CITI Program Certificate

CITI PROGRAM

Completion Date 12-Dec-2020
Expiration Date 12-Dec-2023
Record ID 39983919

This is to certify that:

Allyson Douthit

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

RCR Basic Course
(Curriculum Group)
Research Involving Human Subjects (RCR)
(Course Learner Group)
1 - Basic Course
(Stage)

Under requirements set by:

Columbus State University

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?wbd06f883-132b-4e4c-9491-7a551ae84d9e-39983919

Appendix B

CITI Program Certificate

CITI PROGRAM

Completion Date 06-Mar-2021
Expiration Date 06-Mar-2022
Record ID 41380884

This is to certify that:

David Dennie

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

RCR Basic
(Curriculum Group)
RCR Basic
(Course Learner Group)
1 - Independent Learner
(Stage)

Under requirements set by:

Independent Learner

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?wb6a85d57-38d8-459a-958b-b14e3b16ef80-41380884

Appendix C

Letter of Interest Email

Letter of Interest Email

Dear __________________,

My name is Allyson Douthit and I am currently a doctoral student at Columbus State University. I'm emailing to ask you to participate in a study I am conducting to explore the experiences of administrators who implement STEAM curriculum in the elementary school setting. If you decide to participate in this study, you will be asked to participate in a 30-60 minute interview (your choice of virtual or face-to-face) at a time/day of your choosing.

Participation is completely voluntary. If you'd like to participate, please let me know by responding to this email. More information regarding the logistics of this study will be determined upon your agreement to participate. Additionally, I can be reached at douthit_allyson@columbusstate.edu if you have any questions about this study. I look forward to hearing from you!

Sincerely,

Allyson Douthit
CSU Doctoral Student
706.325.6810

Appendix D

Informed Consent Form

INSTITUTIONAL REVIEW BOARD

Informed Consent Form

You are being asked to participate in a research project conducted by Allyson Douthit, a student at Columbus State University. Dr. Anna Hart, a faculty member in the College of Education and Health Professions at Columbus State University will be supervising the study.

I. Purpose:

The purpose of the study is to explore the perceptions of administrators toward the process of STEAM curriculum implementation.

II. Procedures:

Elementary administrators will be contacted to participate in this study via email. Once consent has been given, a semi-structured interview will be scheduled. The interview will last approximately 30-60 minutes and will be recorded and stored on a shared Google Drive that only Allyson Douthit and Dr. Anna Hart have access to. The interviews will take place in a setting of your choosing (face-to-face or virtual via Zoom). Participants will be given the option to have cameras turned on or off at the time of the interview. The data collection phase of this study will take nine weeks to complete. Data collected during this study will be retained by the researchers for one year after completion and may be used to triangulate. At no time will the identification of any participants or settings be revealed in any context.

III. Possible Risks or Discomforts:

Because this study involves discussion on reflections of experiences, participants may be reminded of emotional, social, and/or economic situations they experienced as a result of the implementation. Additionally, the pre-existing relationships among participants and researcher may cause discomfort when sharing perception during the interview. To mitigate these effects, participants will be given the option to discontinue participation at any time without consequence.

IV. Potential Benefits:

You will receive no direct benefit from participating in this research study. However, your responses may help in better understanding how to implement STEAM education at the elementary school level.

V. Costs and Compensation:

There is no compensation for participating in this study.

VI. Confidentiality:

You (as well as your school/school system) will be assigned a pseudonym. Only Allyson Douthit and Dr. Anna Hart will know the pseudonym. The pseudonym will replace your name on all written documentation related to the study. As mentioned, you will have the option to be interviewed face-to-face or electronically via Zoom. Each interview conducted via Zoom will be assigned a unique meeting web link and entry password, ensuring only the researcher and you as the participant will have access to the meeting space. IP addresses will be collected, as Zoom does not allow users the option to not have this information harvested; however, Zoom uses end-to-end encryption, meaning data will remain secure. Collected electronic data will be stored on a password-protected shared Google Drive only accessible by the PI and Co-PI, while data collected in hard copy/paper format (researcher field notes, etc.) will be stored in a locked cabinet in the PI's office. Data will be retained for one year after the completion of the study, at which time all raw data will be permanently deleted or shredded, as appropriate. As mentioned previously, at no time will the identification of any participant or setting be revealed in any context.

VII. Withdrawal:

Your participation in this research study is voluntary. You may withdraw from the study at any time, and your withdrawal will not involve penalty or loss of benefits.

For additional information about this research project, you may contact the Principal Investigator, Allyson Douthit at 706-325-6810 or douthit_allyson@columbusstate.edu. If you have questions about your rights as a research participant, you may contact the Columbus State University Institutional Review Board at irb@columbusstate.edu.

I have read this informed consent form. If I had any questions, they have been answered. By signing this form, I agree to participate in this research project.

____ ______________________

Appendix E

Google Form Questionnaire

Google Form Questionnaire

Section 1: Demographics

1. Please select your gender.

Answer options: Male, Female, Prefer not to answer

2. Please select your age.

Answer options: 18-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75+, Prefer not to answer

3. Please select the highest degree or level of schooling you have completed. If currently enrolled in a degree-seeking program, select the highest degree received.

Answer options: Bachelor's, Masters, Ed.S., Ph.D. or Ed.D.

4. For how long have you been employed as a certified educator? Please only include experience as certified educator, and not years spent employed in other non-certified roles (e.g. years as a paraprofessional, tutor, etc.).

Answer options: 0-4, 5-9, 10-14, 15-19, 20-24, 25-29, 30+

5. Please select the grade level(s) with which you have had leadership experience.

Answer options: PK, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11,12

6. Please provide the name of your employing school district.

Answer option: Open-ended, short answer text box

Section 2: STEAM Curriculum

7. How would you define STEAM curriculum and how it differs from other curricula approaches?

Answer option: Open-ended, long answer text box

8. In what format(s) do you participate in making STEAM related professional development available? Choose all that apply.

Answer options: Virtual/online/digital, face-to-face, Hybrid (mixture of virtual and face-to-face)

9. How much time on average are you spending planning and implementing STEAM curriculum opportunities?

Answer options: 10+ hours per week, 6-9, 3-5, 1-2, 0

10. What drives the need for STEAM curriculum for Elementary students?

Answer option: Open-ended, long answer text box

11. Do you ensure development of Arts integration strategies for your teachers?

Answer options: yes, no

12. If you answered Yes to item 11 above, share when teacher trainings/professional learning took place and give a general description of it.

Answer option: Open-ended, long answer text box

Section 3: STEAM Framework Design

13. Have you used a specific model or framework to guide STEAM implementation? If so, which model/framework?

Answer options: Scientific Inquiry Based, Project/Problem Based Learing (PBL), Studio Thinking, With About In and Through (WAIT), Yakman's Model, Claim Evidence Reasoning (CER), school developed model

14. What are the elements of the model/framework(s) that you use to implement STEAM?

Answer option: Open-ended, long answer text box

15. Does the model/framework(s) follow an interdisciplinary approach?

Answer options: yes, no

16. How and by whom was this model/framework(s) chosen?

Answer option: Open-ended, long answer text box

Section 4: Components of Curriculum

17. What expectations have been communicated to your faculty and staff on STEAM curriculum professional development participation?

Answer option: Open-ended, long answer text box

18. What professional learning programs do you use to aid teachers in STEAM curriculum implementation within your school?

Answer option: Open-ended, long answer text box

19. In your journey to full STEAM curriculum implementation, has there been a timeline associated with professional development expectations for your teachers?

Answer option: yes, no

20. Do you personally participate in STEAM professional development through collaborations with other schools in your district as a part of a district STEAM focus?

Answer option: yes, no

Section 5: Future Teachers and Evaluative Measures

21. When looking to employee new teachers, are there particular degrees, endorsements, certifications, etc. that are helpful in STEAM curriculum integration?

Answer option: Open-ended, long answer text box

22. In what way is STEAM curriculum integration measured in teacher evaluations?

Answer option: Open-ended, long answer text box

23. How is feedback given to teachers who implement STEAM curriculum in your school?

Answer option: Open-ended, long answer text box

24. How are teacher leaders developed to support STEAM curriculum integration?

Answer option: Open-ended, long answer text box

Section 6: Principal Roles and Faculty Resistance to Change

25. What type of leader do you consider yourself to be?

Answer option: Open-ended, long answer text box

26. What is your attitude towards STEAM curriculum implementation?

Answer option: Open-ended, long answer text box

27. What is your vision for STEAM curriculum implementation in your school?

Answer option: Open-ended, long answer text box

28. What kinds of instructional supports do you organize to aid your faculty in STEAM curriculum implementation?

Answer option: Open-ended, long answer text box

29. Please share any experiences you had with faculty that was resistant to the changes taking place. Be specific with the experience and detailed in the recollection.

Answer option: Open-ended, long answer text box

30. Do you have any certifications, formal trainings, or experience with STEAM curriculum implementation outside of your school and/or school district?

Answer option: Open-ended, long answer text box

31. If you could advise other leaders on how to implement STEAM curriculum, what would be the steps you would take in order of priority?

Answer option: Open-ended, long answer text box

32. What characteristics do you think a school leader needs to implement STEAM curriculum?

Answer option: Open-ended, long answer text box

33. Please provide any other thoughts or information you'd like to share regarding the implementation process of STEAM curriculum.

Answer option: Open-ended, long answer text box

Appendix F

Interview Protocol

Interview Protocol

Interview #_______________

Date ____________________

Script

Welcome and thank you for your participation today. My name is Allyson Douthit and I am a doctoral student at Columbus State University conducting a research project that explores STEAM curriculum implementation from the perceptions of elementary administrators. This interview will take approximately 30 minutes and will include questions regarding your personal background followed by questions regarding your recent experiences. I would like your permission to [video and/or audio] record this interview so I may accurately document the information you convey. Do I have your permission to do so? (pause for audible response)

If at any time during the interview you wish to discontinue the use of the recorder or the interview itself, please feel free to let me know and we will stop. All of your responses are confidential. Your responses will remain confidential and will only be viewed/heard by the researchers. This interview will be transcribed. The full transcription will only be viewed by the researcher. However, excerpts of this interview may be utilized in published research papers, conference presentations, and/or other scholarly works. All identifying information will be removed from a direct quote from used in any capacity.

Your participation in this interview is completely voluntary. If at any time you need to stop or take a break please let me know. You may also withdraw your participation at any time without consequence. Do you have any questions or concerns before we begin? (pause for response)

Then with your permission we will begin the interview.

Demographic Questions

1. What is your gender? Male Female

2. What is your age? 18-29 years old 30-49 years old 50-64 years old

65 years or older

3. What is your race? Black/African American American Indian/Alaskan Native

Native Hawaiian/Pacific Islander Asian
White/Caucasian Two or more races
Prefer not to respond

4. What is your ethnicity? Hispanic/Latino Not Hispanic/Latino
Prefer not to respond

5. How long have you been an elementary administrator?

6. How many years total have you worked in education?

7. Is your current position full-time or part-time?

8. What degrees and/or certifications do you hold?

Questions Regarding Perceptions of STEAM Implementation

1. Describe your experiences in relation to the start of STEAM curriculum implementation within the school you are leading.

2. What resources were provided to you when you began to implement STEAM curriculum? How effective do you feel they were? Which of those resources, if any, are you still using now?

3. What (if any) professional development or learning opportunities were you offered to ensure your readiness for supporting STEAM curriculum implementation for your staff? Did those opportunities help you to feel better prepared?

4. Describe your comfort level with nontraditional methods of teaching, such as project/problem-based learning, Studio Thinking, With about in and through (WAIT), etc.

5. Are you and your teachers able to engage in meaningful ways to implement these methods? Why or why not?

5. What measures have been put in place for teachers and students to build successful and engaging lessons? Do you feel they are adequate?

6. How did your school facility and/or classrooms look and function before the implementation of STEAM curriculum compared to how it looks and functions today with STEAM curricula in place?

6. Describe your experiences in observing classrooms prior to embarking on STEAM certification. How were teacher/student interactions? Student/student interactions? Parent/teacher interactions?

7. Have those experiences and observations changed? If so, how?

8. Across the world educators were (and continue to be) encouraged to prepare students for careers that do not yet exist. What (if any) affect do you think this has had on your teachers. Where applicable, please provide examples.

9. From whom do you receive the most support for STEAM curriculum implementation?
10. What is your overall leadership approach?
11. How does your leadership approach align with your school's STEAM journey?
12. Before we conclude this interview, is there anything else you would like to share?

Appendix G

Artifact Request Email

Dear __________________,

Thank you for your continued participation in the study of experiences of administrators who implement STEAM curriculum in the elementary school setting. Please submit any artifactual documentation to me via email to add in the data collection process of this study. Artifacts may include master schedules, lesson plans, professional development training logs/certificates, meeting agendas, etc. that provide evidence of STEAM curriculum implementation within your school.

Please email all submissions to xxxxx@columbusstate.edu. If you choose not to participate, please disregard this email and no further action is required.

Sincerely,

Allyson Douthit
CSU Doctoral Student
(XXX) XXX–XXXX

Appendix H

Content Validity Survey

My name is Allyson Douthit and I am a doctoral student at Columbus State University conducting a research project that explores STEAM curriculum implementation from the perceptions of elementary administrators.

The purpose of the study is to explore the perceptions of administrators toward the process of STEAM curriculum implementation. The study centers on gathering qualitative, perceptual data from principals who work toward addressing the aforementioned needs of the world through the STEAM method of curriculum. Interviews with individual elementary principals and assistant principals, portfolio artifacts, and observational noting are the methods for data collection. The ultimate intention of gathering such information is to provide a clear illustration of the thoughts and intentions of the administrators implementing STEAM curriculum.

Thank you for your participation today with surveying the content validity of two data collection instruments for this study. The attached surveys are labeled with a panelist number at the top. This is in place of your name. Use the purpose of the study to reflect upon while placing an "x" in the designated area of the survey that best describes your agreement with the essential or nonessential use of the item.

After completion, please return to Allyson Douthit via email (xxxxx@columbusstate.edu) or contact the researcher via phone call or text to (XXX) XXX-XXXX for a convenient time and date for physical collection.

Sincerely,

Allyson Douthit
CSU Doctoral Student
706.325.6810

Questionnaire Content Validity Assessment Survey

Panelist 1

Place an (x) in the essential or nonessential column for each item.

Item #	Question/Statement	Essential	Useful but not essential	Nonessential
1	Please select your gender.			
2	Please select your age.			
3	Please select the highest degree or level of schooling you have completed. If currently enrolled in a degree-seeking program, select the highest degree received.			
4	For how long have you been employed as a certified educator? Please only include experience as certified educator, and not years spent employed in other noncertified roles (e.g., years as a paraprofessional, tutor).			
5	Please select the grade level(s) you have had leadership experience.			
6	Please provide the name of your employing school district.			
7	How would you define STEAM curriculum and how it differs from other curricula approaches?			
8	In what format(s) do you participate in making STEAM related professional development available? Choose all that apply.			
9	How much time on average are you spending planning and implementing STEAM curriculum opportunities?			
10	What drives the need for STEAM curriculum for Elementary students?			
11	Do you ensure development of Arts integration strategies for your teachers?			
12	If you answered Yes to item 11 above, share when teacher trainings/professional learning took place and give a general description of it.			

13	Have you used a specific model or framework to guide STEAM implementation? If so, which model/framework?			
14	What are the elements of the model/framework(s) that you use to implement STEAM?			
15	Does the model/framework(s) follow an interdisciplinary approach?			
16	How and by whom was this model/framework(s) chosen?			
17	What expectations have been communicated to your faculty and staff on STEAM curriculum professional development participation?			
18	What professional learning programs do you use to aid teachers in STEAM curriculum implementation within your school?			
19	In your journey to full STEAM curriculum implementation, has there been a timeline associated with professional development expectations for your teachers?			
20	Do you personally participate in STEAM professional development through collaborations with other schools in your district as a part of a district STEAM focus?			
21	When looking to employee new teachers, are there particular degrees, endorsements, certifications, etc. that are helpful in STEAM curriculum integration?			
22	In what way is STEAM curriculum integration measured in teacher evaluations?			
23	How is feedback given to teachers who implement STEAM curriculum in your school?			
24	How are teacher leaders developed to support STEAM curriculum integration?			
25	What type of leader do you consider yourself to be?			
26	What is your attitude towards STEAM curriculum implementation?			
27	What is your vision for STEAM curriculum implementation in your school?			

28	What kinds of instructional supports do you organize to aid your faculty in STEAM curriculum implementation?			
29	Please share any experiences you had with faculty that was resistant to the changes taking place. Be specific with the experience and detailed in the recollection.			
30	Do you have any certifications, formal trainings, or experience with STEAM curriculum implementation outside of your school and/or school district?			
31	If you could advise other leaders on how to implement STEAM curriculum, what would be the steps you would take in order of priority?			
32	What characteristics do you think a school leader needs to implement STEAM curriculum?			
33	Please provide any other thoughts or information you'd like to share regarding the implementation process of STEAM curriculum.			
Total				

Interview Questions Content Validity Assessment Survey

Panelist 1

Place an (x) in the essential or nonessential column for each item.

Item #	Question	Essential	Useful but not essential	Nonessential
1	What is your gender?			
2	What is your age?			
3	What is your race?			
4	What is your ethnicity?			
5	How long have you been an elementary administrator?			
6	How many years total have you worked in education?			
7	Is your current position full time or part time?			
8	What degrees and/or certifications do you hold?			

9	Describe your experiences in relation to the start of STEAM curriculum implementation within the school you are leading.			
10	What resources were provided to you when you began to implement STEAM curriculum? How effective do you feel they were? Which of those resources, if any, are you still using now?			
11	What (if any) professional development or learning opportunities were you offered to ensure your readiness for supporting STEAM curriculum implementation for your staff? Did those opportunities help you to feel better prepared?			
12	Describe your comfort level with nontraditional methods of teaching, such as project/problem-based learning, studio thinking, with about in and through (WAIT), etc.			
13	Are you and your teachers able to engage in meaningful ways to implement these methods? Why or why not?			
14	What measures have been put in place for teachers and students to build successful and engaging lessons? Do you feel they are adequate?			
15	How did your school facility and/or classrooms look and function before the implementation of STEAM curriculum compared to how it looks and functions today with STEAM curricula in place?			
16	Describe your experiences in observing classrooms prior to embarking on STEAM certification. How were teacher/student interactions? Student/student interactions? Parent/teacher interactions?			
17	Have those experiences and observations changed? If so, how?			
18	Across the world educators were (and continue to be) encouraged to prepare students for careers that do not yet exist. What (if any) affect do you think this has had on your teachers. Where applicable, please provide examples.			
19	From whom do you receive the most support for STEAM curriculum implementation?			
20	What is your overall leadership approach?			

21	How does your leadership approach align with your school's STEAM journey?			
22	Before we conclude this interview, is there anything else you would like to share?			
Total				

Appendix I

Guidelines From the CDC

The researcher will use information from the Centers for Disease Control and Prevention (CDC) to guide all interactions of the study. Participants will be asked to provide responses via email and video to counter exposure due to contact. The following guidelines contributed by the CDC's "How to Protect Yourself and Others" informational tab will constitute the manner by which the researcher and participants will interact during the study. Guidelines address each aspect of the work and home environments of both the participants and the researcher.

According to the CDC (2020), "Preventative actions to prevent the spread of respiratory illnesses such as COVID-19 include staying home when sick, appropriately and consistently wearing masks, cleaning and disinfecting frequently touched surfaces, and washing hands often with soap and water for at least 20 seconds. If soap and water are not readily available, use an alcohol-based hand sanitizer with at least 60% alcohol. Always wash hands with soap and water if they are visibly dirty."

The researcher will adhere to the following guidelines:

Keeping the workplace safe

Encourage your employees to...

Practice good hygiene

- Stop handshaking – use other noncontact methods of greeting
- Clean hands at the door and schedule regular hand washing reminders by email
- Create habits and reminders to avoid touching their faces and cover coughs and sneezes
- Disinfect surfaces like doorknobs, tables, desks, and handrails regularly
- Increase ventilation by opening windows or adjusting air conditioning

Be careful with meetings and travel

- Use videoconferencing for meetings when possible
- When not possible, hold meetings in open, well-ventilated spaces
- Consider adjusting or postponing large meetings or gatherings
- Assess the risks of business travel

Handle food carefully

- Limit food sharing
- Strengthen health screening for cafeteria staff and their close contacts
- Ensure cafeteria staff and their close contacts practice strict hygiene

Stay home if...

- They are feeling sick
- They have a sick family member in their home

What every American and community can do now to decrease the spread of the coronavirus

Keeping the home safe

Encourage your family members to...

All households

- Clean hands at the door and at regular intervals
- Create habits and reminders to avoid touching their face and cover coughs and sneezes
- Disinfect surfaces like doorknobs, tables, and handrails regularly
- Increase ventilation by opening windows or adjusting air conditioning

Households with vulnerable seniors or those with significant underlying conditions

Significant underlying conditions include heart, lung, kidney disease; diabetes; and conditions that suppress the immune system

- Have the healthy people in the household conduct themselves as if they were a significant risk to the person with underlying conditions. For example, wash hands frequently before interacting with the person, such as by feeding or caring for the person
- If possible, provide a protected space for vulnerable household members
- Ensure all utensils and surfaces are cleaned regularly

Households with sick family members

- Give sick members their own room if possible, and keep the door closed
- Have only one family member care for them
- Consider providing additional protections or more intensive care for household members over 65 years old or with underlying conditions

What every American and community can do now to decrease the spread of the coronavirus

Keeping the school safe

Encourage your faculty, staff, and students to…

Practice good hygiene

- Stop handshaking – use other noncontact methods of greeting
- Clean hands at the door and at regular intervals
- Create habits and reminders to avoid touching their faces and cover coughs and sneezes
- Disinfect surfaces like doorknobs, tables, desks, and handrails regularly
- Increase ventilation by opening windows or adjusting air conditioning

Consider rearranging large activities and gatherings

- Consider adjusting or postponing gatherings that mix between classes and grades
- Adjust after-school arrangements to avoid mixing between classes and grades
- When possible, hold classes outdoors or in open, well-ventilated spaces

Handle food carefully

- Limit food sharing
- Strengthen health screening for cafeteria staff and their close contacts
- Ensure cafeteria staff and their close contacts practice strict hygiene

Stay home if…

- They are feeling sick
- They have a sick family member in their home

What every American and community can do now to decrease the spread of the coronavirus

Keeping commercial establishments safe

Encourage your employees and customers to…

Practice good hygiene

- Stop handshaking – use other noncontact methods of greeting
- Clean hands at the door, and schedule regular hand washing reminders by email
- Promote tap and pay to limit handling of cash
- Disinfect surfaces like doorknobs, tables, desks, and handrails regularly
- Increase ventilation by opening windows or adjusting air conditioning

Avoid crowding

- Use booking and scheduling to stagger customer flow
- Use online transactions where possible
- Consider limiting attendance at larger gatherings

For transportation businesses, taxis, and ride shares

- Keep windows open when possible
- Increase ventilation
- Regularly disinfect surfaces

What every American and community can do now to decrease the spread of the coronavirus

Appendix J

Sample Projects

A World In Motion Challenges

Primary (grades K-3)

Making Music Challenge (1) Students explore sound and vibrations, learn how the eardrum works and explore the concepts of pitch, longitudinal and transverse waves. They collect information and engineer a musical instrument according to specific criteria. The book component, Sleep Soundly at Beaver's Inn brings the concepts to life for the students through a fictional story about animals and sounds within nature.

Rolling Things Challenge (K)
Students explore the story, The Three Little Pigs Sledding Adventure. Based on the scientific concepts presented in the story, students explore toy cars and car performance. Students launch the cars from ramps and investigate the effects that different ramp heights and car weights have on distance traveled. Students make adjustments for performance through variable testing.

Pinball Designers Challenge
Students explore the concept of optimizing a design by designing and building a pinball game. The story of Malarkey & the Big Trap introduces students to the concept of improving a design through experimentation and data analysis. Students test the launch ramp to explore how launch position affects the behavior of the pinball. Students make their games more challenging by adding targets, walls, and bumpers to the game board.

Engineering Inspired By Nature
Students investigate methods in which seeds are dispersed in nature through the story, Once Upon a Time in the Woods. The story leads the students to further explore seeds dispersed by the wind. Students use the designs of nature to develop paper helicopters and parachutes and perform variable testing to improve performance.

Straw Rockets Challenge
(2) Students explore the early life of Dr. Robert Goddard through the age appropriate biography, The Rocket Age Takes Off. Investigating Goddard's early trials and tribulations to create the first liquid fueled rocket engine, students begin to uncover the work necessary to optimize a design. Students use a design process to build and perform variable testing on straw rockets. Design goals include farthest and highest flight.

Elementary (grades 4-6)

Skimmer Challenge (3)
Students construct paper sailboats and test the effects of different sail shapes, sizes, and construction methods to meet specific performance criteria. Friction, forces, the effect of surface area and design are some of the physical phenomena students encounter in this challenge.

JetToy Challenge (5)
Students make balloon-powered toy cars that meet specific performance criteria: distance traveled, weight carried, accurate performance, and speed. Jet propulsion, friction, air resistance, and design are the core scientific concepts students explore in this challenge.

Gravity Cruiser Challenge (4)
Students focus on understanding the relationships between the "sweep" of the lever arm, the number of winds the string makes around the axle, and the distance the gravity cruiser travels. They also investigate how the diameter of the wheels, the diameter of the axles, and the amount of weight placed on the lever affect the gravity cruiser's speed and distance. This challenge introduces a rich activity in critical thinking and learning how to use the experimental method to test hypotheses and solve an engineering problem.

Middle School (grades 6-8)

Gravity Cruiser Challenge
Students focus on understanding the relationships between the "sweep" of the lever arm, the number of winds the string makes around the axle, and the distance the gravity cruiser travels. They also investigate how the diameter of the wheels, the diameter of the axles, and the amount of weight placed on the lever affect the gravity cruiser's speed and distance.

Motorized Toy Car Challenge (8)
Students develop new designs for electric gear driven toys. To meet a specific set of design requirements, students must write proposals, draw sketches, and work with models to develop a plan. Force and friction, simple machines, levers and gears, torque and design are core concepts covered.

Glider Challenge
Students explore the relationship between force and motion and the effects of weight and lift on a glider. The glider activity culminates in a book-signing event where each design team presents its prototype and the class presents its manuscript of Glider designs. Students learn the importance of understanding consumer demands and the relationships between data analysis and variable manipulations.

Fuel Cell Challenge
Student teams design a toy car that uses a PEM (Proton Exchange Membrane) fuel cell to power the electric motor. Elements of electrical currents, Green Design, and transformations of energy are explored as the teams develop their product.

Keeping Our Networks Secure
Students explore a number of physical models that simulate the movement of information through the Internet; they identify problems with each model and test different enhancements to help make the network operate better and faster. After learning about these important attributes of cybersecurity, students work in teams to create marketing materials to help the target audience feel more comfortable and confident about Internet security.

P8193349

Appendix K

Schedules

[redacted] Elementary [redacted] Calendar

Week of March 1, 2021

Daily Checklist:

- ✔ Take your temperature before leaving home
- ✔ Clock-in using Infinite Campus/CheckMate
- ✔ Take student temperatures **BEFORE** entering the classroom
- ✔ Submit Attendance (IC) and Lunch Count (Google Form) by 8:30

Thank you for washing your hands frequently and not using air fresheners to keep our campus safe and clean!

Monday, March 1 **STEAM Leadership Meeting- 2:45**
Tuesday, March 2 **STEAM Journal Check-In with [redacted] Grade Level Planning (Specials 2:30)**
Wednesday, March 3 **School Leadership Team Meeting 2:45 [redacted]'s Room**
Thursday, March 4
Friday, March 5 **Typing Club Test Closes (3rd and 4th)**

- **March 10**- Code Red Drill 9:00
- **March 10**- STEAM Leadership Meeting
- **March 16**- End of 3rd 9 Weeks
- **March 17**- Fire Drill 9:00 (weather permitting, students will exit building)
- **March 18**- Grades Due to Mrs. [redacted]
- **March 23**- Report Cards Released
- **March 24**- Severe Weather Drill 9:00
- **March 25**- Spring Pictures
- **March 29-April 2**- **SPRING BREAK**
- **April 7**- PreK Registration 7:00am
- **April 7**- School Leadership/Improvement meeting
- **April 9**- Purple Up Day for Military Kids-Wear Purple
- **April 14**- Fire Drill 9:00
- **April 14**- STEAM Leadership Meeting
- **April 19**- Grades due to Mrs [redacted]
- **April 21**- Progress Reports Released

Appendix L

Community Supports

LAGRANGEARTMUSEUM

February 26, 2020

Dear [redacted]

The LaGrange Art Museum education staff is looking forward to providing arts education programming for Park Elementary Kindergarten. This is an exciting opportunity for both the museum and the school, and we look forward to the positive outcomes for our students. I have attached a Memoranda of Agreement outlining the details of our partnership.

Kindergarteners will explore The LaGrange Art Museum program, *Literacy through Photography*. Museum Educator guided questioning (Visual Thinking Strategy), will allow students to examine art, to think, to contribute observations, and ideas, to listen, and to build understandings together.

Students will be able to:

From facilitated Visual Thinking Strategies;

- Participate in collaborative conversations
- Describe people, places, things, and events with relevant details, expressing ideas and feelings clearly
- Begin to analyze photographers choice of framing, lighting, and point of view

From artmaking experience;

- Create a tableau (frozen pose) to communicate an idea that leads to story making
- Create photographs utilizing light, framing, and point of view
- Create photographs that communicate ideas or tell a story

If this meets with your approval, please sign one copy of each and return them to me, keeping copies for yourself. If you have any questions please contact our Education Director Sallie Keith at 706-882-3267 or 706-957-2954.

Sincerely,

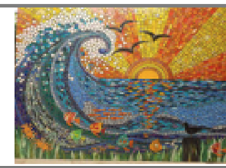
Laura R. Jennings

Laura Jennings
Executive Director
LaGrange Art Museum

LAM 112 Lafayette Parkway LaGrange, Georgia 30240 T 706.882.3267 F 706.882.2878 www.lagrangeartmuseum.org

Appendix M

Lesson Templates

<table>
<tr><td colspan="2">Lesson Title: Fraction Mosaic Art</td><td rowspan="2"></td></tr>
<tr><td>Grade Level: 4th Grade</td><td>Quarter: 2nd Nine Weeks</td></tr>
<tr><td colspan="3">Standards:
MGSE4.NF.1 Explain why two or more fractions are equivalent = ex: = by using visual fraction models. Focus attention on how the number and size of the parts differ even though the fractions

MGSE4.NF.6 Use decimal notation for fractions with denominators 10 or 100.

S4L1. Obtain, evaluate, and communicate information about the roles of organisms and the flow of energy within an ecosystem.

VA4.CR.3 Understand and apply media, techniques, processes, and concepts of
two-dimensional art.</td></tr>
<tr><td>Lesson Essential Question:

How are decimals and fractions related?

How are decimal fractions written using decimal notation?</td><td colspan="2">Vocabulary:
Fractions
equivalent
simplest form
reduce
denominator
numerator
ecosystems
producers
consumers
decomposers</td></tr>
<tr><td>Lesson Materials
- various colors of construction paper
- glue
- scissors
- STEAM Journal</td><td colspan="2">Lesson Assessment:
Student Journal
Teacher Observation
Fraction Calculation Sheet</td></tr>
<tr><td colspan="3">STEM Challenge Overview: Create a mosaic piece of art using 100 to 200 pieces of paper only.</td></tr>
</table>

Appendix N

Professional Development