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EXPLORING TEACHERS' AND ADMINISTRATORS' PERCEPTIONS OF STEAM EDUCATION IN K-12 SCHOOLS AND ITS IMPLICATIONS ON THE DEVELOPMENT OF STEAM: AN EXPLANATORY SEQUENTIAL MIXED METHOD DESIGN

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ABSTRACT

EXPLORING TEACHERS' AND ADMINISTRATORS' PERCEPTIONS OF STEAM EDUCATION IN K-12 SCHOOLS AND ITS IMPLICATIONS ON THE DEVELOPMENT OF STEAM: AN EXPLANATORY SEQUENTIAL MIXED METHOD DESIGN

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The purpose of this explanatory sequential mixed method design was to investigate, identify and document the similarities and differences in perceptions when implementing a STEAM (Science, Technology, Engineering, Arts, and Mathematics) education between teachers and administrators at the K-12 level. Throughout this process, teachers' and administrators' beliefs and perceptions towards STEAM instruction were analyzed to determine how they perceived, interpreted, implemented and sustained this new initiative. The problem, however, is that studies have demonstrated that educators have a limited understanding of STEAM content knowledge (CK), pedagogical content knowledge (PCK), as well as low self-efficacy in teaching STEAM concepts, which results in educators avoiding teaching a STEAM based education (Epstein & Miller, 2011).

The sample for this research included educators that teach grades K-12 in a suburban region of New York that encapsulated 5 school districts. It also included school

administrators (superintendents, assistant superintendents, principals, assistant principals, directors and department chairs) from elementary, middle and high schools in the same suburban, New York region as the teachers, within those same 5 school districts. All participants in this research (educators and administrators) were from a suburban region of New York that had a STEAM model within their district. Data collection and analysis consisted of the participants completing a STEAM Education Perception Survey, which was administered to participants anonymously through Survey Monkey, examined and then transferred into SPSS statistical analysis software. It also consisted of teacher and administrator interviews, in which the qualitative data was analyzed.

This study revealed that ongoing and continuous efforts are needed in order to develop more effective methods for promoting the perceptions of STEAM education. This study is significant and has valuable implications to educators, administrators, researchers and policy makers in understanding the perceptions, experiences and challenges when integrating and implementing a STEAM curriculum. The findings of this study will seek to assist educators, researchers, school and district leaders and policy makers in identifying areas of strengths and weaknesses in relation to teachers' and administrators' pedagogical knowledge, CK, PCK, as well as their perceptions in connection to STEAM implementation.

DEDICATION

I dedicate my dissertation to my Mom and Dad-Daphne and Bryan. Without the love and support of my parents, I would never have been able to complete this extraordinary and remarkable journey in attaining a Doctoral degree in Instructional Leadership. This project is dedicated to them. Their encouragement, understanding, love, support and confidence in me is what has motivated me in every aspect of my life. You both have encouraged, supported, and never wavered in your love—this example has shaped me into the person I am today. Thank you endlessly for all that you did and do for me to instill a firm foundation of love, faith, family and education.

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CHAPTER 1 Introduction

Albert Einstein once said, “After a certain level of technical skill is achieved, science and art tend to coalesce in esthetics, plasticity and form. The greatest scientists are always artists as well” (Calaprice, 1996, p. 171). Within the past two decades, Science, Technology, Engineering, and Mathematics (STEM) centralized curricula has been championed as the contemporary form of education in America. The acronym STEM was introduced by Judith Ramaley in 1958, as she defined STEM as an educational transformation where learning was placed in context and where students solved practical problems and created opportunities for the quest of innovation (Spears, 2018). By 1996, however, the STEM education movement has been a profoundly prominent transformation in elementary, middle and secondary schools in America. Since then, many schools and educational institutions have acquired various STEM related grants and training programs. This played an important role in establishing and boosting the number of students pursuing a STEM related field and an overall interest in STEM learning.

However, as the fundamental objective of STEM education relies in the knowledge of computer science, mathematics, engineering and the life and physical sciences, there was a developing concern that many American students are not continuing in STEM. Students are opting out of Science and Math courses, citing both a lack of interest or that these courses are too demanding (Sanders, 2009). As the enthusiasm and confidence surrounding STEM education began to diminish, a new approach began to emerge, which included adding the Arts. As the Arts in STEM became a prevalent approach to learning, STEAM education (Science, Technology, Engineering, Arts,

Mathematics) was introduced to educational institutions, colleges and universities. STEAM is a newly created acronym that adds the arts into the original STEM equation. By giving students information to analyze, critique or investigate from an Arts based source, this can allow the students to think more creatively (Floerke, 2021). The Institute for Arts Integration and STEAM (2021) illustrates that STEAM is essentially a concept that takes the benefits of STEM and provides a more comprehensive package by allowing students to connect their learning with the arts practices, elements, designs principles and national standards to provide a rich, meaningful and cultural learning experience. A STEAM based approach abolishes limitations and replaces them with inquiry-based learning, critique, and innovation. STEAM is an integrated approach to learning which requires a thoughtful connection between national standards, assessments and a lesson design utilizing and leveraging the integrity of the Arts. STEAM also involves two or more standards from the content areas from Science, Engineering, Math and the arts to be taught and assessed through each other (Institute for Arts Integration and STEAM, 2021).

Roehrig, Dare, Ring-Whalen, E., & Wieselmann (2021) illustrate that STEAM is interdisciplinary and define interdisciplinary learning as an integration approach whereby two or more disciplines are combined or interconnected in such a manner that they are difficult to separate from one another. In this manner of learning, teaching can go beyond a problem or theme delve deeper into individual content areas, creating a coherent and consistent learning environment. Helmane and Briška (2017) delineate that the interdisciplinary approach refers to educators organizing curricula around accepted and common themes across various disciplinary boundaries. When utilizing STEAM, students are able to make meaningful and pragmatic connections that assimilate concepts

and allow for an understanding of the material that is relevant in a 21st century world (Martin-Paez, Aguilera, Perales-Palacios, & Vilchez-Gonzalez, 2018). According to the Institute for Arts Integration and STEAM (2021), there are 6 steps to creating and implementing an interdisciplinary STEAM centered classroom: focus, detail, discovery, application, presentation and link. In the first focus step, students are introduced to the essential question, followed by the detail step, in which the teacher is looking for elements that are contributing to the problem or question. In the discovery phase, students are actively taking part in the research and coming up with solutions. During the application, students can begin to create their own solution to the task at hand and share it during the presentation stage. The last link step is where students can close the loop and reflect on the feedback that was shared and on their own skills and processes.

When investigating and implementing a STEAM based approach, it is important to have practical lessons that are standards based and grade level appropriate. According to Floerke (2021), when combining mathematics and music, educators can compare music notes to points on a graph and plot points on a Cartesian graph. Students should have a basic fundamental grasp of music note vales, whereby the teacher should explain what each note looks like, as well as how many beats each note accounts for. Then, compare the fact that like variables that have value in an equation, music notes also have value within a musical measure. Students who are not familiar with mathematics concepts may understand an aspect of math by their knowledge of music. This can also allow students to think and investigate critically about the music they listen to, relating the melodies they hear in songs to math they are learning in class. Connections between music and math can draw many parallels at higher-level education, including utilizing

using complex ratios to understand tone frequencies (Shah, 2010). Another example would include connecting technology and art, whereby students learn about a particular artist or style and they would then create a work in that specific style generating a website or social media for the artwork. Students creating their own work in the style of another artist, allows them to be creative in how a piece is constructed. Additionally, they are also utilizing critical thinking skills when they take the newly-learned information about the art and decide how to interpret that in a digital format using a website or social media platform. Floerke (2021) also states that when integrating the humanities with science in a STEAM based approach, students can research a debatable topic, analyze the information and then apply critical thinking to come up with an argument for their topic. Students can choose their topic from a list provided from the teacher making sure that each issue has a supporting and opposing side. When a debate topic has been chosen, students can work collaboratively in groups to form a claim for their argument and gather data to support their claim. By allowing students to expand upon developing their moral compasses and psychological development, they can collaborate with their peers to establish 21st Century Skills.

Background of the Problem

As there recently has been a growing focus and implementation surrounding STEM education, there are only a few cases that document STEAM education in depth. This study sought to further investigate and better understand teachers' and administrators' perceptions of STEAM education. Educators who are confronted with integrating STEAM within the humanities, creative disciplines or social sciences, should ultimately discover and further explore comprehensive opportunities to acquire this

knowledge (Constantino, Guyotte, Kellem, Sochaka &Walther, 2015). As Shin and Han (2010) investigated and researched the attitudes and perceptions of self-efficacy related to the integration of STEAM education in the classroom, they discovered that both attitudes and self-efficacy affected classroom implementation of STEAM subjects. Bandura (1997) illuminates that self-efficacy is as significant and important for people's lives, as is their judgement of their abilities and the capacity to fully complete fundamental tasks and objectives. As there has been a growing focus on the commitment to better prepare K-12 students with the skills and knowledge needed to become successful innovators and creators in the 21st century workforce, advancement in STEM/STEAM subjects requires students to be literate (Woods, 2020).

The Carnegie Corporation of New York (2009) illustrated that the American education system has made remarkable enhancements in reading and writing skills over the past two decades. However, as literacy continues to evolve as unprecedented technology develops, the pace of literacy has been unbale to keep up with the pace of the global economy. Students in high school are expected to infer and convey complex text information and determine the reliability of the sources, as well as to evaluate and synthesize arguments (Deboer, Carman & Lazzaro, 2010). The academic demands from vocabulary, to the length of text, as well as sentence and structural complexities for elementary and middle school aged students have increased significantly (Deboer, Carman & Lazzaro, 2010).

The interdisciplinary approach that is offered and developed in a STEAM education, with emphasis on Arts based learning can be vital for students to be college and career ready. Skills such as communication, writing, expression, logical, critical and

divergent thinking skills, as well expression through music and the arts are acquired through STEAM related activities. The inclusion of the Arts can encourage students to move beyond recall or rote memorization (Gullatt, 2008). When students engage in STEAM based activities, they can gain deeper and more impactful learning experiences that can offer an inquiry-based approach to challenging problems. They can then ask thoughtful questions and pragmatically apply what they have learned, discover their answers and problem solve creatively. Many STEAM activities can require students to work independently or collaboratively in groups, which can then give them the opportunity to manage and self-assign group roles and can engage them in thoughtful and consequential discussions to problem solve (Deboer, Carman & Lazzaro, 2010).

Most educators, especially at the elementary school level, have not had any formal training on disciplinary content utilizing STEAM based concepts. As a result, educators may potentially integrate STEAM in a way that is most effective to them, that is in conjunction with their beliefs about the purpose and value of a STEAM education and its implementation (Wang, Moore, Roehrig & Park, 2011). As teachers and administrators' attitudes, belief systems, experiences, self-efficacy and perceptions can ultimately affect STEAM achievement, this study is essential as it sought to investigate a viewpoint of STEAM education at the K-12 level. Nadelson (2013) states that understanding teachers' and administrators' perceptions of a STEAM education is critical for the success of all educators, leaders and for the advancement of the program.

Throughout this investigation, the intention was to gain a deeper and more thorough understanding of teachers' and administrations' perceptions of STEAM education. This study proved to be beneficial and pragmatic as it targeted teachers' and

administrators' understanding of STEAM education, as well as analyzed what potentially supported or impeded teachers' and administrators' implementation of STEAM. The knowledge gathered from this study could potentially provide valuable insight into the opinions and perceptions regarding the value of an Arts based education within the K-12 education system (Arts Education Partnership, 2018).

Baer (2017) illustrates that, as it relates to school improvement efforts, perceptions from stakeholders can produce positive and effective changes in schools. Convincing studies, such as Jones & Risku (2015) and Marshall (2016) have demonstrated that an Arts and Music based education should be an essential and applicable part of the educational system. Many advocates of the core content areas, such as STEM subjects (science, technology, engineering and math) consider those subjects alone, are needed in order to fulfill the demands of today's students' needs (Liao, 2016). However, initiatives such as Arts in Action, suggest that with the inclusion of the Arts and music, STEAM education can more fully and comprehensively prepare students with creative and unique skill sets that they need in order to become successful and innovative thinkers (Patton & Knochel, 2016).

Despite sufficient research supporting a comprehensive STEAM based approach and literacy, teachers in nontraditional classrooms are reluctant to incorporate STEAM activities into their pedagogy. Hammack and Ivey (2017) believe that K-5 teachers have low self-efficacy as it relates to engineering and engineering pedagogy content knowledge. Shin and Han (2010) illustrated that although teachers generally have positive viewpoints about integrating STEAM in the classroom, many believed that they

did not completely and pragmatically understand how to incorporate these specific components into their pedagogy.

Professional development that can focus on building personal and professional confidence can be essential, vital and of critical importance to bridge the gap towards the lack of self-efficacy and knowledge in these STEAM components for educators. Sparks (2002) illuminated that with research and experience, professional development that is meaningful, ongoing and of high quality can provide teachers with a deeper sense of content knowledge and pedagogical skills. Guskey (2002) stated that with a consistent discovery in educational research, significant improvement in education rarely transpires if there is a lack of professional development. With effective and pragmatic professional development, educators can be given the tools needed for research, practice and reflection, as well as an approach to job-embedded, sustained and collaborative work around a comprehensive STEAM pedagogy.

Problem Statement

The problem, however, is that despite much interest and popularity in STEAM education, little is known about effective instructional practices, the challenges associated with a STEAM instruction and how to appropriately incorporate the Arts component. Additionally, most schools have not implemented a STEAM curriculum due to district policies and a lack of appropriate professional development. However, research and literature clearly support the need for effective STEAM pedagogy, learner and teacher empowerment, professional development for teachers and administrators, as well as an intention for success and sustainability within a STEAM program (Huser, 2020). A STEAM curriculum is also new and therefore not fully and comprehensively

implemented into the curricula of K-12 schools. By 2010, STEAM education became an objective for all U.S. schools due to the increasing demand and intentions of global competitiveness in both the public and private sectors (Zaratin, 2020). According to the data for the U.S. DOE (2018), the Unites States is currently ranked 25th in science and 39th in mathematics. A marginal STEAM education can potentially affect an entire economy, educational system, homeland security, global stature and the quality of students' education (Zaratin, 2020).

The rationale for conducting this research is evident as low national standardized tests scores are prevailing in America, as well as a general decrease in creativity and innovation, STEAM education is a movement that has been on the rise. Hayman (2017) exemplified that we are facing an unprecedented creativity problem in America and that currently we are ranked between 3rd and 8th in international innovation. Music and Arts education supports and reinforces the STEAM movement by establishing and evolving indispensable skills such as creativity, teamwork, self-reflection and can close the achievement gap within student learning (Long II, Davis, 2017). STEAM education also provides creativity and imagination that can lead to discovery, which is the essence of advancement in science and engineering. When students are immersed in a STEAM based education, they are centered on designing challenges that require them to uniquely solve problems in creative ways and promote careful observation of the world around them, which that can ultimately help expand the right hemisphere of the brain (Hayman, 2017).

However, there have been many gaps in the research concerning how available and accessible STEAM education is at the K-12 level. There needs to be more

exploration into STEAM goals, initiatives and perceptions in order to expand and maximize accessibility, interest and proficiency in a STEAM program. Currently there is a lack of literature on the perceptions of a STEAM education, how it can potentially impact the whole student and how to implement and sustain it effectively at the K-12 level. This current research investigated teachers' and administrators' perceptions of STEAM education and explored the effectiveness of STEAM education. Research is needed as some studies have found that integrating a STEAM based curriculum had profound implications on understanding of complex concepts. Along with project-based learning, STEAM education can make real world connections with an interdisciplinary approach and can cultivate students' skills and deepen their understanding of Science, Technology, Engineering, Arts and Mathematics (Gross & Gross, 2016).

Purpose of the Study

The purpose of this explanatory sequential mixed method study, was to explore and investigate teachers' and administrators' perceptions of STEAM education. In addition, it also examined how these stakeholders viewed and perceived the implementation, support and sustainability of a STEAM program in their schools. Lastly, it also examined the perception and professional support for these STEAM educators and administrators. As the instructional leaders of their schools, principals and other school and district administrators can play a vital and meaningful role in improving STEAM education (Scott, 2012).

In order to compare and contrast the data and gain a more thorough understanding of the research, this study involved a mixed methods investigation. It began with a quantitative phase in which the researcher collected and then analyzed the data from a

quantitative STEAM Education Perception Survey. This was then followed by a qualitive phase, in which teacher and administrator interviews were conducted by the researcher. The research from the results of this study could potentially benefit STEAM education perspectives and perceptions that can ultimately motivate teachers to adjust their instructional practices and grant school administrators to gain a better understanding of the importance of a comprehensive STEAM based education for all learners, in order to give a more holistic view of relationships, behaviors and practices. The participants in this study included educators and administrators (superintendents, assistant superintendents, principals, assistant principals, directors, department chairs) at the K-12 level in five school districts that have a STEAM program in a suburban region of New York. The independent variable in this study was the educator role with two levels (teacher and administrator). The dependent variable was the teachers' and administrators' mean perception scores of STEAM education from the STEAM Education Perception Survey.

Theoretical and Conceptual Framework

This study utilized the Change Theory and the 21st Century Skills Framework in order to illustrate the importance towards the utilization of a STEAM based education to transform schools and modify learning. Additionally, the theoretical and conceptual framework demonstrated how education is presented and accomplished in a manner that is comprehensive and practical to meet learning demands for all learners in a 21st learning environment. The data from this mixed method design, including the STEAM education Perception Survey for teachers and administrators and the interviews, permitted the researcher to examine the Change Theory and the 21st Century Skills Framework and to

the practices and relationships that are involved when implementing STEAM education in schools, which can then be explored more in depth. The concepts of the Change Theory and the 21st Century Skills Framework were both central to the theoretical and conceptual framework in the current study. The theoretical framework defined these concepts and discussed the theories of the relationships between them. The conceptual framework was the P21 Framework for 21st Century Learning, which described and illustrated the phases of the change process.

Michael Fullan's Change Theory is defined as a need for change or modification to meet the demands of 21st century learning and policies. Fullan (1992, 2001) illuminated that educational change is multidimensional and involves many levels (classroom, school, district level) and each group of stakeholders can affect the implementation, form and nature of this type of change. Change Theory can be a powerful tool in informing education reform strategies and capturing results from the individuals who have a comprehensive knowledge of the dynamics of how the factors in question operate to get the specific results that are needed (Fullan, 2006). Nair and Hussin (2016) illustrate that when shaping any curricula or initiative, a Change Theory like Fullan's is essential to assimilate, as it can incorporate interdisciplinary skills, community engagement, academic literacy and creativity in a global manner. Utilizing the Change Theory can create a strong organizing framework to improve STEAM design, implementation, evaluation and learning (Nair, 2019). For the purpose of the current research, the P21 Framework for 21st Century Learning functioned as the conceptual framework for this study. This conceptual framework illustrated the learning environment, professional development, curriculum and instruction and standards and

assessments, as well as the skills needed in a STEAM based approach and will be further described and elaborated in Chapter 2.

Fullan also exemplifies the importance of Professional learning communities (PLC's) which involve developing and sustaining communities of learners in which teachers and administrators work together to improve an initiative or learning condition and the results in schools. Dufour, Eaker, and Many (2006) expound that PLC's should consist of six components: a focus on learning, a collaborative process stressing learning for all, inquiry-based learning, action orientation or hands on project-based focus, a commitment to being reflective and a focus on the results. Crampes (2020) emphasizes that PLC's can consist of experts, such as teachers and administrators, with shared goals and when incorporated effectively, can impact retention and engagement in STEAM and lead to larger-scale reform across STEAM education.

The Framework for the 21st Century Learning was developed by the Partnership for 21st Century Learning (P21) in order to help educators and practitioners integrate 21st Century Skills into the teaching of core academic subjects and all content areas. It targets on the skills and knowledge needed for a comprehensive education for all learners to succeed in work, life and citizenship in a global market. According to the Partnership for 21st Century Skills (2013), mastery of key subjects such as science, technology, engineering, arts, mathematics, geography, history, government, reading and language are essential to student success. Learning and innovation skills such as creativity and innovation, communication, project-based learning, critical thinking skills, problem solving and collaboration are also important for preparing students for a changing world driven by a global market. As the current world is constantly evolving and changing,

students need to be prepared to bring knowledge and skills in an interdisciplinary manner to solve complex problems and be college and career ready in a manner that they can pragmatically apply the knowledge to meet the demands of the modern era (Singh, 2021). By researching teachers' and administrators' perceptions towards STEAM education and applying the skills and foundation acquired utilizing the Framework for the 21st Century, the research can provide these stakeholders with the tools to make a change to extend beyond the classroom to produce critical thinkers, problem solvers, entrepreneurs and innovators needed in the 21st century.

Michael Fullan's Change Theory and The Framework for the 21st Century Learning by the Partnership for 21st Century Learning (P21) helped to guide this study. It is also important to understand the importance that the Change Theory and The Framework for the 21st Century Learning together plays in creating active and independent learners and thinkers that can master critical principles through innovative and creative approaches by incorporating the 4C's of change and 21st century learning: creativity, critical thinking, collaboration and communication. The Change Theory, the Framework for the 21st Learning and the conceptual framework supported the need for the current research, as it guided the study. Very little research has been conducted on teachers' and administrators' perceptions of STEAM education. The theoretical framework and conceptual framework together helped to unravel the significance of the literature review articles and interpreted the results of the current study.

Significance of the Study

Determining the perceptions that teachers and administrators have of a STEAM education and its implementation is of great importance, as it can have a societal and

universal impact on all students to develop their 21st Century Skills. Students at any age will be encouraged to think deeply to become innovators and pioneers of STEAM subjects and will be able to solve the most pressing issues facing the future of the world. This study explored and examined teachers' and administrators' perceptions of a STEAM education. A cognizance of STEAM education perceptions will ultimately improve practice, reinforce and invigorate a more comprehensive understanding of educational structures, policies and methodologies. Ozkan and Topsakal (2017) emphasized that STEAM education is used for improving the structural understanding between science, technology, engineering, art and mathematics areas. When STEAM assessment and rubrics are implemented in content outcomes, high level questioning, academic discussion, meaningful work and career connections, problem solving with technology engineering and arts integration, students can develop high expectations and ongoing improvement (STEAM focused Needs Assessment Report, 2015).

As the United States has recently become a global leader in developing and sustaining STEM related fields, an inadequate number of teachers in the classroom are proficient in teaching these subjects (Cotabish, Dailey, Robinson & Hughes, 2013). Neuroscience, which is the study of how the nervous system develops, its structure and what it does, demonstrates that effectively utilizing components of STEAM based subjects can improve cognitive performance (Chapman and Kirkland, 2013). The State Education Agency Directors of Arts Education-SEADAE (2021), illustrates that STEAM education is intentional and a collaborative pedagogy for teachers that empowers learners to engage in pragmatic and real-world experiences by aligning the standards, procedures and principles in science, technology, engineering, the arts and mathematics. STEAM

education allows for students and educators to be immersed in inquiry-based learning, dialogue, problem-solving and real-world, experiential application that can deepen and broaden their educational and pedagogic experience (Huser, 2020).

The significance of this study to leadership is that understanding teachers' and administrators' perceptions about STEAM integration can potentially provide school district leaders insight into developing and sustaining effective programs for STEAM integration and effective professional development opportunities that support the needs of educators. Without an effective and sustainable STEAM based education for all K-12 students, the United States would not be able to compete in a world-based economy, as its workforce would be inadequate and the United States would be behind other nations in which STEAM disciplines are more emphasized (Scott, 2012). STEAM literacy can potentially support all learners to enhance creativity in learning and assist the United States to improve its overall rank in the global marketplace and in the international evaluation of school quality (Zaratin, 2020).

The present research sought to extend theory in the area by investigating the perceptions of the cognitive value of the arts in a STEAM based education, its implementation and how these stakeholders perceive the support and sustainability of STEAM programs. Developing a pellucid understanding of the perceptions of a STEAM education while focusing on the Arts, can sustain interest and engagement and can allow for a more holistic approach to education, that can empower the learner both immediately, in the classroom and in a real-world setting (Huser, 2020). Additionally, researching and exploring the perceptions of a STEAM based education and its principles can guide the creative processes, to ultimately frame the design of a STEAM curriculum

that can fundamentally align standards-based learning in all STEAM based content areas (Huser, 2020). The National Council of Teachers of English Elementary Section Steering Committee (1996) highlights the demand to define the language arts broadly in order to include all of the ways that learners can make and create, including art, music, drama, mathematics and movement as well as the traditional and fundamental four pillars of language – reading, writing, speaking and listening, all of which are paramount to a STEAM based education.

The findings of this study can potentially support educators in developing and sustaining an authentic description and implementation of STEAM, serve as a guide to the development of STEAM programs and ultimately establish an engaging intertest among students to pursue STEAM areas in education and in a real-world setting (Breiner, Harkness, Johnson & Koehler, 2012). Limited research has been conducted in the United States on teachers' and school and district administrators' perceptions and implications of a STEAM based education at the K-12 level. The National Center on Education and the Economy (2005) illustrates that there should be a holistic approach to creativity, in which educational programs are differentiated in order to address students' creative potential and psychological aspects of creative thought processes, such as divergent thinking. As project-based learning (PBL) is the foundation for an effective STEAM based education, the National Center on Education and the economy (2005), states that PBL can represent a greater paradigm shift, can prove to be significant for stimulating creativity and an overhaul to traditional methods. Cropley (2001) also suggests that notwithstanding the presence of a myriad of creative programs in the formal education K-12 classrooms, conventional education systems can oftentimes hinder the development of skills,

behaviors and motives that are fundamental for the production of creativity and novelty. He states that there should be more of a commitment to jettison the idea that there is always a single best answer to a problem and to replace that with multiple idea getting techniques, which includes brainstorming, divergent thinking methods and other instructional approaches to increase and sustain creativity.

By ascertaining the perceptions of a STEAM based curriculum, a significant contribution can be achieved in the field of interdisciplinary learning. This study will add to the scholarly research and literature in the field by investigating the perceptions of STEAM education. Utilizing a STEAM based model will allow for interdisciplinary learning which can ultimately lead to using both the logical and creative – the work of both hemispheres of the brain, which are essential in developing unity, harmony and balance, neurologically and educationally (Anisimova, Kalimullina, Sabirova & Shatunova, 2019). Additionally, it will demonstrate the importance of research in STEAM education and provide information of how to improve inconsistencies in the current research. Educators and school leaders must ask themselves what supports and resources must be implemented in order to encourage and motivate a robust STEAM education and how can districts provide K-12 students with best practices and innovative opportunities to effectively learn STEAM. The goal is to establish a plan whereby all educators are well equipped to provide K-12 students with the fundamental skills, tools, experiences and knowledge in order to compete in a global world and to grant school and district administrators with the research needed in order to be a change agent and support all stakeholders. This study will also help to improve practice, as currently there are no published large-scale studies of the affiliation of students, teachers and administrators'

perceptions of a STEAM education. With the developing and demanding interest in STEAM education, it is important to examine and investigate these issues with clarity and understanding. The current research study will make a contribution to fill the gap that exists in the literature.

Connection with Social Justice

By evaluating the perceptions, views, implementation, sustainability and the meaningfulness of a STEAM education program, educators, pedagogues and school administrators can promote global connections for educational advancement. John Maeda (2013) states that with competition rising globally, America is at a critical point in defining its economic future. He states that art and design will ultimately revolutionize the economy in the modern era, as science and technology did in the 20th century. Maeda also explains that STEAM education is an opportunity for the United States to preserve its character as the pioneer of the world. A STEAM education asks students to define a problem, synthesize and evaluate it and can ultimately provide them with global initiatives and collaborative opportunities to support meaningful skills such as critical thinking, creativity, a connection to the Arts, communication and collaboration. In order for societies' educational institutions to prepare their citizens to be productive working members of society, theses educational institutions need to provide rigorous and comprehensive educational experiences that will prepare students for the twenty-first century job market (Woods, 2020). Perignat and Buonincontro (2013) emphasized that the foundation and principles that inspire STEAM education consist in the knowledge that students need a logical, natural and creative perception of the world in order to compete and succeed in a global economy and in the twenty-first century.

In a research study, Minneapolis public schools collaborated on mathematics with the arts to raise achievement. Ingram and Riedel (2003) described and illustrated their finding for Arts for Academic Achievement (AAA), which is an organization that focuses on demonstrating the impact of the arts on core subjects. The study included 45 schools from third to fifth grade, which lasted for four years. The AAA produced significant and meaningful improvements. Ingram and Riedel (2003) reported that the most substantial gains were from disadvantaged students. For each grade that was evaluated, a continuous relationship between frequency of arts inclusion and higher achievement was demonstrated. The conclusions revealed that arts integration is substantially related to mathematics achievement for third grade students and that the more that mathematics is combined with the arts, the more students can potentially gain on math tests (Rabalais, 2014). Ingram and Riedel (2003), illuminated that the AAA program impacted all students regardless of previous education, parental involvement or socioeconomic status. Conducting this research on teachers' and administrators' perceptions of STEAM education, its implementation and sustainability, will support all learners equally and globally, as well as reinforce the ideologies of the Change Theory, the Framework for the 21st Learning and the conceptual framework.

Research Questions

The purpose of this explanatory sequential mixed method study was to explore and investigate teachers' and administrators' perceptions of STEAM education. Sampled teachers and administrators completed a STEAM Education Perception Survey, which was a compilation Likert survey that was developed by the researcher and by Kristin Turner (2013). Using this data, the researcher discovered, evaluated and ascertained the

complex dynamics between teachers' and administrators' perceptions of STEAM education. Additionally, in order to compare and contrast data and gain a more thorough understanding of the research, after the researcher collected and analyzed the data from the quantitative survey, the study then followed a qualitative phase in which interviews were conducted by the researcher. This helped support the survey results by triangulating the data and provided a more comprehensive understanding of teachers' and administrators' perceptions towards STEAM education.

This study sought to answer the following broad research questions:

Research Question One

What are the perceptions of teachers and administrators towards STEAM education?

Research Question Two

How do teachers and administrators view the implementation of STEAM education in their schools?

Research Question Three

How do teachers and administrators perceive the support and sustainability of STEAM programs in their schools?

Hypotheses

Based on the review of literature and the research questions, the following hypothesis were formulated:

Hypothesis One

Ho: There will be no significant difference in the perceptions of teachers and administrators towards STEAM education.

H_1: There will be a significant difference in the perceptions of teachers and administrators towards STEAM education.

Hypothesis Two

Ho: There will be no significant difference in how teachers and administrators view the implementation of STEAM in their schools.

H_1: There will be a significant difference in how teachers and administrators view the implementation of STEAM in their schools.

Hypothesis Three

Ho: There will be no significant difference in how teachers and administrators perceive the support and sustainability of STEAM programs in their schools.

H_1: There will be a significant difference in how teachers and administrators perceive the support and sustainability of STEAM programs in their schools.

Additionally, the researcher sought to answer the following qualitative research questions when conducting the qualitative interviews for teachers and administrators:

1. How do teachers perceive a STEAM program?
2. How do administrators perceive a STEAM program?
3. How should teachers implement and teach a STEAM education?
4. How can administrators support and sustain an effective STEAM program?
5. What changes need to be made to support and sustain STEAM programs?
6. What skills should students in an effective STEAM program possess?
7. Do you feel there are gaps in the current STEAM model at your school? If so, what are they?

Design and Methods

This study followed a non-experiment criterion group design, as there were no active independent variables and no random assignments of subjects. Independent Samples *t* Tests and one way ANOVA's were conducted as part of the quantitative phase of this study to determine any statistical difference in the perceptions towards STEAM education based upon the two groups (teachers, administrators), as well as gender, levels of education, years of experience as a teacher or administrator, along with all other independent variables to determine the mean differences and similarities in teachers' and administrators' perceptions. The rationale for choosing an Independent Samples *t* Test, was that it is utilized to investigate the differences between two groups on a continuous variable (Knapp, 2018). The independent variable in this study was the educator role with two levels (teacher and administrator). The dependent variable was teachers' and administrators' mean perception scores of STEAM education from the STEAM Education Perception Survey. The survey data from Survey Monkey was directly inputted into SPSS. The data analyses were conducted and reported separately for administrators' perceptions and teachers' perceptions. The final analysis included the comparisons of both teachers' and administrators' perception results. Additionally, for the qualitative phase of this study, the researcher coded and determined the themes and patterns from the transcribed manuscript from the teacher and administrator interviews. The survey and interview data were triangulated to draw valid and reliable conclusions.

Participants

The participants in this study included educators that teach grades K-12 in a suburban region of New York, within 5 sampled school districts. It also included school

administrators (superintendents, assistant superintendents, principals, assistant principals, directors, department chairs) from elementary, middle and high schools in the same suburban, New York region as the teachers and within those same 5 sampled school districts. The sample included teachers that use a STEAM based model in grades K-12 in a general education, Science, Technology, Engineering, Music or a Mathematics setting. The teaching staff were all certified as state licensed teachers in their content area for grades K-12. The teaching experience for teachers ranged from one year to 30 plus years.

For administrators, the sample included superintendents, assistant superintendents, principals, assistant principals, directors, and department chairs that have a STEAM program in their school. The administration experience ranged from one to 30 plus years. All of the administrators were certified as school building leaders and had various backgrounds in education. The participants in this current study were purposively selected in order to have the inclusion of teachers and administrators that implemented a STEAM model or have a STEAM program within their school or district. The rationale for choosing these districts within this suburban region of New York will be further discussed in Chapter 3.

An advantage of purposive sampling is that the researcher can utilize their knowledge of the population to ascertain whether a specific sample will be representative (Vogt, Gardner & Haeffele, 2012). Purposive sampling can also be used when the researcher wants to access a particular subgroup of individuals, as all of the participants of a study are chosen because they fit a certain profile. A disadvantage of purposive sampling is that the researcher's judgment may be in error as the researcher may be

incorrect in supposing the representativeness of a sample. Additionally, there can be a low level of reliability and a high level of bias.

Instrument

Sampled teachers and administrators completed the STEAM Education Perception Survey, (Appendix C) which was a compilation survey that was developed and altered by the researcher and by Kristin Turner (2013). Permission was requested from the original author and the researcher piloted the survey. The STEAM Education Perception Survey was a 5-point Likert scale survey ranging from strongly agree, moderately agree, no opinion, moderately disagree to strongly disagree. The survey consisted of 35 questions regarding the perceptions of STEAM education and was divided into three strands, which was reflective of the research questions and four demographic questions regarding educator role, gender, years of experience and school level. The last question on the survey was an open-ended question, which allowed participants to describe their comments or experiences that they have had in regard to their perceptions of STEAM education and to indicate if they would like to be included in the follow up focus group. The STEAM Education Perception Survey assisted in the exploration of the research problem by providing teachers' and administrators' perceptions of STEAM education from two points of view: educator role (teacher or administrator) and school level (elementary, middle, high school or K-12). The wording and format of the survey was appropriate for teachers and administrators from all school levels.

Procedures

As the researcher was granted IRB permission from St. John's University (Appendix A), the researcher then sent a recruitment email (Appendix B) to the Superintendents of the select 5 sampled school districts in the suburban region of New York. Permission was then requested from the Superintendents of those 5 sampled districts to send the survey link to all teachers and administrators in their respective district. Once approved, the data was then collected. The last question on the survey was open ended and was used to identify a sample of survey respondents that were asked to participate in a follow up interview for teachers and administrators. The survey was administered as a Survey Monkey form where respondents' information was received anonymously, as no email addresses or IP addresses were collected. It was kept on a secure, password protected laptop and locked in a cabinet. The survey was sent out in December. Teachers and administrators were asked to reflect back on their experiences in STEAM during the past and most recent school year and throughout their careers.

As the researcher sent the email with the link to the Superintendents in the 5 sampled districts, the participants were given four weeks to respond to the online survey, in which during the course of those four weeks, emails were sent to remind those Superintendents to prompt participants to complete the survey. The data and responses to the online survey were then assembled and examined, which were then transferred into SPSS statistical analysis software. As this study was an explanatory sequential mixed method design, the researcher then began to follow up with the qualitative phase and conducted in depth interviews with four participants. The data was then triangulated to

determine themes and patterns. The interviews, as well as the open-ended responses from the survey were coded and studied to determine patterns and themes.

Definition of Terms

For the nature of this study, the following terms must be defined:

STEM

This term and acronym refer to science, technology, engineering and mathematics. In education, STEM training can be cultivated at the elementary, secondary and post-secondary level and can often be intertwined into unified fields of study. STEM also can refer to the field of computer science, mathematics, engineering, and life and physical sciences (Langdon, McKittrick, Beede, Khan & Doms, 2011). To encourage enthusiasm, devotion and development of STEM programs, government aid along with college, university and high school learning institutions have offered financial incentives to those students in learning facilities (Rabalais, 2014). STEM has been popularized during the 1990's by the National Science Foundation as an educational reform and since then has stimulated a global renaissance in educational and workforce contexts.

STEAM

This term and acronym refer to science, technology, engineering, arts and mathematics and places an emphasis on the integration of the arts within a teaching approach, to reflect real world phenomenology. STEAM education is a contemporary movement, which intersperses music, visual and performing arts concepts to problem solve pragmatic issues. John Meade, the president of the Rhode Island School of Design, began a federal initiative to support the advancement of STEAM, which would inspire

and revitalize the inclusion of the Arts in STEM programs to include artistic and creativity in STEM agendas (Perignat & Buonincontro, 2018).

Arts

Arts refers to music, visual arts, imagery, writing, painting or drawing. This is not to be confused with language Arts, which revolve around ESL (English as a second language), English, sign language or other means that relate to communication. The arts or fine arts are expressed as those that are learned in art classes, as in sculptures, paintings, or creative expressions that can be categorized. The term fine arts and arts are often used synonymously and in the STEAM movement, arts and fine arts generally include visual arts, orchestra, band, choir, drama or theatre and dance (Forbes, 2017). Liberal Arts at the university level are defined as academic studies that are expected to contribute general knowledge and skills, as opposed to a more definite, precise and particular vocational skills (Rabalais, 2014). Liberal Arts remain a broad undertaking, and includes the social sciences, such psychology, philosophy, sociology, civics, politics, theology and history and remains influential to pedagogues (Yakman, 2008). Manual Arts, however, are broadly defined as using cognition, hands, or tools with skills and other materials to make physical objects and physical arts refer to that such as sports, dance or movement.

Creativity

Anisimova, Kalimullina, Sabirova & Shatunova (2019) define creativity as the rejection of the cliched mental patterns, the ability to find non-standard solutions to problems and the ability to offer an original idea. In essence, creativity associates the unexplained with the explained and can be descriptive and figurative, as it creates a

kinship between two disparate ideas and is paramount in STEAM/STEAM (Long II, Davis, 2017). Since creativity is subjective and abstract, how it's measured remains unexplored and enigmatic. However, the research illustrates that creativity and science are associated. Hadzigeorgiou, Fokiali and Kabouropoulou (2012) contend that after investigating creativity in science, during the initial birth of creating, artists and scientists are committed to the exact imaginative means. They also state that although science and creativity come under diverse sections, as art educates students on the aesthetics and science requires a continuous focus on an analytical task, there is empirical evidence to support the view that individuals who have opportunities to operate in imaginative worlds can in fact become more creative. Kind and Kind (2007) illuminated that imagination can potentially offer the promise of making scientific creativity more concrete and help to identify a potential starting point for further research.

Integrated Curriculum

As subjects were once taught in isolation, reading in reading class, music in music class and so on, an integrated curriculum refers to a curriculum that combines different areas of study by utilizing and implementing unifying concepts and cross traditional linear learning. With this style of integration, it allows for students to make deeper and more meaningful connections in order to fully associate their learning to real world experiences. The integrated curriculum connects various subjects, including the arts into a unifying theme that focuses on cultural diversity, higher level learning and engagement. Rabalais (2014) postulates that in an integrated curriculum, the objectives of a math, social studies, science or core academic subjects can potentially be enhanced by congruently including other subjects such as art or music. This can also be called

interdisciplinary learning, multidisciplinary teaching or the distributed intelligence approach. STEM education can be perceived as integrating teaching and learning of some of the STEM themes with other school subjects (Nguyen, V., Nguyen, T., Lin, P., Lin, J., & Chang, 2020). For a successfully integrated curriculum and for arts education to be effective, students need to see the big picture of ideas; arts lessons should be authentically connected to a robust academic curriculum, whereby content and lessons should be planned efficaciously.

Literacy

Although fundamental literacy in education in the traditional sense is the ability to read, write, listen, and speak fluently, Alberta education (2020) characterizes literacy as the ability, confidence and enthusiasm to engage with language to acquire, construct and communicate meaning in all aspects of life. According to Tiemensma (2009), literacy is the ability to discern and utilize the written language forms that are recommended by society or esteemed by that individual. Tiemensma (2009) states that literacy is knowing how to read and write in a particular context, as well as also pragmatically applying this knowledge for definitive purposes in specific contexts of use. As every content area and subject has its own distinct and specialized literacy demands, literacy education in the 21st century relies in the Language Arts classroom, as well as on the responsibility of all educators.

21st Century Skills

Grunwald Associates (2010) illustrates that 21st Century Skills can include creativity and innovation, problem-solving, communication's, cross cultural learning, collaboration, media and technology, leadership and responsibility productivity and

accountability and life and career. National Research Council (2005) emphasized the importance of developing 21st Century Skills of students by designing integrated STEAM initiatives.

Self-efficacy

In this study, self-efficacy refers to one's belief in their ability to accomplish a certain task or objective. Established in Bandura's social cognitive theory, self-efficacy is a personal construct that can be determined by behaviors and social or environmental variables. Wagstaff (2014) delineates that self-efficacy is exclusively internal and does not relate to social views of the individual or how other others view one's abilities. Schunk and DiBenedetto (2021) illustrate that self-efficacy is the perceived capabilities to learn or carry out specific actions at designated levels and that self-efficacy is important to motivation that can ultimately affect one's efforts, choices, persistence and achievements.

Project Based Learning (PBL)

Project-based learning (PBL) is essentially a model and framework for teaching and learning whereby students acquire various content knowledge and 21st Century Skills in order to answer philosophical questions based on real-world problems, needs, challenges or concerns. PBL incorporates pedagogic methods such as student choice, time management, diversity, product focus, exploration, and self-directed learning to develop and refine student's skills toward learning objectives (Fillippatou and Kaldi, 2010). PBL can allow students to remain product-focused, to create hands on presentations and to ultimately construct solutions to problems that are challenging, in

order to design, analyze, generate and declare findings all while reflecting on their own self-discovery (Kilinc, 2010).

Theory of Multiple Intelligences

Howard Gardener's Theory of Multiple Intelligence's proposes that there are eight intelligences; naturalist, spatial, linguistic, intrapersonal, interpersonal, musical, logical-mathematical and bodily-kinesthetic. Gardner (2011) states that traditional psychometric views of intelligences are too limited and that when an individual might be particularly capable in one area, such as music, that person also possesses a wider range of abilities as in verbal, musical, and naturalistic intelligence. Multiple intelligences reflect the idea that individuals are adept at resolving issues that are esteemed in certain organizational systems; very seldomly are these intelligences utilized in isolated sequences (Rabalais, 2014). Gardner (2011) also illustrates that individuals can apply one or several of these profile of intelligences to complete tasks, conceptualize or solve a problem and explore understanding across different content areas and contrasting domains.

CHAPTER 2 Review of Related Literature

Introduction

The purpose of this explanatory sequential mixed method design was to investigate, identify and document the perceptions when implementing a STEAM (Science, Technology, Engineering, Arts, and Mathematics) education between teachers and administrators at the K-12 level. The findings and implications of this study sought to assist educators, educational leaders, researchers and policy makers in understanding teacher and administrator beliefs and perceptions encompassing the development, support and sustainability of STEAM programs. The previous chapter introduced the study and the research questions. Chapter two will provide an in-depth understanding of Michael Fullan's Change Theory, the Framework for the 21st Century and the P21 Conceptual Framework for 21st Century Learning and introduce the reader to the review of related literature. The chapter will conclude with a statement of how the present study contributes to the knowledge base of the perception and views of STEAM education, it's implementation and sustainability. In the following chapter, the methods and procedures used to conduct the current research study will be explained.

Theoretical Framework

Several guiding theories and theorists can potentially explain, demonstrate and clarify how the perceptions of teachers and administrators and how they perceive and support the development of STEAM programs can help build and sustain a unique vision of change and innovation for 21st century learners. As stated in Chapter 1, the two most applicable to this study will focus on the interrelationship between the Change Theory and the Framework for the 21st Century and will utilize the conceptual framework will be

the P21 Framework for 21st Century Learning. Both the Change Theory and Framework for the 21st Century provided a rationale and theoretical evidence for how the concept and model of STEAM education can potentially change and improve human capabilities in the 21st century (Bybee, 2010).

Change Theory

Michael Fullan's Change Theory emphasizes that much of educational change has focused on a better understanding of what kind of knowledge is needed to make substantial educational change, particularly improvement to learning outcomes. Fullan depicted that the cornerstone of change was the application of the correctly calibrated combination of capacity building (support) with accountability (pressure). Fullan (2003) constructed a perspective that incorporates a tri-level model of reform, which addresses the need for change in school, the community and the district or at the federal level, the state. Fullan (2013) clarifies that leading change in complex and dynamic places like school districts are mainly about the clarity of focus and communication. He states the policy drivers are the main stakeholders that essentially allow systems to change; for example, capacity building, teamwork, pedagogy, systemic policies (Kaye, 2020). Fullan's Change Theory can be classified as a framework of ideas, supported by evidence, that expounds an aspect of change beyond a single initiative (Reinholz & Andrews, 2020). Fullan (2013) discusses that there is a significant amount of work that any change process requires, such as constant attention, cultivation and reflection. He also outlines the potential that teachers could feel disconnected from the change if they feel there is a lack of support coupled with too much pressure. Teachers and educational leaders must provide and attend ongoing and high-quality professional development,

support and resources to incorporate STEAM successfully and effectively into a school district.

In order for a change for an initiative of STEAM to take place and be successfully implemented in a school or district, Fullan (2006) illustrated that in the Change Theory, there are 4 broad phases in the change process: initiation, implementation, continuation and outcome. The initiation phase depicts teacher and administrator advocacy, as well as support from central administration and external change agents as the federal government for grants and funds for a successful STEAM program to be launched. In the implementation stage, local factors such as the principal, teacher, community, board of education or school district are the main stakeholders largely responsible for this type of development. Each STEAM related task provider can provide a context for leaders to frame coaching and professional development around this stage, as well as coming up with the resources needed to fund STEAM based opportunities, school's budgetary designations, collaborations with other educators and workshops/trainings that develop a knowledge base (Douthit, 2021). According to Ellsworth (2000), in the next stage, the continuation phase depends on whether the change gets embedded into the structure or curricula, the change has generated critical mass of teachers and administrators that are skilled in STEAM and the change has acquired procedures for continuing assistance, either financially or pedagogically, at the local or federal level. In the final outcome phase, all stakeholders involved in the process may support the achievement of a positive or successful change outcome. Changes in skills, thinking and committed actions, as well as pressure, support and negotiation are needed to implement, build, support, sustain and evaluate a STEAM initiative (Ellsworth, 2000).

The utilization of Fullan's Change Theory within this study can inform implementation, policies, practices and reception of a change, such as STEAM in a complex organization like a school district (Douthit, 2021). The observation of change within a system can influence the impact of STEAM curriculum implementation. Therefore, a STEAM curriculum and implementation can be considered a focus of design with a change perspective. Cawsey, Deszca and Ingols (2016) emphasized the characteristics of an organization that is ready for change. This includes the flexibility and adaptability of the school districts culture, the engagement, involvement and participation of leadership, other stakeholders' perceptions about leadership and the experience that those stakeholders may have had with change in this organization and beyond. Freeman, Becker, Cummins, Davis and Giesinger (2017) state that there is a need for a change towards STEAM education as the current future hallmark of transformational education.

Framework for 21st Century Learning

As the current educational system in America, notwithstanding years of reform and lobbying, has remained in a sense, traditional, the developing conditions and exponential growth of the world's technology, entrepreneurship and creativity constantly requires countries to transform their learning and teaching that fits societies needs and demands (Orhan & Kurt, 2017). Countries such as Denmark, Finland, Australia and New Zealand are ranked as the best education systems in the world. Albeit these countries are geographically smaller than America, Programme for International Student Assessment-PISA (2012) states that these statistics are based on their tests scores in reading, math and science. As Taylor (2012) delineates these specific countries focus on providing students

with the necessary innovative problem-solving skills and more on retention-based hands-on learning that are needed for today's work needs, they also spend significantly less time on standardized testing and do not require students to undertake hours of homework.

The Framework for 21st Century Learning correlates to the specific skills that are needed to succeed in a global market (Partnership-for-21st-Century-Skills, 2013). In this framework, the core components for 21st century learning are identified into four themes: Key subjects (reading, writing, mathematics), Learning and innovation skills, Information, Media and Technology Skills and Life and Career skills. In connection with the key subjects, students must become accustomed in 21st Century interdisciplinary themes within the key subjects, including global awareness, financial/economic/business and entrepreneurial literacy, civic literacy and the arts (Partnership-for-21st-Century-Skills, 2013). According to the P21 Framework, learning, innovation and creative decision-making skills are increasingly being more accepted as those that separate students who are prepared for a more fulfilling life and work environment in the 21st century and those who are not (Partnership for 21st Century Skills, 2013). For a student to be fully prepared for 21st Century challenges, they must be equipped with the abilities to think critically, to communicate effectively and to collaborate with other peers (Partnership for 21st Century Skills, 2013).

As the 21st Century is a century of skills and abilities, 21st Century Skills generally refer to core competencies of technology, critical thinking, creativity, innovation and problem-solving in the real world and how these skills can be pragmatically applied in all fields of study and all professions of teaching (Singh, 2021). As traditional models of learning are inadequate to fully equip students with the

knowledge they need to bloom, the gap between the skills people acquire and the skills that are in demand and needed are becoming more apparent (World Economic Forum Report, 2020). The NSW Department of Education published an evidence-based review which illustrated the skills and dispositions that were found to be prominent in existing practice. Problem solving, creative thinking, metacognition (awareness of one's own thought processes), self-efficacy, motivation, determination and conscientiousness (Singh, 2021). As 21st Century Skills have great value for K-12 schools, Moore (2009) depicts that with the transition in education in the 21st century, the skills that students learn, need to be adapted and modified. While the educational field continues to seek novel strategies to empower students with inventive skills and knowledge, they require successful thinkers, innovators and creators. There has been a growing emphasis on a STEAM based model and similar learning tactics incorporating the Arts to infuse engagement, collaboration and creativity as a way for making this possible.

Singh (2021) states that to ultimately prepare students to be college and career ready, they need to discuss real-life topics that are important; STEAM education requires that students need to be active learners utilizing concepts of creativity and problem-based learning with critical principles through an innovative and creative approach. Moreover, it also provides a creatively designed space for the teacher in different content areas to work together to develop an integrated curriculum. Davies and Ryan (2011) illustrate that interdisciplinary curriculum programs such as a STEAM model offer an alternative to formal education for the development of the 21st Century Skills. STEAM education has been regarded as an important educational initiative for cultivating students' 21st

Century Skills and it is important to utilize a 21st Century model to achieve this (Huang, Jong, King, Chai and Jiang, 2022).

P21 Conceptual Framework for 21st Century Learning

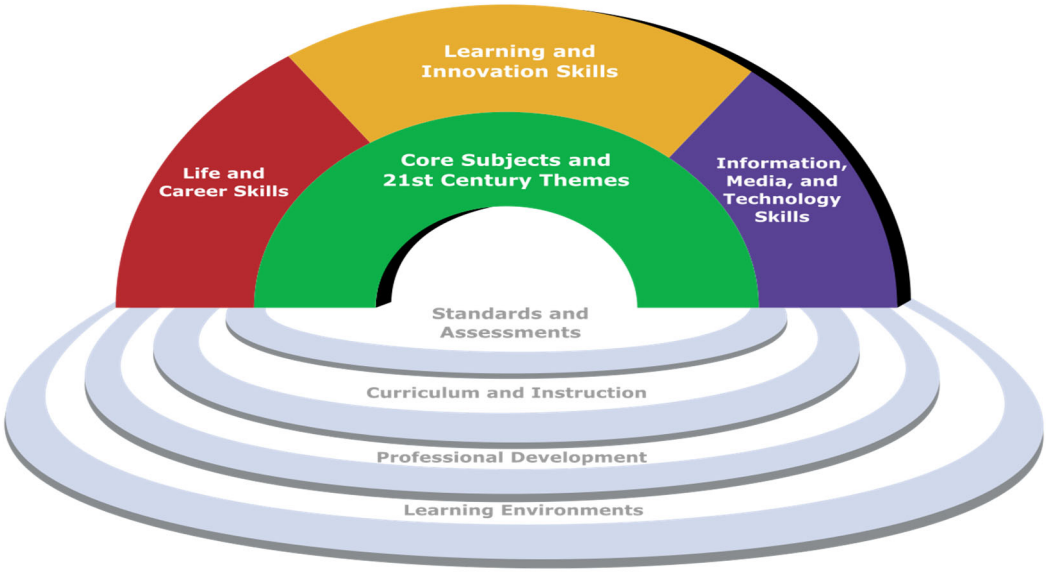
The conceptual framework for this study is the P21 Framework for 21st Century Learning that was developed by the US Department of education (2018), as well as companies such as Apple, Microsoft, Cisco and the National Education Association, which became known as the Partnership-for-21st-Century Skills (2013). It illuminates 21st Century student outcomes and support systems. The goal was to better prepare students to be college and career oriented in a 21st Century society and the interdisciplinary skills in this framework are critical for success in all content areas and in the workplace. According to the Partnership for 21st Century Skills (2013), the foundation believes that work environments are getting more complex in today's modern world and therefore students must be able to integrate and transfer traditional academic subjects with interdisciplinary skills in a way that would stimulate and promote the 4 Cs: creativity, critical thinking, communication and collaboration.

Figure 1 illustrates the Conceptual Model of the P21 Framework for 21st Century Learning, which illustrates 21st Century Student Outcomes and Support Systems (Partnership for 21st Century Skills, 2013). When implementing a STEAM based model, it is important to utilize each of these domains to support learning and 21st Century Skills. According to Remake Learning (2016), the learning environment assists teachers and administrators to utilize a STEAM based approach to create relevant learning experiences for students. Professional development is needed for teachers and administrators at the building and district level to integrate these 21st Century Skills, as well as to sustain and

support the initiative. Curriculum and Instruction allows stakeholders to differentiate learning to meet the needs of all students and as a tool to be used to navigate the core curriculum. Standards and assessments in this framework focused on the skills needed to accurately measure learning through standardized testing, inquiry and project based learning and creative feedback from the teacher or observation feedback from an administrator. The core subjects and 21st Century themes include English (reading or language arts), World Languages, the Arts (music or visual art), mathematics, economics, science, geography, history, government and civics (Partnership-for-21st-Century-Skills, 2013). Life and career skills include flexibility and adaptability, social and cross-cultural skills, leadership and responsibility and productivity and accountability. In the Learning and Innovation Skills domain, students need to collaborate with others in a manner that allows them to think creatively and work creatively with others, be innovative in their work and communicate their thoughts clearly (Toro, 2019). By integrating Information, Media and Technology Skills domain, in a STEAM based approach, students will develop information, communications and technology literacy and learn how to use the information accurately and creatively for the project or issue they are working on.

Figure 1

P21 Conceptual Framework for 21st Century Learning, which illustrates 21st Century Student Outcomes and Support Systems (Partnership for 21st Century Skills, 2013)



Review of Related Literature

The purpose of this explanatory sequential mixed method design was to ascertain teachers' and administrators' perceptions towards STEAM education and how it can potentially affect the development and sustainability of a STEAM programs in K-12 schools. The findings of this study sought to assist teachers, scholars, educational leaders and policy makers in understanding the perceptions of the implementation and integration of STEAM programs, which can potentially affect the manner in which students can learn and develop creativity. The review of literature is divided into three sections: STEAM Integration Through Professional Development; STEAM, Design Thinking and Project Based Learning; and Interdisciplinary and Real-World Applications of STEM and

STEAM. Each of the three sections provide summaries of research studies, which provide detailed critical reviews of the research and how each study is related to the current research. Any gaps found in the literature are noted. The review of related literature concludes with a demonstration of how the current study supports and extends the knowledge base on the integration of STEAM and outcomes highlighted in the review.

STEAM Integration Through Professional Development

The purpose of the study by Boice, Jackson, Alemdar, Rao, Grossman & Usselman (2021) was to utilize a mixed method of a yearlong STEAM teacher training program, in which a STEM teacher and an arts teacher collaborated in order to design and implement integrated STEAM lessons at each of the nine participating schools. The study was guided by the following research questions: What do teachers consider to be the important elements of a STEAM teacher training experience designed to support the creation and implementation of STEAM PBIL lessons? How does participating in a STEAM training experience influence teachers' perceptions and practices related to collaboration, pedagogy, self-efficacy, and arts integration? What are the challenges of implementing STEAM PBIL activities in the classroom? and how can a STEAM training program be designed to include support mechanisms that mitigate these challenges?

The sample and participants included 17 teachers from nine schools across three school districts that participated in a 2019 summer Professional Development experience. During its first year, these 17 teachers participated in the Go STEAM@Tech program, which is a teacher training program in partnership with Georgia Institute of Technology, preK-12 schools in the metro Atlanta area and local arts focused community

organizations. Teachers taught students at the elementary school (n=8), middle school (n=5) and high school (n=4) levels. One arts teacher and one STEM teacher participated from each school. The researcher used a mixed methods design and descriptive statistics were also used to ascertain the trends in quantitative data. Inferential statistics were also used to analyze quantitative data. Qualitative data were used in analyzing interactive content thematic approach to examine the meanings and patterns within the data. Social networks analysis (SNA) was utilized to map network diagrams which depicted changes in teacher collaboration networks.

The primary sources included both formative and summative assessment to show the influence of the program on teachers and students. Online surveys were administered to teachers four times during the pilot year. Additionally, a background survey was administered in the Spring semester prior to the summer PD. A pre and post survey were administered on the first and last day of summer PD to assess the teacher's social networks and their teaching self-efficacy before the PD and their satisfaction with the entire experience and ongoing support needs after the PD.

The main findings from surveys, focus groups and written reflections indicated that notwithstanding certain challenges, various aspects of the training program supported teacher implementation of STEAM. These findings offered insight into the forms of support that teachers' value in STEAM teacher training programs, as well as the benefits of such a program for teachers' professional development. The main findings indicated that students exposed to the STEAM lessons demonstrated greater improvement on physical science benchmark assessments than students that were exposed to a STEM only physical science curriculum. Additionally, STEAM lessons were as beneficial to

children who spoke English at home, as to English learners alike; Arts integration was especially meaningful and helpful to young English learners.

The study by Boice, Jackson, Alemdar, Rao, Grossman and Usselman (2021) connected to the Literature Review by providing research and data on STEAM teacher training and the challenges and different perspectives with implementing STEAM instruction. Additionally, it is important to understand the ways in which various teacher training programs can mitigate some of these challenges.

The purpose of the study by Mastrorilli, Harnett and Zhu (2014) was to examine whether and to what extent, providing teachers with high quality and intensive Professional Development can have a positive impact on arts teachers and their students. The following Research questions were examined: What is the nature of Arts achieve implementation? What are the successes and challenges of Arts Achieve implementation? What is the impact of the Arts Achieve project on arts teachers' Blueprint knowledge and instructional practices, including their use of the Blueprint standards and their interpretation and use of formative and summative assessment data? What is the impact of the Arts Achieve project on students' arts achievement? and are there differential impacts of the Arts Achieve project by arts discipline and school level?

The sample and participants included a total of 77 schools, 43 treatment and 34 control participated in the first year of implementation. One Arts teacher per school participated in the treatment. A total of 79 art teachers participated in the project, 44 arts teachers from the treatment schools and 45 teachers from the control schools. A total of 4,066 students received instruction that was yearlong in art within the arts teachers' targeted classes, including 2,046 students in the treatment schools and 2,020 students in

the control schools. The researcher used cluster randomized control trail whereby the schools examined were assigned to either the treatment or status-quo control condition. Descriptive statistics were used and then calculated, including frequencies, means, and standard deviations, on the attendance, survey, and arts achievement data. Additionally, multiple regression analyses were conducted to analyze the impact of the Arts Achieve project on arts teachers' knowledge and instructional practice scores, as measured by the arts teacher post-survey and students' arts achievement scores on the post-Benchmark Arts Assessments. Covariates that have a relationship with the treatment or outcome were included in each regression model to reduce the impact of threats to the study's internal validity. Covariates in the study included arts teachers' years of experience, arts discipline certification, and pre- survey composite scores. The primary sources for Arts Achieve included program documentation, arts teacher surveys and focus groups with art teachers and the Benchmarks Arts Assessments. Secondary data collection was collected from the NYCODE including students' background characteristics, and English Language Arts achievement.

The main findings indicated that from year one, while there were not statistically significant differences between the growth of treatment and control teachers, the students of treatment teachers resulted in a significantly greater growth in arts achievement from the students of control teachers. This suggests that a different tool for detecting change in teachers is needed. In the Pre- to post-survey administration, arts teachers in the treatment schools had increases in their perceptions of their Blueprint knowledge ($M_{pre} = 3.48$, $SD_{pre} = 0.41$; $M_{post} = 3.55$, $SD_{post} = 0.35$) and Blueprint use in instruction ($M_{pre} = 3.37$, $SD_{pre} = 0.96$; $M_{post} = 4.15$, $SD_{post} = 0.81$). Arts teachers in the treatment schools

reported more use of formative assessment strategies (M_{pre} = 3.99, SD_{pre} = 1.05; M_{post} = 4.95, SD_{post} = 0.84) and a higher understanding of the importance of reviewing and analyzing data for instruction (M_{pre} = 6.79, SD_{pre} = 2.99; M_{post} = 7.72, SD_{post} = 2.30) over the course of the school year.

The study by Mastrorilli, Harnett and Zhu (2014) connected to the Literature Review by providing research and strong evidence that increasing Arts teachers knowledge and skills in assessments (including formative and summative) and the utilization of data trends, can lead to an overall improvement in students' arts achievement. Moreover, that professional development can positively impact the teachers' knowledge and skills in that content area.

The purpose of the study by Quigley and Herro (2016) was to examine the implementation of STEAM teaching practices in science and math middle school classrooms in order to provide research-based evidence on STEAM to guide educators. The sample and participants included 21 science and math teachers (5 males and 16 females) from seven middle schools in the same school district. The school district is rated as the 110th largest in the nation. The participants were grouped by work experience (0-3, 3-6, 7-12, 12-20, 20+) and obtained approval from their principal to obtain a professional development.

The researcher used a qualitative methodology in order to ascertain the extent to which STEAM practices were implemented in a variety of middle school settings. The primary sources included teacher reflective journals, observation tool and field notes, reflective journal entries base on observation tool, online discussion topics, field notes and artifacts from teaching. The post survey indicated that some teachers had difficulty

understanding arts integration beyond the media arts and also had difficulty conceptualizing authentic assessment. The main findings indicated that there were five main consistencies that included relevance, student choice, technology integration, problem based and authentic instruction. Most teachers discussed traditional assessments remaining a part of their practice due to district requirements. While all teachers were able to create and implement authentic assessments, the data did not conclusively show that teachers formed future learning steps for individual students based on these assessments.

The study by Quigley and Herro (2016) informed this research study by providing research-based evidence of how to improve STEAM teaching and how it impacts student learning. Additionally, the study also informed this analysis by providing further research towards the growing interest in STEAM education, collaboration skills, arts integration, transdisciplinary learning, technology integration and will explore best practices of STEAM in middle school math and science classrooms.

The purpose of the study by Quigley and Herro (2017) was to examine teachers' perceptions and practices before and after a PD in which STEAM integration was explored through project-based learning which involved the social, political, economic, environmental and historical context of a local river. The sample and participants included 21 science and mathematics teachers (five males and 16 females) from a seven middle schools in the same school district. The STEAM district coordinator recruited the participants and they were grouped according to their years of experience as well as their certification area. Measures included pre-test and post-test open-ended surveys which included observations, written reflections, recorded focus group interviews and teacher-

created artifacts. Post surveys and focus groups interviews were focused on increased understanding of STEAM.

The researcher employed qualitative research in this case study and included pre-test and post-test surveys. Pre surveys were used to better gauge teacher's prior beliefs and experiences regarding STEAM, Project based learning, design thinking, use of technology and expectations for the PD. Post-surveys focused on an increased understanding of STEAM and perceptions of value of the PD. Artifacts included unit plans from topics ranging from issues related to invasive species, doctors diagnosing a disease, planning a school garden, raising money to support a field trip, adaption of native species after a catastrophe and the effects of infectious diseases on various populations. The main findings indicated that teachers increased their understanding of STEAM to be able to teach content and perceived the STEAM PD as an effective and substantial initial step to change practice, as they cited the importance of collaboration and technology integrated directly into the learning process.

The study by Quigley and Herro (2017) informed this dissertation by providing valuable research and considerations on developing effective STEAM professional developments in order to effect successful STEAM teaching.

STEAM, Design Thinking and Project Based Learning

The purpose of the study by Zhou, Pereira, George, Alperovich, Booth, Chandrasegaran, Tew, Kulkarni and Ramani (2017) was to provide key findings into the pivotal elements of middle school students engineering design learning and the potential benefits of engaging those middle school students as it relates to STEM hands-on toy design workshops. The researchers examined the framework of a toy design workshop

and investigated the influence of the workshop activities on students' understanding and their self-efficacy beliefs in design engineering. The researchers collected data from twenty-seven middle school students that participated in a toy design workshop at a university in the Midwestern part of the USA. The participants were between the ages of 13 and 14 years old (M=13.21, SD=0.83) and approximately 30% were female. The workshop lasted for two weeks and was conducted twice consecutively within a month.

A mixed method approach was used to collect the data. Quantitative analyses were utilized in order to demonstrate changes in students' design engineering self-efficacy. The quantitative data were provided by using the Engineering design self-efficacy survey of student's beliefs as it related to design engineering in a total four types of design engineering processes. The researchers examined student's efficacy beliefs in design activities in the four categories of sketching, prototyping, design iteration and collaboration. Observations were scored using a Likert scale (1=strongly disagree, 5=strongly agree). The researcher then used descriptive statistics, coding and a sample t-test to analyze the data. Descriptive analyses results indicated significant increases in students' self- efficacy in engineering sketching (mean=15.96, SD=2.57) design iteration (mean=33.58, SD=3.82) and prototyping (mean=28.54, SD=3.58) from before to after attendance of the workshops. However, student's self-efficacy in collaboration from the pre-survey to the post-survey did not change. The findings indicated that the participant's self-efficacy in sketching, prototyping, and design iteration increased after the toy design workshop. Additionally, this study provided evidence that hands on design in engineering related activities can foster middle school's self-efficacy in the above three categories.

The study by Zhou, Pereira, George, Alperovich, Booth, Chandrasegaran, Tew, Kulkarni and Ramani (2017) informed this dissertation by providing research on self-efficacy in STEAM related activities, design thinking and fundamental aspects of the design process and developing self-efficacy beliefs though mastery and vicarious experiences.

The purpose of the study by Rayfield and Smith (2017) was to find out the effect of cognitive sequence of instruction and student learning for acquiring information on student learning of STEM concepts as it relates to agricultural education. Researchers wanted to analyze the effect of cognitive sequencing of instruction and how participants grasp information through experiential learning theory (ELT). The researchers also wanted to investigate the cognitive sequence of instruction and student preference for acquiring information, in association to the dependent variables of student change score from pretest to post test for both of the units of instruction. This was a quantitative quasi-experimental, a purposive sample of 121 students (n=121) enrolled in the principles of agriculture, food and natural resources courses at four high schools in Texas were selected as the functional units of study. Data were selected from introductory agricultural science courses in four Texas high schools in the fall semester of 2015.

The data were collected in two phases, the collection of students characteristics and collection of STEM assessment knowledge, parental consent and student assent were obtained by each student enrolled in the Agriculture, Food and Natural Resources courses in each of the four schools. The independent variables were student preference for grasping information and cognitive sequence of instruction. The dependent variables were the student change score from pretest to posttest for both units of instruction. Three

instruments were used in this study; content knowledge assessments for both the water and soil units and the paper version of KLSI v 3.1, which was utilized to ascertain student preference for grasping experience in study participants. Data were analyzed using ANOVA to determine if statistically significant differences were present in the four test sites on the pretest. No significant differences were found in the pretest water sciences assessment scores between the students at the sites F (3,117) =1.22, p=0.30. However, there were statistically significant differences in the ANOVA examination of the raw scores on the soil science unit exams F (3,117) =5.10, p=0.02 in the means between sites on the soil science pretest assessment. Additionally, post hoc analysis showed discrepancies only between sites three and four. The differences in pretest scores were recognized for examination in the outcomes of hypothesis testing, but were found not to be a threat to analysis of data as related to the objectives. The main findings indicated that sequencing of instruction concluded in higher changes in assessment scores as it relates to preferences for grasping experience. Student differences based on cognitive sequences have explicit consequences for agricultural educators as they instruct STEM concepts.

The study by Rayfield and Smith (2017) guided this dissertation by providing structure, research and a substantial understanding on how agricultural education could be viewed as a way to teach STEM concepts as these courses often include a framework for STEM subjects. Additionally, this study also provided evidence on the conceptual nature of STEM concepts that has coerced researchers to conclude that STEM topics are best taught using pragmatic real-world issues.

The purpose of the study by Graham and Brouillette (2016) was to test the hypothesis that the Arts might provide upper elementary students with a powerful means of observing phenomena that they could not directly observe. The study also investigated the impact of STEAM lessons on physical science learning in grades 3 to 5. The sample and participants included ten out of the 55 Title 1 (high poverty) elementary schools in a large district in California, which were randomly chosen as treatment schools, which included two cohorts of five schools each, across a time span of two years. The first cohort of treatment group consisted of 893 students across five schools whose teachers had one year of training before the experiment. The second cohort of treatment group consisted of 1,263 students whose teachers were co-teaching with teaching artists. The control group consisted of 5,683 students.

In this quasi-experimental study, the researcher used OLS regression to demonstrate the effectiveness of the STEAM curriculum, while at the same time controlling for socio-demographic covariates and non-targeted science scores that could vary by each school. Three models were provided to show the importance of covaries, as experimental schools had already had a higher achievement going into the program. The study examined the impact of nine-hour long arts/physical science lessons that were implemented during the 2011-2012 school year across two randomly selected cohorts of schools with the cohorts differentiated by degree of experience with the curriculum. The nine lessons combined elements of dance, theatre and visual art in order to review science vocabulary and concepts over a nine-week period. The main findings indicated that students exposed to the STEAM lessons demonstrated greater improvement on physical science benchmark assessments than students that were exposed to a STEM only physical

science curriculum. Additionally, STEAM lessons were as beneficial to children who spoke English at home, as to English learners alike; Arts integration was especially meaningful and helpful to young English learners.

The study by Graham and Brouillette (2016) connected to the Literature Review by providing research on the design process used in engineering into science classrooms and adding visual and performing arts together. By recognizing the importance and potential of a STEAM curriculum, the research can assist that the arts, like mathematics can have a dual role in education.

Interdisciplinary and Real-World Applications of STEM and STEAM

The purpose of the study by Christensen, Knezek and Wood (2015) was to examine positive tendencies by middle and high school students that were participating in various programs relating to STEM activities. The sample and participants encompassed three groups of students in secondary school settings: Middle Schoolers out to Save the World (MSOSW), Communication, Science, Technology, Engineering and Mathematics Program (CSTEM) and the Texas Academy of Mathematics and Science (TAMS). The MSOSW group utilized 115 of the 914 students that completed project activities under supervision of their teachers. The CSTEM group, which was an after-school group, consisted of 8 middle school students and 64 high school students. The TAMS group consisted of 360 juniors and seniors and were exclusively for high achievers that were interested in math and science. The participants were asked to complete the STEM semantics survey which was used to assess dispositions for each of the three programs. The survey had semantic adjective pairs that students could check (boring, interesting, exciting, unexciting and so on) which served as anchors on a seven-point rating scale.

ANOVA was used for inferential statistics questions to ascertain if STEM preferences differed by gender. Effect size (ES) estimates were used to examine the magnitude of differences found.

The researchers used descriptive statistics, analysis of variance (ANOVA) and effect size (ES) computations (Cohen's d) to examine the data. ANOVA was utilized for inferential statistics questions as to whether or not inclinations for STEM differed by gender. CSTEM students were found to be highly positive in STEM dispositions and higher than MSOSW student dispositions during the posttest. The average ES between MSOSW and CSTEM middle school students was Cohen's d=.51, which was considered moderate and academically meaningful. The main findings indicated that many kinds of student centered and active learning, engaging STEM programs that are relevant to students lives and that real world applications may be effective and positive in promoting or retaining positive interest in STEM content areas. However, program type such as school-based programs, in which all students participate, as opposed to a program in which select students participate, clearly impacts the measured levels of STEM dispositions.

The study by Christensen, Knezek and Wood (2015) informed this study by providing research that STEM activities that are authentic, relevant to real world applications and apply prior knowledge and experiences to solve new problems could lead to meaningful interest and support the learning in STEM for both males and females. Additionally, for this dissertation, as the researcher compares and contrasts the similarities and differences between STEAM perceptions of teacher's and

administrator's, examining the research that relates to STEM and STEAM dispositions can improve STEAM literacy for all ages.

The purpose of the study, a cluster random sample experimental study, by O'Leary and Thompson (2019) was to examine and ascertain the effect of visual art instruction, specifically drawing, on long-term retention of science content. The Research question examined was: to what extent do students retain content using visual art integration, specifically employing art techniques to develop visual note taking and drawing skills, in STEM learning, as compared to students taught using a traditional approach?

The sample and participants included fifty-five 5th and 6th grade students and included 31 in the experimental group and 24 in the control group. Both the experimental and control group received specific instruction based on a modified science lesson developed by Arizona State University in accordance with National Aeronautics and Space Administration. The researcher used one-way repeated measures ANOVA using the current version of the Statistical Package for the Social Sciences (SPSS version 23). This was conducted to compare the effect of visual art integration on the long-term retention of content area test scores following the extremophile lesson and also after one month of instruction. The control group had received traditional STEM instruction which included note taking to gather information. The experimental group was asked to complete an 11-question multiple choice test to assess prior knowledge and also to assess content learning and retention immediately after instruction and one month after instruction. The dependent variables included participants' scores on the Retention post-test/multiple distance post-tests. Independent variables included the grouping of the class

(5th or 6th grade). The main findings indicated that the visual art integration group (visual-note taking) demonstrated a higher retention rate on the delayed post-test (dependent variables) than the traditional note taking group. Additionally, there were no significant differences that were found between the 5th and 6th grade participants on the measures.

The study by O'Leary and Thompson (2019) connected to this Literature Review by providing research on the need for policy makers to re-examine the importance and authenticity of a fully integrated and interdisciplinary educational experience for students in order to include the Arts.

The purpose of the qualitative multiple case study by Zaratin (2020) was to illustrate and document the process that educators go through when implementing a STEAM curriculum at a K-4 elementary school and to gain a more thorough understanding of teachers' beliefs and perceptions of an effective STEAM program. The study was guided by the following main research question: What is required for elementary teachers to effectively implement a STEAM curriculum within their classrooms? Sub questions included: What are elementary teachers' understandings of what STEAM education is at the elementary level? How do K-4 teachers feel about their ability to teach STEAM education and do those feelings affect their willingness to integrate it into their classrooms? and what problems, if any, do teachers perceive in implementing and integrating STEAM at the elementary level?

The sample and participants included five (n=5) K-4 teachers, one per grade, during the 2019-2020 school year that were participating in a STEAM initiative which was selected from one suburban New York elementary school. The researcher utilized a

grounded theory design to conduct the research. Grounded theory is a systematic, qualitative procedure that is used to develop a theory that illustrates, at a general and conceptual level, a process or action about a substantiative topic (Creswell, 2012). The researcher collected data from lesson plan reviews, lesson observations and a focus group interview. Guided by Merriam (2002) and Yin's (2009) method of inquiry, data analysis included transcribing recorded interview, coding data, categorizing the coded data and detailing the main patterns and themes in the data. Document analysis included a review of teachers' STEAM lesson plans and observation field notes; the focus group interview that was conducted and dialogue concerning teachers' thoughts, opinions, perceptions and suggestions were discussed; field notes were collected in order to ensure the recollection of behaviors, tone and mannerisms that could have affected more clarity to conducting the research.

The main findings from this study indicated that out of the ten lessons reviewed, none of the lessons provided rich opportunities for inquiry-based STEAM learning despite the term being utilized by teachers in interviews. Moreover, as many teachers used technology in their lessons, mathematics, engineering and the arts were not were observed through either observation or lesson planning documents. Additionally, as the researchers recognized in observations, science was utilized 100% of the lessons while technology was utilized only 50%, followed by mathematics and arts 30% and engineering at 10%. The average amount of time for a STEAM lesson varied by grade level, with 3rd and 4th grade being the most amount of time, followed by first grade, then second and kindergarten last.

To ensure trustworthiness and reliability, the researcher considered creditability, dependability and transferability. The researcher attempted to build rapport and communication with participants in order to gain authentic responses, as well as engaged in prolonged analysis with data sources to provide the reader with a thick description of the data. As Stake (2010) illustrated that triangulation is a research strategy to increase the validity of the study by probing two or more perspectives, the researcher utilized triangulation by incorporating multiple data sources, including field notes, document analysis and a group interview.

Due to the method of the study, there were a few limitations. As the researcher utilized focus groups, the results could have been biased as it corresponded to the interviewer's personality, as well as due to the study taking place in a small school district, as the results could potentially not be generalized to the extent of the entire population due to the possible regional biases of the schools and specific cultural contexts. Additionally, the perspectives of the participants were examined could potentially differ widely due to variables such as educational experiences, backgrounds and levels of experiences. This study by Zaratin (2020) informed this dissertation by providing authentic and meaningful research related to the perceptions of STEAM and the effective qualities of a STEAM education utilizing a qualitative approach.

Conclusion

The review of literature on the implementation of STEAM and STEM teaching practices provided evidence regarding the efficacy of this method of instruction. Most researchers (Graham & Brouillette, 2016; Mastrorilli, Harnett & Zhu, 2014; Boice, K., Jackson, J., Alemdar, M., Rao, A., Grossman, S. & Usselman, M., 2021) have concluded

that although there is great significance in recognizing the importance and potential for STEAM education and the arts, the results are not extensive enough to consider how much it impacts student learning. On the other hand, a few researchers (Quigley & Herro, 2017; Zhou, Pereira, George, Alperovich, Booth, Chandrasegaran, Tew, Kulkarni & Ramani, 2017) suggested that research-based evidence is needed to ascertain how to improve STEAM teaching and how it directly impacts student learning, collaboration skills, arts integration, transdisciplinary learning and technology integration. The only study that explored STEM activities that were authentic, relevant to real world applications and applied prior knowledge and experiences to solve new problems was by Christensen, Knezek and Wood (2015). The NRC (2010) states that a generalized teacher certification curriculum requires candidates to complete two college level science courses in addition to two college level mathematics courses, which can lead to inadequate preparation for teaching a STEAM curriculum. However, to overcome these limitations associated with being inadequately prepared, the NRC (2010) also encourages teachers to engage in continuing education and professional development in order to be prepared effectively to meet the demands of the 21st Century Skills of a STEAM curriculum.

The present study extended the literature by investigating and exploring teachers' and administrators' perceptions towards STEAM education, as well examining how these stakeholders view and perceive the implementation, support and sustainability of a STEAM program in their schools and districts.

CHAPTER 3 Methods and Procedures

Introduction

The purpose of this explanatory sequential mixed method design study was to explore and investigate teachers' and administrators' perceptions of STEAM education, as well as to examine how these specific stakeholders view and perceive the implementation, support and sustainability of a STEAM program in their schools. Additionally, it also inspected the effectiveness of professional support for STEAM educators. This study is important and beneficial to educators, school and district leaders, researchers and policy makers because currently there is a lack of available research in regards to STEAM education and little is known about effective instructional practices and how to appropriately incorporate the Arts component. By discovering the perceptions of a STEAM education, a significant contribution can be achieved in the field of interdisciplinary learning. Additionally, it is important to review and investigate the requirements needed for effective instruction that affect teachers' and administrators' attitudes, perceptions and confidence to implement STEAM education (Wang, 2012). As this study sought to provide insight and potential implications for how teachers' and administrators' perceptions affect the integration and effectiveness of STEAM education, the themes that were identified looked to provide a meaningful understanding of how teachers' and administrators' personal feelings about STEAM, as well as their experiences can potentially affect the quality of student learning.

Chapter 3 includes the description of the research method and design and the rationale and appropriateness for choosing an explanatory sequential mixed study design.

Additionally, included in this chapter will be a list of the research questions and descriptions of the sampling criteria, sampling frame, study participants, informed consent, confidentiality, and geographic location of the study. Also discussed within this chapter will be data collection procedures, rationale, validity and reliability, and data analysis. According to Pearson Education (2019), mixed method designs include sampling, recruitment, sample size, identifying forms of data collection, recording, transcribing and storing data. Creswell and Poth (2018) illustrate that a mixed method design is essentially a procedure for collecting, analyzing, and mixing both quantitative and qualitative data in a single study. Qualitative researchers study naturally occurring phenomena and try to interpret and make sense of them; quantitative research, on the other hand, involves describing a problem through a description of trends or a correlation among variables and quantifying them (Creswell & Poth, 2018).

This explanatory sequential mixed method design was a two-phase model in which the researcher first collected the quantitative data using the STEAM Education Perception Likert Survey, quantified the results, determined the quantitative results to explain the research questions and hypothesis' and then collected the qualitative data by conducting online interviews with K-12 teachers and administrators. The researcher then explained how the qualitative results related to the quantitative results. A Likert scale has equal theoretical intervals among the population being studied and it is assumed that the scale, from strongly agree to strongly disagree is proportioned in equal intervals (Creswell, 2012). Creswell (2012) also states that focus groups or interviews are the process of collecting data through conferences with a group of people, typically four to

six individuals that are used to collect shared experiences. Figure 2 illustrates a conceptual model of the explanatory sequential mixed method design.

Additionally, the reasons for combining the quantitative and qualitative data were: triangulation – which is a way to provide greater validity in the view that both quantitative and qualitative research can be combined, in order to triangulate the findings so that they both can be mutually authenticated (Bryman, 2006); completeness – which refers to the idea that when utilizing a mixed method approach, the researcher can bring together a comprehensive and holistic approach of inquiry utilizing both quantitative and qualitative data (Bryman, 2006); explanation – refers to when one is used to help explain the results and findings that is generated by the other (Bryman, 2006); interdependent - this refers to enhancement, elaboration and clarification of the results from one method, with the results of the other method (Greene, Caracelli & Graham, 1989); balance – refers to the idea that both quantitative and qualitative have their own balance of strengths and weaknesses and in combining them together, can allow the researcher to balance those strengths and weaknesses to draw on the strengths (Bryman, 2006).

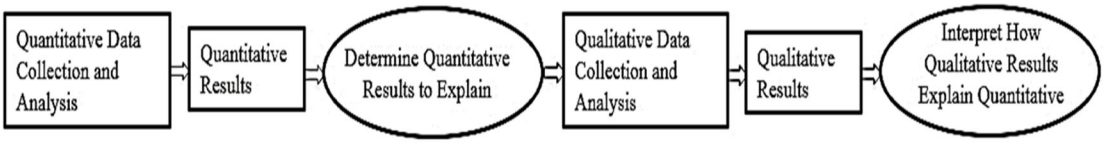
As the researcher reported two separate analyses: first, the quantitative data results of the survey, followed by the qualitative results of the interviews, the quantitative results that were discussed in chapter 4 were more extensive, while the qualitative analysis was in depth and descriptive. The researcher then ended the study with a discussion that compared the quantitative statistical results with the qualitative thematic findings to describe how the qualitative results explained the quantitative results. The researcher also utilized a sequential nested relationship, which described that some of the sample members that were selected from the first quantitative study, also represented a

subset of the participants chosen for the qualitative interviews. The researcher administered the STEAM Education Perception Survey to all sampled teachers and administrators within the 5 school districts to collect both quantitative and qualitative data, as well as conducted in-depth interviews with select K-12 teachers and administrators for the qualitative phase.

The qualitative data utilizing the interviews and open-ended questions on the survey were reviewed to augment this study. The advantages of using qualitative data in this study were that: the research took place in a relaxed and naturalistic setting (virtual and online), since human behavior can be influenced by the setting in which it can occur (Bogdan & Biklen, 2007); the research provided an understanding of the process of what takes place during the interviews; the researcher collected the data that was descriptive in nature and provided an in depth account of teachers' and administrators' perceptions, perspectives and experiences of STEAM education by using direct quotes (Fraenkel, Wallen & Hyun, 2012) and that the researcher made sure to collect meaning to ensure that the participants' perspectives were portrayed accurately and fairly (Bogdan & Biklen, 2007). According to Fraenkel, Wallen & Hyun (2012), the strengths of a mixed-method study is that it can help to analyze, interpret and explain the various relationships between variables as well as authenticate and substantiate those relationships found between variables.

Figure 2

Conceptual Model of the Explanatory Sequential Mixed-Method Design (Pearson, 2019)



Research Questions and Hypothesis

The data collection allowed the researcher to triangulate the data. This study sought to answer the following research questions:

Research Question One

What are the perceptions of teachers and administrators towards STEAM education?

Research Question Two

How do teachers and administrators view the implementation of STEAM education in their schools?

Research Question Three

How do teachers and administrators perceive the support and sustainability of STEAM programs in their schools?

Hypotheses

Based on the review of literature and the quantitative data collected from the STEAM Education Perception survey, the following hypotheses were formulated from the research questions:

Hypothesis One

Ho: There will be no significant difference in the perceptions of teachers and administrators towards STEAM education.

H_1: There will be a significant difference in the perceptions of teachers and administrators towards STEAM education.

Hypothesis Two

Ho: There will be no significant difference in how teachers and administrators view the implementation of STEAM in their schools.

H_1: There will be a significant difference in how teachers and administrators view the implementation of STEAM in their schools.

Hypothesis Three

Ho: There will be no significant difference in how teachers and administrators perceive the support and sustainability of STEAM programs in their schools.

H_1: There will be a significant difference in how teachers and administrators perceive the support and sustainability of STEAM programs in their schools.

Additionally, the researcher sought to answer the following qualitative research questions when the interviews for K-12 teachers and administrators were conducted:

1. How do teachers perceive a STEAM program?
2. How do administrators perceive a STEAM program?
3. How should teachers implement and teach a STEAM education?
4. How can administrators support and sustain an effective STEAM program?
5. What changes need to be made to support and sustain STEAM programs?
6. What skills should students in an effective STEAM program possess?

7. Do you feel there are gaps in the current STEAM model at your school? If so, what are they?

Research Design and Data Analysis

This study followed a non-experiment criterion group design, as there were no active independent variables and there were no random assignments of subjects. An independent samples *t* test and one-way ANOVAS were conducted to determine any statistical difference in the perceptions towards STEAM education based upon the two groups (teachers, administrators), as well as gender, levels of education, years of experience as a teacher or administrator, along with all other independent variables to determine the mean differences and similarities in teachers' and administrators' perceptions, implementation, support and sustainability of STEAM education. The rationale for choosing to use an independent samples *t* test is that it is utilized to investigate the differences between two groups on a continuous variable (Knapp, 2018). The independent variable in this study was the educator role with two levels (teacher and administrator). The dependent variable was the teachers' and administrators' mean perception scores of STEAM education from the STEAM Education Perception Survey. The descriptive statistics included the correlations between all variables in the study and demographic information conducted using SPSS (Statistical Package for the Social Sciences) for both and teachers' administrators' perceptions. The survey data from Survey Monkey were directly inputted directly into SPSS. The data analyses were conducted and a comparison of both teachers' and administrators' perception results were reported.

For the qualitative phase of this study, the researcher coded and determined the themes and patterns from the transcribed manuscript from the online interviews. The survey and interview data were triangulated to draw conclusions. Open-ended responses allowed the participants to respond and answer freely to questions; the researcher did not give any of the participants a fixed response option (Creswell, 2012). The interviews were used to collect shared experiences and understandings from several participants. The last open-ended response in the quantitative survey was recorded and coded to determine themes and patterns (Salkind, 2017). Focused coding was used for both the last open-ended response in the survey and the interviews (Saldaña, 2016). According to Saldaña (2016), focused coding refers to categorized coded data that are based on similarities in themes or in concepts. Searches for the most frequent or significant initial codes, such as breaking down qualitative data into discrete parts, then examining them and comparing them for similarities and differences, are important in order to develop the most salient categories in the data. Each quantitative survey question and interview question were assigned to a variable from the conceptual framework and the research questions (see table 1, Variable Matrix).

The data analysis for the qualitative component of this explanatory sequential mixed method study proceeded through the methodology as illustrated by Merriam (2002) and Yin (2009). Guided by Yin's method of inquiry, data analysis included a transcription of the recorded interviews, coding of the data, categorizing the coded data and identifying the primary patterns and themes in the data. Merriam (2002) delineated coding as the process of interacting with the data, asking questions about the data, comparing it and finally reaching appropriate conclusions from knowledge generated

from the qualitative data. Yin (2009) stated that the main purpose of coding is to describe the data and also to acquire a unique understanding of the phenomenon of interest or events central to the study. The researcher utilized the constant comparative method, which involved breaking down the data into meaningful units and then coding them to specific categories. Based on the approach of Creswell (2012), the researcher completed a preliminary analysis after the interviews, coded and then recorded the data according to the constant comparative method, until themes began to emerge.

The researcher read through the teacher and administrator interview transcripts and coded the highlighted terms and phrases into broad themes. The researcher then assessed these specific themes for commonalities with the quantitative survey and observational data, while looking for any commonalities that provide evidence and supported the theme. The transcribed interview data were highlighted and grouped by specific code words around meaningful phrases or ideas which surfaced in the data, which is described as categorizing. This ensured the researcher to see the relationships between the coded data and identify categories and emerging themes.

Table 1

Variable Matrix

Research Question	P21 Conceptual Framework Concepts	Survey Questions	Interview Questions
RQ1	Core Subjects and 21st Century Themes, Learning and Innovation Skills, Critical Thinking Skills, 4 C's	7, 8, 14, 16, 17, 20, 24, 30	How do teachers perceive a STEAM program?

RQ1	Learning and Innovation Skills, Creative Thinking, Collaboration, Core subjects and 21st Century Themes, Learning and Innovation Skills, Critical Thinking Skills, 4 C's	7, 8, 14, 16, 17, 20, 24, 30	How do administrators perceive a STEAM program?
RQ2	Core Subjects and 21st Century Themes, Social and Cross-Cultural Skills, Productivity and Accountability, Mastery of Key Subjects	10, 11, 14, 22, 23, 24, 25, 34	How should teachers implement and teach a STEAM education? What changes need to be made to support and sustain STEAM programs?
RQ3	Learning and Innovation Skills, Problem Solving, Creative Thinking, 4 C's, Core Subjects and 21st Century Themes, Social and Cross-Cultural Skills, Life and Career Skills, Learning and Innovation Skills	5, 6, 9, 12, 15, 19, 35	What skills should students in an effective STEAM program possess? How can administrators support and sustain an effective STEAM program? Do you feel there are gaps in the current STEAM model at your school? If so, what are they?

Reliability and Validity of the Research Design

Cypress (2017) illustrated that trustworthiness and validity in a study indicate the accuracy of research processes and the dependability of the research findings. To validate the trustworthiness and credibility in this study, the researcher employed various research sources and methods in order to authenticate evidence. Credible and reliable sources such as journals, academic books, dissertations and other scholarly works were utilized. Janesick (2015) illuminated that is crucial to have reliable research resources,

just as it is invaluable as using ambiguous sources in a research study would make the research less forbidding. Additionally, Creswell (2012) states that the triangulation of data from various sources, methods and investigators establishes credibility within a study (Creswell & Poth, 2018). The researcher distributed the recruitment email with the survey to superintendents, who then forwarded it to teachers and administrators within their districts. The data were collected from the quantitative survey and the respondents for the qualitative phase were identified. This method of collecting data allowed the researcher to triangulate the data and to analyze themes and to come to valid and reliable conclusions within the study. The researcher piloted the survey and interview questions to receive feedback.

As qualitative research takes place in a natural and realistic setting, Golafshani (2003) illustrates that the terms of reliability and validity, as they relate to qualitative research, emphasize that triangulation can improve the validity and reliability of the research. Creswell & Miller (2000) delineates that triangulation is a validity procedure whereby researchers search for commonalities among multiple and different resources in order to form themes within a study. In this study, internal validity occurred through a logical analysis of the data and results were verified by utilizing data from multiple sources. Data were collected from demographic questions, open-ended questions on the survey, as well as the interviews and the researchers' reflective notes. Bogden and Biklen (2007) advocate that when utilizing data from many sources, one gains a broader, more comprehensive and clearer understanding of the issues.

The first threat to the design included Interaction of selection and treatment. The researcher used a representative sample of n=140 participants, 102 teachers (72.86%) and

38 administrators (27.14%) throughout 5 school districts in a suburban region of New York. Although limited information was given regarding the socio-economic backgrounds of the districts, the results may not potentially generalize to districts and participants from various socio-economic backgrounds, age groups, different characteristics or to teachers and administrators from other parts of the USA. To minimize this threat, the researcher used a large sample size of n=140 and also ensured that the STEAM Education Perception survey instrument was tested for reliability and validity. The second threat included Interaction of setting and treatment. The researcher selected participants who were in 5 school districts. However, it can be potentially difficult to generalize an experience or perceptions in one school district to that in another school district, as teachers' and administrators' perceptions are dependent on many factors, including their gender, personality, ethnic/cultural background, education level of the participant and funding from the school building, district or state. To minimize this threat, the researcher explicitly stated that the demographic data from the quantitative survey was reflective of the region examined and albeit the districts are diverse in terms of their own specific demographics, the province as a whole represented a suburban region of New York. An additional threat to the qualitative design included respondent bias, which referred to respondents during the interview phase potentially not providing honest and reliable responses, due to being socially acceptable, wanting to please the interviewer or for any other given reason. To minimize this threat, the researcher asked open ended and indirect questions to the respondents and ensured prolonged involvement during the interviews.

To ensure trustworthiness of this study, the researcher considered dependability, credibility and transferability. Merriam (2002) illustrates that credibility refers to the acceptance of the findings that are enhanced by evidence such as confirming the evaluation of conclusions with research participants and having an appropriate theoretical fit. To establish credibility of this study, the researcher engaged in prolonged analysis with data sources in an attempt to describe and present the reader with a thick and rich description of the data. The researcher made sure to build rapport with the participants to obtain honest, reliable and open responses during the interviews. During the qualitative interviews, the researcher restated the information given, questioned and presented the questions to the participants in order to determine accuracy of the interview. This allowed the participants to analyze the information and comment when necessary. Merriam (2002) stated that the study is believed to have credibility only if the participants affirm the accuracy and completeness of the questions and answers.

As triangulation depicts the process that is often used in qualitative research to investigate results using two or more data sources, Stake (2010) described triangulation as a means where evidence is collected from various individuals, data types, or a variety of data collection methods for corroborating evidence. Bogdan & Biklen (2007) state that triangulation of data can be achieved using the responses and answers of participants in open-ended interviews or focus groups and by asking those participants to review and verify the accuracy of the data, which is called member checking. Triangulation in this study consisted of using multiple data sources including interviews , field notes and a quantitative survey. The interviews consisted of asking demographic questions and open-

ended questions about topics related to teachers' and administrators' perceptions, attitudes, beliefs and mental models encompassing a STEAM education.

Morse, Barret, Mayan, Olson, and Spiers (2002) believe that specific strategies are needed to verify and ensure both the reliability and validity of qualitative research. Morse, Barret, Mayan, Olson, and Spiers (2002) illustrated five strategies to ensure this process of verification. The first strategy is methodological coherence, which can ensure coherence of the research questions and the various components of the method. As the research develops, questions may need to be altered or methods may need to be adjusted. The second strategy is that the sample should be appropriate and should consist of participants that best represent or have sufficient knowledge of the research topic in order to make sure that the data is saturated. The third step is collecting and analyzing the data concurrently, which allows a combined interaction between what is already known and what needs to be known and discovered within the research. The fourth strategy is thinking theoretically, which allows emerging ideas from data to be reconfirmed in new data. This requires checking and rechecking in order to establish a firm groundwork for the research. The final strategy according to Morse, Barret, Mayan, Olson, and Spiers (2002), illustrates theory development, in which the researcher moves from a more comprehensive perspective to a more definitive view, utilizing a theoretical understanding.

Shank (2006) illustrated that in qualitative research, the validity and reliability are important concerns in when collecting data, analyzing the results, and in deciding the quality of the study. Miller and Miller (2000) stated that the validity is the strength in qualitative studies that are based on whether the results are accurate from the viewpoint

of the researcher, the participants and the readers of a study. Validity, on the other hand, is the level of confidence that a researcher draws from the results of the study. Yin (2009) illustrates that reliability for qualitative studies refers to the consistency and dependability of the data collected. Bogdan & Biklen (2007) also describe that interviews, member checking and triangulation can curtail the risk of bias and positively increase the reliability of the data of a qualitative study.

As Shank (2006) delineated that the internal validity in a qualitative study refers to the creditability of the data collected, Stake (2010) described triangulation as a process where evidence or data are collected from different individuals, types of data, or variety of data collection methods for corroborating evidence to ensure it is valid. Bogdan & Biklen (2007) stated the importance of member checking and that in qualitative studies, data triangulation can be accomplished with the responses and answers of participants in open-ended interviews and by asking participants to revise and corroborate the accuracy of their answers.

External validity is the extent to which the conclusions reached from the study are applicable and pragmatic to other contexts and scenarios (Stake, 2010). However, external validity is not commonly utilized in qualitative studies because qualitative research predominantly centers on researching or describing a specific phenomenon, not on generalizing the results (Christensen, Johnson, & Turner, 2011). This study will contain descriptive data, including anonymous participant details and context, collected from K-12 teachers and administrators from the interviews in selected districts in New York. The results of this study may enable external validity via naturalistic generalization

and reveal insight into and administrators' perceptions, attitudes, beliefs and mental models encompassing a STEAM education.

During the interviews, the researcher's observations were recorded by hand to ensure recollection of behaviors, mannerisms, tone, body language, or observations of verbal and nonverbal nature that can add further clarification of the research (Merriam, 2002). Field notes provided the researcher with a unique opportunity to collect the data and comment on their thoughts about the setting and what is taking place during the research. Shank (2006) illustrates that as an educator, during interviews, the researcher was able to relate to the conscious experiences of the participants and capture the relevance of the perceptions that were discussed, which aided in adding depth and significance to the themes and data collected. Attention was given to ensure that bias was minimized and past experiences and knowledge did not interfere with data collection or analysis of the qualitative phase.

The researcher followed the strategies by Morse, Barret, Mayan, Olson, and Spiers (2002) and consideration was given to establish that the qualitative research questions matched the data, methods for collecting the data and analyzing the data. Additionally, the sample participants were state licensed teachers and certified educational administrators at the building and district level. They were fully cognizant and had knowledge about STEAM education. Also, the data has been collected, gathered and analyzed and additional information was accumulated when needed. Ideas have been coordinated and reconfirmed throughout the study as new data were collected. Lastly, the Change Theory and the 21st Century Skills Framework were applied as an outcome of the study, where it was adjusted to compare and further establish the study.

Sample and Population

The participants in this study included educators that teach grades K-12 in a suburban region of New York that encapsulated 5 school districts. It also included school administrators (superintendents, assistant superintendents, principals, assistant principals, directors, department chairs) from elementary, middle and high schools in the same suburban, New York region as the teachers within those same 5 school districts. The sample also included teachers who use a STEAM based model in grades K-12 in a general education, Science, Technology, Engineering, Music or Mathematics setting. The teaching staff are certified as state licensed teachers in their content area for grades K-12. The teaching experience for teachers ranged from one to 30 plus years.

For administrators, the sample included superintendents, assistant superintendents, principals, assistant principals, directors and department chairs that have a STEAM program in their school. The administration experience ranged from one to 30 plus years. All of the administrators are certified as school building or school district leaders with various backgrounds in education. The school districts that were surveyed and the nearby suburban school districts are all within a 100-mile radius from a large northeast metropolitan city. The participants in this current study were purposively selected in order to have the inclusion of teachers and administrators who implement a STEAM model or have a STEAM program within their school and district. Additionally, purposive sampling was utilized to select teachers and administrators for the interviews. An advantage of purposive sampling is that the researcher can utilize their knowledge of the population to ascertain whether a specific sample will be representative (Vogt, Gardner & Haeffele, 2012). Purposive sampling can also be used when the researcher

wants to access a particular subgroup of individuals, as all of the participants of a study are chosen because they fit a certain profile. A disadvantage of purposive sampling is that the researcher's judgment may be in error as the researcher may be incorrect in supposing the representativeness of a sample. Additionally, there can be a low level of reliability and a high level of bias. The sample selected enhanced the researcher's ability to make inferences from the data and produce credible and valid explanations.

The researcher chose these districts from the website Niche.com, which listed the 2023 top 50 best school districts for STEM/STEAM education in this suburban region of New York. According to Niche (2022), they calculate their reviews based on established surveys which include: quantitative and qualitative data from school districts, rigorous analysis, user insights, school district report cards, academic grades, cultural diversity and parent/student surveys. The quantitative survey sample included all available teachers and administrators that choose to participate in the online survey within the top 5 school districts of the suburban region of New York. Additionally, the teacher and administrator interviews consisted of two teachers and two administrators, also within the 5 chosen school districts.

Instrument

As the researcher utilized a 35-question survey and wanted to have a reliable and valid study, a 5-point Likert scale was designed; numerical values were not assigned to each response category, the forced choice option was avoided by utilizing the response category "no opinion" and response scales were equally balanced between positive and negative choices. The order of responses from top to bottom were listed from "Strongly Agree" to "Strongly Disagree." Conditions of reliability and validity of a Likert scale

were reviewed before the researcher constructed the rating scale used for the STEAM Education Perception Survey. Friedman and Amoo (1999) advised that researchers might potentially try to manipulate the outcomes of their studies unintentionally and stated several important issues that could bias a study. Rating scales that contain an unequal number of favorable and unfavorable response choices could be unbalanced and the effect would not be very compelling and would therefore bias the results. Friedman and Amoo (1999) also advised against utilizing scales in a survey that had an unequal number of favorable and unfavorable responses, as well as the forced choice bias or by eradicating the "no opinion" or "undecided" choices on a survey would also bias the results by making it appear that more respondents have opinions that they actually do; and that the mean and median would be modified toward the middle of the scale. Friedman, H.H., Friedman, L.W. & Gluck (1988) advised that the results determined that placing all of the agreeable descriptors on the left side of the scale had the consequence of shifting responses to the left which is the more favorable side of the survey scale.

Teachers and administrators in the sampled school districts completed the STEAM Education Perception Survey, (Appendix C) which is a compilation survey that was developed by the researcher and by Kristin Turner (2013). The STEAM Education Perception Survey that was used by the researcher in this study, was modified/altered and permission was granted from the original author. The researcher piloted the survey and interview questions to receive feedback. To assess reliability, which is the extent to which the survey would give the same results if it were to be retaken again under the same conditions, the researcher utilized test-retest reliability, which had a score of .91 and piloted the survey at two different points in time and compared both results. The

researcher also utilized Cronbach's Alpha, which is a measure of internal consistency and was .921674, suggesting that the items on the survey had a high internal consistency. To assess validity of the survey, the researcher incorporated face validity, which asked other researchers to review the measurement techniques and items, to gauge their appropriateness for measuring teachers and administrations perceptions of STEAM. The internal reliabilities ranged from 0.82 to 0.92. The STEAM education perception survey is a 5-point Likert scale survey ranging from strongly disagree, disagree, no opinion, agree, to strongly agree. The survey consisted of 35 questions regarding STEAM education and four demographic questions regarding educator role, gender, school level and years of experience. In addition, demographic information was collected on the following items: gender, number of years teaching/being an administrator, grades taught (teachers), and grades supervised in the building or within a district (principals). Two open-ended questions allowed the participants to acknowledge the 3 most important challenges facing STEAM education and also to define STEAM education in their own perception and words. The last question on the survey was also an open-ended question, which allowed participants to describe their final comments or experiences that they have had in regards to STEAM education. Additionally, it also asked those participants (teachers and administrators) if they would like to be part of the interviews, which was the next qualitative phase of the study. Respondents that were interested in being a part of the interviews were asked to either email the researcher, or to state their interest and email address on the survey form. The survey assisted in the exploration of the research problem by providing teachers' and administrators' perceptions of STEAM education from various points of view including gender, school level (elementary, middle or high

school), educator role and years of experience. The wording and format of the survey is appropriate for teachers and administrators from all school levels, grades K to 12.

This instrument was suitable for this population (in terms of format, length, content, etc.) because teachers and administrators are professionals that lead busy and complex lives. The survey was designed in order to achieve the best and most effective results, as it pertains to the research in a timely manner. In a research study Preston and Coleman (2000), they illustrated that as reliability, validity and respondent preferences were analyzed, the ratings from each of the scales were evaluated for test-retest reliability and also utilized Cronbach's alpha for consistency. Test-retest reliability was found to be substantially higher with scales that contain five or more responses. Respondent's preferences ratings that contained scales of five, seven or ten responses were rated as easier and more effective to utilize. The researcher was concerned with having a reliable and valid study and determined appropriate precautions necessary by designing the 5-point Likert scale; the response scales were balanced between positive and negative choices, on a numerical scale and a forced-choice was avoided by using the response category "no opinion." As far as the order of the response categories, all of the responses were listed from top to bottom in order of "Strongly Agree" to "Strongly Disagree." However, questions within the survey itself were written in positive and negative statements and these were randomly placed in the survey. This helped to reduce the bias caused by the order of response categories. As rating scales are commonly utilized as measuring instruments in psychological research, most rating scales including Likert scales contain either five or seven response categories (Bearden, Netmeyer, & Mobley, 1993). In the present research study, the Likert scale had five response categories, which

had a test-retest reliability of 0.91, with an alpha coefficient Cronbach's a of 0.82 for the internal consistency reliability, statistically significant at $p < 0.05$ (Preston & Colman, 2000).

Procedures for Collecting Data

Once the researcher received IRB permission (Appendix A) from St. John's University, the researcher then sent a recruitment email (Appendix B) to the Superintendents of the 5 selected districts in the suburban region of New York. The researcher then requested permission from the Superintendents of the districts for them to forward the email, which contained the Survey Monkey link of the STEAM Education Perception Survey, as well as information about the interviews to all teachers and administrators in their respective district. Once approved, the data was then gathered and collected. As the quantitative survey was administered as a Survey Monkey link, respondents' information was received anonymously, as no email or IP addresses were collected. It was kept on a secure, password protected laptop and locked in a cabinet. The survey was sent out in December. Teachers and administrators were asked to reflect back on their experiences in STEAM during the past and most recent school year and throughout their careers.

As the researcher sent the recruitment email to the Superintendent of the chosen districts, which included a link to the survey, as well as information about the interviews, the participants were then given four weeks to respond to the online survey and interview formation, in which during the course of those four weeks, emails were sent to the Superintendents to remind the participants to complete the survey. The data and responses to the online survey were then assembled, examined and then transferred into

SPSS statistical analysis software and utilized to determine the results of the research questions. As this study was an explanatory sequential mixed method design, the researcher then began to collect qualitative data and conducted online interviews, with select teachers and administrators. The data were then triangulated to determine themes and patterns. The interviews, as well as the open-ended responses from the survey were coded and studied to determine patterns and themes.

Research Ethics

Confidentiality was maintained as no names or other identifiers were used in the data collection of the quantitative survey. All of the participants, when receiving the survey link, were provided a description of the study, approximate time it would take to complete it and that it was voluntary. Additionally, the survey also provided information that informed the participants that their name and information would be anonymous and that all data would also be confidential and for research purposes only. Additionally, participants had the right to withdraw at any given time, as there was no penalty for withdrawing. All data was collected anonymously and all information, including the participants' name, were confidential. All of the participants in the interviews were advised to sign a consent form (Appendix G). All collection of data was kept private and the participants' names and setting were coded to preserve confidentiality. Since this study had a significant number of questions, a statistical package (SPSS) was used to interpret the data. The coding and analysis of the qualitative data were conducted using the Rev voice recorder app and transcriber.

Conclusion

Chapter three described how the data from the survey was collected and analyzed, as well as how the interviews were conducted. Additionally, the methods and procedures of the research study were discussed, as well as research design, data analysis, sample and population, the procedures for collecting the data and the reliability and the validity of the instrument. The researcher also stated that the quantitative instrument, which was a compilation survey that was developed by the researcher and by and by Kristin Turner (2013) was modified/altered and permission was granted from the original author. Additionally, the researcher piloted the survey and interview questions to receive feedback. This chapter also addressed how trustworthiness was established and the steps for dealing with ethical considerations. In chapter four, the researcher will provide the quantitative results and findings for each research question and hypothesis from the data analysis by utilizing SPSS tables and figures, as well as the qualitative results from the interviews. Variables will be discussed as well as the means and standard deviations of scores between groups.

CHAPTER 4 Results

Introduction

In Chapter 1, the researcher detailed the purpose, research questions and significance of the study, while defining ambiguous terms. In Chapter 2, the review of related STEAM research was investigated and expounded, as well as the theoretical and conceptual framework were discussed and analyzed. Chapter 3 purported the description of the research method and design and the rationale and appropriateness for choosing an explanatory sequential mixed study design. Chapter 4 described the results and analysis of this explanatory sequential mixed-methods research. The advantage of using a mixed method design, specifically the explanatory sequential design, allowed the researcher to be able to use the qualitative results to assist in explaining and interpreting the findings of a primarily quantitative study. The purpose of this mixed method study was to explore and investigate teachers' and administrators' perceptions of STEAM education. It also examined how these stakeholders viewed and perceived the implementation, support and sustainability of a STEAM program in their schools. Additionally, it also examined the perception and professional support for these STEAM educators and administrators. The researcher also sought to gain a more meaningful understanding about teachers' and administrators' perceptions of STEAM education at the K-12 level and how it could support educators and administrators in implementing, developing and sustaining an authentic STEAM program. This study was intended to serve as a guide on the development of STEAM programs and ultimately to establish an engaging interest among students to pursue STEAM areas in education and in a real-world setting in order to pursue the goal of college and career readiness for all learners.

As this study was an explanatory sequential mixed-methods research, there were two phases of data collection. The quantitative results were presented as they related to the three research questions, each containing a hypothesis. First, teachers and administrators completed a 35-item quantitative survey, that included questions regarding demographic information as well as STEAM perception inquiries from the STEAM Education Perception Survey (see Appendix C). The researcher then collected and analyzed the quantitative results utilizing SPSS to conduct independent samples *t* tests and one-way ANOVAS to determine any statistical difference in the perceptions towards STEAM education based upon the two groups (teachers and administrators), as well as gender, school level affiliated with, years of experience as a teacher or administrator, along with all other independent variables to determine the mean differences and similarities in teachers' and administrators' perceptions, implementation, support and sustainability of STEAM education. The survey data from Survey Monkey were directly inputted directly into SPSS. The survey questions incorporated both scaled response choices and open response formats (for 3 questions).

After the quantitative survey data were collected and analyzed, four respondents (two teachers and two administrators) were purposefully selected for a qualitative follow-up online interview that utilized the Informed Consent for Teachers and Administrators Participating in Online Interview (Appendix G), along with six open ended Interview Questions (Appendix D). The interviews were recorded using the Rev Voice Recorder app. The coding and analysis of the qualitative data were also conducted using rev voice transcription. The researcher coded themes and patterns from the transcribed manuscript from the interviews, based on the theoretical and conceptual framework and other

common themes that became apparent. A co-occurrence analysis was conducted to find patterns within the themes. Following the teachers' and administrators' interviews, the researcher then interpreted the qualitative results. The findings were organized by each interview participant, theme and research question. The data were identified and categorized according to the research questions and the components of the conceptual framework that applied to the research question. The Change Theory and the Framework for 21st Century Learning were applied to the results to provide a theoretical lens to the school and district community of practice.

Demographic Data

Quantitative and qualitative data were collected on teachers and administrators within 5 school districts in a suburban region of New York. The survey was administered between the dates of December 19, 2022 – January 16, 2023. The qualitative interview data was conducted and collected after the quantitative survey.

The quantitative survey requested the following demographic information of all participants: Educator role, gender, school level affiliated with and years of experience as an educator or administrator. Descriptive statistics were used to summarize the following data. A total of 140 respondents (n=140) participated in the study. Figure 3 represents the educator role of those participants. There were 102 teachers (72.86%) and 38 administrators (27.14%). Of the 140 respondents, 69 were male (49.29%) and 71 (50.71%) were female. Figure 4 illustrates the gender of the participants. 60 respondents (42.86%) were affiliated with the Elementary school level (K-5), 23 respondents (16.43%) were affiliated with the Middle school level (grades 6-8), 37 respondents (26.43%) were affiliated with the High school level (Grades 9-12) and 20 respondents

(14.29%) reported being affiliated at the district level (Grades K-12). Figure 5 displays the school level that respondents were affiliated with. Surveyed teachers and administrators shared the following levels of experience within their roles: 70 respondents (50%) had 11 plus years of experience, 54 respondents (38.57%) had 6-10 years of experience, 15 respondents (10.71%) had 3-5 years of experience and one respondent (0.071%) reported having 1-2 years of experience. Figure 6 depicts the years of experience of the participants in the study. Figures 3, 4, 5 and 6 illustrates the demographic data from the quantitative survey, which were reflective of the region examined. Although the districts may be diverse in terms of their own demographics, the province as a whole represents a suburban region of New York.

Figure 3

Educator Role of Participants

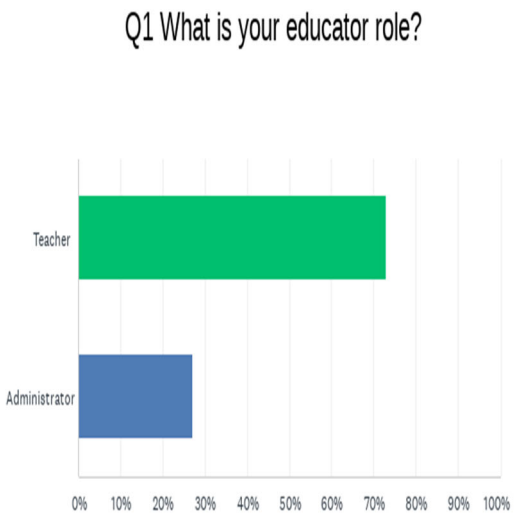


Figure 4

Gender of Participants

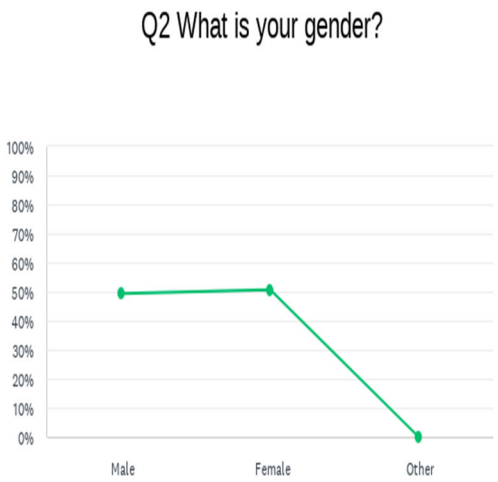


Figure 5

School Level of Participants

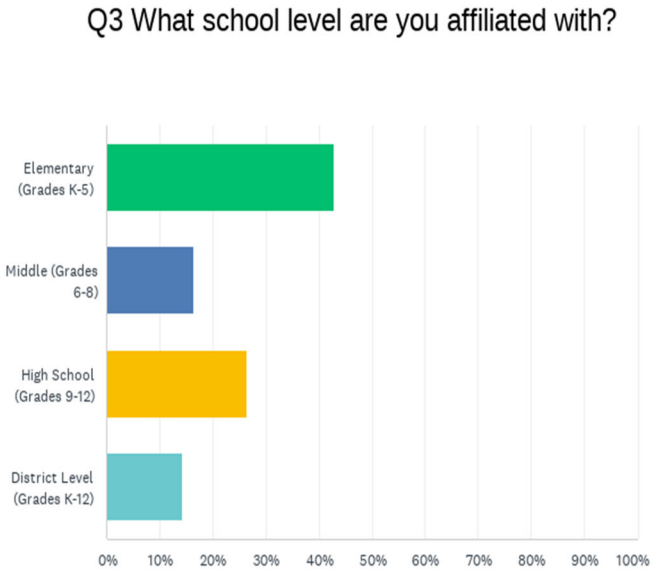
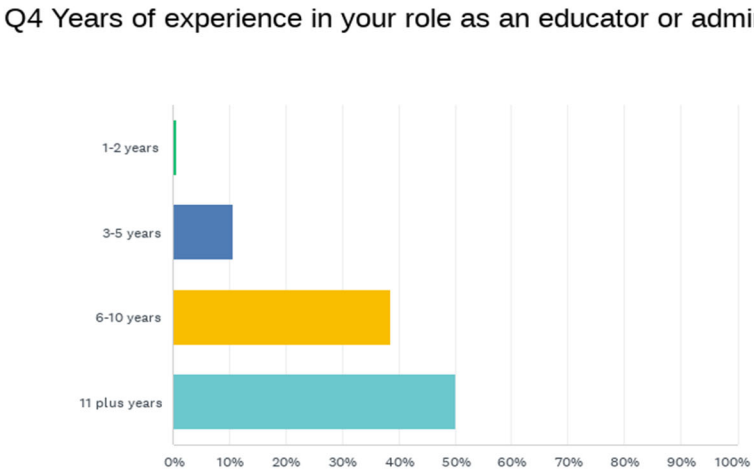


Figure 6

Years of Experience of Participants



Quantitative Results

Research Question One

Research question one, what are the perceptions of teachers and administrators towards STEAM education, was answered by calculating frequencies and percentages of the participants' responses to the STEAM Education Perception Survey. Research question one was further addressed by calculating a composite score for this subscale and conducting an independent samples *t* test to determine if there was a statistically significant mean difference among the perceptions of these two groups. Both survey and focus group responses provided data to examine the first research question. Survey data will be discussed here, while focus group data will be presented later in the chapter. Several of the survey questions made general inquiries regarding perceptions of STEAM education for teachers and administrators.

When asked if teachers and administrators believed that STEAM is needed in the American K-12 school system, (survey question 7), overall, 108 respondents (77.14%) strongly agreed, 31 respondents (22.14%) moderately agreed and one respondent (0.17%) had no opinion. None of the respondents surveyed moderately disagreed or strongly disagreed that they perceived there was a need for STEM education. The Independent Samples T test results from SPSS, illustrated in Table 2, indicated that there were significant differences (t (138) = -.877, p=.382 in the scores, with a mean score for teachers (N=102) that was 1.22 and the mean for administrators (N=38) was 1.29 with a standard deviation of .413 and .515, respectively. Levene's Test for Equality of variances stated that equal variances were assumed, as the sig. is 0.063 or >.05. The one-sided p value was .191 and the two-sided p value was .382. The magnitude for the differences in the means (mean difference=-0.074, 95% CI: -.240 to .093) was significant. Therefore, the H_1: There will be a significant difference in the perceptions of teachers and administrators towards STEAM education was supported for this survey question.

Table 2

Means and Standard Deviations of Educator Roles for Survey Question 7

I believe STEAM is needed in the American education system?

			Levene's Test for Equality of Variances		t-test for Equality of Means					
	Mean	SD	F	Sig.	t	df	Sig (2 tailed	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower Upper
			3.510	0.63	-.877	138	.382	-.074	.084	-.240 .093
Teacher	1.22	.413								
Administrator	1.29	.515								

When asked about having a clear understanding of teachers' and administrators' perceptions of a STEAM education is critical for the success of all educators, leaders and for the advancement of the program (survey question 8), overall, 108 respondents (77.14%) strongly agreed, 30 respondents (21.43%) moderately agreed, one respondent had no opinion (0.71%) and one respondent moderately disagreed (0.71%). The Independent Samples T test results from SPSS for this question, illustrated in Table 3, indicated that there were significant differences (t (138) = -.191, p=.849 in the scores, with a mean score for teachers (N=102) that was 1.25 and the mean for administrators (N=38) was 1.26, with a standard deviation of .516 and .446, respectively. Levene's Test for Equality of variances states that equal variances are assumed as the sig. is 0.955 or >.05. The one-sided p value was .424 and the two-sided p value was .849. The magnitude for the differences in the means (mean difference=-0.018, 95% CI: -.205. to .169) was significant. Therefore, the H_1: There will be a significant difference in the perceptions of teachers and administrators towards STEAM education was supported for this survey question.

Table 3

Means and Standard Deviations of Educator Roles for Survey Question 8

Having a clear understanding of teachers' and administrators' perceptions of a STEAM education is critical for the success of all educators, leaders and for the advancement of the program.

			Levene's Test for Equality of Variances		t-test for Equality of Means					
	Mean	SD	F	Sig.	t	df	Sig (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower Upper
			0.003	0.955	-.191	138	.849	-.018	.095	-.205 .169
Teacher	1.25	.516								
Administrator	1.26	.446								

For survey question 16, teachers and administrators were asked whether a STEAM education can cultivate students' talents and skills in music and the arts. Overall, 119 respondents (85%) strongly agreed, 20 moderately agreed (14.29%), one respondent had no opinion and zero respondents moderately disagreed or strongly disagreed. The Independent Samples T-Test for this question was conducted and revealed that there were significant differences (t (138) =-.507, p=.613 in the scores with a mean score for teachers of M=1.15, SD=.383) was lower than Administrators (M=1.18, SD=.393). Levene's Test for Equality of variances states that equal variances are assumed as the sig. was 0.374 or >.05. The one-sided p value was .306 and the two-sided p value was .613. The magnitude of the differences in the means (mean difference =-.037, 95% CI=-.182 to .108) was significant. Therefore, the H_1: There will be a significant difference in the

perceptions of teachers and administrators towards STEAM education was supported for this survey question.

Table 4

Means and Standard Deviations of Educator Roles for Survey Question 16

A STEAM education can cultivate student's creative talents and skills including in Music and the Arts.

			Levene's Test for Equality of Variances		t-test for Equality of Means					
	Mean	SD	F	Sig.	t	df	Sig (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower Upper
			0.797	0.374	-.507	138	.613	-.037	.073	-.182 .108
Teacher	1.15	.383								
Administrator	1.18	.393								

For survey question 17, which asked teachers and administrators their perception of whether STEAM education is integral and beneficial to all students due to its positive impact in Science, Technology, Engineering, Arts, and Mathematics, 125 participants (89.29%) strongly agreed and 15 participants (10.71%) moderately agreed. The data from Table 5 and the SPSS Independent Samples T test analysis supported that the mean score of teachers was 1.10 and administrators was 1.13, with the administrators viewing the STEAM as more beneficial due to its positive impact than to those of the perceptions of teachers. The standard deviation was .299 for teachers and .343 for administrators. Equal variances were assumed according to Levene's Test for Equality of Variances as F=1.246, sig. was 0.266, p=.527, M= -.034 and SD=.059. The magnitude of the differences in the means (mean difference =-.034, 95% CI=-.150 to .083) was significant.

Therefore, the H_1: There will be a significant difference in the perceptions of teachers and administrators towards STEAM education was supported for this survey question.

Table 5

Means and Standard Deviations of Educator Roles for Survey Question 17

STEAM education is integral and beneficial to all students due to its positive impact in Science, Technology, Engineering, Arts, and Mathematics.

			Levene's Test for Equality of Variances		t-test for Equality of Means					
	Mean	SD	F	Sig.	t	df	Sig (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower Upper
			1.246	0.266	-.567	138	.572	-.034	.059	-.150 .083
Teacher	1.10	.299								
Administrator	1.13	.343								

Survey question 14 asked teachers and administrators whether a large amount of time was needed to prepare for a successful STEAM implementation. 107 respondents (76.43%) strongly agreed, 31 respondents (22.14%) moderately agreed and 2 respondents (1.43%) had no opinion. The Independent Samples T-Test for this question (Table 6) was conducted and revealed that there were no significant differences (t (49.253) =-2.245, p=.029 in the scores, with a mean score for teachers (M=1.19, SD=.391) and for Administrators (M=1.42, SD=.599). The sig. was <0.001 and therefore less than 0.05 and equal variances were not assumed. The magnitude of the differences in the means (mean difference =-.235, 95% CI=-.445 to -.025) was very small. Therefore, the H_1 was not supported and the Ho: There will be no significant difference in the perceptions of teachers and administrators towards STEAM education was supported for this survey question.

Table 6

Means and Standard Deviations of Educator Roles for Survey Question 14

A large amount of time is needed to prepare for a successful STEAM implementation.

			Levene's Test for Equality of Variances	t-test for Equality of Means					
	Mean	SD	Sig.	t	df	Sig (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower Upper
			<0.001	-2.245	49.253	0.029	-.235	.105	-.445 .025
Teacher	1.19	.391							
Administrator	1.42	.599							

As survey question 14 asked teachers and administrators whether a large amount of time was needed to prepare for a successful STEAM implementation, a One-Way NOVA was conducted across four groups or school levels (elementary, middle, high school, district level). The ANOVA results illustrated that the comparison of these 4 school levels differ significantly ($F=3,136) =3.617$, $p<.015$. When comparing the four groups of administrators (elementary, middle, high school and district level), a One-way ANOVA analysis, results was utilized. According to Test of Homogeneity of Variances, based on the mean, the sig was .001 or <.05. It was significant and therefore there were no homogeneity of variances. Since the Levene's Statistic was significant, equal variance was not assumed. To check for individual differences between groups, post-hoc comparisons were assessed using Dunnett's T3. The test indicated that the mean score for teachers and administrators at the elementary level (M=1.23, SD=.465) differed significantly from those at the district level (M=1.55, .605). The middle school level (M=1.17, SD=.388) and high school level (M=1.16, SD=.374) differed significantly from

the elementary school level (M=1.23, SD=.465). The mean differences were significant at the 0.05 level. However, no significant differences were detected between the elementary and middle school levels. Table 7 illustrates a One-Way ANOVA for this question.

Table 7

One Way-ANOVA Descriptive - Means and Standard Deviations across Four School Levels. Survey Question 14. A large amount of time is needed to prepare for a successful STEAM implementation.

	Mean	SD	Std Error	95% Confidence Interval of the Difference Lower	Upper	Minimum	Maximum
Elementary School (K-5)	1.23	.465	.060	1.11	1.35	1	3
Middle School (6-8)	1.17	.388	.081	1.01	1.34	1	2
High School (9-12)	1.16	.374	.061	1.04	1.29	1	2
District Level (K-12)	1.55	.605	.135	1.27	1.83	1	3

Survey question 30 was open ended and asked teachers and administrators, in their own words, to define STEAM education. The researcher compared teacher and administrator common terms to the previously determined STEAM definition that refers to science, technology, engineering, arts and mathematics and places an emphasis on the integration of the arts within a teaching approach, to reflect real world phenomenology. STEAM education is a contemporary movement, which intersperses music, visual and performing arts concepts to problem solve pragmatic issues, is interdisciplinary and

hands on (Perignat & Buonincontro, 2018). The most frequently occurring terms were recorded for frequency and ranked in order of occurrence in Table 7.

Table 8

Teacher and Administrator Definitions of STEAM Education for Survey Question 30

Defining Term	Frequency	Percentage
STEAM	42	30%
Learning	27	19.29%
Hands on approach to learning	22	15.71
Interdisciplinary approach to learning	17	12.14%
Students	17	12.41%
Arts and music	15	10.71%
Incorporate music and the arts	10	7.14%
Learners	10	7.14%
Problem Solve	9	6.43%
Using project-based learning	8	5.71%

In addition to the data summarized in Table 8, there were other definition data worthy of reporting. No definitions included the key term collaborative and only five included the key term 21st century learning. One of the respondents stated that STEAM is an interdisciplinary approach that incorporates music and the arts to develop and enhance creativity as well as different areas of the brain. Another respondent stated that STEAM empowers teachers to employ project-based learning that crosses each of the five disciplines and fosters an inclusive learning environment in which all students are

able to contribute. The definition incorporating the greatest number of key terms was, "STEAM is an interdisciplinary and a hands-on approach to learning."

The data collected to examine research question one, what are the perceptions of teachers and administrators towards STEAM education, offered several insights. The analysis indicated that Hypothesis one was supported and that overall, there was a significant difference in the perceptions of teachers and administrators towards STEAM education.

Research Question Two

Research question two, how do teachers and administrators view the implementation of STEAM education in their schools, was answered by calculating frequencies and percentages of the participants' responses to the STEAM Education Perception Survey. Research question two was further addressed by calculating a composite score for this subscale and conducting an independent samples *t* test and a one-way ANOVA determine if there was a statistically significant mean difference among the perceptions of these two groups. Additionally, as in research question one, several of the survey questions made general inquiries regarding perceptions of STEAM education for teachers and administrators.

When asked if having STEAM education is difficult to implement due to a lack of support from either building administrators or central administration (question 10), overall, 66 respondents (47.14%) strongly agreed, 55 respondents (39.429%) moderately agreed, eight respondents had no opinion (5.71%), eight respondents moderately disagreed (5.71%) and 3 respondents strongly disagreed (2.41%). The Independent Samples T test results from SPSS for this question, indicated that there were significant

differences (t (138) = -1.754, p=0.082 in the scores, with a mean score for teachers (N=102) that was 1.41 and the mean for administrators (N=38) was 1.66, with a standard deviation of .694 and .847, respectively. Levene's Test for Equality of variances states that equal variances are assumed as the sig. is 0.234 or >.05. The one-sided p value was .041- and two-sided p value was .082. The magnitude for the differences in the means (mean difference=-0.246, 95% CI: -.524. to .031) was significant. Therefore, the H_1: There will be a significant difference in how teachers and administrators view the implementation of STEAM in their schools was supported.

As Survey question 10 asked teachers and administrators whether STEAM education is difficult to implement due to lack of support from either building administrators or central administration, a one-way ANOVA was tested across four groups or school levels (elementary, middle, high school, district level). When comparing the four groups of administrators (elementary, middle, high school and district level), according to the test of homogeneity of variances, based on the mean, the sig was .030 or <.05. It is significant and equal variances across the groups were not assumed and therefore there were no homogeneity of variances. Since the Levene's statistic is significant, equal variance was not assumed. To check for individual differences between groups, post-hoc comparisons were assessed using Dunnett's T3. The ANOVA results illustrated that the comparison of these 4 school levels differ significantly (F=3,136) =4.622, p<.004. The test indicated that the mean score for teachers and administrators at the high school level (M=1.46, SD=.650) differed significantly from those at the district level (M=2.40, 1.231). Elementary level (M=1.73, SD=.936) differed slightly from the middle school level (M=1.78, SD=.902). and the elementary school level (M=1.73,

SD=.936) differed significantly from the district level. The mean differences were significant at the 0.05 level. However, no significant differences were detected between the elementary and middle school levels. Table 9 illustrates a one-way ANOVA for this question.

Table 9

One Way-ANOVA Descriptive - Means and Standard Deviations of School Levels for Survey Question 10. STEAM education is difficult to implement due to lack of support from either building administration or central administration?

	Mean	SD	Std Error	95% Confidence Interval of the Difference Lower	Upper	Minimum	Maximum
Elementary School (K-5)	1.73	.936	.121	1.49	1.98	1	5
Middle School (6-8)	1.78	.902	.188	1.39	2.17	1	5
High School (9-12)	1.46	.650	.107	1.24	1.68	1	3
District Level (K-12)	2.40	1.231	.275	1.82	2.98	1	5

When asked if more targeted professional development is needed for a successful STEAM based approach (question 11), overall, 107 respondents (76.43%) strongly agreed, 30 respondents (21.43%) moderately agreed, one respondent had no opinion (0.71%), two respondents moderately disagreed (1.43%) and zero respondents strongly disagreed. The Independent Samples T test results from SPSS for this question, indicated that there were significant differences (t (138) = .109, p=0.029 in the scores, with a mean score for teachers (N=102) that was 1.27 and the mean for administrators (N=38) was 1.26, with a standard deviation of .583 and .446, respectively. Levene's Test for Equality

of variances states that equal variances are assumed as the sig. is 0.582 or >.05. The one-sided p value was 0.015 and two-sided p value was 0.029. The magnitude for the differences in the means (mean difference=-0.11, 95% CI: -.195 to .218) was significant. Therefore, the H_1: There will be a significant difference in the perceptions of teachers and administrators towards STEAM education was supported. Table 10 illustrates the findings for this question.

Table 10

Means and Standard Deviations of Educator Roles for Survey Question 11

More targeted professional development is needed for a successful STEAM based approach?

			Levene's Test for Equality of Variances	t-test for Equality of Means					
	Mean	SD	Sig.	t	df	Sig (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower Upper
			.582	.109	138	.029	0.011	.104	-.195 .218
Teacher	1.27	.583							
Administrator	1.26	.446							

As Survey question 11 asked teachers and administrators if more targeted professional development was needed for a successful STEAM program, a One-Way ANOVA was tested across four groups or school levels (elementary, middle, high school, district level). When comparing the four groups of teachers and administrators (elementary, middle, high school and district level), according to the test of homogeneity of variances, based on the mean, the sig was .052 or >.05. Since the Levene's Statistic is non-significant, the variances are equal. The Levene's statistic is testing the assumption

of the homogeneity of variance. As this was non-significant, the groups were not statistically significantly different and they had equal or homogenous variance. The ANOVA results illustrated that the comparison of these 4 school levels (F=3,136) =1.451, p<.231. Post Hoc testing revealed that significant differences between teachers and administrators at the middle school level (M=1.48, SD=.730) and district level (M=1.30, SD=.470) perceiving that more targeted professional development was needed for a successful STEAM program than those at the elementary school level (M=1.22, SD=.524) and High school (M=1.22, SD=.479) levels. These findings indicate that teachers and administrators at the middle school and district level felt they were not receiving enough targeted professional development as it related to STEAM. Table 11 illustrates a one-way ANOVA for this survey question.

Table 11

One Way-ANOVA Descriptive - Means and Standard Deviations of School Levels for Survey Question 11. More targeted Professional Development is needed for a successful STEAM based approach?

	Mean	SD	Std Error	95% Confidence Interval of the Difference Lower Upper	Minimum	Maximum
Elementary School (K-5)	1.22	.524	.968	1.08 1.35	1	4
Middle School (6-8)	1.48	.730	.152	1.16 1.79	1	4
High School (9-12)	1.22	.479	.079	1.06 1.38	1	3
District Level (K-12)	1.27	.548	.046	1.18 1.36	1	2

Survey question 14, which was also tested for Research Question one, asked respondents if a large amount of time is needed to prepare for a successful implementation. Overall, 107 respondents (76.43%) strongly agreed, 31 respondents (22.14%) moderately agreed and 2 respondents had no opinion (1.43%). The Independent Samples T test results from SPSS indicated that there were no significant differences (t (49.253) = -2.245, p=0.029 in the scores, with a mean score for teachers that was 1.19 and the mean for administrators was 1.42, with a standard deviation of .391 and .599, respectively. Levene's Test for Equality of Variances states that equal variances are not assumed as the sig. is <0.001 or <.05. The one-sided p value was .015 and two-sided p value was .029. The magnitude for the differences in the means (mean difference=-0.235, 95% CI: -.445 to -.025) was very small. Therefore, the H1 was not supported for this question. Table 12 illustrates the results.

Table 12

Means and Standard Deviations of Educator Roles for Survey Question 14

A large amount of time is needed to prepare for a successful implementation of STEAM?

			Levene's Test for Equality of Variances	t-test for Equality of Means					
	Mean	SD	Sig.	t	df	Sig (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower Upper
			<.001	-2.245	49.253	.029	-.235	.105	-.445 -.025
Teacher	1.19	.391							
Administrator	1.42	.599							

Survey question 22 asked teachers and administrators if professional development opportunities around STEAM education were regularly provided to teachers at their

school. 50 respondents (35.71%) strongly agreed, 67 respondents (47.86%) moderately agreed, three respondents had no opinion (2.14%) had no opinion, 13 moderately agreed (9.29%) and 7 strongly disagreed (5.00%). The Independent Samples T test analysis and results indicated that there were no significant differences (t (138) = 1.212, p=0.228 in the scores, with a mean score for teachers that was 2.07 and the mean for administrators was 1.82, with a standard deviation of 1.092 and 1.111, respectively. Levene's Test for Equality of Variances stated that equal variances were assumed as the sig. is 0.538 or >.05. The one-sided p value was .114 and the two-sided p value was .228. The magnitude for the differences in the means (mean difference=-0.253, 95% CI: -.160 to .665) was significant. Therefore, the H1 was supported for this question.

Survey question 23 asked teachers and administrators if they have adequate access to STEAM assets (libraries, agencies, professional development, museums, Arts organizations, etc.). Of the 140 respondents, 34 (24.29%) strongly agreed, 32 moderately agreed (22.86%), 19 had no opinion (9.29%), 55 moderately agreed (39.29%) and 6 (4.29%) strongly disagreed. The Independent Samples T test analysis and results revealed that there were no significant differences (t (138) = 3.799, p=<0.001 in the scores, with a mean score for teachers that was 3.01 and the mean for administrators was 2.11, with a standard deviation of 1.247 and 1.269, respectively. Levene's Test for Equality of Variances stated that equal variances were assumed as the sig. is 0.538 or >.05. The two-sided p value was <.001. The magnitude for the differences in the means (mean difference=0.905, 95% CI: .434 to 1.375) was significant. Therefore, the H1 was supported for this question.

Survey question 24 asked teachers and administrators on their perception if the current condition of STEAM education in their district is meeting the needs of all students. 32 respondents (22.86%) strongly agreed, 69 moderately agreed (49.29%), four had no opinion (2.86%), 32 moderately agreed (22.86%) and 3 (2.14%) strongly disagreed. The Independent Samples T test analysis and results for this survey question revealed that there were no significant differences ($t(138) = 0.036$, $p=<0.971$ in the scores, with a mean score for teachers that was 2.32 and the mean for administrators was 2.32, with a standard deviation of 1.136 and 1.118, respectively. Levene's Test for Equality of Variances stated that equal variances were assumed as the sig. is 0.701 or >.05. The one-sided p value was .486 and the two-sided p value was .971. The magnitude for the differences in the means (mean difference=0.008, 95% CI: -.417 to .433) was significant. Therefore, the H1 was supported for this question.

Survey question 34 asked teachers and administrators if they felt prepared for the implementation of STEAM instruction their school or district. 65 respondents (46.43%) strongly agreed, 65 respondents (46.43%) moderately agreed, five respondents had no opinion (3.57%) had no opinion, 5 moderately agreed (3.57%) and zero respondents strongly disagreed (0%). The Independent Samples T test analysis and results indicated that there were no significant differences ($t(138) = -1.747$, $p=0.083$ in the scores, with a mean score for teachers that was 1.58 and the mean for administrators was 1.82, with a standard deviation of .737 and .652, respectively. Levene's Test for Equality of Variances stated that equal variances were assumed as the sig. was 0.078 or >.05. The one-sided p value was .041 and the two-sided p value was .083. The magnitude for the

differences in the means (mean difference=-0.237, 95% CI: -.506 to .031) was significant. Therefore, the H1 was supported for this question.

The rationale for the researcher utilizing many Independent Samples T-test to examine the survey questions for research questions two, was that it was essential to determine whether there was a statistical difference between the two groups (teachers and administrators), if there was a statistical difference and whether that difference was meaningful and significant (Knapp, 2018). Additionally, it was necessary for reliability, validity, to determine whether the samples were different from one another and also to test the hypotheses between the two groups.

Survey question 25 was open ended and asked teachers and administrators, in their own words what were the most 3 most important challenges facing STEAM education and to rank their top 3 challengers. The researcher compared previous research as to the challenges associated with a STEAM instruction and how to appropriately incorporate the Arts component. Many educators and administrators, especially at the elementary school level, have not had any formal training, or professional development and lack the fundamental resources needed on disciplinary content utilizing STEAM based concepts. As a result, educators and administrators may potentially integrate STEAM in a way that is most effective to them, but not research-based methodologies, that is in conjunction with their beliefs about the purpose and value of a STEAM education and its implementation (Wang, Moore, Roehrig & Park, 2011). The most frequently occurring terms were recorded for frequency and ranked in order of occurrence in Table 10.

Table 13

Teacher and Administrator Challenges facing STEAM Education for Survey Question 25

Defining Term	Frequency	Percentage
Time	43	30.71%
Lack of funding	40	28.57%
Professional development	35	25%
Lack of resources	23	16.43%
Implementation	21	15%
Professional Development	17	12.86%
Knowledge of other content areas	15	10.71%
Lack of awareness of STEAM	10	7.14%
Support	8	5.71%
School and District Policies	4	2.86%
State Demands	3	2.14%

In addition to the data summarized in Table 13, there were other data worthy of reporting. One of the respondents stated in their responses "lack of interdisciplinary approach taken by teachers and administrators, particularly when selecting curriculum, adequate materials to teach STEAM and lack of teacher input when selecting educational programs to be taught." Another respondent stated: "time, too many isolated curriculums programs on the elementary level make it difficult to integrate STEAM into curriculum areas, NYS standards/curriculum take precedent and STEAM is second to racing through the curriculum." A third respondent stated their challenges as "integration of STEAM

initiatives throughout all content areas, creating a high level of STEAM fluency by educators in all content areas and PD for all teachers in terms of inquiry-based learning. The data collected to examine research question two, how do teachers and administrators view the implementation of STEAM education in their schools offered several insights. The analysis indicated that Hypothesis one was supported and that overall, there was a significant difference in how teachers and administrators view the implementation of STEAM in their schools or districts.

Research Question Three

Research question three, how do teachers and administrators perceive the support and sustainability of STEAM programs in their schools, was also answered by calculating frequencies and percentages of the participants' responses to the STEAM Education Perception Survey. Research question three was further addressed by calculating a composite score for this subscale and conducting an independent samples *t* test to determine if there was a statistically significant mean difference among the perceptions of these two groups. Survey responses provided data to examine the third research question. Several of the survey questions made general inquiries regarding perceptions of STEAM education for teachers and administrators.

When teachers were asked if they felt fully supported by their school administrators as related to a STEAM program (question 5), overall, 51 respondents (36.43%) strongly agreed, 55 respondents (39.429%) moderately agreed, 26 respondents had no opinion (18.57%), 7 respondents moderately disagreed (5%) and 1 respondent strongly disagreed (0.71%). When comparing the four groups of teachers (elementary, middle, high school and district level), a One-way ANOVA analysis and results indicated

that there was a significant difference among the four groups, F (3,136) =1.393, p<.248. Post hoc testing revealed that significant differences between the school levels with middle school level (M=1.65, SD=.647) and high school level (M=1.92, SD=.829) having reported that they felt less supported by their school administrators than elementary level (M=1.98, SD=1.017) and district level (M=2.20, SD=.894) teachers. These findings indicate that teachers at the elementary and district level felt more supported by their school administrators. Table 14 illustrates the One-way ANOVA descriptive for this survey question.

Table 14

One Way-ANOVA Descriptive - Means and Standard Deviations of School Levels for Survey Question 5. (For Teachers) I feel fully supported by my school administrators as related to a STEAM program.

	Mean	SD	Std Error	95% Confidence Interval of the Difference Lower	Upper	Minimum	Maximum
Elementary School (K-5)	1.98	1.017	.131	1.72	2.25	1	5
Middle School (6-8)	1.65	.647	.135	1.37	1.93	1	3
High School (9-12)	1.92	.829	.136	1.64	2.20	1	4
District Level (K-12)	2.20	.894	.200	1.78	2.62	1	4

When administrators were asked if they felt fully supported by central administration as related to a STEAM program to further implement a STEAM program in their school and to support their teachers (question 6), overall, 48 respondents (36.29%) strongly agreed, 42 respondents (30%) moderately agreed, 43 respondents had

no opinion (30.71%), 7 respondents moderately disagreed (5%) and zero respondents strongly disagreed (0 %). When comparing the four groups of administrators (elementary, middle, high school and district level), a One-way ANOVA analysis, results and Test of Homogeneity of Variances indicated that Levene's Test was non-significant, as the sig. was .529 or >.05. As this was non-significant, the groups were not statistically significantly different and they had equal or homogenous variance.

There was a significant difference among the four-school level of administrators, F (3, 136) =3.292, p<.023. Post Hoc testing revealed that significant differences between administrators at the high school level (M=2.05, SD=.880) and administrators at the district level (M=1.50, SD=.923) feeling less supported by central administrators than those administrators at the elementary school level (M=2.20, SD=.898) and administrators at the middle school level (M=2.22, SD=.998). These findings indicate that administrators felt more supported by central administration, as it related to a STEAM at the elementary and middle school level. Table 15 illustrates a One-Way ANOVA for this survey question.

Table 15

One Way-ANOVA Descriptive - Means and Standard Deviations of School Levels for Survey Question 6. (For Administrators) I feel fully supported by central administration as related to a STEAM program to further implement a STEAM program in my school and to support the teachers.

	Mean	SD	Std Error	95% Confidence Interval of the Difference Lower	Upper	Minimum	Maximum
Elementary School (K-5)	2.20	.898	.116	1.97	2.43	1	4

Middle School (6-8)	2.22	.998	.208	1.79	2.65	1	4
High School (9-12)	2.05	.880	.145	1.76	2.35	1	4
District Level (K-12)	1.50	.827	.185	1.11	1.89	1	4

Survey question 9 asked teachers and administrators if STEAM education was difficult to implement due to lack of funding. 88 respondents (62.86%) strongly agreed, 43 respondents (30.71%) moderately agreed, three respondents had no opinion (2.14%) had no opinion, 6 moderately agreed (4.29%) and zero respondents strongly disagreed (0%). The Independent Samples T test analysis and results for this survey question indicated that there were no significant differences (t (138) = -1.747, p=0.082 in the scores, with a mean score for teachers that was 1.41 and the mean for administrators was 1.66, with a standard deviation of .694 and .847, respectively. Levene's Test for Equality of Variances stated that equal variances were assumed as the sig. was 0.234 or >.05. The one-sided p value was .041 and the two-sided p value was .082. The magnitude for the differences in the means (mean difference=-0.246, 95% CI: -.524 to .031) was significant. Therefore, the H1 was supported for this question.

Survey question 12 asked teachers and administrators if it is difficult to secure sufficient time for the implementation of a STEAM education. An overwhelming 93 respondents (66.43%) strongly agreed, 41 respondents (29.29%) moderately agreed, two respondents had no opinion (1.43%), 4 moderately agreed (2.86%) and zero respondents strongly disagreed (0%). The Independent Samples T test analysis and results (Table 16) for this survey question indicated that there were no significant differences (t (48.053) = -1.768, p=0.083 in the scores, with a mean score for teachers that was 1.33 and the mean for administrators was 1.61, with a standard deviation of .551 and .887 respectively.

Levene's Test for Equality of variances stated that equal variances were not assumed as the sig. was 0.001 or <.05. The one-sided p value was .042 and the two-sided p value was .083. The magnitude for the differences in the means (mean difference=-0.272, 95% CI: -.581 to .037) was very small. Therefore, the H1 was not supported for this question. Table 16 illustrates the results for this question.

Table 16

Means and Standard Deviations of Educator Roles for Survey Question 12

It is difficult to secure sufficient time for the implementation of a STEAM education?

			Levene's Test for Equality of Variances	t-test for Equality of Means					
	Mean	SD	Sig.	t	df	Sig (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower Upper
			.001	-1.768	48.053	.083	-.272	.154	-.581 .037
Teacher	1.33	.551							
Administrator	1.61	.887							

Survey question 15 asked teachers and administrators if STEAM education is difficult to implement due to insufficient expertise in the content area or lack of confidence in teaching STEAM. An overwhelming 90 respondents (64.29%) strongly agreed, 43 respondents (30.71%) moderately agreed, one respondent had no opinion (0.71%) had no opinion, 6 moderately agreed (4.29%) and zero respondents strongly disagreed (0%). The Independent Samples T test analysis and results for this survey question indicated that there were significant differences (t (138) = .288, p=0.387 in the scores, with a mean score for teachers that was 1.46 and the mean for administrators was 1.42, with a standard deviation of .753 and .642, respectively. Levene's Test for Equality

of Variances stated that equal variances were assumed as the sig. was 0.432 or >.05. The one-sided p value was .0387 and the two-sided p value was .774. The magnitude for the differences in the means (mean difference=0.040, 95% CI: -.233 to .312) was significant. Therefore, then H1 was supported for this question.

Survey question 19 asked teachers and administrators if there needs to be more exploration into STEAM students' goals and perceptions in order to expand and maximize accessibility, interest and proficiency in a STEAM program. An overwhelming 107 respondents (76.43%) strongly agreed, 29 respondents (20.71%) moderately agreed, three respondents had no opinion (2.14%) had no opinion, one respondent moderately agreed (0.71%) and zero respondents strongly disagreed (0%). The Independent Samples T test analysis and results for this survey question indicated that there were no significant differences (t (103.967) = 1.877, p=0.063 in the scores, with a mean score for teachers that was 1.31 and the mean for administrators was 1.16, with a standard deviation of .580 and .370, respectively. Levene's Test for Equality of variances stated that equal variances were not assumed as the sig. was 0.002 or <.05. The one-sided p value was .032 and the two-sided p value was .063. The magnitude for the differences in the means (mean difference=0.156, 95% CI: -.009 to .320) was very small. Therefore, the H1 was not supported for this question.

Survey question 35 was open ended and asked teachers and administrators to state any additional comments or if they would like to share any other experiences or situations that they may have encountered in regards to STEAM education. Additionally, the response to this item was used to identify a sample of survey respondents who expressed interest to participate in the online interviews for K-12 teachers and administrators. One

respondent stated “some of the most practical ways I have seen STEAM centered learning implemented is through thematic units. Students are able to develop literacy and math skills using scientific focused curriculum units.” Another respondent stated that “STEAM can be a great way to incorporate music and utilize the multiple intelligence theory to empower all learners equally. Another stated that “Our district is focused on rejuvenation and growth.” Another respondent stated that “pre-Covid, our district had a STEAM teacher in each building. Students would go to STEAM class a few times a year. The students enjoyed it. It was looked on as a fun class and there was no grade. We are trying to departmentalize in our district. My colleague and I are teaching science and try to incorporate a specific STEAM lesson every week. However, I do believe that time is the biggest issue for teachers. States and districts are always adding new things to teach and expecting teachers to incorporate them into the classroom (SEL, STEAM, extra PE, longer ELA class sessions, etc.) within the same school day. Yet, there are still announcements, cultural arts assemblies, students pulled from the classroom for multiple reasons, etc. that interrupt the day.” Finally, one last respondent stated that “there is no degree in STEM or STEAM. Districts should be working to collaborate and motivate individuals or departments to work together. Not just talking about it. There has never been a bigger disconnect in history between what teachers go through in the classroom and the other educational supporting roles in a school district.” *Table 17* below, the Independent Samples T-test Table, provides a list of all of the Independent Samples T Tests that were analyzed, as well as the results of the t-tests and the resolution for the hypothesis.

Table 17

The Independent Samples T-test Table

STEAM Education Perception Survey Questions	Results of Independent Samples T-Test	Resolution of Hypothesis
I believe that STEAM education is needed in the American K-12 school system? (Survey question 7)	There were significant differences (t (138) = -.877, p=.382 one-sided p=.191 two-sided p= .382	Research Question 1 H_1 supported
Having a clear understanding of teachers' and administrators' perceptions of a STEAM education is critical for the success of all educators, leaders and for the advancement of the program. (Survey question 8)	There were significant differences (t (138) = -.191, p=.849 one-sided p=.424 two-sided p= .849	Research Question 1 H_1 supported
A STEAM education can cultivate student's creative talents and skills including in Music and the Arts. (Survey question 16)	There were significant differences (t (138) =-.507, p=.613 one-sided p=.306 two-sided p= .613	Research Question 1 H_1 supported
STEAM education is integral and beneficial to all students due to its positive impact in Science, Technology, Engineering, Arts, and Mathematics. (Survey question 17)	There were significant differences (t (138) =-.567, p=.572 one-sided p=.286 two-sided p=.572	Research Question 1 H_1 supported
A large amount of time is needed to prepare for a successful STEAM implementation. (Survey question 14)	There were no significant differences (t (49.253) =-2.245, p=.029 sig. was <0.001 or <.05 mean difference =-.235, 95% CI=-.445 to -.025	Research Question 1 Ho: Null Hypothesis
STEAM education is difficult to implement due to lack support from either building administrators or central administration? (Survey question 10)	There were significant differences (t (138) = -1.754, p=0.082 one-sided p=.041 two-sided p=.082	Research Question 2 H_1 supported
More targeted Professional development is needed for a successful STEAM based approach?	There were significant differences (t (138) = .109, p=0.029	Research Question 2 H_1 supported

(Survey question 11)	one-sided p=0.015 two-sided p= 0.029	
Professional development opportunities around STEAM education are regularly provided to teachers in your school. (Survey question 22)	(t (138) = 1.212, p=0.228 one-sided p=114 two-sided p=.228 Levene's Test for Equality of Variances= equal variances w assumed as the sig. is 0.538 or >.05. mean difference=-0.253, 95% CI: -.160 to .665) was significant	Research Question 2 H_1 supported
I have adequate access to STEAM assets (libraries, agencies, professional development, museums, Arts organizations, etc). (Survey question 23)	(t (138) = 3.799, p=<0.001 Levene's Test for Equality of Variances=equal variances w assumed as the sig. is 0.538 o >.05 mean difference=0.905, 95% CI: .434 to 1.375 was significant	Research Question 2 H_1 supported
The current condition of STEAM education in your district is meeting the needs of all students. (Survey question 24)	(t (138) = 0.036, p=<0.971 Levene's Test for Equality of Variances=equal variances were assumed as the sig. is 0. or >.05 mean difference=0.008, 95% CI: -.417 to .433) was significant	Research Question 2 H_1 supported
I feel prepared for the implementation of STEAM instruction in my school. (Survey question 34)	(t (138) = -1.747, p=0.083 Levene's Test for Equality of Variances=equal variances were assumed as the sig. was 0.078 or >.05 one-sided p=.041 two-sided p=.083 mean difference=-0.237, 95% CI: -.506 to .031 was significant	Research Question 3 H_1 supported
STEAM education is difficult to implement due to lack of funding. (Survey question 9)	(t (138) = -1.747, p=0.082 Levene's Test for Equality of Variances=equal variances were assumed as the sig. was 0.234 or >.05 one-sided p=.041 two-sided p=.082 mean difference=-0.246, 95% CI: -.524 to .031 was significant	Research Question 3 H_1 supported

It is difficult to secure sufficient time for the implementation of a STEAM education. (Survey question 12)	There were no significant differences (t (48.053) = -1.768, p=0.083 Levene's Test for Equality of variances =equal variances w not assumed as the sig. was 0.001 or <.05 one-sided p= .042 two-sided p=.083 mean difference=-0.272, 95% CI: -.581 to .037 was ve small	Research Question 3 Ho: Null Hypothesis
STEAM education is difficult to implement due to insufficient expertise in the content areas or lack of confidence in teaching STEAM. (Survey question 15)	There were significant differences (t (138) = .288, p=0.387 one-sided p= .0387 two-sided p= .774 Levene's Test for Equality Variances=equal variances were assumed as the sig. w 0.432 or >.05 mean difference=0.040, 95% CI: -.233 to .312	Research Question 3 H_1 supported
There needs to be more exploration into STEAM students' goals and perceptions in order to expand and maximize accessibility, interest and proficiency in a STEAM program. (Survey question 19)	There were no significant differences (t (103.967) = 1.877, p=0.063 sig. was 0.002 or <.05 mean difference=0.156, 95% CI: -.009 to .320	Research Question 3 Ho: Null Hypothesis

Qualitative Results

The qualitative component of this explanatory sequential mixed method design was to conduct four interviews consisting of K-12 teachers and administrators, in order to follow up with the quantitative data and interpret how the qualitative data results from the interviews could further explain the quantitative data results. Additionally, the purpose of the interviews was to explore and gain a deeper understanding of participants' perceptions, attitudes, beliefs and mental models encompassing a STEAM education and for the meaning of discovering the implementation, effectiveness and sustainability of

STEAM. The participants of this study were composed of a group of individuals with similar or the same characteristics (Creswell, 2012). The interviews consisted of a total of four participants (two teachers and two administrators) who work within the sampled 5 school districts in New York. The researcher identified the teachers and administrators to participate in this study and for purposes of anonymity, the names of these individuals have been revealed as: teacher one, teacher two, administrator one and administrator two. According to Patton (2002), sample size in qualitative research can vary with the nature and context of the study. Patton (2002) also stated that there is no set sample size for qualitative studies due to the large amount of data generated and the complexity of analyzing qualitative data, however, a researcher can continue to gather the qualitative data until saturation occurs or no new information is obtained. Moreover, Patton (2002) illustrated that credibility in qualitative research depends more upon the richness of the information gathered and less on sample size. To reduce the level bias, the researcher conducted the interviews until data saturation was present or until no different ideas were expressed and no other new information was acquired. Table 18 illustrates the participant demographics.

Table 18

Demographic Description of Interview Participants

Participants	Role	Gender	School/District Level affiliated with	Years of experience as an Administrator
Administrator One	Superintendent	Male	District K-12	10
Administrator Two	Principal	Male	Elementary K-5	6

Teacher One	Science Teacher	Female	Elementary K-5	15
Teacher Two	Technology Teacher	Female	Elementary K-5	18

The qualitative research questions addressed were:

1. How do teachers perceive a STEAM program?
2. How do administrators perceive a STEAM program?
3. How should teachers implement and teach a STEAM education?
4. How can administrators support and sustain an effective STEAM program?
5. What changes need to be made to support and sustain STEAM programs?
6. What skills should students in an effective STEAM program possess?
7. Do you feel there are gaps in the current STEAM model at your school? If so, what are they?

The researcher met with participants to conduct the interviews via an online platform and took detailed notes throughout the interview process pertaining to the dialogue concerning teachers' and administrators' perceptions, attitudes, beliefs and mental models encompassing a STEAM education and for the purpose of discovering the implementation, effectiveness and sustainability of STEAM. The interview process allowed the participants to answer openly and allowed for inspection of topics as they presented themselves in an organic manner (Merriam, 2002). Additionally, the researcher made an effort to assist the teachers and administrators to become comfortable and at ease with the online interviews by beginning with an informal conversation about their career, their school and school districts, the current school year and other low-stakes topics. The participants were given the option to opt out of answering any interview

questions that they did not wish to answer. To allowing for confirmation and accuracy of answers, the researcher reviewed the teachers' and administrators' answers with each participant before moving to the next question. The participants signed the informed consent prior to the interview. The audio interview transcripts were transcribed using the Rev voice recorder app, reviewed, analyzed and coded for emerging trends and themes in the qualitative data that related to the research questions. This ensured the researcher to see the relationships between the coded data and identify categories and emerging themes.

Interview One

Administrator one is male, is the Superintendent of a large K-12 school district and has served in that capacity for 10 years. Before being an administrator at the district level, he served as a building principal and his background is in the science and engineering field, where he served as teacher for many years. When asked how do administrators perceive a STEAM program, Administrator one stated that "it's always been a district-wide focus, to connect STEAM in a project-based learning manner to promote college and career readiness, making sure that all students leave school with some skills and understanding of an interdisciplinary content and to incorporate robotics and programming. It's important for them to have knowledge in coding and programming and things of that nature." Administrator one also believed that when teaching STEAM, it should be embedded in the curriculum and should incorporate more hands on and project-based assignments, especially at the elementary school level. To support and sustain STEAM, Administrator one believed that utilizing specific curricula, such as Science 21, a curriculum that can be studied and learned through targeted

professional development, can help students learn in an interdisciplinary manner. He stated that, "it's important to be supportive and open to new ideas and programs at the district level or building level, to always keep your ears to the ground for anything new in terms of either training for teachers or prolific grants that support STEAM and its professional development, as well as how to implement it positively and effectively." When asked about the skills students should have in an effective STEAM program, Administrator one stated that, "It all starts with reading. Students need to be able to do things themselves, in a student-centered approach, whereby the teacher facilitates learning, but the students can work by themselves or collaboratively. In the 21st century, students also need to learn technology and how to code, as well as computer science or cybersecurity, which can lead to high paying jobs. When students learn this in STEAM, you are establishing college and career readiness and ensuring that all students have a path to somewhere, whether it's college, a career, trade school or even the military." When asked about if there are any gaps in STEAM, administrator one illustrated that, "there are a lack of resources and research as it relates to STEAM, as well as a lack of funding, albeit depending on the district. Additionally, there is no specific certification in STEAM, so many educators can find it difficult to gain the knowledge in STEAM. More professional development and research are needed."

Interview Two

Administrator two is male, a principal of an elementary school and has served in that capacity for 6 years. Prior to that, he was an elementary school teacher and taught 5th grade for 10 years. His background and license are in elementary general education and the common branches. He believed that there needs to be more evidence-based research

on the effectiveness of STEAM and how STEAM can support special education students, English language learners and students with disabilities. Additionally, administrator two believed that administrators could support an effective STEAM program by observing teachers and giving them the flexibility to lead and also by providing targeted professional development as related to STEAM. Administrator two stated that: "There's a lot of research on STEM, but with the inclusion of the A and the arts, there's not much research for STEAM education, so to see more research on STEAM education, I think it's very important for all students to be engaged in an interdisciplinary manner and to be college and career ready." When asked about STEAM education, administrator two stated that: "There is no specific degree or certification in STEAM education, however, teachers that teach STEAM need to have ongoing professional development, funding by administrators and the state as well as sufficient time during the day to plan, which are the most crucial forms of supporting STEAM. Gaps in STEAM can include not having the appropriate funding. I think every district is different. In our district, we have strong funding, but a neighboring district could not have enough funding and that could mean not having a successful STEAM program."

To support and sustain STEAM, administrator two stated that "STEAM can cultivate students' talents and creative skills, but all stakeholders need to know how to successfully implement it. Teachers need to have the proper professional development, the proper training that's continuous that will allow them to implement it, measure their success over time and also have proper sustainability over time." Administrator two also stated that, "it is important to have STEAM activities or STEAM events that incorporates parents, where they can come in the school building to see what the students are

accomplishing and ultimately support teachers by providing them the flexibility to not micromanage them and to have confidence in their ability to engage in an effective STEAM curriculum."

Interview Three

Teacher one is female, a science teacher at an elementary K-5 school and has served in that capacity for 15 years. Her background and license are in science education, elementary general education and the common branches. When asked how do teachers and administrators perceive a STEAM program, teacher one stated that "we think that STEAM is very valuable and important and work together to ensure positive results. It's the integration of science, technology, engineering, arts and mathematics, and with the inclusion of arts and music perceive it as very effectively to supporting all students to be college and career ready. We have strong professional development as it relates to STEAM and teachers are trained accordingly. Although there's no STEAM curricula, teachers have in our district have piloted a STEAM program and they also have a mentorship program for STEAM." Teacher one also believed that it's important for administrators to support STEAM through funding and also by supporting teachers by embedding time in their daily schedules to plan and work with other STEAM leaders in a collaborative manner. Teacher one also stated that to support and sustain STEAM, an allocation of funding is crucial to sustainability, as well as a strong curriculum planning and a STEAM certification that can allow teachers that want teach STEAM effectively to be certified. When asked about the skills that students should have in an effective STEAM program, teacher one stated that "in a STEAM program, students should be developing 21st Century Skills, reading, writing, social skills, critical thinking and

creativity skills, the ability to problem solve, coding, computational thinking skills and a real-world connection that allows them to see the work that they are accomplishing in a useful, pragmatic manner." Teacher one also believed that there are several gaps in STEAM, which were a lack of materials and resources, lack of statewide support, lack of a comprehensive research on STEAM and not enough time for planning for all the stakeholders involved in the implementation, support, and sustainability of STEAM.

Interview Four

Teacher two is female, a technology teacher at an elementary K-5 school and has served in that capacity for 18 years. Her background and license are in technology education, where she teaches technology classes and coding. When asked how do teachers perceive a STEAM program, teacher two stated that "STEAM can be a multidisciplinary approach to learning for all students which involves science, technology, engineering, the arts, music and mathematics. As a technology teacher, it's important to connect 21st Century Skills, in a way that combines inquiry, collaboration, learning and growth in hands-on activities to help students better prepare for careers." Teacher two believed that STEAM can be a fun and engaging way to use coding, programming, robotics and a real-world application for all students to become lifelong learners through a process of peer-to-peer collaboration, examination and learning in a variety of formal and informal contexts, inside and outside of school. When asked how should teachers teach and implement a STEAM program, teacher two stated that "it's important to first have a systematic and organized professional development for all teachers, so that they know what they are doing, as well as the resources, support from

administration, proper funding, ample time to plan with other colleagues, as well as a common curriculum or mapping around STEAM."

Teacher two also believed that when teaching STEAM, there should be a mentorship program for newer STEAM teachers, as well as ways to encourage parental support, so that students can be supported in order pursue a STEAM field or degree after high school. When asked about the skills needed for an effective STEAM program, teacher two stated that "students learning and engaged in a STEAM program, can gain invaluable and relevant real-world experiences, inquiry and more involvement actually doing hands on project-based assignments, instead of just textbook reading. Skills such as creativity, whereby they can connect music and the arts, as in building musical instruments and then describing how they can work to produce a musical sound, problem solving activities with their peers and exploration activities, can all be a great path for students to develop their skills for middle and high school and to be college and career ready. When asked about the gaps in the current STEAM model, teacher two delineated that, "finding the time can be an enormous constraint on the ability to incorporate STEAM lessons more frequently, more professional development can also help with incorporating the diverse content areas in STEAM and more resources could be helpful in planning and implementing STEAM lessons while differentiating for the needs of all students."

Coding

As the data from the interviews were analyzed, transcriptions of the interviews were examined and a word cloud diagram was investigated to depict the most commonly used words and phrases by participants in response to the guiding questions. This was

used to determine if the most used words were in alignment with the research objectives. The most frequently occurring terms were: STEAM, 21st Century Skills, interdisciplinary learning, professional development, time, funding, resources, creativity and college and career readiness, along with many other sub-level terms. These terms directly relate to the research and its research questions. In this qualitative phase, the artifacts were also coded with the categories used for coding the interviews, which are shown in Table 19.

Table 19

Coding Categories used to Interpret Data Collection

Color	Attributes
Yellow	STEAM, STEM, education, subject areas, common core subjects, interdisciplinary, science, technology, engineering, mathematics, arts, music, programming, robotics, logic, project-based learning, hands on learning, collaboration, Coding, real-world application, 21st Century Skills.
Green	Funding, time, professional development, district policies, pacing, knowledge, motivation, resources, materials, budget, tax caps, implementation, support, curriculum, planning, no certification.
Blue	Improves creativity, college and career readiness, motivation, critical thinking skills, problem solving, independent thinkers, student achievement, enhanced self-awareness, real world application, encourages exploration of STEM fields, computational thinking skills, social skills.

The coding categories were developed based upon the research questions, as well as the concerns during the qualitative interviews and the application to examine the Change Theory and the framework for the 21st century learning, as it applied to this study on teachers 'and administrators' perceptions of STEAM.

Themes

Three important and major themes emerged from this qualitative investigation and became more apparent as the study continued: the meaning of STEAM, the importance of STEAM and challenges of STEAM implementation and sustainability. The color yellow represented the meaning of STEAM, while the color blue represented the importance of STEAM and the color green represented the challenges of STEAM. All four participants were encouraged to provide very precise, but meaningful and high-quality answers to the interview questions.

Theme 1: The meaning of STEAM

The analysis of the qualitative interviews illustrated that the teachers and administrators had a thorough and profound, but somewhat varied understanding of the meaning of STEAM. Many stated that STEAM is the integration of science, technology, engineering, arts, and mathematics and is interdisciplinary. Administrators believed that it is practical, student centered and can be implemented through thematic units, if taught by seasoned pedagogues. They also stated that students are able to develop literacy and math skills using a scientific focused method. All participants stated that STEAM is fun, engaging, hands on, pragmatic, collaborative and involves inquiry-based model learning, whereby students learn through solving real-world problems. When answering question two, how do administrators perceive a STEAM program, administrator one illustrated that "STEAM means having the ability to incorporate science, technology, engineering, arts and mathematics and music into a comprehensive approach that is hands on, can help students to find their talents utilizing different subjects and can prepare them for real world scenarios." Administrator two stated that "STEAM to me means incorporating

science, technology, engineering, art, and math into 21st century learning that can allow all learners to utilize the multiple intelligence theory and can develop their creative side." The data collected provides evidence that participants had similar accounts in regards to the defining elements and meaning of STEAM. However, during the interviews, administrator one and two stated that much more research is needed on the benefits and implications of STEAM. One participant stated that "with STEAM, there is no college degree or certification, so more learning and more research are needed on what it takes to be a successful STEAM teacher, pedagogue, administrator and innovator of STEAM.

Theme 2: The importance of STEAM

The analysis of the interviews demonstrated that all participants believed that STEAM is important in education, as it prepares students for 21st Century Skills, future employability, real world application and to be college and career ready. Teachers and administrators also believed that STEAM encourages motivation, collaboration amongst all students, including those with disabilities and the special education population in a way that can enhance self-awareness and social skills. Administrator two stated that "STEAM can enhance computational thinking skills and motive students to become independent thinkers while encouraging others to explore STEM fields." Participants believed that STEAM encourages collaboration amongst the students as they are often grouped into teams during project-based learning assignments and therefore, STEAM can potentially increase the level of academic and creative excellence of all students, mainly because they learn in an interactive and fun way. Teacher one delineated that "STEAM can also be a great way for students to develop reading skills and writing skills in a way that is student centered. Additionally, by utilizing technology, music and the arts and a

combination of subjects and interests, students can find their path or their talent and develop it as it best suits them in a way that can enhance their skills for the future." Further analysis also reveals that all four participants believed that STEAM is inclusive and the importance of STEAM is meaningful, as it applies to creating and solving in a fun and engaging manner. Participants also believed that by allowing students to build upon their skills and develop their interests, they can collaborate with their peers to establish 21st Century Skills that can be pragmatic and real world driven.

Theme 3: Challenges of STEAM implementation and sustainability

The analysis of the interviews demonstrated that all four participants believed that there were a variety of challenges associated with the implementation and sustainability of STEAM, which included: the amount of funding needed, allocation of time and resources, targeted professional development for stakeholders involved in STEAM (at the building and district level), pacing or planning and a certification pathway. Administrator two stated that "it can be a challenge to train teachers in all areas of STEAM, especially to incorporate the Arts component, however, professional development that can increase awareness of STEAM and target the interdisciplinary model, can be beneficial to all." The challenges of STEAM can also include a lack of support from building or central administration, as well as demanding school and district policies and curriculum demands that can impede the development of STEAM. Additionally, as the analysis revealed, it's important for stakeholders, especially at the elementary school level, to have formal training on interdisciplinary content utilizing STEAM based concepts, as they provide the foundational core for STEAM learning to higher grade levels. The results also revealed that there needs to be more exploration and

research into STEAM goals, initiatives and how it can affect student achievement, in order to expand and maximize the visibility, accessibility, interest, proficiency and relevancy of STEAM programs in schools and districts.

Analysis of Research Questions

Research Question One

What are the perceptions of teachers and administrators towards STEAM education?

Theme 2 (the importance of STEAM) provides the requirements that are needed to effectively examine how teachers and administrators perceive STEAM. The analysis of the qualitative data revealed the following regarding teachers and administrators' perceptions towards STEAM education: that all four participants had a meaningful and diverse understanding of the meaning and perceptions of STEAM. They illustrated that STEAM is the integration of science, technology, engineering, arts, music and mathematics for instruction. It is a pragmatic, engaging, and interactive manner of teaching as it involves 21st Century Skills in an interdisciplinary way that utilizes the theory of multiple intelligences, Vygotsky's zone of proximal development, the Change Theory, as well as the framework for 21st century learning. Analysis also indicated that all participants stated that STEAM encourages collaboration amongst students, as it allows them to work together in groups during project-based learning assignments. Additionally, participants believed that STEAM can potentially increase the level of academic and creative rigor of students, as they learn in an interactive and fun way. Students who are not familiar with mathematics or science concepts may understand an aspect of math or science by their knowledge of music or the arts. Teachers and

administrators believed that STEAM is also an inquiry-based model of learning, whereby students learn through solving real-world problems in a collaborative manner. Teacher one stated that "As subjects were once taught in isolation, the development and importance of STEAM is essential to sustaining learning for all students as an integrated or interdisciplinary program. STEAM combines different areas of study and engage all learners." Administrator two stated that "STEAM is the ability to integrate science, technology, engineering, art, and mathematics into a 21st century approach, that can connect with all students and needs to be at the forefront of learning. STEAM allows students to prepare for diversified careers by connecting their learning with the arts practices and the core subjects' standards to provide a rich, meaningful and cultural learning experience for all students, including those with disabilities."

Research Question Two

How do teachers and administrators view the implementation of STEAM education in their schools?

Theme 1 (the meaning of STEAM) and theme 3 (challenges of STEAM implementation and sustainability) provided the requirements that are needed to effectively examine how the participants perceived the implementation of STEAM within their schools, or in general. The analysis of the qualitative data revealed the following regarding teachers and administrator's view of STEAM implementation: All participants exemplified that to implement STEAM effectively, stakeholders must have the time, funding from the district or state, support at the building or district level, the appropriate professional development, materials, an effective curriculum and an allocation of useful resources. Administrator one stated that "it's important for administrators to support the

implementation and sustainability of STEAM and we need to see more pathways to certification as it is related to STEAM." Additionally, the administrators believed that there should be continuous and ongoing discussions or check-ins with administration around STEAM before and after its implementation and that it should be piloted beforehand. Teacher one and teacher two also illustrated that those teachers having a STEAM mentor during the implementation, would support the quality and delivery of STEAM. Administrator two stated that "in our district, when we implemented STEAM, teachers had a STEAM mentor to support them, in their instruction and delivery. The mentor coached the teachers during implementation, observed lessons and provided targeted feedback." Additional data revealed that there can be difficulty in implementing specific components of STEAM, especially the engineering, technology and arts elements of STEAM. Teacher two stated that "during the implementation stage of STEAM, it is important to have on board, stakeholders such as the principals, teachers, community, superintendent and support at the local or federal level."

Research Question Three

How do teachers and administrators perceive the support and sustainability of STEAM programs in their schools?

Theme 3 (challenges of STEAM implementation and sustainability) provides the requirements that are needed to effectively examine how teachers and administrators perceived the support and sustainability of STEAM programs in either their school district or in general. The analysis of the qualitative data revealed the following regarding their perceptions towards support and sustainability of STEAM: participants illustrated that in order to support STEAM and measure it, STEAM requires effective

resources and materials. The lack of these materials and resources would significantly diminish the effectiveness of the sustainability of the program. All of the participants also delineated that targeted professional development on instructional strategies were needed, as well as practical ways on how to synthesize STEAM in the classroom. Administrator one stated that "professional development on STEAM would be beneficial for teachers to help them understand the concepts and implementation of STEAM and for administrators to look for keys on how to observe teachers when teaching STEAM." As it relates to support and sustainability of STEAM, the analysis also revealed that in order to sustain STEAM for the long run, stakeholders must have the time for STEAM embedded into their schedules. Collaboration through meetings and opportunities to discuss amongst teachers and administrators are essential. STEAM teachers should collaborate with others and share knowledge on how to effectively conduct teaching lessons using a targeted STEAM approach. This can be achieved through monthly meetings. Administrator two stated that "having a monthly planning time for teachers and administrators whereby they discuss their approach with other STEAM educators would be beneficial. Administrators could listen and work together and collectively brainstorm ideas and have STEAM activities schoolwide or district wide." The analysis also disclosed that all participants perceived that a cohesive and universally planned curriculum for teachers to follow covering all aspects of STEAM within a stipulated yearly time frame and grade level, would help with support and sustainability of STEAM. Teacher one stated that "in our district we have a well thought out and planned STEAM curriculum, however, having a universal outline to follow for all, would be helpful and beneficial to the future of STEAM and ultimately support and sustain STEAM."

Change Theory and the Framework for 21st Century Learning Application

With the application to the quantitative and qualitative data described above, it is necessary that this research identifies how teachers' and administrators' perceptions, attitudes, beliefs and mental models encompassing a STEAM education and its instruction relates to the Change Theory and the Framework for the 21st century Learning. The theoretical and conceptual framework of the Change Theory and the framework for the 21st century needs to be defined within the parameters of this research and as it corresponds to the data. A convincing amount of work is needed for any change process and requires constant attention, cultivation and reflection of any initiation. Teachers, pedagogues and educational school and district leaders must attend ongoing and high-quality professional development, support and resources to incorporate STEAM successfully and effectively into a school district and to measure its effectiveness and to maintain its sustainability. When the need for change occurs within a system, in this case for STEAM, implementation, policies and practices can influence the impact of STEAM curriculum and can be the current future hallmark of transformational education. Qualitative interview question 5 asked participants, what changes need to be made to support and sustain STEAM programs? The quantitative survey question 7 asked participants if they believed that STEAM is needed in the American K-12 school system, prompting the need for a change. Additionally, survey question 19 asked participants if there needs to be more exploration into STEAM students' goals and perceptions in order to expand and maximize accessibility, interest and proficiency in a STEAM program to promote a change.

The framework from the Partnerships for 21st Century Learning (P21) delineates the commitment and need for 21st century themes, such as the key subjects (reading, writing and mathematics), learning and innovation skills, information, media and technology skills and life and career skills. Ellsworth (2000) states that 21st century learning includes critical thinking, communication skills, innovation skills and creativity. Dede, Korte, Nelson, Valdez, & Ward (2005) illustrates that when a society changes, it can potentially cause a shift from the skills taught to previous generations to the skills needed for the 21st century. The skills utilized in subjects such as science, technology, engineering, mathematic and the arts (STEAM) can support the skills needed in the 21st century, therefore supporting the Framework for the 21st century Learning. For students to be prepared for 21st century challenges, teachers and administrators can support and prepare them with the abilities to think critically, to communicate effectively and to collaborate efficiently (Partnership-for-21st-Century-Skills, 2013). According to Taylor (2012), 21st century competences can refer to abilities such as the aptitude to apply pragmatic skills and subjects in a well-integrated knowledge-based agenda in different situations together with the ability to handle the social, communication, and emotional demands of instantly changing environments. To support the Partnership for 21st Century Learning (P21), survey question 18 asked participants if their understanding the perceptions of a STEAM education, could a significant contribution can be achieved in the field of interdisciplinary learning. Survey question 21 asked participants if STEAM education is an interdisciplinary approach that can be vital for students to be college and career ready and survey question 29 asked participants if they empowered students in their own learning and utilized 21st Century Skills. Qualitative interview questions one

and two, respectively, asked participants: How do teachers perceive a STEAM program and how do administrators perceive a STEAM program? Additionally, question 6 asked participants, what skills should students in an effective STEAM program possess?

The qualitative and quantitative data disclosed previously recognized characteristics central for the Change Theory and the Framework for the 21st Century Learning in a community of practice in organizational research. In addition, the mixed method data identified definitive characteristics pertaining to the Change Theory and the Framework for the 21st century Learning that takes place within a school, district or community of practice.

Conclusion

To gain a more meaningful and deeper understanding of teachers' and administrators' perceptions, attitudes, beliefs and mental models encompassing a STEAM education, as well as discover the implementation, effectiveness and sustainability of STEAM, the researcher conducted this explanatory sequential mixed method design utilizing a quantitative survey for K-12 teachers and administrators and qualitative interviews with four purposefully selected K-12 teachers and administrators from a suburban region in New York. This chapter explored the findings of the quantitative survey questions, including the descriptive statistics inclusive of correlations between variables in the study and demographic information conducted using SPSS, illustrated and described the qualitative interview questions, as well as explored the connection to the main research questions and hypotheses. For the interviews, the researcher categorized the coded data and identified the primary patterns and themes in

the data from the transcribed manuscript, while ensuring trustworthiness, validity, dependability, transferability and credibility of the study.

The main quantitative findings indicated that there were significant differences across the three research questions in the perceptions of teachers and administrators towards STEAM education and that differences were also detected between the four school levels. The qualitative interviews revealed that teachers and administrators had a similar perception across the three themes. Given the prominent status of STEAM education in the United States, some may assume that there is a universal understanding and definition of what STEAM is. However, the quantitative and qualitative data collected in this study revealed a discrepancy between how the current literature defines STEAM education and how some teachers and administrators define STEAM education. This lack of a common definition is likely a contributing factor to the extensive range of implementation and professional development practices and varying effects that schools and districts report as a result STEAM programming. Many participants defined STEAM as a hands-on approach to learning, while others defined STEAM as an innovative way to connect students to different disciplines, but only 24.29% of participants strongly agreed to having adequate access to STEAM resources. The interview data revealed themes and patterns that could support the implementation and sustainability of STEAM. As the instructional leaders of their schools or districts, administrators' behaviors can potentially impact the educational activities and practices that the teachers utilize in the classrooms with their students (Pearson Education, 2019).

The majority of teachers and administrators (77.14%) strongly agreed that having a clear understanding of teachers' and administrators' perceptions of a STEAM education

is critical for the success of all educators, leaders and for the advancement of the program**.** The majority of teachers and administrators (76.43%) also strongly agreed that large amount of time was needed to prepare for a successful STEAM implementation. Both teachers and administrators reported that in the quantitative survey and in the interviews that the most 5 most important challenges facing STEAM education were: time, lack of funding, lack of targeted professional development, lack of appropriate resources and an ambiguous implementation of STEAM. Looking at the perceived challenges facing STEAM education that teachers and administrators described, provided meaningful insight into what could be hindering schools and districts from having an effective STEAM implementation and sustainability. The equipment, technology, resources and professional development associated with STEAM for teachers and administrators can be expensive and therefore it is logical that the second most frequently recorded challenge was funding.

Chapter 5 will conclude this explanatory sequential mixed method design with the implication of the findings, the relationship to prior research, limitations of this study and recommendations for future practice and for future research.

CHAPTER 5 Discussion

Introduction

In Chapter 5, the researcher concludes this study with a restatement of the research process, provides implications of the findings and relationship to prior research through literature-based interpretation of the results, discusses the limitations of the study, offers recommendations for future practice and future research and ultimately examines the conclusions. The implication of findings section begins with a discussion of the results of the analysis, as presented in Chapter 4. This section also connects to the main quantitative and qualitative research questions, as well as the theoretical and conceptual framework as presented in Chapter 4. The relationship to prior research section associates the findings of the study to the literature reviewed in Chapter 2 and indicates places where the research supports, extends, questions, or refutes prior research. The limitations section describes the limitations of the study. The recommendation sections focused on guidance for future research and practice, as well as recommended actions, as it relates to STEAM, for school and district administrators, teachers, researchers, educators and policy makers. In culmination, the conclusion section summarizes the entire research.

This research set out to explore, investigate and understand teachers' and administrators' perceptions of STEAM education and also examined how these stakeholders viewed and perceived the implementation, support and sustainability of a STEAM program in their schools. Additionally, the researcher also studied the perception and professional support for these STEAM educators and administrators. The

researcher determined this focus because teachers' and administrators' comfort levels are directly correlated to levels of pedagogical fulfillment or unfulfillment (Southerland, Granger, Hughes, Enderle, Ke, Roseler, Saka & Kisa, 2006). This study also sought to examine the research through the lens of Michael Fullan's Change Theory and the 21st Century Skills Framework, in a way that could provide a rationale and theoretical evidence for how the concept and model of STEAM education is presented and accomplished in a manner that is comprehensive and practical to meet the learning demands for all learners in a 21st learning environment.

Paulson (2012) hypothesized that teachers' and leaders' attitudes and perceptions can affect students' achievement in STEAM and accordingly, this research study is necessary and significant as it seeks to provide a novel perspective for STEAM perceptions and can ultimately support implementation of STEAM at the K-12 level. However, there needs to be more analysis and investigation into STEAM perceptions, initiatives, goals, benchmarks and curricula in order to expand and maximize accessibility, interest, proficiency and to ultimately build and sustain and effective K-12 STEAM program. As Bursal & Paznokas (2006) emphasize, that since there is no official STEAM curricula, guidelines or blueprint, most K-12 teachers have not learned or have not been taught the appropriate disciplinary content using STEAM contexts. Teachers' pedagogical styles and administrators' leadership philosophies in regards to STEAM, may be organized by a manner most comfortable to them, activated by their own perceptions and belief systems about the value and objectivity of STEAM integration (Wang, Moore, Roehrig, & Park, 2011). Nadelson, Seifert, Moll and Coats (2012) illustrate that the link between teachers' and administrators' comfort, motivation

to teach or lead and student learning or achievement in STEAM provides important reasons for enhancing teachers' and administrators' capacities to teach and implement STEAM.

The researcher utilized an explanatory sequential mixed method, non-criterion group design, with the quantitative survey design being cross-sectional. This allowed the research study to take place at one point in time, with the researcher collecting the quantitative data over the course of four weeks. Additionally, it did not involve manipulating any of the variables and it allowed the researcher to look at numerous characteristics at once, such as educator role, gender, level of education taught or supervised and years of experience as a teacher or administrator. The STEAM Education Perception survey was utilized as the main quantitative instrument to collect the data from the sample population. Purposive sampling was utilized in this study as it is a non-probability sample that was selected based on the characteristics of the population and the objective of this study, in this case, to survey teachers and administrators that worked in districts that have a STEAM program. The qualitative phase consisted of in-depth interviews with four select K-12 teachers and administrators that were transcribed and coded. As data were collected from participants across 5 school districts in a suburban region of New York, the specific 5 districts were chosen based on them being the dominant school districts for a STEAM program in this suburb region of New York. The findings from this explanatory sequential mixed method study, including the STEAM Education Perception Survey, as well as the structured and in-depth interviews, have provided the researcher meaningful insights into the perceptions of teachers and

administrators in regards to STEAM and its implementation, support, sustainability and challenges.

Implications of Findings

This research study focused primarily on three research questions. The following section presents the researcher's interpretation of the findings and implications of each of the major discoveries, while relating them to the main research questions, as well as the theoretical and conceptual frameworks as presented in Chapter 2.

As this study utilized the Change Theory and the 21st Century Skills Framework in order to demonstrate the relevance towards the utilization of a STEAM based education to transform schools and modify learning, the results of the quantitative and qualitative analysis revealed that although teachers and administrators perceived that STEAM education is integral and beneficial to all students, due to its positive impact in Science, Technology, Engineering, Arts, and Mathematics, participants illustrated that a change was needed in order to address the challenges facing the implementation, support and sustainability of STEAM. Interview question 5 asked, what changes need to be made to support and sustain STEAM programs, open ended survey question 25, which asked participants to describe the 3 most important challenges facing STEAM education, survey question 14, which asked teachers and administrators whether a large amount of time was needed to prepare for a successful STEAM implementation and survey question 11, which asked if more targeted professional development is needed for a successful STEAM based approach, all supported the foundation and need for the Change Theory, within a system that can influence the impact of STEAM curriculum implementation,

support and sustainability. Therefore, a STEAM curriculum and implementation should be considered a focal point of design within a change perspective.

As the Framework for 21st Century corresponds to the specific skills, such as critical thinking, creativity, innovation and problem-solving, that are needed to succeed in a global market, the results of the quantitative and qualitative analysis as in interview question 6, which asked what skills should students in an effective STEAM program possess, survey question 30 which was open ended and asked participants to define STEAM education and survey question 19 which asked teachers and administrators if there needs to be more exploration into STEAM students' goals and perceptions in order to expand and maximize accessibility, interest and proficiency in a STEAM program, demonstrated the correlation and need for framework for 21st Century. This supported the conceptual framework and illustrated and supported that all students, in order to be college and career ready, must be able to integrate and transfer traditional academic subjects with interdisciplinary skills in a manner that could develop and promote the four Cs: creativity, critical thinking, communication and collaboration.

Research Question One

What are the perceptions of teachers and administrators towards STEAM education?

H_1: There was a significant difference in the perceptions of teachers and administrators towards STEAM education.

The first research question focused on teachers' and administrators' perceptions towards STEAM education, which also included their understanding of the meaning and importance of STEAM. Based upon the results of qualitative interviews in this

explanatory sequential mixed method design, teachers and administrators revealed that: they have a similar and thorough understanding of the meaning and importance of STEAM. All four participants (teachers and administrators) stated that STEAM is interdisciplinary and combines science, technology, engineering, arts music and mathematics for a comprehensive and holistic instruction. They agreed that STEAM is practical, engaging and an interactive way of teaching, that frequently involves experimentation, collaboration and utilization of 21st Century Skills to prepare all students to be college and career ready. Additionally, during the interviews, both teachers and administrators stated that STEAM encourages motivation when an inquiry-based model of learning is used and students learn through solving real-world problems in a way that can enhance self-awareness and social skills to fully develop creativity and social emotion learning. Participants also illustrated that a STEAM model can augment computational thinking skills in a manner that can motive students to become independent and critical thinkers, while encouraging others to explore STEM and STEAM fields as a career. For research question one, teachers' and administrators' perceptions in this qualitative phase were consistent with the literature. Christensen, Knezek and Wood (2015) state that the concepts of STEAM are student centered, hands-on, inquiry, project based and active learning, that are real-world and interdisciplinary programs that connect STEAM-related subjects in a manner that are relevant to students lives. Additionally, Graham and Brouillette (2016) stated that STEAM lessons were as beneficial to English language learners, and all learners, as it combined subjects in an interdisciplinary manner that increased the level of academic excellence of the student, mainly because learners learn in a hands on, project based and practical manner.

Based upon the quantitative results and analysis which utilized SPSS to conduct independent samples t-tests and One way Anovas of participants' responses to the STEAM Education Perception Survey, the conclusions revealed that there were significant differences in the perceptions of teachers and administrators towards STEAM education when: asked if teachers and administrators believed that STEAM is needed in the American K-12 school system (survey question 7), asked about having a clear understanding of teachers' and administrators' perceptions of a STEAM education is critical for the success of all educators, leaders and for the advancement of the program (survey question 8), asked if teachers and administrators believed whether a STEAM education can cultivate students' talents and skills in music and the arts (survey question 16) and when asked teachers and administrators their perception of whether STEAM education is integral and beneficial to all students due to its positive impact in Science, Technology, Engineering, Arts, and Mathematics (survey question 17). However, there were no significant differences in the perceptions of teachers and administrators towards STEAM education when: asked whether a large amount of time was needed to prepare for a successful STEAM implementation (Survey question 14). When defining STEAM education in their own words, both teachers and administrators stated that STEAM is an interdisciplinary and hands on approach to learning that involves utilizing project-based learning with an emphasis on developing 21st Century Skills for all learners.

The qualitative and quantitative data collected to examine research question one, what are the perceptions of teachers and administrators towards STEAM education offered several insights. To interpret how the qualitative results explained quantitative results, the researcher followed up by asking meaningful and open-ended interview

questions such as, how do teachers perceive a STEAM program and how do administrators perceive a STEAM program, eliciting broader responses from the participants. Qualitative analysis revealed that teachers and administrators had a meaningful and similar understanding of the meaning and perceptions of STEAM across the open-ended questions asked. However, the quantitative analysis indicated that hypothesis one was supported and that overall, there was a significant difference in the perceptions of teachers and administrators towards STEAM education in regards to several questions. Collectively, the responses regarding teachers' and administrators' perceptions of STEAM education reveal a picture where they believe there is a need for STEAM, but the current state of STEAM education is not where it should be to address this need.

Research Question Two

How do teachers and administrators view the implementation of STEAM education in their schools?

H_1: There was a significant difference in how teachers and administrators viewed the implementation of STEAM in their schools.

The second research question focused on teachers' and administrators' perceptions on their view towards STEAM implementation. Based upon the results of qualitative interviews in this explanatory sequential mixed method design, both teachers and administrators revealed that to implement STEAM effectively, stakeholders must have the time in their schedules, an increase of funding from the district or state, support at the building or district level, the appropriate training and professional development, a mandated STEAM curriculum and an allocation of pragmatic materials and resources.

Additionally, during the interviews, both teachers and administrators believed that that there should be continuous and ongoing discussions or check-ins with colleagues and administration around STEAM before and after its implementation. Teachers and administrators also stated that having a STEAM mentor during implementation, would support the quality and delivery of STEAM instruction and pedagogy. However, during the interviews, both teachers and administrators stated that a certification pathway for STEAM was needed. The results also revealed that there needs to be more exploration, discovery and research into STEAM initiatives and how it can affect student achievement and creativity, in order to develop 21st Century Skills. For research question two, teachers' and administrators' perceptions on the implementation of STEAM in this qualitative phase were consistent with the literature. Quigley and Herro (2016) when examining the implementation of STEAM teaching practices in order to provide research-based evidence on STEAM to guide educators, discovered that during the implementing of STEAM, it is important to include collaboration skills, arts integration, transdisciplinary learning, technology integration and to have the appropriate funding, time and allocation of resources.

Based upon the quantitative results and analysis which utilized SPSS to conduct Independent Samples t-Tests and One way Anovas of participants' responses to the STEAM Education Perception Survey, the conclusions revealed that there were significant differences in the perceptions of teachers and administrators towards the implementation of STEAM education when asked: if STEAM education is difficult to implement due to a lack of support from either building administrators or central administration (survey question 10), if more targeted professional development is needed

for a successful STEAM based approach (survey question 11), if professional development opportunities around STEAM education were regularly provided to teachers at their school (survey question 22), if they have adequate access to STEAM assets such as libraries, agencies, professional development, museums, Arts organizations, etc. (survey question 23), if the current condition of STEAM education in their district is meeting the needs of all students (survey question 24) and if they felt prepared for the implementation of STEAM instruction their school or district (survey question 34). However, there were no significant differences in teachers and administrators view of implementation of STEAM education in their schools when asked if a large amount of time is needed to prepare for a successful implementation (survey question 14).

The qualitative and quantitative data collected to examine research question two, how do teachers and administrators view the implementation of STEAM education in their schools offered essential understandings of the relationship between the two groups. To interpret how the qualitative results explained quantitative results, the researcher followed up by asking meaningful, comprehensive and open-ended interview questions to participants, such as, how should teachers implement and teach a STEAM education and what changes need to be made to support and sustain STEAM programs? Qualitative analysis revealed that teachers and administrators had a purposeful and complimentary understanding of the perceptions on the implementation of STEAM education in their schools or districts across the open-ended interview questions. However, the quantitative analysis indicated that hypothesis one was supported and that overall, there was a significant difference in how teachers and administrators perceived the implementation of STEAM education in regards to several survey questions. Collectively, the responses

regarding teachers' and administrators' understanding of the implementation of STEAM illustrated that both groups believed that although there are other obstacles to overcome, further professional development and ongoing training were essential to the success of STEAM implementation. Consistent with the literature, these results were continuous with findings from Boice, Jackson, Alemdar, Rao, Grossman & Usselman (2021), which indicated various aspects of training and professional development could support the implementation of STEAM and can mitigate some of these challenges.

Research Question Three

How do teachers and administrators perceive the support and sustainability of STEAM programs in their schools?

Ho: There was no significant difference in how teachers and administrators perceived the support and sustainability of STEAM programs in their schools.

The third research question focused on teachers' and administrators' perceptions on the support and sustainability of STEAM. Based upon the results of the qualitative interviews in this explanatory sequential mixed method design, both teachers and administrators disclosed that: in order to support and sustain an effective STEAM program, it requires high quality resources and materials, time for STEAM planning and collaboration through meetings and professional development opportunities. Both teachers and administrators stated that a broad, extensive and thoroughly planned curriculum for teachers to follow, covering a wide range of aspects as related to STEAM, could help with support and sustainability of STEAM for the long haul. However, both teachers and administrators stated the challenges with the support and sustainability of STEAM, which included: budgeting, tax caps, lack of motivation, no certification for

STEAM, demanding school and district policies that take away time from STEAM planning, curriculum and state testing demands that can impede the development of STEAM and a lack of support from building or central administration. All of the participants also delineated that targeted professional development on instructional strategies were needed, as well as practical ways on how to synthesize STEAM in the classroom.

Based upon the quantitative results and analysis which utilized SPSS to conduct the Independent Samples t-Tests and One way Anovas of participants' responses to the STEAM Education Perception Survey, the conclusions revealed that there were significant differences in the perceptions of teachers and administrators towards the support and sustainability of STEAM programs when asked: if STEAM education was difficult to implement due to lack of funding (survey question 9) and if STEAM education is difficult to implement due to insufficient expertise in the content area or lack of confidence in teaching STEAM (Survey question 15). However, there were no significant differences in teachers' and administrators' perceptions towards the support and sustainability of STEAM when asked if it is difficult to secure sufficient time for the implementation of STEAM education (survey question 12) and if there needs to be more exploration into STEAM students' goals and perceptions in order to expand and maximize accessibility, interest and proficiency in a STEAM program (survey question 19).

The qualitative and quantitative data collected to examine research question three, how do teachers and administrators perceive the support and sustainability of STEAM programs in their schools, presented relevant and consequential understandings of the

relationship between the two groups. To interpret how the qualitative results explained quantitative results, the researcher followed up by asking probing and extensive interview questions to participants, such as, what skills should students in an effective STEAM program possess, how can administrators support and sustain an effective STEAM program and do you feel there are gaps in the current STEAM model at your school and if so, what are they? Qualitative analysis revealed that teachers and administrators believed that in order to support and sustain STEAM, it's important to have all necessary stakeholders on board, such as teachers, administrators, students, parents and members of the community. Participants stated that STEAM is paramount to developing students' 21st Century Skills, as it can develop and cultivate their talents and creativity, however, all stakeholders should have the knowledge and tools of how to successfully implement and sustain STEAM. The quantitative analysis indicated that hypothesis one was supported and that there was a significant difference in how teachers and administrators perceived the implementation of STEAM education in regards to two survey questions. Overall, the responses from research question three revealed that both teachers and administrators believed that that parents, students, school administrators, and the community should value STEAM education, however, more research and awareness are needed on the benefits and implications of STEAM. These results are consistent with findings from by Quigley and Herro (2017) which delineated that teachers and administrators could increase their understanding and knowledge of STEAM by utilizing professional development opportunities as an initial first effective and substantial step to change practice.

Relationship to Prior Research

As the researcher utilized an explanatory sequential mixed method, based on literature reviewed in chapter 2 and the main findings, the quantitative and qualitative data and results from: research question three, which asked how do teachers and administrators perceive the support and sustainability of STEAM programs in their schools, survey question 24, which asked teachers and administrators on their perception if the current condition of STEAM education in their district is meeting the needs of all students and qualitative interview question 7, which asked teachers and administrators if they perceived there are gaps in the current STEAM model at your school all supported the study by Boice, Jackson, Alemdar, Rao, Grossman and Usselman (2021), which provided research and data on STEAM teacher training and professional development and the challenges with implementing STEAM instruction, as well as the need to have formal training on interdisciplinary content utilizing STEAM based concepts, as they can provide the foundational core for STEAM learning for teachers and administrators. Moreover, the quantitative and qualitative results from research question two, how do teachers and administrators view the implementation of STEAM education in their schools, survey question 14, which asked teachers and administrators whether a large amount of time was needed to prepare for a successful STEAM implementation and survey question 11, which asked if more targeted professional development is needed for a successful STEAM based approach, supported the study by Mastrorilli, Harnett and Zhu (2014), which examined whether providing teachers with high quality and intensive Professional Development can have a positive impact on arts teachers and their students and provided evidence that increasing Arts teachers knowledge and skills in assessments

and the utilization of data trends, can lead to an overall improvement in students' arts achievement in an interdisciplinary manner. In the qualitative interviews, theme 3, which illustrated the challenges of STEAM implementation and sustainability, whereby teachers and administrators stated the need to increase professional development also supported the study by Mastrorilli, Harnett and Zhu (2014).

The study by O'Leary and Thompson (2019) which illustrated the need for educators, administrators and policy makers to re-examine the importance and authenticity of a fully integrated and interdisciplinary educational experience for students in order to include the Arts to develop and support their creativity and cognition was supported by the results from: research question one, which stated what are the perceptions of teachers and administrators towards STEAM education, survey question 16, where teachers and administrators were asked whether a STEAM education can cultivate students' talents and skills in music and the arts, survey question 23, which asked teachers and administrators if they have adequate access to STEAM assets (libraries, agencies, professional development, museums, Arts organizations, etc.), interview question four which asked how can administrators support and sustain an effective STEAM program and interview question 5, which asked what changes need to be made to support and sustain STEAM programs.

Limitations of the Study

As with all research studies, there will be some limitations. Certain limitations may occur due to the researcher's limited experience with a certain type of research design. In an attempt to alleviate this effect, the researcher extensively studied theoretical research of qualitative and quantitative designs through a consistent review of

methodological concepts and studies of published works such as: Creswell (2012), Creswell and Poth (2018), Creswell and Miller (2000), Yin, (2009), Cypress (2017), Golafshani (2003), Merriam, (2002), Stake (2010) and Bryman (2006).

Firstly, this study took place in a suburban region in New York and results may not be generalized to the full population because of the potential regional biases of the suburban area, schools, districts and specific cultural and socio-economic contexts. Additionally, the teachers' and administrators' perceptions of STEAM may vary widely due to educational backgrounds, program designs, funding and support from each district, time allotted for implementation and levels of experience. Moreover, the participants of teachers and administrators in the sample for this study were from suburban school districts near a large metropolitan city in New York, where the type and amount of professional training and funding provided to its stakeholders may have influenced the behaviors and perceptions of these members. In this research study, teachers and administrators documented receiving an inadequate amount of professional development and training to support their understanding of the implementation and sustainability of STEAM and although this study could be generalized to other suburban school districts in the United States, it would be meaningful to replicate this study in large metropolitan urban school districts, where the professional training, funding and support received may be very different from the suburban schools. As such, the findings may only be applied in that setting and may not be generalizable across other geographic areas. Furthermore, the results may not necessarily be applied across other educational settings such as catholic or private school systems or even charter school systems.

Secondly, another limitation in this study included the limited response rate from teachers and administrators. The number of respondents available during this time were limited and the findings have been applied with that consideration. With a higher response rate from these two subgroups (teachers and administrators), it is possible that specific findings may be altered. This could threaten the conclusions, as a large population of the subjects were not present for the entire the study, which can impact the findings. Thirdly, another possible limitation is the threat to the internal validity of this study which is labelled as history. A past event could have potentially directly or indirectly influenced the result of research of the participants in the study. Some things like time of the research conducted or school politics can influence the coordination of the research participants and how they chose to perform in this mixed method study. For example, the time of the survey given was between December 2022 to January 2023, which could have prevented the participants from participating in this study or if the participants had a negative past experience with STEAM education, that could have affected the outcome.

Fourthly, the varied approaches to the perceptions of a STEAM curriculum are individualized to each school environment and therefore would have to be differentiated with their respective implementations. One district could be fully funded and supported for STEAM, while a neighboring district might not. Fifthly, the presence of other limitations surrounding COVID-19 protocols limited the study as well, with specific regard to lessening the face-to-face collaborative process, during the online qualitative interviews for K-12 teachers and administrators. Schools were subjected to following social distancing and refraining from sharing materials. They were also limited with their

overall movements in the building. Lastly, additional limitations of the study included the inability to account for the wide variances of educator and administrator approaches to STEAM perception implementation and support and sustainability regarding accessibility to resources, professional learning opportunities, and stakeholders. It was also difficult to identify causality, as this study was exclusive to individual perceptions and opinions of implementation, support and sustainability in regards to STEAM. Moreover, as the researcher produced an analysis of the findings and conclusions, assumptions were not disclosed on the part of the researcher, even if the researcher had outside and additional knowledge of the information. Because there is limited research in STEAM, a mixed method approach was the most effective approach to collect data and identify themes to study more extensively. Notwithstanding the possible limitations that were discovered, a considerable effort in the areas of triangulation and objectivity were made to ensure the validity, reliability, accuracy and of the results in this explanatory sequential mixed method study.

Recommendations for Future Practice

Based on the findings, recommendations for future practice could include an investment of time and money to implement various professional development as it relates to STEAM initiatives for teachers and administrators. Armknecht (2015) illustrates that the most effect STEAM programs utilize teachers and administrators that are well-trained in their content areas. In addition to competency in their own areas, inquiry based- teaching models that incorporate the conceptual framework for 21st Century Learning would give teachers and administrators a greater self-efficacy in their ability to take greater risks in teaching and leading within the framework of a STEAM

program. Ashton, Webb, and Doda (1983) stated that teachers' self-efficacy could be deepened through school organizational structures such as multi-level grouping, teaming and planning among teachers. The Organization for Economic Cooperation and Development-OECD (2020) gave the Teaching and Learning International Survey (TALIS) in 2009, which was the first international comparative study on teaching and learning. TALIS discovered that teachers who had received more professional development in an initiative had reported substantially higher levels of self- efficacy. A content competency assimilating pedagogy, technology, the arts, the framework for 21st century learning, interdisciplinary skills and creativity to incorporate the Change Theory in a global and comprehensive manner, would be viewed as a paradigm shift and as a major part of the process for planning and sustaining a STEAM program.

When seeking to increase the generalizability for others, this study grants actionable steps to guide schools and districts with the implementation process. More research is needed on a STEAM curriculum within a K-12 setting, as teachers and administrators from the study seemed to have a common perception of the three most important challenges facing STEAM education. Based on the findings from this explanatory mixed method study, recommendations that would benefit future practice are: increasing grants and funding for STEAM initiatives, expanding and allowing ample time in the schedule for teachers and administrators to collaborate on STEAM with each other, developing a state approved STEAM curriculum for each grade level, state certification programs in STEAM, granting the appropriate and targeted interdisciplinary professional development for stakeholders, not focusing on too many isolated curriculum programs that make it difficult to integrate STEAM into curriculum areas and additional

support at the district and state level. Additionally, in this study, student perceptions of STEAM education were not collected and analyzed. Further exploration of students' perceptions of STEAM implementation and sustainability would be meaningful to achieve a more extensive data collection. Moreover, future research could include longitudinal data to illustrate time allotments for each phase of the implementation of STEAM. Benchmarks could then be established for accomplishing certain areas of the curriculum change. Additionally, in this study, administrators illustrated that collaboration was a significant part of the implementation process of a STEAM curriculum and therefore, leaders must make sure that teachers are comprehensively prepared for the highly collaborative nature of STEAM implementation.

According to Sanders (2009), practical and effective leadership and guidance are central components of any STEAM initiative, as school and district leaders can directly influence school policies and practices, student achievement, as well as the teaching profession. This type of change requires leaders to work collaboratively and productively to accomplish the intended STEAM outcomes. Maintaining a substantial content knowledge (CK) and pedagogical content knowledge (PCK) with curriculum changes are necessary so that leaders can provide teachers with opportunities to expand their understanding. Stansbury (2012) delineates that school and district leaders could utilize the school or districts available resources for STEAM and adopt these resources to conceive and enhance the vision of STEAM programs in order to broaden and examine new opportunities to differentiate and meet the needs of their individual school district.

Recommendations for Future Research

Recommendations for future research studies could include conducting a study on the perceptions of STEAM from various school districts in other suburban or urban regions in other parts of the state or country, as there could potentially be significant differences in funding and support for STEAM education from one region to another. Additionally, findings from this study can be extended through a more comprehensive and representative sample of STEAM teachers. Future research is also needed to explore professional development that could potentially be offered to teachers in terms of how to effectively implement Arts integration and for administrators on how to look for success and sustainability within a STEAM program in their school or district. Professional development programs can focus on areas of instruction that would allow teachers and administrators to fully and comprehensively prepare K-12 students, to be college and career ready and also to be equipped with the skills and knowledge needed to become successful innovators and creators in the 21st century workforce. Moreover, future research should also consider the specific procedures in which schools, districts, and states are implementing STEAM education, specifically whether teachers and administrators, in connection to STEAM, feel adequately comfortable to teach, observe and lead. Examples of this research could include utilizing online or mobile surveys, polls, interviews with participants or longitudinal studies filled out by teachers, students and administrators and then examine the correlation among their responses.

This study investigated the perceptions and experiences of STEAM education on a sample of participants (teachers and administrators) from 5 school districts in a suburban region. The sample, however, did not represent all K-12 school districts

throughout the entire suburban region of the state involved in the study and therefore, was constrained to only the data available and experiences of the participants within the school district where the study took place. An even wider diversity of participants could be utilized in this explanatory sequential mixed method study, which could potentially lead to an even broader and deeper perspective of the research questions. Expanding the study to include students' perceptions of STEAM would enable the inclusion of the research method of controlled observations, polls and comparative data between the other two target groups, further allowing the researcher to observe students participating in STEAM education that emphasizes both the benefits and difficulties of districts with an established STEAM education program. By including the students' perceptions of STEAM, the results could provide significant implications and considerations regarding the current opinions of STEAM education from the student's perspective.

Based upon the findings and conclusions in the study, the key recommendations for further research are complementary: (a) guidance for further leadership research for school/district administrators and STEAM leaders, and (b) instruction and support for teachers for further study and implementation of a K-12 STEAM education. The researcher also recommends that this study could be replicated in the same region with these 5 districts after the appropriate implementation of STEAM professional development and after teachers and administrators have had an opportunity to become more experienced in best practices surrounding STEAM instruction. Data collection, including comparative data and a statistical analysis, as well as focus groups and interviews could then be designed to assess changes in teachers' and administrators' perceptions as a possible result of STEAM training. Additionally, to further elucidate the

findings of this study, the researcher would advocate multiple mixed method studies from diverse regions throughout the country. A mixed method analysis could then be conducted, that would authenticate the results by using teachers and administrators across the nation as samples in the study. This would provide a greater perspective from teachers and administrators with varying experiences and knowledge of teaching and leadership, as well as integrating and implementing STEAM and they could ultimately be used as guidelines for developing teacher and administrator training for K-12 STEAM education. As these programs would develop, Sanders (2009) illustrated that they could be measured by modifying standards for STEAM education and could include assessments of STEAM skills, based on the review of research that is associated with the modifying views of the fundamental outcomes of STEAM education. The results could then be allowed for as benchmarks or a baseline for teaching STEAM over the course of time.

As shown through this research, the researcher discovered, evaluated and ascertained the complex dynamic between teachers' and administrators' perceptions of STEAM education utilizing the mean perception scores of the STEAM Education Perception Survey and the qualitative data from the in-depth interviews from the K-12 teachers and administrators. As Herro, Quigley & Cian (2019) delineate, that insufficient empirical data exists to guide and sustain effective instructional practices in STEAM education and even less is known about the challenges associated with this type of instruction, further research into the perceptions and implementation of a K-12 STEAM education is recommended.

Conclusion

This study examined, investigated and explored teachers' and administrators' perceptions, attitudes, beliefs and mental models encompassing a STEAM education and for the purpose of discovering the implementation, effectiveness and sustainability of STEAM. The researcher utilized a Change Theory and the 21st Century Skills Framework in order to illustrate the relevance towards the utilization of a STEAM based education to transform K-12 schools and reshape learning. For a school or district to develop students' 21st Century Skills that enables them to become: college and career ready, critical thinkers, problem solvers, entrepreneurs and innovators needed in the 21st century, as well as to have academic literacy, utilize their creativity in a global manner and incorporate interdisciplinary skills, as well as community engagement, it is recommended that the school or district should incorporate the researcher's theoretical and conceptual framework as a template.

In summary, the explanatory sequential mixed method findings of this research have suggested that although teachers and administrators have many of the same perceptions of STEAM throughout the qualitative interviews, the quantitative results indicated significant differences in their perceptions for: research question one, which asked, what are the perceptions of teachers and administrators towards STEAM education and research question two, which asked, how do teachers and administrators view the implementation of STEAM education in their schools. For research question one and two, respectively, hypothesis one was supported: There was a significant difference in the perceptions of teachers and administrators towards STEAM education and there was a significant difference in how teachers and administrators viewed the implementation of

STEAM in their schools. However, the quantitative results for research question three, which asked, how do teachers and administrators perceive the support and sustainability of STEAM programs in their schools, supported the null hypothesis, Ho: there was no significant difference in how teachers and administrators perceived the support and sustainability of STEAM programs in their schools. The qualitative interviews supported the null hypothesis for research question three.

Although teachers and administrators are cognizant of the meaning and importance of STEAM education, they do not always fully understand what STEAM education entails. Each of the four participants interviewed in the study (two teachers and two administrators) perceived STEAM education to mean something distinctive, depending on their experiences, education level, district goals and initiatives, but overall, when analyzing the themes, it became apparent that these participants all had a similar understanding of the meaning, importance and challenges associated with STEAM and its implementation and sustainability. Further research and analysis surrounding the various qualitative themes that were developed throughout this study, could have value and meaning for determining how to successfully implement, sustain and evaluate a STEAM program at the K-12 level.

The findings, implications and recommendations from this study contribute to the ongoing and continuous efforts to develop better and more effective methods for promoting the perceptions of STEAM education. From this explanatory sequential mixed method study, the researcher recommends that future research focus on how the perceptions of STEAM education can potentially affect student achievement and support educators in developing and preserving an authentic description and implementation of

STEAM, serve as a guide to the development of STEAM programs in America and ultimately establish an engaging intertest among all students to pursue STEAM areas in education and in a real-world setting. Additional research on teachers' and administrators' perceptions of STEAM across the nation could provide beneficial information that could be utilized to assess and measure the performance and sustainability of such programs. Moreover, the integration of STEAM programs at the K-12 level has the potential to affect education in a positive and innovative way, whereby school districts could have a more informed ideology about the meaning, significance, implementation, challenges and sustainability in regards to STEAM and how it could provide students with the pragmatic tools needed to become innovators and pioneers of interdisciplinary STEAM subjects and to be able solve the most pressing issues facing the future of the world.

Appendix A St. John's University IRB Approval

Federal Wide Assurance: FWA00009066

Dec 1, 2022 1:37:33 PM EST

PI: Royce J. Lopez
CO-PI: Anthony Annunziato
Ed Administration & Instructional Leadership

Re: Expedited Review - Initial - **IRB-FY2023-111** *EXPLORING TEACHERS' AND ADMINISTRATORS' PERCEPTIONS OF STEAM EDUCATION IN K-12 SCHOOLS AND ITS IMPLICATIONS ON THE DEVELOPMENT OF STEAM: AN EXPLANATORY SEQUENTIAL MIXED METHOD DESIGN*

Dear Royce J. Lopez:

The St John's University Institutional Review Board has rendered the decision below for *EXPLORING TEACHERS' AND ADMINISTRATORS' PERCEPTIONS OF STEAM EDUCATION IN K-12 SCHOOLS AND ITS IMPLICATIONS ON THE DEVELOPMENT OF STEAM: AN EXPLANATORY SEQUENTIAL MIXED METHOD DESIGN*. The approval is effective from December 1, 2022 through November 30, 2023.

Decision: Approved

PLEASE NOTE: If you have collected any data prior to this approval date, the data must be discarded.

Selected Category: 7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies

Sincerely,
Raymond DiGiuseppe, PhD, ABP
Chair, Institutional Review Board
Professor of Psychology

Appendix B Recruitment Email to Superintendents

Dear Superintendent_____

My name is Royce J. Lopez and I am a doctoral candidate in the Department of Administrative and Instructional Leadership at St. John's University, Queens, NY. I am conducting a dissertation study on Teachers' and Administrators' perceptions when implementing a STEAM (Science, Technology, Engineering, Arts, and Mathematics) education at the K-12 level. My co-investigator and mentor for my dissertation is Dr. Anthony Annunziato, Clinical Associate Professor at St. John's University and former Superintendent.

The title of my dissertation is: ***Exploring Teachers' and Administrators' Perceptions of STEAM Education in K-12 Schools and its Implications on the Development of STEAM: An Explanatory Sequential Mixed Method Design***

The purpose of this email is to invite Teachers and Administrators in your district to participate in my mixed method study in order to better understand the perceptions and leadership surrounding a STEAM based education. With their expertise as a K-12 Teacher or Administrator, I would be grateful if they would consider sharing their current experiences surrounding STEAM education.

Participation Requirement for the Online Survey: **This involves the completion of an online survey via the Survey Monkey website (see link below). The survey will take approximately 10 minutes to complete and are comprised of a series of questions about Teachers' and Administrators' perceptions of STEAM education and how they view its implementation, support and sustainability.**

Participation Requirement for the Online Interviews **– As a follow up to the online survey, the K-12 Teachers and Administrators will be asked to participate in online interviews. The interviews are voluntary and will take about 30 minutes. It is comprised of open-ended questions about Teachers' and Administrators' perceptions of STEAM education. If you are interested in being a part of the Teachers and Administrators interviews, please contact me at: Royce.Lopez18@my.stjohns.edu and state your title, district and when you are available for the interviews.**

A copy of my IRB approval is attached along with the survey link below. **By you forwarding this email letter to your Teachers and Administrators in your district, they will be able to click on the link and will be directly connected to the Survey. No IP addresses or email addresses will be recorded or saved by Survey Monkey. Your teachers' and administrators' responses will be completely anonymous. Additionally, they will also be able to be contact me and be involved in the Administrators' online focus group.**

All survey data will be kept confidential; at no time will their name or identifying information be available to me or included in the study. *I will not have access to any names, school information or email addresses of the teachers or administrators.*

Should you have further questions or wish to receive a copy of my completed Dissertation, please contact me via email at Royce.Lopez18@my.stjohns.edu. I would be more than happy to answer any questions that you may have and to share my completed dissertation with you.

Thank you so much in advance for your consideration of my request. It is truly appreciated.

Here is the link to my survey:

https://www.surveymonkey.com/r/28ZW8P8

Sincerely,

Royce J. Lopez
Royce.Lopez18@my.stjohns.edu
Doctoral Candidate, Administrative and Instructional Leadership St. John's University

Appendix C STEAM Education Perception Survey

Dear Educator/Administrator,

As a requirement of the degree of Doctor of Education in Administrative and Instructional Leadership at St. John's University, I am completing my dissertation on Teachers' and Administrators' perceptions of STEAM (Science, Technology, Engineering, Arts, Mathematics) education and its implications on the development of STEAM. This survey is designed to provide insight into K-12 teachers' and administrators' perceptions of STEAM Education. The study of current perceptions of educational professionals in the New York region on the integration of STEAM education will support schools and school districts in the implementation, evaluation and sustainability process.

This survey is both anonymous and voluntary and will take approximately fifteen to twenty minutes to complete. Your responses will be collected anonymously, which will protect your rights of privacy. There are no known risks associated with this research. You will not be penalized in any way should you decide not to participate or withdraw from this study. Taking this survey demonstrates your consent for participation. Please answer these 35 questions about your perceptions of STEAM education. Your voice is very important, so thank you for sharing your thoughts and experiences. If you would like to be included in follow up online interviews for K-12 teachers and administrators, please make sure to fill in the last question.

If you have any questions, please contact me at Royce.Lopez18@my.stjohns.edu

Thank you for your support.

Sincerely,
Royce J. Lopez

Please answer the questions below

1. What is your educator role?

   ☐ Teacher

   ☐ Administrator

2. What is your gender?

   ☐ Male

   ☐ Female

   ☐ Other

3. What school level are you affiliated with?

   ☐ Elementary (Grades K-5)

   ☐ Middle (Grades 6-8)

   ☐ High School (Grades 9-12)

   ☐ District Level (Grades K-12)

4. Years of experience in your role as an educator or administrator.

   ☐ 1-2 years

   ☐ 3-5 years

   ☐ 6-10 years

   ☐ 11 plus years

5. (For Teachers) I feel fully supported by my school administrators as related to a STEAM program.

☐ Strongly Agree

☐ Moderately Agree

☐ No Opinion

☐ Moderately Disagree

☐ Strongly Disagree

6. (For Administrators) I feel fully supported by central administration as related to a STEAM program to further implement a STEAM program in my school and to support the teachers.

☐ Strongly Agree

☐ Moderately Agree

☐ No Opinion

☐ Moderately Disagree

☐ Strongly Disagree

7. I believe that STEAM education is needed in the American K-12 school system.

☐ Strongly Agree

☐ Moderately Agree

☐ No Opinion

☐ Moderately Disagree

☐ Strongly Disagree

8. Having a clear understanding of teachers' and administrators' perceptions of a STEAM education is critical for the success of all educators, leaders and for the advancement of the program.

☐ Strongly Agree

☐ Moderately Agree

☐ No Opinion

☐ Moderately Disagree

☐ Strongly Disagree

9. STEAM education is difficult to implement due to lack of funding.

☐ Strongly Agree

☐ Moderately Agree

☐ No Opinion

☐ Moderately Disagree

☐ Strongly Disagree

10. STEAM education is difficult to implement due to lack support from either building administrators or central administration.

☐ Strongly Agree

☐ Moderately Agree

☐ No Opinion

☐ Moderately Disagree

☐ Strongly Disagree

11. More targeted Professional development is needed for a successful STEAM based approach.

☐ Strongly Agree

☐ Moderately Agree

☐ No Opinion

☐ Moderately Disagree

☐ Strongly Disagree

12. It is difficult to secure sufficient time for the implementation of a STEAM education.

☐ Strongly Agree

☐ Moderately Agree

☐ No Opinion

☐ Moderately Disagree

☐ Strongly Disagree

13. It is too difficult to conduct an evaluation during a STEAM lesson.

☐ Strongly Agree

☐ Moderately Agree

☐ No Opinion

☐ Moderately Disagree

☐ Strongly Disagree

14. A large amount of time is needed to prepare for a successful STEAM implementation.

☐ Strongly Agree

☐ Moderately Agree

☐ No Opinion

☐ Moderately Disagree

☐ Strongly Disagree

15. STEAM education is difficult to implement due to insufficient expertise in the content areas or lack of confidence in teaching STEAM.

☐ Strongly Agree

☐ Moderately Agree

☐ No Opinion

☐ Moderately Disagree

☐ Strongly Disagree

16. A STEAM education can cultivate student's creative talents and skills including in Music and the Arts.

☐ Strongly Agree

☐ Moderately Agree

☐ No Opinion

☐ Moderately Disagree

☐ Strongly Disagree

17. STEAM education is integral and beneficial to all students due to its positive impact in Science, Technology, Engineering, Arts, and Mathematics.

☐ Strongly Agree

☐ Moderately Agree

☐ No Opinion

☐ Moderately Disagree

☐ Strongly Disagree

18. By understanding the perceptions of a STEAM education, a significant contribution can be achieved in the field of interdisciplinary learning.

☐ Strongly Agree

☐ Moderately Agree

☐ No Opinion

☐ Moderately Disagree

☐ Strongly Disagree

19. There needs to be more exploration into STEAM students' goals and perceptions in order to expand and maximize accessibility, interest and proficiency in a STEAM program.

☐ Strongly Agree

☐ Moderately Agree

☐ No Opinion

☐ Moderately Disagree

☐ Strongly Disagree

20. Having a clear understanding teachers' and administrators' perceptions of a STEAM education is critical for the success of all educators, leaders and for the advancement of the program.

☐ Strongly Agree

☐ Moderately Agree

☐ No Opinion

☐ Moderately Disagree

☐ Strongly Disagree

21. STEAM education is an interdisciplinary approach that can be vital for students to be college and career ready.

☐ Strongly Agree

☐ Moderately Agree

☐ No Opinion

☐ Moderately Disagree

☐ Strongly Disagree

22. Professional development opportunities around STEAM education are regularly provided to teachers in your school.

☐ Strongly Agree

☐ Moderately Agree

☐ No Opinion

☐ Moderately Disagree

☐ Strongly Disagree

23. I have adequate access to STEAM assets (libraries, agencies, professional development, museums, Arts organizations, etc).

☐ Strongly Agree

☐ Moderately Agree

☐ No Opinion

☐ Moderately Disagree

☐ Strongly Disagree

24. The current condition of STEAM education in your district is meeting the needs of all students.

☐ Strongly Agree

☐ Moderately Agree

☐ No Opinion

☐ Moderately Disagree

☐ Strongly Disagree

25. In your opinion, what are the 3 most important challenges facing STEAM education?

Please rank your top 3 most important challenges with 1 being the greatest.

26. I think it is important for teachers and administrators to take responsibility for all students' learning.

☐ Strongly Agree

☐ Moderately Agree

☐ No Opinion

☐ Moderately Disagree

☐ Strongly Disagree

27. I use a variety of assessment data throughout the school year to evaluate students' progress in a STEAM model.

☐ Strongly Agree

☐ Moderately Agree

☐ No Opinion

☐ Moderately Disagree

☐ Strongly Disagree

28. I use a variety of data to organize, plan and set goals.

☐ Strongly Agree

☐ Moderately Agree

☐ No Opinion

☐ Moderately Disagree

☐ Strongly Disagree

29. I empower students in their own learning and utilize 21st Century Skills.

☐ Strongly Agree

☐ Moderately Agree

☐ No Opinion

☐ Moderately Disagree

☐ Strongly Disagree

30. In your own words, please define STEAM education:

31. STEAM Education has been a topic of discussion in your district and/or school.

☐ Strongly Agree

☐ Moderately Agree

☐ No Opinion

☐ Moderately Disagree

☐ Strongly Disagree

32. Some schools and districts have implemented programs and courses focused on STEAM education. Does your school or district have programs which integrate core concepts of STEAM?

☐ Yes

☐ No

33. I often observe inquiry-based, problem-solving activities in the classroom setting.

☐ Strongly Agree

☐ Moderately Agree

☐ No Opinion

☐ Moderately Disagree

☐ Strongly Disagree

34. I feel prepared for the implementation of STEAM instruction in my school.

☐ Strongly Agree

☐ Moderately Agree

☐ No Opinion

☐ Moderately Disagree

☐ Strongly Disagree

35. This question will not be used for reporting purposes. If you have any additional comments or would like to share any other experiences or situations that you may have encountered in regards to STEAM education, please do so below.

Additionally, the response to this item will be used to identify a sample of survey respondents who will be asked to participate in online interviews that are for K-12 teachers and administrators. Please indicate if you would like to be included in these follow up interviews for teachers and administrators, which will be held virtually and online (please include your contact information and days/times of availability).

Thank you for participating in this survey and for everything that you do in supporting students and families.

Appendix D Qualitative Interview Questions for Teachers and Administrators

1. How do teachers perceive a STEAM program?
2. How do administrators perceive a STEAM program?
3. How should teachers implement and teach a STEAM education?
4. How can administrators support and sustain an effective STEAM program?
5. What changes need to be made to support and sustain STEAM programs?
6. What skills should students in an effective STEAM program possess?
7. Do you feel there are gaps in the current STEAM model at your school? If so, what are they?

Appendix E Letter of Consent from a District to Conduct Research

December 20, 2022

Dear Mr. Lopez,
We will be glad to assist you. Our Professional Development Committee will review the request and distribute the link as soon as possible.

Best of luck in the process.

Sincerely,

Dr. Kevin Scanlon
Superintendent of Schools

THREE VILLAGE
CENTRAL SCHOOL DISTRICT

100 Suffolk Avenue
Stony Brook, NY 11790

Phone: 631.730.4010
Email: kscanlon@3villagecsd.org
Web: www.threevillagecsd.org

Appendix F IRB Certification

Certificate of Completion

ST. JOHN'S UNIVERSITY

fhi360
THE SCIENCE OF IMPROVING LIVES

THIS ACKNOWLEDGES THAT

Royce J. Lopez

HAS SUCCESSFULLY COMPLETED
THE IRB COURSE IN THE PROTECTION OF HUMAN SUBJECTS

Raymond DiGiuseppe

3 October 2022

Appendix G Informed Consent for K-12 Teachers and Administrators Participating in Online Interviews

Informed Consent Form for K-12 Teachers and Administrators Participating in Interviews

Research Topic: Exploring Teachers' and Administrators' Perceptions of STEAM Education In K-12 Schools and Its Implications on The Development of STEAM: An Explanatory Sequential Mixed Method Design

Introduction

You are invited to participate in a dissertation research study under the direction of Dr. Annunziato, Clinical Professor of Educational Leadership at St. John's University. Taking part in this research is voluntary. The principal investigator in this study is Royce J. Lopez, who is a doctoral student at St. John's University School of Education.

Rationale for the research study

The K-12 teachers and administrators in your school district are invited to participate in a research study being conducted for a dissertation for St. John's University. The purpose of this mixed method study will be to investigate, identify and document the similarities and differences in perceptions when implementing a STEAM (Science, Technology, Engineering, Arts, and Mathematics) education between teachers and administrators at the K-12 level. Throughout this process, teachers' and administrators' beliefs and perceptions towards STEAM instruction will be analyzed to determine how they perceive, interpret and implement this new initiative. The goal of this investigation is to

gain a further understanding of teachers' and administrators' attitudes, beliefs and mental models encompassing a STEAM education. This study is only intended to measure perceptions about STEAM education for K-12 teachers and administrators.

What is involved in this study?

The K-12 teachers administrators will be asked to participate in online interviews. The interviews will be voluntary and will take about 30 minutes. It is comprised of open questions about teachers' and administrators' perceptions of STEAM education, reflection and their knowledge about STEAM education and is a follow up of the online quantitative survey.

What are the risks of participating in this study?

There are no known risks in this study. Every effort will be made to keep your information confidential, and there will be no names recorded in this observation. You may refuse to answer any of the questions that you believe will divulge this information and/or that make you feel uncomfortable. Additionally, you may take a break at any time and stop your participation. Participation is completely voluntary and participants may withdraw at any time and may choose not to respond to any of the questions on in the focus group. All survey data will be kept confidential.

Are there any benefits to participating in this study?

There are no direct benefits to your school district for participating in this research project. No incentives are offered. However, the results may have informational benefits for educators, administrators and policy makers regarding possible ways to improve the effectiveness of STEAM education, which in turn will help teachers and administrators to grow professionally in their instructional practices, directly benefit student achievement and become better and more effective pedagogues and leaders.

Will I receive payment for being in this study?

You will not be paid for taking part in the study.

How will my privacy be protected?

The data collected in this study are confidential. All data are coded such that your school district and teachers will not be associated with them. In addition, the coded data will be only available to the researcher associated with this project. No names will be collected.

*Please keep a copy of this document for future review.

If there is anything about the study or your participation that is unclear or that you do not understand, or if you have questions or wish to report a research-related problem, you

may contact Royce J. Lopez at royce.lopez18@my.stjohns.edu or the faculty sponsor, Dr. Annunziato, at annuzia@stjohns.edu

For questions about your rights as a research participant, you may contact the University's Institutional Review Board, St. John's University, Dr. Raymond DiGiuseppe, Chair digiuser@stjohns.edu 718-990-1955.

If you agree to participate in this study, please sign below:

Documentation of informed consent

I understand the information printed on this form. I have discussed this study, its risks and potential benefits. My questions so far have been answered. My signature, below, indicates my willingness to participate in this study and my understanding that I can withdraw at any time.

_____ _____

Subject's Name (printed) and Signature Date

_____ _____

Name (printed) and Signature of Person Obtaining Consent Date

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