TEACHER PERCEPTIONS OF STEAM IMPACT ON STUDENT ENGAGEMENT AND ACADEMIC ACHIEVEMENT

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Rommie L. Vasser, Jr.

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Student Name: Rommie L. Vasser, Jr

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This dissertation has been approved and accepted by the faculty of the Education Department, Carson-Newman University, in partial fulfillment of the requirements for the degree, Doctor of Education.

Dissertation Committee:

Dissertation Chair
Julia J. Price, Ed.D.

Methodologist Member
P. Mark Taylor, Ph.D.

Content Member
Samuel Hollingshead, Ed.D.

Approved by the Dissertation Committee Date: April 9, 2020

Abstract

This qualitative, phenomenological study sought to determine the impact STEAM had on student engagement and academic achievement from a teacher's perspective. The purpose of the study was to expand upon the limited research on the STEAM approach, so educational leaders can make informed decisions on research-based practices that can be completed to impact student engagement and academic achievement. The study participants taught at an urban Tennessee school district. Data were gathered through a survey, one-on-one interviews, and a focus group, which provided statistical data and a narrative that shared the teachers' perceptions of factors that contributed to student engagement and academic achievement. The study found that teachers' perceptions regarding activities involving problem/project-based learning, hands-on learning, real-world problem-solving, and the 4Cs (Communication, Collaboration, Critical-thinking, and Creativity) were significant factors in increasing student engagement and academic achievement.

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To my sister-cousin, Tarria McNeal. Who knew such an interesting little boy would end up here? You have been with me all my life. We are continuing to defy the odds. I love you cuz. From North Memphis to Nolensville.

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Dedication

I would like to dedicate this study to my hero, Rommie Lee Vasser, Sr. Thanks for modeling how to be a father, a provider, and a husband. Gone but NEVER Forgotten.

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CHAPTER 1: INTRODUCTION

"I want us all to think about new and creative ways to engage young people in science and engineering…encourage young people to create and build and invent—to be makers of things, not just consumers of things."

Barack Obama

The presumption of STEAM education begins with the belief that future economic growth in the United States is linked to an increase of STEAM careers; however, the number of students pursuing STEAM-related degrees is decreasing (U.S. Department of Education, n.d.). The promise that STEAM holds for the future is based on the idea that STEM fields drive critical innovation and that innovation, in line with early- to mid-20th-century notions, is explicitly tied to economics (Godin, 2008). The "A" component indicates that educators are invested in taking a more humanitarian approach to learning by recognizing the importance of the social and creative aspects of problem solving (Quigley & Herro, 2019). Ritter and Webber (1974) asserted that most solutions for today's societal problems need logical, innovative, and creative thinkers that STEAM instruction can produce. This link between creativity and productivity supported the connection between creativity and innovation-based economics, and creativity—although explicitly not art-based creativity—gradually became associated with innovation.

One of the main reasons for STEAM derives from the perspective that creativity is the most important of the 21st Century skills needed to be successful in this growing society (Trilling & Fadel, 2009). The arts provide a perfect platform for creativity. John Maeda (2012, 2013) argued that art and design education are cornerstones of creativity and innovation. Quigley and Herro (2019) contended that STEAM education is a more powerful teaching and learning approach, as it encourages teachers to become facilitators and prompts students to claim more ownership of their learning.

The STEAM approach teaches a type of thinking which has its roots in inquiry, discovery, curiosity, and logical thinking (M. Tanik, personal e-mail communication, March 23, 2013). It focuses on the classroom environment that teachers create, the ways in which they integrate the content, and the skills teachers will support during their teaching (Quigley & Herro, 2019). It is an integral component of in-depth education, which allows teachers to significantly increase the effectiveness of the educational process - from the first stage of understanding and identification of problems to the final stage of practical work. The project approach is inextricably linked with adaptive education, the main component of which is training through practical activities in the subjects of the market, industry and science (Shatunova, Anisimova, Sabirova, & Kalimullina, 2019).

Discipline integration of formal and non-formal educational programs, which means blurring the physical boundaries of the university and shifting the focus from the process of gaining knowledge to its recognition and assessment, to using knowledge as a platform to create multiple solution paths to current societal issues (Shatunova, Anisimova, Sabirova, & Kalimullina, 2019).

The making of creative spaces that act as integration areas for students of various specialties, real business sector and industry, and academic and professional education, exposes students to a mindset needed to compete in today's evolving society. This instructional practice can be recognized as transdisciplinary (Brazell, 2013). A

prerequisite for the work of such sites is a joint work on projects initiated by the real sector of the economy (Shatunova, Anisimova, Sabirova, & Kalimullina, 2019).
This approach will impact universities with how they offer courses for incoming students. Brazell (2013) asserted that the connection of school-based learning and public engagement is paramount to educational innovation and transformation today. Making of inter-university courses (university hubs) - in contrast to the usual network interaction of universities means the creation of real sites in the form of scientific and educational centers created with the participation and under the auspices of various universities (Shatunova, Anisimova, Sabirova, & Kalimullina, 2019).

In many advanced countries, such as Australia, Great Britain, Israel, Canada, China, Singapore, and the United States, STEAM-education is developing, the idea of which has become a continuation of the STEM-education concept (science, technology, engineering, and mathematics). For example, in the United States, STEM-education is recognized by the National Council for Research (National Research Council) and the National Science Foundation (NSF) as the technological basis of a developed society. The degree of training in the field of STEM is an indicator of the nation's ability to support its development (Frolov, 2010).

Statement of the Problem

Current research emphasizes STEM related concepts regarding student engagement and academic achievement. Teacher perceptions of STEAM regarding these variables have not been fully investigated. This study focused on teachers and their perceptions of how STEAM impacted student engagement and academic achievement. Quigley and Herro (2019) asserted that STEAM instruction, as conceptualized in a lesson, reflects the work of steadfast educators who have a singular focus to serve and engage all students.

Purpose and Significance of the Study

The purpose of this study is to determine how a STEAM approach impacts student engagement and overall student performance from teachers' perspectives. STEAM education is a unique approach to teaching and learning that fosters communication, collaboration, creativity, and critical (4Cs) thinking in all students. STEAM is focused on supporting students while they use skills learned during the 4C process to view and experience the world around them. Improving science, technology, engineering, arts, and mathematics education (STEAM) is an international imperative as countries work to improve life and prospects for their people.

Theoretical Foundation

The constructivist theory drives STEAM because students and teachers alike engage in inquiry/reasoning, apply content, and learn to collaborate and communicate effectively. STEAM Education is a conceptual approach that focuses on the classroom environment that teachers create, the ways in which they integrate the content, and the skills teachers will support during their teaching (Quigley & Herro, 2019). Phenomenology was an appropriate approach for this study because it explored experiences of content and exploratory teachers as they implemented a STEAM-focused lesson.

Research Question

One research question directed and guided this qualitative study. The following research question directed and guided this qualitative study:

Research Question One: What are teacher perceptions of STEAM impact on student engagement and student academic performance?

Rationale for the Study

This approach includes instructional practices focused on problem-based learning, incorporation of student voice and choice, integration of technology, and teacher facilitation (Quigley & Herro, 2019). Countries recognize that to improve economic prosperity and national security, their citizens should be prepared to work in a global society that is characterized by digital, technological, and scientific literacy and requires divergent, flexible creative thinking (Honey, Pearson & Schweingruber, 2014). In today's market, almost 100% of jobs require critical thinking and active listening, 70% require mathematical knowledge, and 60% require oral comprehension and expression (Carnevale, Smith & Strohl, 2014). Connected learning draws on students' interests and equitable participation to support academically-oriented, peer-networked, purposeful learning to solve relevant STEAM problems (Quigley & Herro, 2019).

The Association for Middle Level Education (2010) asserts that if young adolescents are to become well-rounded citizens, they must first have an awareness of the world. They must develop the ability to ask significant and relevant questions about that world and wrestling with big ideas and questions for which there may not be one correct answer. This approach creates opportunities for students to think logically and critically and clearly articulate their thoughts. It also involves the use of digital technology to engage students in inquiry, communicate, and collaborate with the world and learn from the resources it offers. Trilling and Fadel (2009) argued that one of the main reasons for STEAM derives from the perspective that creativity is the most important of the 21^{st}

Century skills needed to be successful in this growing society. The ability to critically think, be creative, make connections, and apply major concepts, skills, and tools of inquiry in the areas of science, technology, engineering, humanities, language arts, and mathematics is going to be paramount (AMLE, 2010). Brazell (2013) believed that the TEAMS (STEAM) approach grounded in humanitarian principles focused on using inquiry, discovery, innovation, creativity, critical-thinking, and problem-solving to resolve societal problems is the answer. Quigley and Herro (2019) asserted that the overall goal of STEAM is to increase student engagement for all students.

Researcher Positionality Statement

The researcher for this study has been in the craft of education for 21 years, holds the degree of Ed. S. in School Leadership and Administration, and is currently serving as principal in a middle school that serves 464 students. In 2016, the researcher was introduced to the approach of STEAM education when promoted to the position of assistant principal at a middle school in the Middle Tennessee area. The school district was starting an initiative in middle school in which 18 of the middle schools would go through a STEAM accreditation process in which the schools would become STEAM-certified schools. The school in question went through a STEAM certification process with AdvancEd in which they received certification recognizing them as a STEAM-certified school for the next five years.

Limitations, Delimitations, and Assumptions

There have been studies focused on STEM; however, the addition of the A for Arts in STEAM is a relatively new approach. There is also a lack of research which examines how STEAM-focused lessons versus other environmental factors contribute to or impact student engagement and overall student achievement. For example, classroom sizes, ability of the students within the classroom that was studied, the pedagogical knowledge of the teacher, are relevant factors.

Two limitations for this study were identified. First, the study occurred in a small urban school district without significant diversity. Additionally, the study took place within a limited span of 4 weeks.

Definition of Terms

Constructivist theory: A method that encourages active learning and supports the idea that learners should not simply acquire new knowledge but construct new knowledge (Bodner, 1986).

Design thinking: An instructional approach in which students' critical thinking skills are developed through engagement with problem-based inquiry (Cook & Bush, 2018).

STEAM education: Is an integrative approach in which science, technology, engineering, arts, and math are used to further enhance the learning process (Gess, 2015).

Student engagement: Newmann (1992) described student engagement as students making a psychological investment in the learning process. When students are engaged they are not afraid to participate in inquiry, which causes a deeper learning experience to occur.

TEAMS: is an acronym for technology, engineering, arts, mathematics, and science (Brazell, 2013).

Organization of the Study

This dissertation was developed using the guidelines provided by Carson-Newman University and the American Psychological Association. This research is organized into five chapters. The first chapter contains the introduction and background information about the study. It further discusses the statement of the problem, the significance of the study, and the theoretical foundation. One research question is identified, and limitations and delimitations are also noted. Key terminologies in the study are identified to support the reader's understanding of the research. Chapter Two is a review of literature. Chapter Three provides the methodology which resolves the research in the study. Chapter Four reported the results of the data. While chapter five specified conclusions, implications, and recommendations of the study.

Summary

In summary, the study focused on teachers' perception of STEAM lessons on student engagement and overall student achievement. New instructional practices are often filled with challenges as dedicated educators sometimes find it difficult to be innovative in strict environments (Shaffer, 2016). While STEAM instruction may experience some of the same instructional challenges as project-based learning, STEM teaching, other constructivist approaches, administrative support, and careful preparation during the planning stage will ensure success in the classroom (Quigley & Herro, 2019). At the heart of (STEAM) TEAMS-based schools is the belief that students will be difference makers and problem-solvers in an ever-evolving society through creativity and innovation if we simply facilitate, support, and create opportunities for students to integrate school learning with relevant connections to real-world issues (Brazell, 2013).

CHAPTER 2: REVIEW OF LITERATURE

Introduction

The purpose of this study was to determine how a STEAM approach impacts student engagement and overall student performance from teachers' perspectives. STEAM education is a unique approach to teaching and learning that fosters communication, collaboration, creativity and critical (4Cs) thinking in all students. STEAM is focused on supporting students while they use skills learned during the 4C process to view and experience the world around them. The research sought to determine whether STEAM lessons focused on problem-based learning future jobs and careers had an impact on student engagement. Educators and researchers, having long sought the key to raising student achievement, recognize that there is no single answer. Factors outside of the classroom, such as student poverty, health, and parent education levels, require societal shifts and are not easily influenced by teachers and administrators (Barone, 2003; Flood & Anders, 2005). There are, however, factors that can be controlled inside the classroom. These factors center on the curricular materials and instructional practices that constitute school, as well as the teacher expertise to leverage both to the best advantage of the learners (Fisher, Frey, & Lapp, 2011). This research depicts how one school community implements its STEAM approach and how the teachers in that community perceive STEAM has impacted student engagement and student academic performance.

Sputnik and Its Impact on Science Education

Two years and seven months after the initiation of the U. S. satellite program, Soviet Russia launched a rocket north of the Caspian Sea carrying the now famous

Sputnik I satellite. U. S. scientists were aware that Soviet Russia was planning on putting an artificial satellite into orbit (Sullivan, 1957); however, secrecy surrounding the timing and the location of the launch of the satellite served to intensify the Cold War and America's deepening distrust of Soviet Russia (Hartman, 1955). Launching of the Soviet Russian's satellite had been planned and previously announced as part of the International Geophysical Year, an 18-month multinational scientific study of the Earth, its crust, atmosphere, and space surrounding it. It was widely believed in the scientific community that the satellite's intended purpose was to take samples of the atmosphere (Ubell, 1957) and pictures of the Sun's corona (Berry, 1957; Ubell, 1957). On the day following its launch, the polished aluminum sphere with a mass of 83.6 kg and a diameter of 58 cm bearing four antennae was successfully circling the earth every 92 minutes at a velocity of 8,000 meters per second. For the first two days after the launch, Americans could see Sputnik, through a telescope or binoculars in the light of the rising or setting sun (Wald, 1957). The American people were both bewildered and frightened by the orbiting metal sphere known as the Red Moon. They were wondering if it could fall out of space, how fast it was going, what held it up, if it had military value, and if they could hear the radio signals from it on their own radios. More importantly, the launch deeply shook America's confidence in her technological superiority to Soviet Russia and left government officials, politicians, scientists, and educators scrambling to find ways to close the gap.

Education in general, and particularly science education, seem to be in a constant state of reform. New trends last about 15–20 years before being replaced by a new set of philosophies, goals, or teaching strategies. On occasion, novel changes differ slightly from the old and seem to be part of a natural progression; at other times, the variations are more drastic (Wissehr, Concannon, & Barrow, 2011).

The launching of Sputnik was a trumpet sound to the U.S. educational community. All Americans understood the potential impact this event could have on the United States. Before this event, The United States were the forerunners in the fields of medical research, automobile design and manufacture and electronics. The launch of Sputnik altered that perception. Especially since The United States could not seem to get one of their missiles off the launch pad (Bracker, 1975). The U.S. was in an unfamiliar situation. They had fallen behind their adversary, and the focus had to be on what could be done to regain supremacy. To achieve this, schools must inspect their science curriculum and include arts and humanities courses to develop the innovation and design aspects (Wissehr, Concannon, & Barrow, 2011).

In launching Sputnik, the Soviets did not pass up the opportunity to extol the virtues of the "new socialist society" that could turn the dreams of mankind into reality (Jorden, 1957) and indicated plans to launch more and larger artificial satellites in the near future. Soviet Russia's military officials publicly stated that the satellites would have no practical military applications in the immediate future, including worldwide aerial inspection of military forces, nor could they be used to drop hydrogen bombs on the Earth. Privately, however, this was another matter. Soviet Russia refused to share information regarding the progress of its program, leading to speculation regarding the real intent behind the missile program (National Security Council, 1957).

The 1950s and early 1960s were a period of social change in the United States. Abroad, attention was turned from Korea and the military to political conflict between the opposing ideologies of democracy and communism. Distrust between Soviet Russia and the United States had resulted in the Cold War. Political pressures in Southeast Asia and Vietnam were on the rise. Domestically, Brown v. Board of Education brought racial inequity to the educational forefront. The civil rights movement and happenings in Little Rock, Arkansas dominated the headlines. Women's right were becoming political focus as well. The publication Silent Spring by Rachel Carson in 1962 was also cultural focal point in history. The welfare and economic status of the middle class was a growing concern as well (Wissehr, Concannon, & Barrow, 2011). With so many other issues occupying the attention of the American people, they were uncertain of how to react to the launching of the satellite. While some newspapers, like the New York Times, devoted much of the front page to the Sputnik story, most media buried the event on back pages and ends of newscasts. At that time, most newspapers focused on the integration of Central High School in Little Rock, the World Series, or Jimmy Hoffa and the Teamsters Union. Most people attending the International Affairs Seminars of Washington (1958) reported that they had never heard of an "earth satellite" and knew even less about rockets or space. They reported that the public was not fascinated by the "beeps" broadcast from the orbiting satellite and were oblivious of the military implications of satellite technology (Wissehr, Concannon, & Barrow, 2011).

The reaction of the U.S. government to the launching of Sputnik could be separated according to the branch (executive, legislative, military, etc.) examined. President Dwight D. Eisenhower, at the time, was preoccupied with civil rights events unfolding in Little Rock, Arkansas. Lyndon B. Johnson, then senate majority leader, reported feeling uneasy and apprehensive, and immediately called for support from both political parties to investigate the use of missiles and space. Ironically, John F. Kennedy, then senator from Massachusetts, showed little public interest in Sputnik, calling rockets a “waste of money” and their use in space “frivolous” (Dickson, 2001, p. 19).

Regardless of the public reaction by government officials, it was disturbing that the Soviet Russians had dealt a blow to the United States’ image and prestige. Privately, U.S. scientists agreed that the launch proved that the Soviets had perfected their design for ICBMs, which posed a real threat to the United States, as they were capable of carrying atomic warheads for long distances. Meanwhile, progress in launching the Vanguard missile was slow, plagued with malfunctions and disappointment. The United States could not seem to get one of its missiles off the launch pad (Bracker, 1957). Psychological and political pressure to launch a rocket greatly increased after the launches of Sputnik I on October 4th and quickly followed by Sputnik II a month later on November 3, 1957.

Scientists, conversely, were keenly aware of the implications of the launch. Alan Shepherd commented that this event would affect him directly and quickly. John Glenn, who knew that space flight would become the “yardstick for measuring military superiority,” echoed the same sentiment (Dickson, 2001, p. 19). Scientists and science educators alike were excited at the prospect that school curriculums would now have to turn from their progressive science to a much more rigorous curriculum to produce the kinds of students who could beat the Soviets in this new space age (DeBoer, 1991).

STEM

The Science, Technology, Engineering and Mathematics (STEM) framework is an instructional shift that advocates a more inclusive classroom approach. Introduced by the National Science Foundation (NSF) in the 1990s, STEM education removes the obstacles between content areas, with real-world integration, rigorous, relevant" student teaching (Vasquez, 2014). Schools are encouraged to change from a segmented-subject approach to one that stresses an interdisciplinary connection and relating classroom lessons to real-world societal issues. STEM emphasis is using an instructional model that teaches students 21st Century skills – collaborating, questions, problem-solving, and critical thinking – to be competitive in future jobs and careers (Gunn, 2017).

STEM is a key concern for all those interested in the advancement of education and workforce competitiveness, and now provides the impetus for promoting economic growth, wealth creation, and national security in the United States and most industrialized nations. Although STEM is now at the forefront of policy and education practice, the current approaches are driven by the perception that there is a shortage of STEM talent (Brazell, 2013).

Labor market data do not indicate a rise in STEM wages attributed to labor market shortages. Thus, the laws of supply and demand indicate that overall there is no shortage of STEM workers today relative to demand. There are, however, a few pockets of STEM jobs where there are shortages, including engineering disciplines, multi-skill technicians, and the Federal cyber security workforce. While data do not indicate an overwhelming demand for STEM workers, many job forecasts show increasing demand for STEM workers over the next decade (Brazell, 2013). In fact, PCAST (2012) argued that based on the economic forecasts for the coming years, one million STEM college graduates would need to be produced.

Mitt (2016) described STEM as follows: Science - proposes why: the theory.

Technology - explains how: the process. Engineering - determines what: the design. Math - reveals relationships: the concept. He revealed the connection between STEM and the four components of a whole-problem solution. This requires more of a student-centered approach with a focus on creativity, innovation, design and relevant approach to finding the best ideas and ultimate solutions (Brown, 2008). STEM education is a combination of the Seven-Step Problem-Solving Process (and socially relevant and engaging design problems that lead students to explore STEM knowledge and skills, through which they can discover whole solutions to technical problems: a theory, process, design, and underlying concept).

In STEM, research processes and disciplines are being redefined by the functional integration of disciplinary knowledge and processes. This effect was labeled *convergence* at the turn of the century by the National Science Foundation and other scientific, engineering, and computer science institutions (NSF/DOC, 2003). This consilience—jumping together—of knowledge and disciplines distinctively marks the birth of a new era: Convergence means a broad rethinking of how all scientific research can be conducted, to capitalize on a range of knowledge bases, from microbiology to computer science to engineering design. Thus, the convergence revolution does not rest on an advance, but on a new integrated approach for achieving advances (MIT, 2011).

The functional integration of disciplinary knowledge and processes is not only part of emerging science and technology research and development; it is also an overwhelming characteristic of work in the 21st Century. The convergence of technology, data, and work processes drive this trend. While computers deliver efficiencies often resulting in less people required to perform work tasks, the activities left to humans often require integration of knowledge and skill for individual workers, and they are also requirements for mini multi-disciplinary teams to effect work products (Brazell, 2013).

The predecessors stood at the edge of the world and gazed at Sputnik orbiting; they did not respond to the Russians' apparent lead in science and technology with a narrow focus on cultivating science- and technology-based leaders. Brigadier Gen. Robert F. McDermott, the founding dean of the U.S. Air Force Academy, redefined military training and set a precedent for the transformation of military academies and universities to connect art and science, classical learning, and applied arts. Rather than focusing exclusively on military life and science and technology, General McDermott, created the Air Force Academy by converging military leadership training, classical education studies, and STEM (Brazell, 2008). In effect, he advocated and created a model of classical contemporary education based on his experience at the first American public school and his alma mater, Boston Latin. The object lesson for STEM proponents in General McDermott's approach is that a world characterized by increasing science- and technology-based complexity requires expanding human development to include a broader range of disciplines, subjects, knowledge, perspectives, and processes to enable creativity and ultimately cultural sustainability. Similarly, today's strategy for education, workforce, and economic development innovation requires a transdisciplinary approach.

Obama and STEM

The Obama Presidency is linked to Sputnik and the impact it had on Science Education. In 2009, Obama asked the President's Council of Advisors on Science and Technology (PCAST) to create a series of recommendations to support the United States to becoming a frontrunner in STEM education. To accomplish distinction in STEM, two goals were developed: all students, including all genders and races, should be both prepared and skillful in STEM subjects, and all students must be encouraged to not only learn STEM but be motivated enough to pursue STEM careers (President's Council of Advisors on Science and Technology, 2010). The research determined that, at the federal level, no comprehensive strategy to accomplish a high-level of performance regarding STEM education had surfaced for various reasons. The following recommendations were suggested to resolve the lack of clear vision: 100,000 "great" STEM teachers would be recruited and trained over the next 10 years; a system of recognition was established to reward the nation's top 5% of STEM teachers through the creation of a STEM Master Teachers Corps; technology will forge the innovations and design component, playing a transformative educational role; students will be provided with STEM experiences outside-of-the classroom; and 1,000 newly created STEM-focused schools would open over the next decade. To achieve the recommendations of PCAST, President Obama allocated $4 billion to pay for improvements toward STEM education in the 2017 budget. The budget was streamlined by the following: $125 million improving STEM teaching; $10 million designated for the STEM Master Teacher Corps; and $109 million ensuring undergraduate students had "the most effective learning experiences" (Office of Science and Technology Policy, 2016).

Innovation has been a focus in the United States in recent years. In business corporations, as detailed through the daily news, a consistent message is conveyed about the importance of global competitiveness through advancement of technology and innovation and design and creative ideas. President Trump's newly developed Office of

American Innovation seeks to continue the development of the position of the nation through motivation and supporting innovation. Television shows such as “Shark Tank” and “American Inventor” showcase the excitement of novel ideas contributing to the marketplace. In keeping pace with a fast-changing global economy, the 2017 Global Innovation Performance Index compares countries in terms of innovation. The United States has a Global Innovation Index below that of Switzerland, Sweden, and the Netherlands (MIT, 2011). Though measures for innovation are comprised of various factors such as market outputs, new patents, and creative business exports among others, discussions in education about how to stimulate innovation center on science, technology, engineering, and mathematics (STEM) workforce and development—preparing citizens to cultivate the skills and habits of mind for the jobs of tomorrow (Cook & Bush, 2018).

History of STEAM

2003. A study published by the National Academies (2007) discovered interdisciplinary relationship between IT and creative practices in arts and design. (ITCP) The National Research Council (2003) later asserted that practices of inquiry and production that focus on innovation and creative results can also be supported in concrete and specific ways.

2007. Members of the U.S. Senate, concerned with national “prosperity, health and security,” called on the National Academies to address the impact of globalization on U.S. economic competitiveness—particularly in the fields of science and technology. Emphasis was placed on [STEM] job creation resulting from “… the nation’s need for clean, affordable, and reliable energy.” The National Research Council (2007) included recommendations for increased investments in K–20 STEM education and in academic research.

2010. The National Education Association (NEA)/National Science Foundation (NSF) established a joint committee "… to identify synergies and foster collaborations across and between constituencies and develop a set of actionable areas of mutual interest: inquiry, collaboration, funding opportunities, lifelong learning, and innovation that are recognized by both the National Science Foundation and the National Endowment for the Arts." The committee's output included recommendations for investments in "STEAM" research (Harrell & Harrell, 2010).

2011. The Office of Science and Technology Policy (OSTP) inventoried federal investments in STEM education in order to establish specific national targets for federal science and technology partners in a variety of areas across practically all the capacities of the executive branch (National Science and Technology Council, 2011). Support for STEM programs could be traced to various legislation and became a potential opportunity for STEAM endorsement.

2012–2015. The NSF/NEA join committee's work was further explored by the NSF-funded SEAD: Network for Sciences, Engineering, Arts, and Design—a research collaborative focused on the intersections of arts and science. SEAD formed a working group tasked with, among other things, examining "roadblocks to improve collaboration between science and engineering and arts and design," and building on the work of "Beyond Creativity" to develop a "meta-analysis" of white papers on arts/science collaborations over the past 10 years, an important resource for STEAM advocates (Sciences, Engineering, Arts, and Design, 2012). These studies, along with many others, led to policy discussions about enhancing or innovating STEM education and research (Allina, 2018).

STEAM Education

Experts advocate for educators to utilize integrative approaches that exploit the design process to presenting STEM content across subjects in order to promote literacy for all students (Bybee, 2010a; Dugger, 2010; Sanders, 2009). Integrative STEM education refers to technological/engineering design-based learning approaches that intentionally integrate the concepts and practices of science and/or mathematics education with the concepts and practices of technology and engineering education. Integrative STEM education may be enhanced through future integration with other school subjects, such as language arts, social studies, art, etc. (Sanders, 2009). The intent of this definition was to focus educators on instructional approaches that purposely set the stage for teaching and learning of STEM ideas and concepts (Seifter, Haley-Goldman, Yalowitz & Wilcox, 2016). Similarly, the goals of integrative STEAM education, from an instructional standpoint, are to intentionally present the content and practices of math and science in the context of technology, engineering, and artistic (T/E/A) design, and further enhance learning through meaningful integration with other school subjects, such as language arts and social studies (Gess, 2015). Studies have shown that students do not learn at optimal levels by being lectured to by teachers, memorizing prepackaged assignments, and giving routine responses (Rabkin & Hedberg, 2011). Harrell & Harrell (2010) noted that the most significant feature of being actively involved in the learning process is by engaging students in higher-order thinking assignments that require them to analyze, synthesize, and evaluate.

As teachers try to navigate the stages of effective STEM and STEAM education.

(1) Instructional practices should be integrative and not integrated; (2) Practices should be intentional on the part of the teacher; (3) The design process should be used to engage students in creating authentic considerations through iterative cycles of learning in transdisciplinary classrooms; and (4) An artistic artifact may be created as a problem solution that is equal to one in engineering or technology (Dugger, 2010).

Integrative. When speaking about STEM and STEAM education, the -ive ending really matters. By using the -ive ending instead of -ed, a clear and concise message is conveyed that STEM education should be dynamic and student-responsive. Learning should be situated squarely in the present needs of the learner, not in the plans of the teacher that may have occurred months or years prior (Rosen & Smith, 2011). Allina (2018) asserted that STEAM demonstrates the merging of interests that could potentially be realized through a comprehensive or integrative educational approach.

Intentional. Remembering that an important goal of public education is to produce globally literate students, it stands to reason that basic knowledge is no longer enough. This approach provides opportunities for teachers to plan with the end in mind by intentionally leveraging multidisciplinary standards applied in the context of an authentic, transdisciplinary situation. This point was emphasized when college students were taught Anatomy and Physiology (Gess, 2017). Filippatou & Kaldi (2010) asserted that this learning approach permits students to improve their critical thinking skills, which allows them to become involved in research and decision-making processes.

Anchored in design. The design process is the central element through which students may apply knowledge and construct deeper understandings. Design thinking (DT) is a perfect example of STEAM learning. DT sets the stage for a rich learning experience through which students can meaningfully and purposefully learn integrated multiple subject content while attempting to improve the world around them (Cook & Bush, 2018). By engaging students in iterative cycles of design and meaningful reflection on the creation, may conceive of and realize new ideas and concepts (Brown, 2008). Vest (2006) describes how DT creates passion, curiosity, engagement, and empowering situations and simultaneously creates an experience in which students learn in a personally meaningful and relevant context. Design is the transdisciplinary endeavor that intersects each STEM discipline and enables students' development of the habits of mind and hand that are characteristic of global literacy (Brown, 2008). The intention of design projects is to develop the students' grit and perseverance to work through the complete design process, ending up with a practical design solution (Cook & Bush, 2018). Students may not be successful in their first or even second design solution. They may encounter a seemingly insurmountable obstacle when working on their projects. Teachers should be at hand to discuss the problem and brainstorm with the student to propose a possible solution. This process teaches students how to confront problems and persist until success is achieved (Brown, 2008). By connecting pedagogical content with real-world scenarios, students develop a deeper understanding of knowledge which forges a potential desire to solve real-world societal issues (NRC, 2013, p. 437).

Art as an equal, not an afterthought. The engineering design process is largely concerned with designing and engineering solutions to societal wants and needs. An important component of this work is to ensure that whatever solution is created is aesthetically pleasing as well. Moving from STEM to STEAM by adding the arts STEM education can produce powerful and authentic learning opportunities (Jolly, 2014). In fact, the artist also constructs design solutions to real-world problems. Art does not just have to be used as an aesthetic component to an engineering solution; rather, the art may become the embodiment of experience or solution to the conundrum (Daugherty, 2013). Arts integration or teaching through the arts is most commonly associated with STEAM. It includes arts and humanities such as visual, English language arts, history or social studies, foreign language, media arts, and performance art (Quigley & Herro, 2019). This approach is described as a balanced curriculum that educates the total child by intentional integrating the arts and STEM (Florida Department of Education, 2009).

The Power of STEAM Teaching

In essence, the integrative STEAM classroom has the potential to be a vehicle through which high-quality, evidence-based, differentiated, standards-grounded instruction may be delivered to all students. In this environment, clear learning targets are established by teachers and students that are anchored in literacy and connected to real-world scenarios. The pathway to such an ideal learning environment is through employing the design process to connect hands-on with minds-on experiences so that learning has a deeper impact on (Brown, 2008). In doing so, students may be more likely to persist through education (Vasquez, 2014), transfer knowledge among disciplines and contexts, both in and out of school (Seifter et al., 2004) and increase depth of knowledge and understandings (Brown, 2008). Artistic ways of thinking and visual art content are fundamental and valuable components of high-quality STEAM education (Guyotte, Sochacka, Constantino, Walther, & Kellam, 2014; Wynn & Harris, 2012). Situating STEM learning in the arts may provide the opportunity for meaningful scaffolding that all students, but especially students with disabilities, need in order to construct understandings (Watson & Watson, 2013). Additionally, by adding the arts into the STEM classroom, increased motivation, engagement, and achievement may result for wider student audiences (Becker & Park, 2011). Meaningfully integrating the arts into K-12 education can create opportunities for the inception of learning STEM disciplines because it facilitates student access to STEM knowledge (Watson & Watson, 2013). A corporate study revealed that progressively more companies are looking for skills in their new employees that involve creativity rather than achievement in core subject matter (Lichtenberg, Woock, & Wright, 2008). What does this mean for schools that prepare students for the workplace? More specifically, how does what happens in the K–12 classrooms connect to this larger national goal of creating citizens that, as President Obama stated, are not just consumers of things but makers of things (Cook & Bush 2018)?

Some argued that STEAM teaching, particularly in K-12, has been represented in strong STEM programs over the years through creativity and innovation in teaching methods and presentation options (Lichtenberg et al., 2008). The phenomena supports teachers in designing problem-based curriculum. The problems are rooted in scenarios aligned with real-world issues, drawing on students' interest in digital technology activities such as games, media and video development as part of the problem-solving process. Thus, students are more likely to become aware of, and connected to, future STEM-related careers. Another opportunity for increasing participation is through relevant problem-solving (Quigley & Herro, 2019).

Engaging artistic imagination and scientific interplay is not new, and humans' centuries-old fascination with flight is a case in point. For example, 2000 years ago the

Roman poet Ovid imagined the inventor Daedelus's crafting and use of artificial wings (Book II: lines 71-95), and other imaginative writers envisioned methods of flight and space exploration centuries before these creative ideas were made real by modern science and technology. As Jolly (2014) notes "Science fiction […] is not only good fun, but it also serves a serious purpose, that of expanding the human imagination. . . Science fiction suggests ideas that scientists incorporate into their theories . . ." (pp. xi-xii).

The goal of STEAM is to create a sense of excitement so that all students would be encouraged to participate in the learning process focused on real-world issues faced by society each day. STEAM is regarded as a way to improve the involvement of all students in the areas of science, technology, engineering, arts, and mathematics. Early findings on STEAM teaching practice demonstrate more participation from females and students of color (Sousa & Pilecki, 2013). Participation is increased by engaging students through a variety of strategies outlined in the conceptual model. Creating instructional strategies from the standpoint of various abilities includes providing different ways of presenting the information, which will draw on multiple skills to be called upon to access or complete the activity (Quigley & Herro, 2019).

The Language of STEAM in Practice

Science. Science activities, experiments, and inquiry are a great way to connect children to reading many types of books, especially picture book biographies. There are many different types of scientists featured in picture book biographies, but there are some notable scientists who studied animals or the natural world (Morgan & Collett, 2018). An example of discovery and inquiry could showing students a shark tooth and letting them feel the serrated edge. Students may focus on the physical characteristics and want to study general facts about the shark. This is a great opportunity to probe students for deeper thinking. Morgan & Collett (2018) asserted that teachers could experiences like this question students about physical features and adaptations. Examining animal adaptations or the special features that let an animal thrive in its environment opens the door to sharing a book about a scientist who studied an animal and discovered unknown things about them. Students demonstrate greater motivation and involvement, as well as learn more deeply, when they can apply classroom-gathered knowledge to authentic problems, and also when they take part in problem solving that requires sustained engagement and collaborative activities (Barron & Darling-Hammond, 2008).

Technology. Morgan & Collett (2018) asserted when being introduced to new technology, it should be done similar to introducing a book. The teacher should be intentional about the purpose for activity and develop the essential questions students will engage in during the experience. This strategy is called making learning relevant. Quigley & Herro (2019) defines relevancy and authenticity as creating a scenario that includes an interesting, local, or publicized topic and is developmentally and intellectually appropriate. When teachers connect the introduction of a new robot with a new book, they are making relevant and authentic connections between digital and printed literacy (Morgan & Collett, 2018).

Engineering. One of the goals of STEAM education is to create opportunities to engage all students in the learning process (Quigley & Herro, 2019). One of the best ways to start to understand how concepts work is to take an item apart and tinker with the parts, or to build something new with scrap materials. The importance of tinkering, in building future engineers and innovators, has led to the maker movement, in public libraries and educational organizations across the United States, to encourage youth to use the maker spaces to tinker (Morgan & Collett, 2018).

The building of structures requires significant knowledge of engineering and how structures can be built safely and securely. Kids at the library love to build with Magna-Tiles, Keva Planks, Straws & Connectors, wooden blocks, LEGOs, and Zoob BuilderZ (and the loud crashing sound of knocking them over!) (Morgan & Collett, 2018).

Art. Art and science do not exist in separate realms. Daugherty (2013) stated that a false divide between the art and non-art subjects was established. In an art-infused environment, the disciplines are inclusive and there is an intentional connection to real-world and future jobs and careers. Artists practice science regularly, analyzing lighting and color theory and using new technologies to produce their work. This sort of progressive thinking takes time, time for planning, and time for students to complete work, and time for assessment (Hunter-Doniger, 2018).

Art infusion allows students to do more than just memorize content; it encourages them to search for it, find it, make their own meaning out of it, and apply this newfound knowledge in ways that interest them (Hunter-Doniger, 2015). When the art-infused classroom operates successfully, lessons are student-centered as they construct their own knowledge; thus, students have multiple ways of reaching their potential, providing each child with the necessary skills, tools, and strategies for success (Friend & Bursuck, 2012).

Math. During the content area, students could focus on ratios of live births of sea turtles over time. Afterwards, they could discuss what some of the causes could be. Students could be given opportunities using rockets to predict whose will travel the farthest. Teachers could use a video clip from the movie Hidden Figures, to depict a visual of a rocket on its' way to outer space. There are several authentic assessment opportunities that can be learned from this kind of experience. Quigley & Herro (2019) found that transdisciplinary teaching in which a relevant real-world program authentically integrates disciplines to provide a complete experience for students.

The 4 Cs of Learning

The Partnership for 21st Century Skills (www.p21.org), an organization promoting these skills, has as its mission statement: "To serve as a catalyst to position 21st century readiness at the center of U.S. K12 education by building collaborative partnerships among education, business, community, and government leaders." To accomplish this, it emphasizes the "3 Rs" (English, reading or language arts; mathematics; science; foreign languages; civics; government; economics; arts; history; and geography) along with the "4 Cs":

Critical thinking. Critical thinking and problem-solving mandates scrutinizing problems in a new way, linking learning across subjects and disciplines. Critical thinking and reflection allow individuals to detect misconceptions and underlying problems as well as see new opportunities in practice (Noonan, 2013). Critical thinking skills enable preservice teachers "to reflect on their practice in meaningful ways, to consider the effect their teaching had on student learning and develop habits that will stay with them" (Ward & McCotter, 2004).

In approaches such as problem-based learning, students develop these skills though the exploration of ill-defined or "wicked problems" (Buchanan, 1992) for which there may not exist a final correct answer, but instead engage students in considering multiple viewpoints, synthesizing data, and generating solutions that invoke their creativity, collaboration, critical thinking skills, and communication skills. Complementing the aims of problem-based inquiry, a pedagogical approach called Design Thinking (DT) has students grapple with issues that require a creative redefinition and reimagining of solutions akin to professional skills of designers, who consider conflicting priorities and complex negotiations to arrive at a solution to an ill-defined problem. Similar to other student-centered inquiry approaches, Design Thinking offers teachers a way to invoke and hone the creative problem-solving skills connected to the national goal of paving mindsets of innovators (Cook & Bush, 2018).

Communication. Claymier (2014) defines communication as sharing thoughts, questions, ideas and solutions. Communication is briefly to express themselves effectively, whether in productive skills as spoken or written forms, or receptive skills as listening and reading. Teachers must develop communication skills to exchange information, feelings, and meaning through verbal and non-verbal messages; Communication also refers to tone of voice, facial expressions, gestures and body language effectively. Teachers also learn how to use computers, the Internet and digital and mobile devices to make reading books and watching TV as an interactive communication activity (Bedir, 2019).

Collaboration. Claymier (2014) describes collaboration as working together to reach a goal; putting talent, expertise, and smarts to work. Collaboration is commitment to work skillfully with others in groups. Collaborators create effective groups by (1) establishing goals, (2) sharing ideas and workload, (3) serving as facilitators and contributors, (4) sharing power and decision making, and (5) engaging in productive conflict (Johnson & Johnson, 2013, pp. 24-26). Professional Learning Communities

(PLCs) providing discussion is effectively used to integrate collaboration and communication skills into pre- service teacher education (Kagle, 2014). Pre-service teachers also can work with their peers or in small groups to investigate and collaborate to develop their content, pedagogical, and technological knowledge. They can also collaborate to discuss students’ actions, find similarities and differences between the students from different classes, to use graphic organizers for drawing inferences or conclusions about their teaching practices.

Creativity. Claymier (2019) defines creativity and innovation as trying new approaches to complete tasks with a focus on innovation and invention. Creative thinking is developing the productive thought incorporating both creative thinking of pre-service teachers. Creative thought can be imagining situations and events, generating new characters or scenarios, producing tentative explanations or solutions, and planning actions (Moseley et al., 2005) It is imperative for teacher education programs that they develop, model, and assess what it means to be creative (Beghetto, 2007). Pre-service teachers must: Demonstrate ability to work effectively and respectfully with diverse teams; Exercise flexibility and willingness to be helpful in making necessary compromises to accomplish a common goal; Plan instruction purposefully using a wide range of idea creation techniques encourages students to apply creative thinking and problem-solving skills.

Educators’ attention to practices that stimulate students’ creativity and problem-solving abilities is certainly not new. The high impact practices of student-centered, inquiry-based instruction are well researched and can take various forms in pedagogical approaches that aim to value divergent thinking and creativity, inspire innovative approaches, and support student collaboration and argumentation as students develop their claims, evidence and reasoning without seeking one final answer to a problem (Cook & Bush, 2018). Although intended to illustrate the importance of the communication, collaboration, critical-thinking, and creativity as 21st Century skills to students' futures, it also serves as a great example of a STEM-based learning approach. Probably to no one's surprise in this reading audience, an integrated STEM approach is a powerful way to ensure that students develop the 21st Century skills and knowledge they will need to succeed in an ever-changing world (Claymier, 2014).

Gess (2017) discovered the distinctions between a STEM and STEAM (science, technology, engineering, arts, and mathematics) education and offered several conclusions. Regardless of whether the approach is STEM or STEAM, educators must provide an integrative curriculum, meaning that the process is continuous. The classroom instructional approach must also be one that is an intentional construction for authentic, real-world learning that is problem-based.

STEAM in the Classroom

STEAM integrates multiple disciplines, such as science, toward multiple modes of discovery from various perspectives (Connor et al. 2015). It is a combination of content areas by merging the subjects and humanities by asking students to problem solve around real-world scenarios. STEAM education has been conceptualized as interlude to the problem to be solved by using (1) project-based learning; (2) technology is involved for creativity and design; (3) inquiry approaches, allowing multiple paths to solve a problem; (4) science, technology, engineering, arts/humanities, and math as required by the problem; and (5) collaborative problem solving (Herro and Quigley 2016). Art incorporates new approaches to solving problems. Art integration is a combination the arts, English language arts, Social Studies, and fine arts which sets the stage to deliver a natural platform for transdisciplinary discovery.

Some researchers argue the scientific and humanistic division that has existed for centuries in Western culture has been unsuccessful in acknowledging the value of art and innovation in the progression of producing scientific knowledge (Watson and Watson 2013). STEAM education in the K-12 setting is still relatively new, but some findings demonstrate STEAM teaching increases motivation, engagement and effective disciplinary learning in STEM areas (Henrkisen et al. 2015). Although there are successes in STEM framework that also have similar positive outcomes (Davis 2014), the STEAM movement looks to increase the ways in which students can make connections between the disciplines (Rosen & Smith, 2011). Students not only strengthen their learning within the disciplines, but between disciplines, recognizing the opportunity to make connections with art, music, and design to reinforce this learning (Miller and Knezek 2013). At its 2014 annual meeting, AEP identified "…priorities driving state action for ensuring all students are prepared for success in college, careers, and citizenships—all of which have implications for the arts: (1) increasing expectations through improved standards, assessment, and accountability systems, (2) preparing and supporting educators to promote excellence in instruction, and (3) leveraging innovations in the teaching and learning environment to improve outcomes for all" (Arts Education Partnership, 2014).

Active Learning. Lachat (2001) examined the structure of traditional classrooms. The research acknowledged how educators within the traditional framework recognized that various students might experience failure; in fact, minimal monitoring of student success was conducted. Assessments did not promote higher-order thinking in students, and the teaching strategies utilized by teachers required students to only display knowledge or recall of the material (Guisepi, n.d.). This practice often referred to as autocratic, traditional teaching methods did not focus on student learning. The learning process was teacher-centered, and students were looked at as being receivers of the knowledge being presented (Brown, 2007).

Brown (2008) defined active learning as students being active participants in the learning process by both doing the activities and then thinking about those activities. During this approach, students are expected to engage in the learning process by engaging in higher-order thinking scenarios which contrasted with traditional teaching methods. Classrooms where active learning was present are dynamic in nature: teacher and students are mobile, students have opportunities to collaborate, and the instructor facilitates while students own their learning (Watson & Watson, 2013).

Unlike the traditional classrooms where students sat in rows, an active learning environment is one that forges student collaboration. Some studies seemed to suggest there is a correlation between how a learning space approach impacts the way teaching happens (Brown, 2007). Lichtenberg et al. (2008) discovered that teachers who incorporated more active learning strategies showed evidence of utilizing more of their classroom space and believed their students showed more engagement during the lesson. The research identified that teachers who used a more constructivist approach seemed to have experienced more of a seamless transition and were better equipped when promoting active learning into the classroom.

There are two factors that involve student engagement: student choice (what time and energy are they devoting?) and school facilitation (how does the school encourage student engagement?). While teachers have some restrictions when it involves the first factor, educators can intentionally create an environment where active learning permeates throughout their classroom setting (Watson & Watson, 2013).

During the initial stages of implementing this approach, students may display some resistance. Students may resist for various reasons and in different ways (i.e. not engaging in in-class activities, causing distractions, working with minimal effort). Some of the reasons for resistance during an active learning environment might be: active learning demands students to work more, students may experience anxiety about performing well in an active learning environment, or students are given expectations when they are poorly prepared to meet those expectations. (Finelli, et al, 2018).

Inquiry-Based Learning. Inquiry-Based Learning (IBL), is another form of active learning, affords students a sequence of tasks, which have been scaffolded, and the learners are queried to solve the task – either individually or through group collaboration (Academy of Inquiry-Based Learning, n.d.). IBL seeks to provide opportunities for all learners – teachers and students – to work toward building knowledge and seeking interrelated connections (Repinc & Južnič, 2015) IBL is not a new approach in the craft of education; in fact, the National Science Foundation recommended that IBL be incorporated as an instructional model in 1996 (National Science Foundation, 1996), and when implemented successfully, students excel. Scott et al. (2018) asserted that in the 2015 Program for International Student Assessment (PISA) results, the top three leaders in the world of education have several approaches to education, however they have one common denominator: a commitment to inquiry-based learning.

Repinc & Južnič (2015) expounded on the advantages of IBL, especially for gifted students. Project-based work that is multi-tiered and interdisciplinary causes students to make connections across the curriculum, engage in critical thinking, and work collaboratively. Because of the approaches used in IBL, it is a suggested technique especially in conjunction with STEM subjects (Silm et al, 27 2017). Typically, IBL incorporates a constructivist approach in that students learn by doing, aligning with what Dewey contended students should be able to do: learn how to learn. IBL encompasses both problem and project-based learning, which supports why it is an effective strategy for STEM classrooms (Watson & Watson, 2013).

Product-Based Learning. Teachers today must become skilled at facilitating the learning process for the 21st Century student. Lachat (2001) referenced the National Association of Secondary School Principals (NASSP) policy on how educators can best succeed at this practice. The school setting must be intellectually stimulating, rigorous, personalized and differentiated and must connect to real-world scenarios. While several assessments are used within the classroom, Product-Based Learning (PBL) is the foundation of STEM classrooms. Well-planned and organized PBLs afford students with both authentic and meaningful learning opportunities. Students collaborate with peers to answer real-world questions that are multifaceted in nature over an extended length of time. This process causes students to engage in communication and collaboration with peers, think critically about multiple perspectives, and be creative about resolutions to the problem (Watson & Watson, 2013).

Rosen & Smith (2011) asserted that challenges enhance multifaceted learning, a necessary component for effective PBLs. Additionally, some studies seemed to specify that students whose classrooms incorporated PBLs retained more information than their counterparts who did not experience PBLs (Watson & Watson, 2013). Bruce et al. (2014) stated that as teachers reflected on PBLs within the classroom students began to display more independence in conducting their investigations. Teachers cited was that students had to draw on their prior knowledge and then transfer that knowledge to solve the problem at hand.

Problem-Based Learning. Problem-Based Learning is best defined as a combination of inquiry instruction and product-based learning. Vanhala (2018) cited that previous researchers had described PBL as an approach where students solve authentic, complex problems. Teachers are facilitators over the learning as students, work at their own pace and are focused on acquiring the knowledge necessary so that they can apply the knowledge learned to answer the question. Problem-solving and collaborative skills exist at the core of PBL, which motivates students to become lifelong learners.
Watson & Watson (2013) contended that PBL, at its core, affords students the opportunity to demonstrate knowledge acquired (or gaps in knowledge), which creates more transparency about the knowledge learned. Students who have experienced this approach have shown a greater ability to conceptualize concepts and content. Studies indicate that problem-based learning stimulates cognitive processes.

Student choice. Student engagement has been defined in several ways. Newmann (1992) stated that involved students make a psychological speculation in learning. Students try hard to attain what school offers. They emphasis on excelling with their grades, but more importantly they have a desire to comprehend the content and how it is connected to their lives. Research showed a disturbing number of students who are not engaged in classroom instruction (Cook & Bush, 2018). Studies also revealed that instructors who implement the STEAM approach during their instruction increase opportunities for student engagement. Student-centered instruction personalize curriculum by providing students with the opportunity to have some choice and control over the learning process. By offering students choice and autonomy over their individual learning process, they become more vested over their own learning (Seaver, 2019).

Technology integration. The first 21st Century skill is Digital Age literacy, which encompasses communication competency, analyzing and interpretation of data, understanding and assessment of models, task management and task prioritization, involvement in problem solving, and ensuring wellbeing and safety (Rosen & Smith, 2011). Digital Age literacy must be developed in a student to ensure that the student can maximize technology usage in 21st Century learning. Inventive Thinking is a cognitive activity which supports application of creative thinking in a creative and critical manner with skills in problem solving through innovative or specifically designed activities. NCREL and Metiri Group, (2003) as well as the Committee Workforce Needs in Information Technology (2001) defined a few elements or ‘life skills’ in inventive thought ability, which adapting and managing complexities, self-regulation, curiosity, willingness to take risks, and high-level thinking. The third skill, Effective communication. Effective communication is a skill which is essential in the 21st Century.

This skill involves information delivery, teamwork, interpersonal skills, social responsibilities, shared communication, and communication concerning the environment. The learning process becomes much more exciting and valuable when communication activities use ICT as a medium to obtain information, to communicate faster, and as a supporting medium which assists in the learning process. High Productivity is the next skill. According to NCREL and Metiri Group (2003), high productivity is defined as the ability of a student to adeptly produce products that are relevant, high in quality, intellectual, of current information and original. Additionally, a high productivity skilled-student is also competent in delegating and structuring tasks in terms of degree of importance.

Discipline integration. This process involves multiple subject areas (science, technology, design, and social studies), and encourages multiple solution paths to solve problems. Although there are some constraints for what the students must do (for example, research the threats to sea turtles, the ecological and historical significance), how students arrive at solutions could vary. There is a combination across the curriculum in that disciplines do not appear distinct but related to the problem to solve. The tasks created, which would be more developed during the curricula, are specific to the problem. This method is transdisciplinary in that it begins with the problem to solve versus the disciplines (Quigley, Jamil, & Herro, 2017). Wickson et al. (2006) added that transdisciplinary teaching is problem focused, while multidisciplinary teaching is often structured thematically. Discipline integration is the second dimension of instructional content in this process. This dimension involves the different ways in which the content and methods of various fields are intertwined to teach curricular concepts and solve complex problems. During this study with teachers, it was discovered that discipline integration was congruent when the problem for the students to solve met the criteria described previously. In this way, the disciplines would be naturally used to solve the problem. Therefore, the teachers looked beyond including all the content areas of science, math, technology, engineering, and arts/humanities in STEAM teaching, but which disciplines assist in problem solving. In this conceptualization, it is not necessary for five content areas to always be represented. When certain subject areas were incorporated in the problem scenario, students became disinterested from the learning. Students experienced challenges with finding relevance or how it connected to the problem.

Multidisciplinary encompasses the knowledge, methods and skills from more than one subject such as science and math. Multidisciplinary is categorized within the study as the least integrative form of integrated research—yet, equally, it is arguably the most achievable because there is no attempt to blend the subjects (Janseen & Goldsworth, 1996). An example of this discipline, would be asking students to compute the densities of a variety of sodas which encompasses a single content area and includes only identifying densities from a list of densities. Multidisciplinary would ask students to compute the densities. The advantage of this method is that even though the methods are disciplinary, the different viewpoints on the issue can be gathered and combined for reporting of the findings (Rosen & Smith, 2011); however, it is typically not well integrated (Watson & Watson, 2013).

Embedded assessments. In the STEAM framework, the goal is for students to engage in various types of inquiry methods, develop specific skills such as problem solving and collaborate in multiple ways. Thus, a multiple-choice assessment denotes a misalignment amid the authentic, student-driven aspects of STEAM (Gulikers, Bastiaens, & Kirschner, 2004). These assessments are known to measure student outcomes throughout the teaching progression. Quigley and Herro (2019) suggested that as teachers are drafting their unit plans, they create a process in which the learning can be measured as the teaching continuum progresses. During the formative assessment, the goal serves a dual purpose: for teachers to understand what the students know, and for students to be given an opportunity to understand the knowledge they have acquired. The first goal is a common understanding for teachers—formative assessments communicates to teachers their impact on student learning, what the students know. It helps to drive their teaching to see if the teaching plan needs to be adjusted to meet the needs of all students. The second goal affords students with understanding into their learning process. This understanding is important to afford students with an insight of how they learn and can assist them throughout their career (Black et al., 2004).

Authentic assessments. Students are asked to apply the knowledge and skills they learned during the STEAM unit and to mirror what would be done to solve the problem. Quigley & Herro (2019) asserted that authentic assessments are tasks that mimic what is happening in the real world. Authentic assessments are a way that teachers can support connected learning theory in their classrooms. Specifically, authentic assessments, when designed in a way to solve the problem, often tap into students' interests through choice, and as well as tapping into the design principles of connected learning. These design principles include learning by doing, everyone can participate, challenge is constant, and everything is interconnected. Authentic assessment provides opportunity for fostering engagement and self-expression because typically students can "add their own spin" on the project.

Although authentic and embedded assessments are mentioned, there are various ways in which teachers can assess student learning. There are many ways teachers can assess student knowledge, including models, stories, performances, scripts, and designs, among others. The goal is that assessments reflect the learning objectives and content standards of the unit.

Summary

STEAM subjects have become a major focus for educators in many countries, developing from the initial STEM subjects (Taljaard, 2016). It can be said that educators now realize the importance of the Arts and that there is more importance than simply adding Art as a subject, but inquiring for associated standards between these STEM subjects and their implementation into the curriculum is also meaningful.

Art-infused schools like Hart Hall Art Infused Magnet School (HHA) provide the ideal environmental conditions, including a reciprocal dynamic, in which STEM subjects can embrace a STEAM curriculum. These conditions are not unique to HHA and can be found in most art-infused schools, providing a ready-made platform for instituting a STEAM program. Hunter-Doniger (2018) identified four essential components of successful STEAM instructional approaches: (1) taking time to value the arts, (2) cultivating 100% buy-in into the arts, (3) encouraging collaboration between discipline areas, and (4) reinforcing the rigor of the arts through community partnerships. Although each school's conditions differ, replicating these conditions can benefit schools considering a STEAM curriculum. When considering STEAM education, schools should consider art-infused schools as the model for the ideal conditions for success.

Working toward the daily practice of these teaching approaches will create the right conditions for embracing STEAM education. Such pedagogies encourage a view of the arts that will align with other academic subject areas (Hunter-Doniger, 2018).

The Arts introduce artistic or creative processes into the STEM content areas for the purpose of solving problems (Bequette & Bequette, 2012). Furthermore, they tap into the creative mind, prompting forth creative and divergent thinking to fuse with ‘design thinking’ prevalent in engineering. Harris & de Bruin (2017) argued the most significant pedagogical developments in 21st Century learning may not be just the continued specialization of skills and knowledge, but … “learning and teaching in ways that fuse arts, sciences, mathematics, and humanities domains through contemporary real-world curricula that enhances learning potentials, creative possibilities and adaptive growth-mindsets in learners” (Doyle, 2019).

The Arts provide alternate approaches to solving problems and more opportunities for collaborative processes within ‘transdisciplinary’ spaces (Guyotte, Sochacka, Costantino, Walther, & Kellam, 2015). Ultimately, the STEM content areas can be described as problem-solving areas. Employing art as a representative resource, as well as a means to engage in the problem-solving process provides an ‘aesthetic nature’ to discover and represent solutions (Bequette & Bequette, 2012; Hogan & Down, 2015; Maeda, 2013; McAuliffe, 2016). Quigley and Herro (2016) contended that the ‘transdisciplinary nature’ of STEAM promotes ‘non-linear problem-solving’ and open-endedness in creative thinking (p. 414). McAuliffe (2016) argued that while convergent thinking evaluates and synthesizes creative thought, divergent thinking produces solutions. The Arts provide a space for divergent thinking, allowing solutions to be represented through such means as graphics, models, software, diagrams, and other means of visual imagery such as composite photography, paintings, animation, or video imagery. Sochacka, Guyotte, & Walther (2016) found an example of the power of artistic representation is reported. They found that Arts-Engineering students who had difficulty in articulating their process of solving, reasons for their methods and thinking, as well as their ultimate solution, were able to express and represent their thinking after ‘questioning and dialogue during the artists critique.’ (p. 43). This led to students investigating further as they developed ‘an awareness of their personal and shared processes of creation and (making) sense of the complex relationships between people, artefacts, and the natural world’ (p. 43). The Arts in STEM content areas are both a means of problem-solving and a means to represent solutions. Thus, the Arts provide a visual language by which to express the concepts and design of Science, Technology, Engineering and Mathematics (Doyle, 2019).

The future of economic progress chiefly depends on the readiness of competent engineering personnel, the foundation of which should be established at the secondary school level and continue in colleges and universities through the support and active implementation of STEAM education. This support should be carried out through the targeted development programs, which, in their turn, should include the active involvement of trainees and their mentors in project activities. Project activities in the context of "creative spaces" within the framework of informal and informational education make it possible to form and develop in each of its participants the skills and competencies that are necessary for the person of the digital age (Shatunova, Anisimova, Sabirova, & Kalimullina, 2019).

CHAPTER THREE: METHODOLOGY

The purpose of this study was to determine how a STEAM approach impacts student engagement and overall student performance from teachers' perspectives. STEAM education is a unique approach to teaching and learning that fosters communication, collaboration, creativity, and critical (4Cs) thinking in all students. A qualitative research approach known as phenomenology was used to gather the data. Phenomenology is appropriate because this study explored experiences of content and exploratory teachers as they implemented a STEAM curriculum. Improving science, technology, engineering, and mathematics education (STEM) is an international imperative as countries work to improve life and prospects for their people. Nations recognize that to improve economic prosperity and national security, their citizens should be prepared to work in a global society that is characterized by digital, technological, and scientific literacy and requires divergent, flexible, creative thinking (Honey, Pearson & Schweingruber, 2014). In today's market, almost 100% of jobs require critical thinking and active listening, 70% require mathematical knowledge, and 60% require oral comprehension and expression (Carnevale, Smith & Strohl, 2014).

Research Question

What are teachers' perceptions of STEAM impact on student engagement and student academic performance?

Qualitative Research Method

A qualitative research approach known as phenomenology was used to gather the data for this study. Qualitative research is an investigation process that begins with a research hypothesis, a worldview, and the probable use of a theoretical paradigm (Creswell, 2011), using unique methods to understand and explain a problem. This study addressed teachers' perceptions of STEAM focused lessons on student engagement and student academic performance.

Qualitative research is a technique used to answer questions about or interpret a phenomenon of interest, a social process, or a culture by collecting and analyzing account of experiences from the perspective of the participant (Gray, 2017). In qualitative research, the researcher is completely engaged in the process of the study—the research setting, participants, and the data being collected. The qualitative researcher engages in reflective practices, aware of personal political and cultural perceptions, yet willing to challenge and question personal beliefs to better understand others. Qualitative research enables one to better understand the how and the why of the story. The key idea of the study is known as the central phenomenon in scholarly writings.

While it is imperative for educators to read and understand research to improve instructional practices, this skill may not be a focal point of development in routine teacher education programs. A critical analysis process considers the strengths and weaknesses, contributing to the evaluation of findings that are applicable to teaching practice. There are several necessary considerations that facilitate a critical analysis of qualitative work. The first is to recognize and value the philosophical foundation of the research design (Gray & Grove, 2017; Powers, 2015). For example, the phenomenology approach may be based on hermeneutics, a philosophical belief that aligns the researcher's ability to engage in discourse about life through the exploration of the lived experience of participants (Powers, 2015). The second consideration is to be aware of the different designs of qualitative work; this foundational knowledge will support the readers' understanding and expectations of the work (Gray & Grove, 2017). For example, when reading a grounded theory qualitative report, the reader should expect to ascertain developing themes that may support theory development. Guba and Lincoln (2005) asserted that authenticity should also be considered when evaluating qualitative research. Authenticity is the degree of accuracy the researcher uses to describe the thoughts and experiences of the participant in the research report (Beck, 2009). The fourth consideration is that the reader must have an innate appreciation of the perceptions of the participants (Gray & Grove, 2017). It is this consideration of qualitative research that provides its richness and uniqueness.

Phenomenological Approach

Phenomenology was utilized because this study explored experiences of teachers on different grade levels as they experienced the STEAM approach in their classrooms. This study sought to understand how this approach impacts student engagement and overall student performance. A phenomenology study seeks to recognize the lived experience related to the research interest (Creswell & Poth, 2018). A phenomenology researcher may challenge personal thoughts and ideas to strive for a cleaner and more comprehensive, richer account of a phenomenon from the perspective of the participant (Tufford & Newman, 2012). Thus, research targeting to support a more thorough understanding of several individuals' common or shared experiences of a phenomenon—for example, to improve practices or policies—constitutes the proper approach of phenomenology (Creswell, 2007). The purposes of a phenomenological study are to better understand and depict a given phenomenon by connecting to the lived experiences and perceptions of others.

Description of the Specific Research Approach

Qualitative research is a process to answer questions about or explain a phenomenon of interest, a social process, or a culture by collecting and analyzing descriptive data from the perspective of the participant (Gray, 2017). In qualitative research, the focus is to detail the phenomenon with accuracy and inclusiveness of the participants' experiences (Astroth & Chung, 2018). Powers (2015) identified sources of typical data in qualitative research, including questionnaires, interviews, focus groups, and artifacts. This study collected data from teachers regarding their experiences through questionnaire responses, semi-structured interviews, focus-group interpretations, and artifacts.

Questionnaire. A questionnaire was given to the entire staff at a middle school in Middle Tennessee. The questionnaire was formatted in the form of a Likert scale. The Likert scale is a popular rating scale used to question participants regarding their experiences. In the Likert scale, the answers range from one extreme to the other including "strongly agree" to "strongly disagree." This type of questionnaire provides a clear understanding on the opinions of the participants (Astroth & Chung, 2018). A 5-point Likert scale questionnaire with closed-ended questions was given to the entire staff at the school with statements regarding the research concepts of the study. The open-ended questions allowed for participants to provide information about their own perspectives of STEAM teaching and how this approach impacts overall student engagement and academic performance. After the questionnaires were reviewed, teachers were randomly selected to participate in semi-structured interviews.

Semi-structured interviews. In semi-structured interviews, the core questions were decided prior to the start of the interview process. In general, the interviewer asked the same questions included in the questionnaire and the participants had the autonomy during the interview process to explore some of the responses given. Depending on the responses provided, the interviewer might elect to probe to gain more information or more insight from the participant. In semi-structured interviews, the order of delivery of the questions can differ between interviewees as it is led by the answers provided (Dearnley, 2005). Ary, Jacobs, Irvine, and Walker (2019) acknowledged the benefits of one-on-one interviews as restricting the amount of bias to the moderator rather than other participants, greater individual input, a deeper revelation of emotions, and being more appropriate with sensitive topics, such as the barriers teachers face when planning lessons to increase engagement and student achievement.

Participants, who provided informed consent, were sent email reminders three days before the scheduled interview and the morning of the interview. An informed consent form was provided to participants (see Appendix A). Interview questions used to guide the semi-structured interviews were influenced by the responses from the questionnaire and by the review of literature from the Tennessee STEM Innovation Network, an organization that outlines a process in which schools can engage in to receive a special designation as a STEM school. An interview guide (see Appendix B) was utilized. Six participants were involved in semi-structured interviews. At the end of each interview, participants were asked if they wished to add comments by the questions that were posed.

The interviews were recorded with participant permission and immediately transcribed to accurately capture all responses during each interview. A reflective data trail was noted following each interview and after listening to the audiotaped interview and reading of each transcription.

Focus group. A focus group was used to provide a better understanding of participants' perceptions along with the potential of receiving new insight on the phenomenon being studied. Kneale (2002) used focus groups to explore student experiences of Personal Development Plans. The focus group was comprised of the six participants who were individually interviewed. A focus group is a group of individuals who are guided in a discussion led by a facilitator. The group was given an opportunity for member checks as an additional data resource. In preparation for the focus group, a focus group interview guide (see Appendix C) was created based on the review of literature, the theoretical and conceptual frameworks, and data gathered from the semi-structured interviews. The ideal setting for the focus group environment should be inclusive and interactive to encourage an open dialogue between the participants and the facilitator. Focus group members were sent email reminders three days before the scheduled focus group meeting and the morning of the focus group. The focus group discussion was audio recorded with participant permission and immediately transcribed to accurately capture all responses during each interview. A reflective data trail was noted following each interview and after listening to the audiotaped interview and reading of each transcription.

The combination of a questionnaire responses, semi-structured interviews, focus group transcriptions, and artifacts were used to explore individual teachers' perspectives regarding how a STEAM approach implementation impacts student engagement and overall student performance. The focus group provided pertinent information for the study, and triangulation was achieved by also examining the questionnaires, interview responses, and artifacts. These artifacts included teacher lesson plans and student work. Since teacher's perceptions were paramount to this study, it was essential that this study be conducted qualitatively.

Research Design

A qualitative research study was used to determine the answer to the essential question in this study. This research method provided a platform for data to be collected regarding the participants in their natural environment. Teacher lesson plans and student work samples were analyzed to examine the impact of the STEAM approach had on student engagement and student performance. Questionnaires were given to teachers in one school in East Tennessee to gain a basis for the individual interview questions for the semi-structured interviews. A focus group of three teachers was organized for participation. From the results of questionnaires, interviews, and the focus group data, were coded and analyzed for patterns and consistencies in relation to the research question. The results gathered from this research will be beneficial for educators who are searching for a creative approach to support and develop 21st Century skills students need for a globally competitive society.

Data Collection

The research was initially approved by the Carson-Newman University Institutional Review Board to begin the study and data collection process. Prior to beginning the research, the following approval forms were required: the school district, the school, and the teachers participating in the study.

One middle school in East Tennessee was selected to participate in the research study. The Likert scale is a popular rating scale used to question participants regarding their experiences. In the Likert scale, the answers range from one extreme to the other, including “strongly agree” to “strongly disagree.” This type of questionnaire provides a clear understanding on the opinions of the participants (Astroh & Chung, 2018). A 5-point Likert scale questionnaire with closed-ended questions were given to the entire staff at the school with statements regarding the research concepts of the study. The open-ended questions allowed for participants to provide information about their own perspectives of STEAM teaching and how this approach impacts overall student engagement and academic performance. After the questionnaires were reviewed, teachers were organized to participate in semi-structured interviews. The interviews were completed during the participants’ planning periods and lasted in range from 30-45 minutes. One meeting was conducted with the focus group of six teachers during the research process. The questions were derived from responses provided by the participants during the interview process. There was a predetermined set of questions used during the research process; however, because of the type of study, there is a probability of different shifts to occur during the conversations with the participants. The focus group was audio recorded and transcribed for further study. A reflective journal was utilized by the researcher to record to capture the thoughts and responses during the focus group.

Coding Process

Data coding is the process of deriving codes from the observed data. In a qualitative research approach, the method of data coding is used to process information from the questionnaire, interviews, document and artifact analysis, and focus group transcriptions. During this process, the purpose of data coding is to make sense of the data being provided by the participants. All participants were referred to according to their job title and an assigned number; For example, Teacher 1, Teacher 2, Teacher 3, Teacher 4, Teacher 5, and Teacher 6. These were created to distinguish information in interviews, observations, and notes. This study comprised open coding, allowing the separation of the data in similar categories of information. Open coding uses the text to define concepts and categories. During this research, open coding was employed and categories in the data were the basis for analysis. Patterns were determined both from the interview and focus group responses, after which they were used as concepts and categories in the study. Next, the process of axial coding was applied to recognize relationships among the open codes. Axial coding was used to combine the categories into larger themes to establish a clearer understanding of the research. Categories were grouped and collapsed into themes through selective coding, which answered the research questions.

Data Analysis Procedures

After each interview, the notes and audio recordings were transcribed into a journal. After each meeting with the focus group, data analysis was conducted. Member checks were also conducted to verify that transcripts were accurately recorded. Member checking, also known as participant or respondent validation, is a technique used to ensure that the data recorded are credible. Data or results are returned to participants to verify the accuracy of their experiences (Birt, Scott, Cavers, Campbell & Walter, 2016).

Description of the Study Participants and Setting

The study involved one urban school located in Middle Tennessee. The school was a 5-8th grade school composed of approximately 450 students with the following demographics: 283 (63%) African American, 118 (26%) White, 34 (8%) Hispanic, 15 (3%) Asian. Of these students, 88 (20%) are (ED) economically disadvantaged, 49 (11%) are (LEP) limited English proficient, and 33 (7%) students are (SWD) students with disabilities. There are 26 certificated staff at the school. The entire staff (all certificated teachers) participated in the Likert-scale questionnaire.

Ethical Considerations

Ethical considerations were guided by the Collaborative Institutional Training (CITI) guidelines on research with human subjects. Permission from the Carson-Newman University Institutional Review Board (IRB) and the school district IRB were obtained before collection of any data. Participants provided informed consent prior to participation in the study. The process included the rights of participants, risks, the value of the research, the time involved in the study, and an opportunity to ask questions. Participants were informed that their participation was voluntary and that they could withdraw from the study at any time. Informed consent forms were collected prior to interviews. The forms are secured with other study data.

The identity of the school and the participants was protected to assure confidentiality. Privacy and confidentiality measures were taken to protect the identity of all participants. Participants received a pseudonym that would be used to identify individuals throughout the study.

Summary

This qualitative study was conducted in one urban school located in East Tennessee through a phenomenological approach as the data sought was lived experiences and perceptions of the participants. Participants were teachers whose years of experience varied from 2-20 years. Three data sources - questionnaires, interviews, and a focus group provided data triangulation. Data generated were used to answer the research question: What are teachers' perceptions of STEAM focused lessons on student engagement and student academic performance?

From the results of questionnaires, interviews, and the focus group data were coded and analyzed for patterns and consistencies in relation to the research question. This research method provided a platform for data to be collected regarding the participants in their natural environment. Teacher lesson plans and student work samples were analyzed to examine the impact of the STEAM approach on student engagement and student performance. Questionnaires were given to teachers in one school in Middle Tennessee to gain a basis for the individual interview questions for the semi-structured interviews. A focus group of three teachers was organized for participation. From the results of questionnaires, interviews, and the focus group, data were coded and analyzed for patterns and consistencies in relation to the research question. The results gathered from this research will be beneficial for educators who are searching for a creative approach to support and develop 21st Century skills students need for a globally competitive society.

Chapter 4: Presentation of the Findings

Introduction

This phenomenological, qualitative study sought to determine how a STEAM instructional approach impacts student engagement and academic achievement from teachers' perspectives. The study identified the impact of activities that foster communication, collaboration, critical thinking, and creativity concerning engagement and academic achievement. This chapter describes and presents the participants, the study methods, the data, and the findings.

The following research question guided this study: What are teacher perceptions of STEAM impact on student engagement and academic achievement? The research question is aligned with the purpose and significance of the study. The question considers the impact of this phenomena have on student engagement and academic achievement.

To obtain a deeper understanding of the impact of this approach has on student engagement and academic achievement, three sources of data were used in this qualitative study. Data were obtained through surveys, interviews, and a focus group.

The participants responded to an online Google document Likert Scale Survey (see Appendix A), individual interviews, and in a focus group to support triangulation and dependability. The data are presented through statistical and description forms to present an accurate and thorough result. Open, axial, and selective coding were used to deconstruct the data, classify, and categorize the data to reveal the meaning consistent with the Grounded Theory Method (Blair, 2015). The findings are presented in a sequential, statistical, and narrative process sequenced beginning with the survey data and analysis, followed by the interviews and focus group data and analysis, and ending with a summary of the research data consistent with the categories identified because of the coding process. Member checks and a peer reviewer were used throughout the process to support validity, transparency, accuracy, and dependability. These findings confirm, contradict, and expand upon prior research.

Descriptive Characteristics of Participants

The participants for the study worked in a small urban school district in East Tennessee. There were 23 teachers in total from two different middle schools who were contacted to participate in the survey. The district serves about 4,500 students in grades K-12, with a student-teacher ratio of 14 to 1.

A request was sent to the district, asking for permission that research be conducted. As a result, on January 27, 2020, the district granted approval for the research to be done. Subsequently, the district STEM/STEAM coordinator was responsible for contacting all middle school teachers in the district about the study to solicit volunteers. Twenty-three teachers were contacted via email inquiring about their participation in the study.

Nine teachers responded to the online Google based Likert Scale Survey. Each of those teachers were invited to participate in semi-structures interviews, and six of those teachers accepted. There were 6 interviewees, 2 from Middle School A and 4 from Middle School B. The interviews lasted from 30-60 minutes depending on the additional facts that were revealed during the interview process. At the beginning of each interview, introductions were completed and the participants were informed that the conversation was being recorded. All interviews were conducted via telephone conversation and responses were recorded in narrative form. All the interviewees were invited to participate in the focus group, and three teachers (all from the same school) agreed to participate. All three teachers were female and one of the teachers was a 29-

year veteran in the field of education and had worked at the school her entire career. Of the teachers that participated in the focus group, one teaches 6th grade science, one teaches 8th grade math, and the other teaches 8th grade English Language Arts. Two of the teachers serve in a dual capacity; one is the data coach and one is the STEM/STEAM coach for the school.

Survey Data

On February 18, 2020, 23 teachers were emailed a hyperlink to the anonymous Google Forms 5-Point Likert Scale Survey (see Appendix A). The survey contained 10 questions, ranging from Strongly Disagree to Strongly Agree. Additionally, the email included the informed consent document, evidence of IRB approval, and the memorandum authorizing research within the district. A follow-up email was sent to the participates asking for participation in the interview process. After participates agreed to be interviewed, an email was sent to each participate requesting their contact information. Forty percent of teachers responded to the online survey's scaled questions and 65% of those teachers participated in the interview process. One peer reviewer compared and reviewed the Google Likert Scale data and comments with the survey data, findings, and tables for accuracy and dependability.

Table 4.1

Teachers Perceptions of STEAM Impact on Student Engagement and Academic Achievement

Theme	*Questions*	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
Creativity activities and the impact on student engagement	Q1	0%	0%	11.1%	44.4%	44.4%
Collaboration activities and the impact on student engagement	Q2	0%	0%	0%	33.3%	66.7%
Critical thinking activities and impact the on student engagement	Q3	0%	0%	11.1%	44.4%	44.4%
Real-world problem-solving activities and the impact on student engagement	Q4	0%	0%	0%	11.1%	88.9%
Hands-on activities and the impact on student engagement	Q5	0%	0%	0%	11.1%	88.9%
Collaboration activities and the impact on academic achievement	Q6	0%	0%	11.1%	44.4%	44.4%
Critical-thinking and the impact on academic achievement	Q7	0%	0%	22.2%	11.1%	66.7%
Real-world problem-solving and the impact on academic achievement	Q8	0%	0%	0%	22.2%	77.8%
Student choice impact on academic achievement	Q9	0%	0%	0%	66.7%	33.3%

Discipline integration impact on academic achievement	Q10	0%	0%	22.2%	44.4%	33.3%

Survey Findings

According to the survey data, most teachers indicated that engagement is increased when the following activities are involved: creative processes anchored in design, meaningful collaboration, critical thinking, real-world problem-solving scenarios, and hands-on experiences.

Effective schools have well-defined processes in place for gathering and using the essential fuel for productive collaboration: meaningful data tied to results for all students (Blankstein, 2004).

In all five categories, at least 8 of 9 respondents strongly agreed or agreed that when students are involved in creative, collaborative, critical-thinking, real-world problem-solving scenarios, or hands-on experiences, student engagement is increased. For example, when asked if activities that expose students to creative processes anchored in design increase student engagement in the classroom, 88.8% (8 of 9) of the teachers strongly agreed or agreed that these activities increased student engagement. When asked activities that involve meaningful collaboration have a positive effect on classroom student engagement, 100% of the teachers strongly agreed or agreed that these activities increased student engagement. When asked about activities that involve critical thinking increasing student engagement in the classroom, 88.8% (8 of 9) of the teachers strongly agreed or agreed that these activities increased student engagement. When asked if activities that involve solving real-world problem-solving scenarios increase student engagement in the classroom, 100% of the teachers strongly agreed or agreed that these activities increased student engagement. When asked if activities that involve hands-on experiences increase student engagement in the classroom, 100% of the teachers strongly agreed or agreed that these activities increased student engagement.

The teachers were also surveyed regarding their perceptions of how the following activities impacted academic achievement: collaboration, critical thinking, solving real-world societal issues, student choice, and discipline integration. When asked whether learning that involves innovation and collaboration with peers increase academic achievement, 88.8% (8 of 9) of the teachers strongly agreed or agreed that this type of learning increased academic achievement. When asked if learning that involves developing critical-thinking skills increases academic achievement, 77.8% (7 of 9) teachers strongly agreed or agreed that this type of learning increased academic achievement. When asked whether learning that is focused on solving real-world societal issues increased academic achievement, 100% of teachers strongly agreed or agreed that this type of learning increased academic achievement. When asked whether learning that involves student choice increases academic achievement, 100% of teachers strongly agreed or agreed that this type of learning increased academic achievement. When asked whether learning that involves discipline integration increasing academic achievement, 77.8% (7 of 9) teachers strongly agreed or agreed that this type of learning increased academic achievement.

Interview Data

Six semi-structured interviews were conducted with six different teachers from two different middle schools. Twelve initial questions were developed for the interviews (see Appendix B). All teachers who agreed to do the interviews after they completed the survey were asked to send their contact information. The six teachers that agreed to participate were sent emails asking for two optional days and times they would be available for the interview. The interviews were completed via telephone and responses were recorded and later transcribed.

Table 4.2

Interviewee's Background Information

Participant	*Gender*	*Content Subject*	*Years of Experience*
Teacher 1	Female	Science	29
Teacher 2	Female	English Language Arts	13
Teacher 3	Female	Math	13
Teacher 4	Female	Math	21
Teacher 5	Female	Gifted	12
Teacher 6	Male	Math	18

Focus Group Data

The focus group was conducted on Tuesday, March 24, 2020. Three teachers participated in the focus group. Eight initial questions were organized for the focus group (see Appendix C). All three teachers that agreed participate in the focus group after the individual interviews were sent emails asking to select two possible days and times. The focus group was conducted via the Zoom platform and responses were recorded and later transcribed. The focus group lasted about 45 minutes, and several topics were discussed; no limitation was placed on responses or follow-up questions. The questions of interest that structured the conversation for the focus group were areas that each participant mentioned and/or were additional components of information that would support the study. The following topics were the emphasis during the focus group: project/problem-based learning (PBLs), Buck Institute professional development, the impact of 4Cs (communication, collaboration, critical thinking, & creativity) of learning, implications of STEAM on learning, and how this approach has shaped the participants and their teaching practices.

Table 4.3

Focus Group's Background Information

Participant	*Gender*	*Content Subject*	*Years of Experience*
Teacher 1	Female	Science	29
Teacher 2	Female	English Language Arts	13
Teacher 3	Female	Math	13

Interview and Focus Group Findings

The interview and focus group findings depicted below focus on teachers' perceptions of the impact of the STEAM approach had on student engagement and academic achievement. Numerous factors were noted in the interview and focus group processes: project/problem-based learning, activities focused on 4Cs (communication, collaboration, critical-thinking, & creativity) of learning, impact on student behaviors, hands-on activities, real-world problem-solving activities, and the impact of this approach on personal teaching practices.

The findings were presented with a narrative focus in support of the phenomenological approach, as the foundation of the findings was grounded in the teacher's perceptions. Open, axial, and selective coding procedures were used. Open coding is the beginning step in the Grounded Theory Model (Blair, 2015), and it was used to identify the meaning without preconceptions. Data were deconstructed during the open coding and grouped by similarity. Subsequently, data were reexamined and connections between categories were identified, resulting in a new grouping. An additional examination and comparison of data began the selective coding process, resulting in core variables or factors related to the research question.

This process is visually represented in Table 4.4, which follows the teachers' narrative descriptions of STEAM impact on student engagement and academic achievement. In support of transparency, validity, and accuracy, a draft of this chapter was shared with all interviewees, individually by email, for review and feedback.

Project/problem-based learning. Most of the teachers interviewed (5 of 6) revealed that one of most noticeable instructional shifts has been the inclusion of project/problem-based learning (PBLs) into the academic curriculum. During the focus group, the teachers detailed the benefits of PBLs. They confirmed that PBLs being embedded in the curriculum has been a noticeable shift. Teacher 1 stated that PBLs are embedded in the curriculum, which also involves more interdisciplinary activities and tasks. Teacher 2 stated that at her school, the entire 8^{th} grade engages in PBLs. Teacher 3 mentioned how grade-level PBLs are the focus in Math. Teacher 4 mentioned how PBLs encompass other content subjects versus how the former way of teaching and learning involved content subject learning in isolation. Teachers 5 and 6 stated that it is expected that each teacher engages students in at least one PBL per year. Teachers noted that this approach helps students to make connections in terms of the relevance of their content subject matter, which they indicated increases student engagement.

4Cs of Learning. The 4Cs of learning represent activities that involve experiences in which students are communicating, collaborating, critically thinking, and being creative. All teachers interviewed mentioned at least two of these learning processes and their impact on student engagement and academic achievement. For example, during a joint interview, Teachers 5 and 6 stated that they believe their school strives at engaging its students in collaborative activities. They said that their students really enjoy working together in teams and in groups. During the focus group, the participants detailed their perspectives about the impact of 4Cs of learning. Teacher 3 stated that when students are given opportunities to be creative, it helps them to become more well-rounded people, and it is an essential life skill. Teacher 2 stated activities like "Socratic Circles" teach students how to communicate and collaborate effectively. Teacher 1 said that the benefit of engaging students by using the 4Cs is that students begin to discern the connections across their other content areas. All three teachers who participated in the focus group agreed that communication was the most important of all the 4Cs of learning. Teacher 2 "being able to effectively communicate is the foundation of it all?"

Student behaviors. When asked what kinds of student behaviors are noticed when students are given opportunities to collaborate, Teacher 4 claimed that when structured collaborative time is provided, engagement is increased. Teacher 4 also claimed there was a decrease in student misbehavior because students felt valued and were more engaged in the learning. Teachers 5 and 6 stated that collaboration provides students with opportunities to interact productively. Teacher 2 mentioned how students engage in collaborative activities using a strategy from the Buck Institute. During these activities, students were required to communicate the following with their peers: something they noticed and something they were curious about. Teacher 2 described communication as being "the match that lights the fire." Teacher 1 highlighted an increase in dialogue from peer to peer. Teacher 1 also noticed the use of academic vocabulary being a focus that deepened conversations between students.

Hands-on activities. When asked what kinds of hands-on activities they used in their classrooms, the responses were as follows. Teacher 1 uses 3-4 hands-on activities per week. Some of the activities mentioned were pulse rate lab to talk about circulatory, reaction rate lab for nervous system, and digestive rate lab for digestion system. Teacher 2 uses Spotlight on Strategies (SOS) format offered by Discovery Education. These research- based strategies are used for integrating Discovery Education digital curriculum resources in meaningful, effective, and practical ways. These strategies support students as they generate ideas to solve problems.

Teacher 3 uses manipulatives to observe the math. Teachers also use PBLs for creation something in math. Students had to create a kite focused on shapes, and were required to explain why thought it would fly the best. Teachers 5 and 6 mentioned using the Maker space area in the library, a mini maker space in the gifted classroom, and the use of robots.

Real-world problem solving. When asked which real-world problem-solving activities students engage in, Teacher 1 mentioned an activity in which students had to research aspects about unclean water. Students studied a novel focused on how water-born diseases traveled through the unclean water. As a culminating activity, students were required to present different ways in which to ask the community for donations to a charity to promote clean water. Teacher 2 had 8th graders participate in a novel study focused on “Chasing Lincoln’s Killer” by James Swanson. They invited guest speakers to provide background information about the study. The students participated in conversation via Skype with a member of the United States Secret Service. As a culmination activity, the students created presentations to a panel focused on proposed improvements to Secret Service protocols. The presentations were required to be grounded in the 4Cs and needed to specifically demonstrate how they accomplished the 4Cs within their presentation. Teacher 3 mentioned an activity in which students had to answer how long it would take to travel from Earth to Mars. The students had to also determine how much fuel it would take to get there. Teacher 4 provided the scenario in which students were building a doghouse. While in the process of building the house, it was discovered that the measurements in the blueprint were inaccurate. The scenario required students to rebuild blueprint to correct measurements. This activity involved all four students. Teachers 5 and 6 discussed activities that involved students creating, student memoirs, video trailers, or documentaries focused on students and their life stories.

Impact on academic achievement. Teacher 1 believes the STEAM approach increases academic achievement because it increases retention of knowledge and promotes understanding across core areas. Teacher 2 stated that when students engage in STEM/STEAM learning, academic achievement is impacted. Teacher 2 termed it "The Longevity of Learning." Teacher 2 also stated that when students are given a story to read, they may become unmotivated; however, when learning is posed as a problem, it helps with retention. Teacher 4 responded by saying this approach to learning teaches students how to think, which enables students to apply their knowledge learned to various situations.

When asked if students engage in learning focused on real-world societal issues, academic achievement is increased, Teachers 5 and 6, responded "yes." They further stated that when students are engaged in real-world conversations, they interact completely differently. These teachers also said “it’s obvious in their motivation and body language.” During the focus group, this question was posed again. Teachers 1, 2, and 3 provided the following responses: “Longevity impact, it goes beyond just learning content.” Students learn through PBLs and hands-on activities. STEAM focuses on real-world connections and thus creates avenues for remembrance. Teacher 3 stated that if a student is taught something and one connecting point is made, the student is not likely to remember, but if a teacher makes multiple points of connections, the student is likely to remember, and it increases retention. Teacher 2 concluded by saying “it makes connections deeper, richer, and long lasting.”

Table 4.4

Interview and Focus Group Data by Level of Coding for the Research Question: What are teachers' perceptions of STEAM Impact on student engagement and academic achievement?

Raw Data	*Open Coding*	*Axial Coding*	*Selective Coding*
"…PBLs focus school-wide." "…connections across other contents." "…forges effective communications between students." "…students can see actual organs at work…" "…4Cs are focus of learning process." "…Buck Institute: one thing you notice; one thing you wonder."	PBLs are embedded in the academic curriculum 4Cs: Communication, Collaboration, Critical-thinking, Creativity Hands-on activities Real-world problem-solving issues as a focus	PBLs learning 4Cs learning Hands-on learning Real-world societal issues learning	Teachers identified that embedding PBLs, the 4Cs, hands-on activities, and real-world problem-solving learning in the academic curriculum increases student engagement; It was also discovered that these STEAM approaches along with student choice opportunities, forged deeper understanding, and helped students with retention which positively impacts academic achievement.
"…Longevity of learning impact goes beyond content." "…teach a student uses one connecting point not likely to remember, use multiple points and retention increases." "…helps students makes connections to world." "…teaches student to think." "…increases retention, promotes understanding across content areas."	Retention is increased Uses foundational knowledge to apply to other content areas Student-centered Able to use knowledge and solve real-world problems	Retention Deeper understanding Student-focused Ability to explain, evaluate, & resolve	

Impact for Future Educators

When asked how this approach will impact future educators, Teacher 1 stated that the STEAM approach connects students to the real-world and it prompts them to think deeply about the content they are learning, along with how it connects to their world. Teacher 2 stated that this approach increases engagement and has the potential to have a long-term impact on learning. Teacher 3 stated that this approach helps one stay in love with teaching. “You are able to witness the sparkle in students’ eyes and it keeps the sparkle and motivation within yourself. It makes you want to do it again and keep teaching.” Teacher 4 stated that student engagement is increased. Teachers should see a decrease in student misbehavior, because the students feel more valued and more engaged in the learning process. Teachers 5 and 6 stated that this approach is innovative. Teachers must continue to re-assess their own practices and adapt to continue to reach students. These teachers stated that “the ones that do not have left and retired.” Teacher must also move from their comfort zones to become effective facilitators.

Summary

Chapter 4 provided the data and findings for a survey, semi-structured interviews, and a focus group that sought to determine teachers’ perceptions of STEAM impact on student engagement and academic achievement. The participants for the study worked in a small urban school district in East Tennessee. Twenty-three teachers from two middle schools were contacted to participate in the survey. The district serves approximately 4,500 students in grades K-12 with a student-teacher ratio of 14 to 1. Six teachers participated in the interview process and three teachers participated in the focus group. The district also has been certified as a STEM/STEAM district by Cognia, formerly known as AdvancED.

Several factors were elucidated as a result of the survey, the interviews, and the focus group processes: project/problem-based learning, activities focused on 4Cs (communication, collaboration, critical-thinking, and creativity) of learning, impact on student behaviors, hands-on activities, real-world problem-solving activities, and impact this approach has had on personal teaching practices. These areas were perceived to have had significant impacts on student engagement. Survey results indicated that 88.9% of participants believed that when students are involved in the following: creative processes anchored in design, meaningful collaboration, and critical-thinking opportunities, student engagement increased. The perceptions increased to 100% when students' activities involved real-world problem-solving and hands-on activities.

Numerous factors were revealed from the survey, the interviews, and focus group processes: activities that involve innovation and collaboration, critical-thinking development, focusing on real-world societal issues, student choice, and discipline integration significantly impacted academic achievement. Accordingly, 77.8% of the teachers surveyed stated that when students are involved in the following activities: innovation and collaboration with peers that develop critical-thinking skills, focusing on real-world societal issues, and discipline integration, academic achievement is increased. Additionally, 100% of teachers surveyed perceived that student choice increases academic achievement.

Chapter Five: Conclusion, Implications, and Recommendations

The purpose of this qualitative study sought to determine teachers' perceptions of STEAM impact on student engagement and academic achievement. The conclusions, implications, and recommendations for this study are based on findings obtained through a survey, interviews, and a focus group. This chapter presents the significant factors and conclusions, connects the research with previous research and theoretical concepts, examines and explains how this research expands upon previous research and the implications for future studies, and expands upon the limitations of this study. Chapter 5 includes six sections: the research question, conclusions and summary of findings, implications, limitations, and recommendations. The conclusion and summary of the study section reviews the type, the purpose of the study, and connects the data to the research questions and theoretical framework. This section also describes how the data were used to determine the significant factors of the STEAM and its impact on student engagement and academic achievement. The implications for educators, and their instructional practices moving forward.

Research Question

The following research question guided this study: What are teacher perceptions of STEAM impact on student engagement and academic achievement? The research question is aligned with the purpose and significance of the study. The question considers the impact this phenomena have on student engagement and academic achievement.

Conclusions and Summary of Findings

Analysis of data revealed the following constructs which STEAM implementation impacts regarding student engagement: project/problem-based learning (PBLs), activities focused on communication, collaboration, critical-thinking, and creativity (4Cs) of learning, impact on student behaviors, hands-on activities, real-world problem-solving activities, and impact this approach has had on personal teaching practices. Analysis of data revealed the following construct which STEAM implementation impacts regarding academic achievement: activities that involve innovation and collaboration, critical-thinking development, focusing on real-world societal issues, student choice, and discipline integration. The study used a convenience sampling of teachers. The participants for the study worked in a small urban school district in East Tennessee. There were 23 teachers in total from two different middle schools who were contacted to participate in the survey. The district serves about 4,500 students in grades K-12 with a student-teacher ratio of 14 to 1. There were 6 teachers who participated in the interview process and 3 teachers participated in the focus group. The district also has been certified as a STEM/STEAM district by Cognia formerly known as AdvancED.

Data were gathered using a survey, interviews, and a focus group. An open, axial, and selective coding process was used to analyze, organize, categorize, and determine the most significant factors for impacting student engagement and academic achievement. The findings were presented with a narrative focus in support of the phenomenological approach, as the foundation of the findings was grounded in the teachers' perceptions. Open, axial, and selective coding procedures were used. Open coding is the beginning step in the Grounded Theory Model (Blair, 2015) and, it was used to identify the meaning without preconceptions. Data were deconstructed during the open coding and grouped by similarity. Subsequently, data were reexamined and connections between categories were identified resulting in a new grouping. An additional examination and comparison of data began the selective coding process, resulting in core variables or factors related to the research question.

This process is visually represented in Table 4.4, which follows the teachers' narrative descriptions of STEAM impact on student engagement and academic achievement, as perceived by the teachers. In support of transparency, validity, and accuracy, a draft of this chapter was shared with all interviewees, individually by email, for review and feedback.

Project/problem-based learning. The large majority of the teachers interviewed revealed that one of most noticeable instructional shifts has been the inclusion of project/problem-based learning (PBLs) into the academic curriculum. During the focus group, the teachers went into more detail about the benefit of PBLs. They confirmed that PBLs being embedded in the curriculum has been a noticeable shift. They stated that PBLs are embedded in the curriculum which also involves more interdisciplinary activities and tasks. One teacher stated that at their school the entire 8th grade engages in PBLs. It also mentioned that grade level PBLs are the focus in Math in which they have to create something. PBLs encompass other content subjects versus how the former way of teaching and learning involved content subject learning in isolation. At some schools this approach has become an expectation that each teacher has engaged the students in at least one PBL per year. It also noted that this approach helps students to make connections in terms of the relevance of their content subject matter which as they stated increases student engagement.

4Cs of Learning. The 4Cs of learning represent activities that involve experiences in which students are communicating, collaborating, critically thinking, and being creative. All the teachers interviewed, mentioned at least two of these learning processes and their impact on student engagement and academic achievement in their responses. For example, during a joint interview, it was stated that they felt their school really strives at engaging their students in collaborative activities. They said that their students really enjoy working together in teams and in groups. During the focus group, the participants went into more detail about their perspectives about the impact of 4Cs of learning. It was stated that when students are given opportunities to be creative, it helps them to become more well-rounded people, and it's a great life skill to learn. Activities like "Socratic circles" teach students how to communicate and collaborate effectively. Teachers stated that the benefit of engaging students by using the 4Cs, is that students begin to see the connections across their other content areas. All three teachers who participated in the focus group, agreed that they felt communication was the most important of all the 4Cs of learning. They stated "being able to effectively communicate is the foundation of it all?"

Student behaviors. When asked what kinds of student behaviors are noticed when students are given opportunities to collaborate, it was shared that when a good job is given in terms of relaying instructions for structured collaborative time, engagement time is much higher than the reverse. Teachers also claimed there was a decrease in student misbehavior, because students felt valued and were more engaged in the learning. They also stated that students were more engaged in collaborative activities, productive relationships were encouraged, and students were given opportunities to interact productively. One practitioner mentioned how students engage in collaborative activities using a strategy that was learned from the Buck Institute. During these activities students had to communicate the following with their peers: one thing they noticed and one thing they had wonderings about. One teacher described communication as being "the match that lights the fire." This approach creates a sense of confidence in students as they dialogue with one another. Practitioners also noticed the use of academic vocabulary being a focus that deepened conversations between students.

Hands-on activities. When asked what kinds of hands-on activities they used in their classrooms the responses were as follows. One practitioner shared that she uses 3 to 4 hands-on activities per week. Some of the activities mentioned were pulse rate lab to talk about the circulatory system reaction rate lab for the nervous system, and digestive rate lab for the digestion system. Another teacher stated that she used Spotlight on Strategies (SOS) format offered by Discovery Education. These research- based strategies are used for integrating Discovery Education digital curriculum resources in a meaningful, effective, and practical ways. These strategies support students as they generate ideas to solve problems. Manipulatives are used to observe math along with PBLs focused on creating something using math concepts and design methods. Students also engaged in hands-on activities in which they had to create a kite focused on shapes, and they had to explain how they thought it would fly the best. Teachers also mentioned using the Maker space area in the library, a mini maker space in the gifted classroom, and the use of robots. Teachers were consistent in terms of the positive impact hands-on activities had on increasing student engagement.

Real-world problem solving. When asked in which real-world problem-solving activities students engage, teachers were just as consistent with how they felt these kinds of experiences positively impacted student engagement. Teachers mentioned how when students engaged in these kinds of activities with students they observed the following behaviors in students: they seemed more empowered to collaborate, they increased student dialogue from peer to peer, students viewed these activities as a challenge, formed productive relationships, and became motivated to understand how content connecting to world around them.

Impact on academic achievement. When asked about the impact the STEAM approach has on academic achievement for students, Teachers shared that the STEAM approach had the potential to increase academic achievement for the following reasons: it increases student engagement, it increases retention of knowledge, promotes a deeper understanding across core areas, it challenges students by developing their critical-thinking skills, students learn how to effectively collaborate and communicate, it helps students to make connections with content and the society they live in, it gives them the skills to resolve real-world issues, and it helps student to learn how to establish and sustain meaningful relationships.

Implications for Practice

The study revealed the following implications for the future practice of teachers in the craft of education: that the STEAM approach connects students to the real-world and it pushes them to think bigger and broader about the content they are learning along with how it connects to their world. This approach has the potential to create a renewed energy and love for teaching and learning. It creates opportunities for teachers to become learners and witness an approach that focuses real-world application. Teachers shared how this approach creates a motivation to inspire continued growth and learning as a teacher. They consistently shared that this approach increases student engagement and academic achievement. This approach has the potential to decrease misbehaviors, because the students feel more valued and more engaged in the learning process. Teachers also commented how this approach is innovative, and it keeps everyone young. Teachers must continue to re-assess their own practices. It becomes about adapting and changing to reach your students. They further stated that “the ones that do not have left and retired.” They also said it is about pushing teachers out of their comfort zone because they have to become the facilitators.

Limitations

Two limitations for this study were identified. First, the study occurred in a small urban school district without significant diversity. Additionally, the study took place within a limited span of 4 weeks.

Recommendations

Gaps in knowledge pertaining to student engagement and academic achievement remain at the conclusion of this study. Future research to extend this study could be beneficial in two areas. First, this study should be replicated for a longer period of time. This would address the limitation of the study, which restrained the study to a period of four weeks. Next, this study should be replicated in a larger more economically diverse setting. Doing so would address the limitation of diversity in this study.

Summary of the Study

This qualitative case study focused on the aspects of the STEAM approach perceived by practitioners to be beneficial for student engagement and academic achievement. The following research question guided this study: What are teacher perceptions of STEAM impact on student engagement and academic achievement. To answer the research question, data were obtained from three sources: a survey, semi-structured interviews, and a focus group. Analysis of data revealed the following outcomes regarding student engagement: project/problem-based learning (PBLs), activities focused on communication, collaboration, critical-thinking, and creativity (4Cs) of learning, impact on student behaviors, hands-on activities, real-world problem-solving activities, and impact this approach has had on personal teaching practices. Analysis of data revealed the following outcomes regarding academic achievement: activities that involve innovation and collaboration, critical-thinking development, focusing on real-world societal issues, student choice, and discipline integration. To positively impact student engagement and academic achievement, future educators must realize the imperative of remaining current with educational trends that focus on student-centered learning.

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Appendix A

Please respond to the following statements regarding the STEAM effect on student engagement and academic performance.
Key: SA (Strongly Agree), A (Agree), N (Neutral), D (Disagree), AD (Strongly Disagree)

STEAM Effects on Student Engagement

1. Activities that expose students to creative processes anchored in design increase student engagement in classroom activities. SA A N D SD
2. Activities that involve meaningful collaboration have a positive effect on classroom student engagement in classroom activities. SA A N D SD
3. Activities that involve critical thinking increase student engagement in classroom activities. SA A N D SD
4. Activities that involve real-world problem-solving scenarios increase student engagement in classroom activities. SA A N D SD
5. Activities that involve hands-on experiences increase student engagement in classroom activities. SA A N D SD

STEAM Effects on Academic Achievement

1. Learning that involves innovation and collaboration with peers increases student academic achievement. SA A N D SD
2. Learning that develops critical thinking skills increases student academic achievement. SA A N D SD
3. Learning that is focused on real-world societal issues increases student academic achievement. SA A N D SD
4. Learning that involves student choice increases student academic achievement. SA A N D SD
5. Learning that involves discipline integration increases student academic achievement. SA A N D SD

Appendix B

Interview Questions

1. How long have you been teaching/working in the craft of education?
2. What grades levels have you taught?
3. What content subjects you have taught?
4. What are the major shifts in teaching practices you've notice while being a part of this STEAM movement?
5. What kind of hands-on experiences do you use to engage students in your class?
6. What are the benefits for student engagement in STEM approach?
7. What are some of those activities that involve students in collaboration?
8. What kinds of student behaviors do you notice when students are given opportunities to collaborate?
9. Do you think that when students participate in activities that involve critical thinking student engagement is increased? If so, why?
10. Describe some problem-solving activities that you engage your students in
11. Do you think that when students engage in learning focused on real-world societal issues academic achievement is increased? If so, why?
12. What's the impact for other educators to use the STEAM approach as an instructional practice? It helps you stay in love with Teaching. You get the sparkle in students' eyes, it keeps the sparkle and motivation within you, It makes you want to do it again and keep teaching.

Appendix C

Focus Group: Interview Questions

1. How do you think the various roles you've served in has supported you in implementation of STEM/STEAM in your classes?
2. What could your school do differently to take PBLs to scale school-wide?
3. How has the Buck Institute training supported the STEAM approach in your school?
4. What are the benefits of engaging students by using the 4Cs?
5. Which one is the most important and why?
6. What are the implications on student engagement?
7. What are the implications on academic achievement?
8. How has this approach shaped you as a teacher?