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How Content Teachers Transition to Teaching a STEAM Curriculum

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Doctorate of Education Program

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How Content Teachers Transition to
Teaching a STEAM Curriculum

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College of Education

Dissertation submitted to the Faculty of the College of Education

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Abstract

An increasing number of educators are supporting the STEAM approach to education, so that students will have the necessary skills and abilities needed for the 21st century workforce. Entire schools as well as school districts have transitioned to STEAM. The purpose of this multiple case study was to explore how content teachers make the transition from their traditional educational approach to implementing a STEAM curriculum. The researcher used purposeful sampling to select one participant from the arts discipline and one teacher from the STEM discipline at two research sites used in the multiple case study. Data collection methods included one-on-one interviews, a focus group, and observations of corroborating artifacts and documents. Findings led to four themes which depicted the process that teachers went through to transition to STEAM. Teachers developed a mindset to teach from STEAM perspective, started small and built up, used collaboration as a resource, and participated in ongoing professional development. The transition process appeared to support Mezirow's (1991) steps involved in transformational learning theory and the STEAM movement. Future research could include a deeper look at how teachers transition to STEAM, how non-STEM classes are involved in STEAM, and how educational leaders make decisions to transition a school's curricular approach.

Keywords: arts, Mezirow's transformational learning theory, STEAM, STEM, STEM to STEAM movement

Dedication

This dissertation is dedicated to all of my friends and family who have shown me tremendous support in my pursuit of this degree. I especially want to thank Jesse, Jr., my dear husband, for your encouragement and extra efforts that you made to assist our family during this process. Jesse III, my son, thank you for being patient and understanding as I had to hide in my office to do work. Never let go of achieving your dreams!

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Chapter 1: Introduction

President Obama made STEM a priority in the education field to help students improve their individual skill sets and to increase interest and participation in related career fields. Obama stated:

> [Science] is more than a school subject, or the periodic table, or the properties of waves. It is an approach to the world, a critical way to understand and explore and engage with the world, and then have the capacity to change that world. (Obama, 2015, para. 5)

STEM fields are responsible for technological advances in areas such as: medical practices, communication, technology, education, and economics. Obama also noted that our science and math rankings are lagging internationally, half of the students who major in STEM disciplines in college do not work in those fields, and this is "unacceptable" in the competitive global economy (U.S. Department of Education, 2015).

In any given math or science class, some students may naturally be interested in the subject or wish to seek a career in a STEM related field; however, other students may take the classes only as a requirement and have no real interest in the subjects. Coxon (2012) reminded that greats such as Darwin, da Vinci, Einstein, and Michelangelo relied on their special and artistic creativity along with their mathematical and scientific knowledge while making lasting impacts on society through their works. Students' interests and abilities in STEM may be sparked and improved by learning the content in conjunction with arts. This novel approach has surfaced as a means to engage students, equip them with the necessary skills related to creativity, innovation, critical thinking, and problem solving so that they may become the generation to make impactful contributions to society and the economy.

Background, Context, and History

At the end of the 20th century, a push to include engineering in the attention being given to the science, technology, and mathematics educational focus led to what is now commonly known as STEM education (Bequette & Bequette, 2012). Similarly, the beginning of the 21st century is witnessing a movement to include arts in STEM education, which is referred to as STEAM (Bequette & Bequette, 2012). The Rhode Island School of Design (RISD) is credited with creating the "STEAM movement" (Gunn, 2017; Zalaznick, 2015). The STEAM movement is believed to be a way to ensure America's economic success in the 21st century; its objectives include: transforming research policy by placing arts and design at the center of STEM, encouraging art and design integration in K–20 education, and influencing employers to hire artists and designers to drive innovation (RISD, 2018).

Numerous research studies have been conducted in relation to STEM education, which became an educational focus following the Sputnik era and development of NASA (Marick Group, 2016). STEM is presently a common curriculum found in many school districts. STEAM education, however, has limited research due to the fact that it became more of an educational practice in the 2000s (Jones, 2014). Additionally, a growing number of researchers are showing that creativity and innovation can enhance STEM curriculum by including arts in STEM instruction (Adding Arts to STEM, 2012; Bequette & Bequette, 2012; Jones, 2014; Sharapan, 2012). As a result of benefits associated with STEAM, more educators are choosing to institute a STEAM curriculum in answer to a call to increase the amount of students interested in STEM and who decide to pursue STEM careers.

Just as the move to STEM education initially received some opposition, opponents of STEAM do not see the need to merge content areas (Adding Arts to STEM, 2012; Bequette &

Bequette, 2012). However, the integration of content areas may better prepare students for the real world. Educators, charged with a call to increase the number of students who are interested in STEM related fields, face the decision of whether to keep the status quo or take a risk to embrace a new method, such as STEAM, for educating students in STEM courses. Fullan (2001) referred to schools as living systems and suggested that remaining in a state of equilibrium while change occurs around the living system can be a precursor to death. Despite recognizing the beneficial skills that art can add to STEM, a debate still ensues in the professional realm as to the need for the STEAM movement. Proponents acknowledge that more data are needed to support the movement; whereas opponents have suggested that arts and STEM both benefit learning, yet the fusion of the two may take away from their distinctive qualities (Adding Arts to STEM, 2012).

Fullan (2001) further noted that educators can become frustrated when multiple programs and initiatives are implemented in a school system. Such frustrations may be alleviated by the manner in which programs are implemented. As the body of knowledge surrounding STEAM education increases, those who make the transition from STEM to STEAM may be better prepared by having reliable resources available to assist with the transition. Because current research studies indicate that STEAM education increases engagement in STEM courses (DeJesus-Rueff, 2016; Gaskins, 2014; Lahana, 2016; Leysath, 2015; Morris, 2015), teachers may consider making a transition to implement a STEAM curriculum.

Not only do students need to be prepared through the educational system for future success in their careers, but teachers also require additional training and education to stay abreast of the best ways to instruct their students. As the number of educators who choose to prepare their students through STEAM instruction increases, more information is needed to ensure their success. The context of this study is to explore how content teachers make the transition from STEM to STEAM by identifying the steps taken during the transitional process and noting the perceived challenges related to such a transition.

Statement of the Problem

While the prospect of teaching a STEAM curriculum may seem worthwhile to some teachers, the actual task of transitioning from one's traditional manner of instruction to a new method may seem daunting. Teachers typically are certified in a particular content area or closely related areas, so incorporating material from a seemingly unrelated content area may pose a challenge. Therefore, the problem is to identify ways for how content teachers may transition from a traditional curriculum to a STEAM curriculum.

Purpose and Research Question

Educators are tasked with piquing the interest and adequately preparing students to enter into STEM fields. With increasing momentum over the years, some educators have decided to join the STEM to STEAM movement. As other educators contemplate joining this movement, they may not have clear understandings of STEAM, or how to change their current curriculum to a STEAM curriculum. Hence, my study sought to identify steps taken by teachers who transitioned to STEAM instruction while noting their processes taken and perceived challenges encountered.

As researchers find favorable results with the STEAM initiative, the experiences and practices that educators have pursued to implement programs may be of value to their peers who also desire to incorporate a STEAM curriculum. Qualitative research explores a phenomenon or process in the natural setting, and interacts with the participants to obtain multiple perspectives while identifying emergent themes that lead to inductive understanding of the issue (Creswell, 2008). My qualitative study investigated teachers of different content areas by exploring the processes they underwent to implement a STEAM curriculum. Based on the problem and purpose of this study, the research question became: How do content teachers transition to teaching a STEAM curriculum?

Rationale, Relevance, and Significance

Insights into how a teacher transitions to a STEAM program will be useful for educators who decide to embrace this new educational phenomenon. Booth, Colomb, and Williams (2008) suggested that research topics should not just be significant to the researcher, but to others in the field as well, while addressing the question of “so what?” The movement from STEM to STEAM becomes an instructional focus that proposes to enhance existing STEM goals by creating more interesting and relevant educational experiences which focus on improved skill sets and interests in STEM careers. Current research provides evidence to support the benefits for students who experience learning through STEAM. Most of the research is primarily focused on the arts practices used in traditional STEM courses to reflect STEAM. Considering the fact that the arts are just as an important component of STEAM as the STEM component (Gunn, 2017), more attention should also be provided for the effects of providing STEAM in the arts. Herro, Quigley, and Dsouza (2016) recommended that future studies in STEAM implementation not only look at STEM subjects, but also include the arts. This qualitative study aims to add to the limited, yet growing, body of knowledge on STEAM education by exploring how STEM as well as arts teachers transition to STEAM.

A closer look at the processes involved with transitioning to a STEAM curriculum may allow other educators to have smooth transitions to STEAM, which will maximize the potential benefits of STEAM education and add to the body of knowledge surrounding the STEM to

STEAM movement. Other educators may benefit from the findings of this multiple case study by learning what the process looks like for a transition to STEAM. Common themes may arise from the study indicating certain practices to incorporate for finding resources and planning lessons. Certain challenges may also surface as a common theme. As a whole, the findings of this study may provide guidance for others who choose to transition to providing a STEAM curriculum.

Definition of Terms

The following terms are defined for the purposes of this study:

Arts. The broad range of content areas which include fine arts, performing arts, and the humanities are referred to as the arts. Visual arts, music, English, and social studies are examples of the arts (Great schools Partnership, 2015).

Curriculum. The lessons and academic content taught in a school, specific course, or program is represented by the term curriculum (Great Schools Partnership, 2015).

STEAM. The acronym used to indicate the inclusion of arts in science, technology, engineering, and mathematics; whereas, arts includes fine arts, performing arts, and the humanities (Herro, Quigley, & Dsouza, 2016).

STEM. The acronym used to refer to science, technology, engineering, and mathematics in the career fields and in educational curriculum (Hallinen, 2017).

Assumptions and Limitations

Assumptions and limitations help to shape the results of the research. Assumptions are the researcher's preconceived beliefs and limitations are the reported constraints (Creswell, 2014). A discussion of assumptions and limitations may provide transparency of the reporting and possible shortcomings of the research.

While this case was exploratory in nature, certain preconceived assumptions were held by the researcher. Each of the participants were assumed to have followed a documentable procedure during her transition to teaching a STEAM curriculum. Participants were also assumed to provide honest and true responses during the interview and focus group sessions. Participants were also assumed to provide authentic supporting artifacts and documentation throughout the data collection process.

Time constraints, sample size, and setting are factors that imposed limits to this case study. Qualitative studies generally produce thick, rich descriptions of the phenomena being studied; however, the data collection, data analysis, and interpretation processes can be time consuming (Creswell, 2014). One-on-one interviews, a focus group, and review of relevant documentation served as data collection sources; each required time to gather, sort, analyze, and report.

The sample size was limited due to the amount of available participants who meet the requirements of the study. The school district's setting is one where no schools are required to implement a STEAM curriculum. Therefore, the available population was limited to teacher participants who voluntarily teach a STEAM curriculum.

Summary

The number of students graduating and entering STEM careers may not be sufficient to fulfill the available positions, which could pose a threat to the country's technological and economical advancements (Partnership for 21st Century Learning, 2007). Educators may assist with this potential problem. STEAM has been associated with an increase in students' STEM engagement and skill levels (Borsay & Foss; DeJesus-Rueff, 2016; Maguire, Donovan, Mishook, de Gaillande, & Garcia, 2012).

This study was developed to discover how content teachers transition from teaching a traditional curriculum to teaching a STEAM curriculum. Knowledge gained from this exploration may assist other educators who decide to make a transition to teach STEAM. The remainder of this dissertation describes in more detail what is known about the STEAM movement and how this study adds to the body of knowledge.

Chapter 2 provides a review of existing literature. A conceptual framework is provided that supports the research. A review of methodological literature and issues are discussed, followed by a synthesis and a critique of previous research before the summary.

Chapter 3 describes the procedures of the study. The research purpose and question are restated followed by a discussion and choice of the design. Population, sampling method, instrumentation, data collection, and analysis procedures are shared. Design limitations, validation, credibility, dependability, and transferability are discussed. Finally, expected findings, ethical issues, and the chapter summary are provided to close out the chapter.

Chapter 4 presents the data along with an analysis and discussion of the results. Data is presented in the forms narratives and tables. The data was analyzed with respect to the guiding question of how teachers of different content areas transition to teaching a STEAM curriculum.

Chapter 5 contains the conclusion and discussion for how well the problem was addressed in this study. Results are also discussed in terms of existing findings in the field. Finally, suggestions are made for future research to be conducted as related to this topic.

Chapter 2: Literature Review

Prominent sources have contributed to the background of STEAM. The Department of Education, under the leadership of President Obama, partnered with various organizations to promote a STEM (Science, Technology, Engineering, Math) initiative that focused efforts and funds toward better preparing teachers and all levels of students with the tools needed to be successful in the STEM fields. Ken Kay, president of the Partnership for 21st Century Learning (P21), proposed that "U.S. education can and should be doing more to prepare our young people to succeed in the 21st century. Skills such as problem solving, innovation, and creativity have become critical in today's global economy" (Partnership for 21st Century Learning, 2007, para. 12). In addition, P21 recommended that all teachers use instruction that focuses on four C's: critical thinking and problem solving, communication, collaboration, and creativity and innovation. Perhaps thinking of daVinci, Einstein noted that the greatest scientists were also artists, stating how "imagination is more important than knowledge" (Calaprice, 2000, p. 10). As a musician and one who thought in terms of images before words and equations, Einstein is a powerful example of how being creative can enhance logic and problem-solving skills in the sciences (Root-Bernstein & Root-Bernstein, 2010).

Along with home and religious institutions, schools play an important role in shaping society through lessons taught to students. School mission statements generally incorporate aims to develop students socially, emotionally, and mentally so that they can be creative and productive citizens (Center for School Change, 2017). In efforts to produce such citizens, some educators are embracing the movement to adjust STEM curriculum to include the arts, also referred to as STEAM curriculum (Adding Arts to STEM, 2012).

While critical thinking, communication, and collaboration are considered to be related to STEM classes, a growing number of researchers are showing that creativity and innovation can enhance STEM curriculum by including arts into STEM instruction (Adding Arts to STEM, 2012; Bequette & Bequette, 2012; Jones, 2014; Sharapan, 2012). More educators today are also transitioning from STEM to STEAM education (Jolly, 2014). An expanding amount of national and international attention to this novel instructional approach necessitates an in-depth exploration of the practices used by STEAM teachers, including nontraditional STEM teachers (Herro, Quigley, & Dsouza, 2016).

Problem, Purpose, and Research Question

Once a teacher decided to take a journey to teaching STEAM, certain steps were followed in order to have a successful transition. A novice STEAM teacher may not be aware of where to start the journey. The purpose of this study was to explore how content teachers transition to STEAM. In order to address this problem, the guiding question of the study became how do content teachers transition to STEAM?

Organization

The remainder of this literature review is divided into six sections. The conceptual framework immediately below is followed by a review of literature and methodological literature. Next, a review of methodological issues is discussed, followed by a synthesis of research findings and a critique of previous research, ending with a summary of the literature that situates and justifies the research question.

Conceptual Framework

Conceptual frameworks are informed by research and help to guide research. Ravitch and Riggan (2017) described conceptual frameworks as superstructures for the work composed of "personal interests and goals, identity and positionality, topical research, and theoretical frameworks" (p. 9). Early exposure to STEM programs influenced my decision to major in physics as an undergraduate student and to later become a science teacher with a goal of inspiring students to pursue STEM related careers. Government and private industries have noted that an increasing amount of STEM jobs need to be filled presently and in the future, yet the number of qualified candidates is not sufficient to fulfill the demand (NEA, n.d.; P21, 2007). Hence, educators are charged with finding ways to increase students' interest and abilities to enter STEM related career paths (U.S. Department of Education, 2015).

The movement of adding arts to STEM education, known as STEAM, is one proposed solution for increasing the number of students who are properly educated and interested in STEM fields. Educators play an important role in the movement to use STEAM initiatives to increase student engagement in STEM and promote interest in STEM careers. A teacher's understanding and implementation of STEAM instruction may determine the success rate for increasing the number of students who become engaged with STEM and opt to pursue careers in the field. Teachers ultimately provide instruction based on their individual teaching styles; however, understanding the process involved with moving from a traditional STEM or arts curriculum to a STEAM curriculum may enhance the goal of increasing the number of students interested and able to pursue STEM careers (see Figure 1).

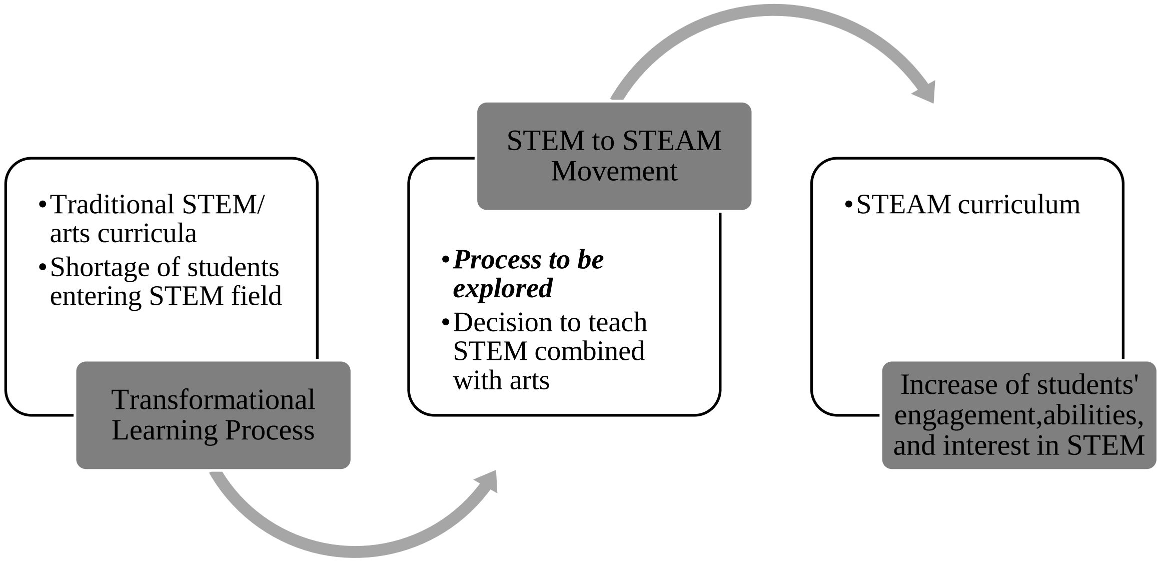

Figure 1. How teachers transition from a traditional curriculum to a STEAM curriculum.

Influenced by the transformational learning process (Mezirow, 1991) teachers may change their perspectives of teaching a traditional science, technology, engineering, and math (STEM) or arts curriculum to a transdisciplinary approach of adding arts to STEM known as STEAM. The process that teachers follow to transition from the former to the latter curriculum is left to be discovered. However, the benefits are expected to increase students' engagement, abilities and interest in STEM careers.

While STEM subjects traditionally have a connection surrounded by analytical and critical thinking processes, the arts tend to involve more abstract and creativity skills; therefore, presenting a likely challenge for teachers from the respective content areas to incorporate multiple content areas during instruction. Mezirow (1991) posited how adult learners change their perspectives during the transformational learning process, which then can "bring great power to social movements" (p. 194). Teachers who believe in a need to prepare and encourage more students to enter STEM careers may be more willing to step outside of their comfort zone of only teaching STEM or art subjects in traditional, isolated ways.

Teachers who decide to change from implementing a traditional curriculum to a STEAM curriculum may do so because of a transformational experience. Mezirow (2000, p. 22) suggested that transformations occur in some variance of the following 10 steps:

1. A disorienting dilemma;
2. Self-examination with feelings of fear, anger, guilt, or shame;
3. A critical assessment of assumptions;
4. Recognition that one's discontent and the process of transformation are shared;
5. Exploration of options for new roles, relationships, and actions;
6. Planning a course of action;
7. Acquiring knowledge and skills for implementing one's plans;
8. Provisional trying of new roles;
9. Building competence and self-confidence in new roles and relationships;
10. A reintegration into one's life on the basis of conditions dictated by one's new perspective.

I believe that teachers who transition to STEAM on their own accord will experience these steps of transformational learning. A teacher may find the dilemma to be students are not currently being adequately prepared with the 21st century skills needed to enter the workforce upon completion of their formal educational training. The teacher may feel a sense of guilt if he or she believes that the best educational environment has not been provided to better equip students with the needed abilities and skills. Reflection is often a part of a teacher's role; a critical or deeper reflection may cause the teacher to reassess her beliefs of how education should be provided to students. A teacher may at some point recognize that her discontent with the status quo is a view shared by other educators as well. The teacher may then begin a search to find new ways to teach, deciding that STEAM would be a worthy option. The teacher would then need to plan a course of action to begin implementing STEAM instruction. In the process, the teacher would need to learn more about STEAM and acquire the skills needed to implement it. Next the teacher may try out new teaching practices as a STEAM teacher. The teacher's confidence may be increased as success is achieved with implementing STEAM. Finally, the teacher may have a new perspective that understands STEAM is an appropriate way to teach students and preparing them with 21st century skills and abilities.

Review of Literature and Methodological Literature

The background of a study shared in a literature review presents a story in the form of an argument of discovery, sharing what is known about a study topic (Machi & McEvoy, 2012). STEAM education is relatively new compared to traditional STEM education. Studies are gradually adding to the body of knowledge regarding the aforementioned phenomenon, framing its picture in academia. Recent research findings of the STEM to STEAM movement and methodological trends are used to present what is currently known in the educational field and how we know it.

STEM Initiatives

While the late 1950s is noted as the time when a focus on STEM was formed in the U.S. due to the Sputnik era and the development of NASA, STEM as an educational focus began in the 1970s and 1980s (Marick group, 2016). STEM is considered to be project based learning that integrates at least two of the contents that make up its acronym. The goal of STEM education was to prepare students for the 21st century workforce that would be needed to keep the country in competitive economic standing for the current century. President Obama announced that the STEM education focus would move American students "from the middle to the top of the pack in science and math over the next decade" (The White House, Office of the Press Secretary, 2009, para. 1). Numerous programs and funding have been put into STEM to advance this goal.

In order to make STEM more credible and clearly defined as to what and how it should be taught, standards and frameworks were developed (Bartholomew, 2015). The International Technology and Engineering Educators Association (ITEEA) developed various educational resources over the years to promote STEM including a Standards for Technology Literacy publication (2007). ITEEA listed both content and activity based objectives for teachers. Similarly, the Next Generation Science Standards (NGSS) developed a set of cross cutting concepts that could be addressed through core science areas including, life sciences, physical science, earth and space science, and engineering and design (2014). The National Research Council (NRC, 2015) provided a new vision for science education based off the NGSS standards; the vision placed the teacher in more of a facilitator roll who guided student learning through inquiry and project based learning. As of 2019, NGSS standards have been adopted by 20 states and the District of Columbia (NGSS, 2019).

Despite the national efforts that have been put into STEM, the United States is still considered to be "in the middle of the pack" for math and science compared to other countries (Desilver, 2017). After highlighting several successful STEM programs that were in operation throughout the country, Gomez and Albrecht (2014) commented that STEM has still fallen short due to a lack of effective changes in the classroom and ineffective local educational policies. These shortcomings are noticed on the college level as well. Ramsey and Baethe (2013) "concluded that instruction and drill to pass standardized tests" are insufficient methods to prepare students to be future STEM majors, students need improved writing, mathematics, and critical thinking skills along with the ability commit to duty in order to achieve long-term goals

(p. 32). The goal appears to be accurate for STEM education; however, the approach does not seem to be as effective as desired because the nation is not seeing improvements in students' STEM achievement.

STEM to STEAM Movement

The STEAM movement seeks to replace STEM education with STEAM because of the increased benefits associated with STEAM (Maeda, 2013). Like STEM, STEAM is being promoted as a means to prepare students for the 21st century workforce. Numerous research studies have been conducted in relation to STEM education and as mentioned in the previous section, the goal of STEM has not fully been reached through prior STEM efforts. The alternative STEAM educational approach has limited research due to the fact that it became a more standard educational concept in the 2000s (Jones, 2014), yet current research has presented favorable findings.

Such favorable findings has led to an increase in the number of schools, districts, and other educational institutions that use STEAM. The Rhode Island School of Design (RISD) was one of the original institutions which championed for STEAM, it's president stated design, a major component of STEAM, "creates the innovative products and solutions that will propel our economy forward" he continued that art and science are better together as they both seek to find "truth and beauty" (Maeda, 2013, p. 1). More institutions of higher education are promoting STEAM as well. According to their respective websites, Clemson University; Concordia University–Portland, and University of San Diego offer Mater of Education degrees with specializations in STEAM. More states are also addressing STEAM in their educational policies. Georgia and Ohio offer STEAM certification to schools, Nevada has requirements for students to receive a STEAM designation on their diploma, Rhode Island has a STEAM coalition that addresses educational policies, and South Carolina has a STEAM Implementation Continuum that provides guidance and establishes consistency in STEAM practices (Dell'Erba, 2019).

STEAM Impacts on Students

Integration of arts into STEM is believed to be the factor that will better prepare students for the 21st century. The increased use in STEAM trends may be a result of positive impacts on students as reported by research associated with this approach. Wilcox (2014) reported on the historical evidence and even medical findings which suggested a correlation between a success in STEM and a success in arts. STEAM is said to increase students' engagement with STEM, performance in Science and Mathematics, increased capabilities, and with abilities that form relevant connections.

Student engagement. Art integration in STEM has been examined in various environments including science and math classes from elementary to undergraduate levels. Students have shown increased engagement with STEM courses when STEAM has been used. In one study, specific visual art pieces were used to teach mathematical concepts, the art work was credited with increasing student engagement (DeJesus-Rueff, 2016). Similarly, Deepa (2014) found that students were more interested in STEM content after interacting with an art fractal kit. Another study noted that pre- and post-test scores were not significantly different in a middle school social studies class; however, students who completed a STEAM project were more engaged as they wrote reports on a social awareness topic compared to the control group of students who conducted traditional research and wrote reports on the social awareness topics (Lahana, 2016). An art teacher and a chemistry teacher in a Texas high school collaborated on a STEAM project to integrate pottery lessons with learning stoichiometry, student interviews showed that students developed a more positive attitude towards chemistry by the end of the project (Leysath, 2015). Non-STEM undergraduate majors indicated during a group interview that they became more engaged in their STEAM health science course when the professor integrated storytelling as part of the class lectures (Morris, 2015). Pre- and post-surveys found that middle school students' perceptions of science increased after using a digital science game to enhance their learning (Li-Wei, 2009).

Another form of engagement that surfaced during the review of literature was play. Hallowell (2011) stated, "Without play, peak performance is impossible;" he equated play to imaginative engagement (p. 113). Student opportunities to "play" demonstrated creativity (Borsay & Foss, 2016; Ernest, 2016; Thwaits, 2016). Ernest (2016) observed play as students interacted and discussed art pieces in terms of geometry. Third graders experienced play as they learned about sound while creating musical instruments (Borsay & Foss, 2016). During a case study which looked at the use of STEAM at the Exploratory Museum, Thwait's (2016) identified three categories of play: social, creative, and object play, which engaged patrons of all ages.

Increased capabilities and performance. Integration of arts in STEM courses appeared to increase students' capabilities and academic performance. STEAM instruction helped students to improve capabilities, such as making arguments, posing problems, and reasoning abstractly (Conley, Douglass, & Trinkley, 2014; Ernest, 2016; Maguire et al., 2012). This may have been a result of increased engagement with STEM due to art interventions. Other studies listed improved academic performance as a result of art integration (Borsay & Foss, 2016; Maguire et al., 2012; Rabalais, 2014).

Some recent studies have provided data regarding the effects of an art intervention on student's capabilities. Conley's et al. (2014) qualitative study observed a learning environment where art from museums and other outside excursions was integrated with the observe, describe, interpret, and prove (ODIP) model; participants were found to use abstract mathematical thinking, posing arguments from discussions, and examining multiple aspects of a problem. Ernest (2016) observed some participants demonstrating increased inquiry skills and abstract reasoning after their undergraduate math professor had placed them in groups to discuss pieces of art in relation to mathematical concepts. DeJesus-Rueff (2016) also found that as teachers collaborated and strategically implemented art pieces into math tasks in the classroom, students demonstrated higher-order thinking, cognitive demand, and academic language. Each case suggested that art as an intervention in STEM enhanced participants' capabilities.

Another study found arts integration to be linked with student academic performance and self-reported capabilities. Maguire et al. (2012) used mixed methods research to examine students' capabilities in five arts based urban high schools. They referenced Sen and Nussbaum's (1993) capability approach (capabilities, functions, and agency) to develop questions related to practical reasoning: educational resilience, knowledge and imagination, learning disposition, emotional integrity, social relations, as well as respect, dignity, and recognition. Overall, 68% of students in the schools identified access to various arts pathways in and out of class as a factor in their capabilities. A breakdown of students' prior year grades revealed that "A" students identified themselves higher in capability functions, while decreases in each letter grade saw a corresponding drop in capabilities.

Making connections. Another notable finding recognized in the STEM to STEAM movement is the ability for students to make pertinent connections. Students found the integration of art and science to be relevant to their lives and allowed them to transfer skills (Leysath, 2015). Ernest (2016) identified two participants who supported the claim that STEAM allows students to make personal connections. One participant stated that the notion of yin and yang from his martial arts involvement inspired his art piece, while the second participant was inspired by her passion for dance as she used spirals in her picture of dancers. Auto-ethnographers observed that arts, engineering, and architectural landscape students collaborated and had an opportunity to work on tasks that they may realistically encounter during their careers; they reported the STEAM experience “provided a space for all of us, students and instructors alike, across all three disciplines, to ‘dig deeper’ and make personally relevant connections between materials, design, society, and the natural environment,” (Shochacka, Guyotte, & Walther, 2016 p. 25).

Teacher’s Role in STEAM

In addition to the impacts on students, STEAM research has considered the teacher’s role in STEAM. In order for STEAM to be properly implemented, teachers should be intentional in their delivery to allow the arts just as much room in the lessons as the STEM content (Bequette & Bequette, 2012; Gess, 2017). In order to maneuver the transition to STEAM as an educational approach, teachers need training, guidance, and resources. Studies have looked at the effects of teacher preparation programs as well as teacher practices.

Teacher preparation. Teacher preparation is a key component needed for teachers to properly implement STEAM in the classroom. One notable manner in which teachers have been prepared to integrate arts and STEM content together is through partnerships with local universities. As discussed in the STEM to STEAM section, institutions of higher learning are beginning to offer courses and certifications in STEAM. As local schools and school districts move in the direction of STEAM, they have found mutually beneficial roles by partnering with those colleges and universities to provide STEAM education for teachers.

After being inspired by Maeda at a STEAM conference, McGarry (2018) led a partnership between the university where she instructed and an elementary school. The partnership consisted of preservice art teachers serving as instructors and mentors for elementary school teachers in a school that was transitioning to STEAM. The example shared in the study shared how preservice teachers collaborated with the elementary school teachers to choose a topic that was to be implemented in the class. The art teachers planned lessons for a civics unit on "community." Two pieces of art work were chosen by the preservice teachers to be used during the civics on teaching to enhance student learning. By the end of the lesson, students had created their own art work and wove them into a model that represented their own community.

Another partnership was formed between preservice middle school mathematics teachers at an Ohio university and the Columbus Museum of Art. Using the Common Core State Standards in Mathematics, the museum collaborators taught the preservice students how to integrate arts into mathematics by using their ODIP Model. The ODIP model mirrored the scientific method. Participants learned to use a piece of art practice critical thinking skills. First, participants *observed* the art piece using their senses to study it deeply. Second, they *described* the art work highlighting the most important features. Third, they were asked to *interpret* the art work in a greater context based on the discussion of descriptions provided by the other participants. Fourth, they were asked to *prove* their claims based on supporting evidence from the discussions in the first three steps. Participants found value in this training because they were engaged during the process and by the end of year long course found that the ODIP model actually supported with three of the math standards that they were required to teach.

Aside from preservice programs, teachers used professional development opportunities to acquire training to implement STEAM. A school district in the southern United States partnered with a local university to design three courses to be used as STEAM professional development opportunities (Herro et al., 2016; Herro & Quigley, 2016). Project-based Learning and Digital Media and Learning were both offered for graduate credits, and a Reflective Practitioner course was designed as a professional development course where the research/ teacher educators continued to provide support during the implementation phase of STEAM units developed during the summer. A separate school in a South Carolina school district which promoted STEM, branched off to move toward STEAM after the STEM efforts at the school were unsuccessful (Hunter-Doniger & Sydow, 2016). That particular school received a state grant which allowed four art teachers, two non-art teachers, and an administrator designated as the school's core STEAM leadership team to receive up to six professional development trainings which they would use to help train the rest of the school in STEAM. Both of these studies are discussed further in the section on teaching strategies.

Teacher collaboration. Collaboration is a valuable aspect for teacher preparation and implementation of STEAM curriculum. One collaborative experience between a teacher and a dance teaching artist allowed students to learn about energy while covering content from both science and dance (Simpson Steele, Fulton, & Fanning, 2016). Another collaboration noted as "unlikely" allowed a university to partner with a nonprofit art group to provide a STEAM unit where K–12 students were afforded an opportunity to learn about volcanoes within their own local environment (Gates, 2017). Collaboration appeared to be one avenue to success by bridging the gaps between multidisciplinary subjects for STEAM teachers.

Project based learning. One of the components of STEAM is to implement project-based learning. Quigley and Herro (2016) found that 16 out of 21 teachers in a longitudinal case study used project based learning. Examples included a project where students had to design ways to improve the school's electrical units after learning about electricity and magnetism, one group chose to design student desks with outlets so that they could charge their devices. Another teacher had students to use design a strong, yet lightweight tower which the students researched and were able to build a tower made of straws which was able to hold a tennis ball. A different teacher used a project based learning project where students had to program robots to perform three difficult tasks that would be associated with lawn care (Herro & Quigley, 2016). Collaboration between the students also appeared to be strategy used by the teachers that most often was used in conjunction with project-based learning.

Transdisciplinary teaching. Teachers also used transdisciplinary teaching strategies when implementing STEAM. Teachers used performing arts to have students create a dance routine as they learned their vocabulary lists and act out scenes to recreate history scenes (Hunter-Doniger & Sydow, 2016). Art and science were integrated when teachers had students to create a model of the human body system which helped them to understand the design and functions of the individual components (Quigley & Herro, 2016). These examples reiterate that transdisciplinary teaching is not simply adding art to a lesson such as coloring parts of the human body system, but students were actively learning about modeling as a concept for art while learning about the human body system.

Technology integration. Teachers used technology in various ways to implement STEAM as well. Technology was used in the form of tablets to perform research. Teachers had students to research sound and musical instruments (Borsay & Foss, 2016). While having students to complete a project concerning a social action project, teachers allowed the use of technology to perform research (Lahana, 2016). Problem-solving tasks were even assigned through Google Docs in one class (Quigley & Herro, 2016). Technology was also used when students worked with robotics to code and program commands (Herro & Quigley, 2016) Digital science games were used to increase student understanding of science concepts (Li-Wei, 2009).

Teacher as facilitator. Another practice used by teachers was to change their role from direct instructor to facilitator. One teacher noted that it took time to get used to allowing the students to direct their own learning through project based learning, but the process increased student engagement (Herro, Quigley, Dsouza, 2016). After going through professional development, teachers in one school were able to create a "studio-like environment" where students learned from their experiences more so than direct instruction (Hunter-Doniger & Sydow, 2016).

Methodological Literature

Qualitative research allows researchers to explore and understand the meaning that individuals or groups ascribe to a social or human problem (Creswell, 2014). In studying the STEM to STEAM movement, most available research has used qualitative research to explore this relatively new phenomenon in educational instruction, while quantitative and mixed methods have also been used to lesser extents. Stake (2010) describes qualitative research as being experiential, interpretive, situational and personalistic, aiming to describe the complex background, and relating the study to similar cases while highlighting its uniqueness. The purpose and research question of the study should guide the method used. Qualitative research tends to address *what* and *how* questions.

Relevant studies related to my study topic have taken the qualitative approach. Quigley and Herro (2016) examined the implementation of a STEAM program, asking, "What do STEAM practices look like when enacted in middle school classrooms? Specifically, how do teachers make sense of STEAM practices within the context of their teaching environment?" (p.

411). This study seeks to explore how content teachers transition from a traditional art or STEM curriculum to a STEAM curriculum; therefore, a qualitative approach will follow in the steps of previous investigations in this area of research.

Methodological Issues

Social scientists are more thorough than lay persons when it comes to measuring, sampling, and analyzing; however, researchers cannot cover everything due to limitations and imperfections, which opens up their research to critiques (Harris, 2014). Qualitative research has been known to provide rich descriptions for a particular phenomenon that has been examined. However, some weaknesses associated with qualitative research have been identified: time consumption, researcher's personal bias, and lack of transferability (Johnson & Onwuegbuzie, 2004). Analysis of previous research designs' strengths and weaknesses will be used to justify my choices in relation to methodological approach.

Time

Time constraints are an issue when it comes to collecting and analyzing data during qualitative studies. Both Ernest (2016) and Thwaits (2016) mentioned that having an over-abundance of available data proved to be an issue when determining what to include in their respective case studies. Sorting through, organizing, and coding data to identify common themes can take a considerable amount of time.

While time is an issue for qualitative studies, it is needed to complete valid and reliable research. Researchers need time to engage participants and build trust, learn the culture, and search for distortions injected by the researcher or participants (Creswell, 2008). Time is also needed to triangulate data through various methods, such as, interviews, observations, and taking detailed notes. The process of sorting and analyzing data may also be time consuming, though necessary, to provide thick and rich descriptions of a phenomenon or process.

Bias

Not only does qualitative research present issues for time with data collection and analysis, but the researcher's biases are more likely to influence the results than in quantitative methods (Johnson & Onwuegbuzie, 2004). Ernest (2016) suggested that he may have been biased when selecting his participants for the study because he knew which students reacted favorably to the arts-integration project. A researcher's bias can affect results not just from participant selection, but also when identifying and analyzing themes. Preconceived ideas of a specific outcome may taint the observers lens when sorting and analyzing data. St. Onge (2009) acknowledged that the researcher was a member of the participants' community, so interpretation of participants' responses may have included personal bias.

Bias can enter qualitative research via the researcher or participant; however, researchers often acknowledge their biases up front. Creswell (2008) stresses clarifying researcher bias so the reader will understand the researcher's position as related to past experiences, bias, prejudices, and orientations that have likely informed the interpretation and approach to the study. Creswell further identified peer review and debriefing as validation strategies to keep the researcher "honest" during qualitative research. Such strategies may be useful to limit bias after a peer review or debriefing session is used to question methods, meanings, or interpretations.

Transferability

Another challenge regarding qualitative research is transferability. A unique case study which follows Stake's (1985) intrinsic approach, for example, may yield results which are applicable to the particular case being studied. When results are primarily applicable to the case being studied, then transferability to other cases may not be as strong. Qualitative research can be limited to a certain population, small sample size, or very specific geographic location causing the results to only be meaningful to a specific audience. Results of a case study which examined the leadership practices used by three principals of high achieving schools may not be transferable because the study's geography was confined to the midland of South Carolina (Williams, 2006). Likewise, Sheppard and Brown (2014) examined the leadership role involved with integrating technology into schools in a Canadian providence; the governing school system in that providence may differ from other countries or even other providences. This is why transferability is left to the reader who resides or works with a different context, and thus why a study should supply a thorough description of the setting, participants, findings, and research process.

Aside from geographical concerns, qualitative methods may include data from a relatively small number of participants compared to quantitative methods. Herro et al. (2016) looked at the practices of two STEAM teachers in their case study. An autoethnographic exploration experience of two researcher participants used their journaling and observations to describe the benefits of a STEAM collaboration experience between an arts and a technology class.

Despite limitations defined by location or sample size, qualitative researchers are able to give rich descriptions of the process being studied and can be fluid with the developments that occur during the research. Qualitative findings may also be relevant to a specific group of stakeholders connected to the study (Johnson & Onwuegbuzie, 2004). Beyond the specific study, qualitative research may set the stage for quantitative studies where the data can become more generalizable. A noted strength of qualitative research is the inclusion of triangulated data through multiple methods such as surveys, interviews, focus groups, documents, and observations Creswell (2008). Multiple sources of data can assist with framing, confirming, or disconfirming the findings about a phenomenon or process.

Synthesis of Research Findings

Synthesis of the literature review situated and provided insights into my research question. The STEM to STEAM movement is relatively novel, yet available research is beginning to present trends associated with the movement. Some benefits of using STEAM have previously been discussed in this literature review such as increasing student engagement, capabilities, and abilities to make relevant connections (Borsay & Foss, 2016; Ernest, 2016; Lahana, 2016). Teacher training and preparation are likely to have an impact on the successful implementation of a STEAM curriculum. Research findings show that arts are often incorporated into STEAM lessons primarily by STEM teachers who have been provided with educational training or professional development and collaborative opportunities (Herro et al., 2016; Hunter-Doniger & Sydow, 2016; Quigley & Herro, 2016).

As more educators express interests in STEAM, teacher training and preparation has surfaced as a need. In cases where the entire school or school district is moving toward STEAM, training is provided for instructors. Cook (2012) studied commonalities amongst STEAM schools noting that faculty members' training, background, and interests drove the STEAM instruction in the schools. School-university partnerships have been explored in regard to providing training. Teachers find the collaboration helpful when they have experts from the university level who not only provide general STEAM integration training, but who also provide services such as: specific professional development, lesson planning assistance, and co-teaching opportunities (Herro & Quigley, 2016).

In some cases, local universities have been the source to prepare teachers for their transition to provide STEAM education. Novice teachers may gain training through undergraduate or preservice training. Preservice training at a Texas university allowed students to perform peer reviews of STEAM lessons to compare and contrast levels of creativity demonstrated in group lesson plan presentations; perceived similarities amongst most levels of creativity were observed by the participants (Tillman, An, & Borman, 2016). Veteran teachers may also receive STEAM training through continuing education or graduate courses as did the participants in Herro et al.'s (2016) case study involving a math and a science teacher.

Another finding is that collaboration amongst educators appears to be an important component of successfully implementing STEAM. Collaboration amongst colleagues within a school such as an art teacher and a chemistry teacher can provide valuable cross-content learning through STEAM (Leysath, 2015). Gates (2017) described the benefits of an atypical collaborative experience between a university and a nonprofit organization who partnered with local schools to provide a memorable STEAM experience for students learning about volcanoes. Simpson Steele and Fulton (2016) described a collaborative experience between a public school teacher and a dance teacher who provided students with opportunities to explore real world problems while collaborating with peers and creatively modeling their comprehension of wind turbines and energy transformation.

In addition to collaboration, another STEAM practice used by teachers is to include project-based learning. This form of instruction places the teacher in more of a facilitator role. Students use various components of STEAM to investigate problems, design and pose solutions. These projects are typically applicable to real-world problems, so the connections tend to increase engagement.

Transdisciplinary instruction is another common practice of STEAM. Transdisciplinary teaching can be comprised of any combination of multiple disciplines that make up STEAM. The arts include visual, performing, and humanities art forms. Transdisciplinary approaches “blur the boundaries” between the content areas (Herro, Quigley, Dsouza, 2016).

By incorporating technology into lessons, teachers used another strategy that supports STEAM. Technology is represented by the “T” in STEAM, and it can easily be applied to lessons. One of the more noticeable uses of technology included the use of tablets to conduct research. Technology is also included in lessons when teachers use robotics and online games to enhance learning.

As teachers embark on a journey toward STEAM instruction, either under the direction of their school district or by individual choice, they may require some form of training or guidance. Research findings indicate that district-wide training, professional development, or higher education courses are prevalent sources for teacher preparation. Teachers who collaborate with other colleagues or experts are further enabled to provide students with creative lessons where they can become more engaged and make personal connections with STEM.

Critique of Previous Research

Boswell and Cannon (2009) stated that a critique should answer questions associated with the study’s purpose and research design. STEM education is fairly common place in most educational institutions; however, a push to move STEM towards STEAM is gaining momentum. As more educators decide to teach STEAM, a clearer understanding as to how teachers of various content areas transition to implementing a STEAM curriculum should be developed. Herro et al. (2016) conducted a study that explored two STEM teachers’ practices involved with implementing STEAM curriculum as part of a larger study designed to help provide a conceptual model of STEAM. They suggested that future research could include non-STEM teaching participants. Following Herro et al.'s (2016) study, my research sought to explore how various teachers made the transition to providing STEAM instruction in their classrooms. Unlike other studies, the exploration of these teachers transition process to STEAM was not a follow up to a specific school or district-related STEAM professional development.

While knowing that STEAM stands for including arts in STEM to promote creativity and interest in STEM, teachers may possess different understandings of STEAM. For example, in the Herro et al. (2016) study, the two participants had various understanding of what transdisciplinary instruction involved. One participant implemented transdisciplinary instruction individually while another participant felt that collaboration was needed for this component. Both teachers relied on technology and made adjustments to their teaching instruction throughout the year. Tillman's et al. (2016) study found that teachers' peer-review observations for STEAM lessons were ranked highest in the categories of creatively innovative and creatively connected, yet differences were found in the categories of creative choices and creatively challenging. This latter study further expresses the notion that teachers have various understandings of what quality STEAM instruction should like.

Since much of the available research examines STEAM from STEM teachers' perspectives, I posed a slightly different focus for my research, which included perspectives from art teachers. Whether researching STEAM in regards to teacher preparation or its impact on students, much of the research in the field looks at instruction provided within traditional STEM courses, science and math in particular. The STEAM acronym stands for science, technology, engineering, arts, and math; whereas, the arts component may encompass visual, performing, and humanity arts. As a major component of STEAM, art instruction which facilitates STEM learning would add to the body of research that is helping to shape STEAM.

I would like to help fill in existing gaps that are present in the STEAM movement research to help present a clearer picture of how teachers transition to implement STEAM. As presented in this critique, teachers may demonstrated similarities with regard to understanding and implementing STEAM in some aspects; however, differences still exist. Qualitative research was used to provide rich descriptions of phenomena and was especially beneficial in the developing stages. Therefore, my choice to use a qualitative approach to conducting research that addressed the question of how do content teachers transition to teaching a STEAM curriculum was appropriate.

Summary

STEAM has been introduced as a form of instruction to increase students' interest and engagement with STEM by adding a component of creativity via the arts. The STEM to STEAM movement is touted as one method to increase the number of qualified students who study and pursue STEM related careers. Creativity and innovation are skills that are desired in STEM fields which support technological development and economic growth.

In *My Pedagogic Creed* (1897), Dewey wrote:

> I believe that much of the time and attention now given to the preparation and presentation of lessons might be more wisely and profitably expended in training the child's power of imagery and in seeing to it that he was continually forming definite, vivid, and growing images of the various subjects with which he comes in contact in his experience. (p. 14)

Teachers have demonstrated that STEAM instruction increased student engagement, interest, and abilities in STEM content areas (Borsay & Foss; DeJesus-Rueff, 2016; Maguire et al., 2012). Creativity in lessons has appeared to help strengthen learning for students and teachers alike (Sochacka, Guyotte, & Walther, 2016).

Mezirow's (1991) transformational learning process and the STEM to STEAM movement supported the conceptual framework for this research (Bequette & Bequette, 2012). Educators who reflect upon and analyze their existing educational beliefs and practices may be led to try a different approach, such as those teachers who transitioned from traditional art or STEM instruction to STEAM. By teachers providing positive STEAM experiences, more capable students may elect to fill STEM jobs and benefit society.

Shortcomings in the available research include a lack of common understanding of STEAM amongst teachers and the process teachers take to provide instruction. Herro et al. (2016) conducted a case study that is part of a larger body of research, which will be used to develop a conceptual model of STEAM and suggestions for future studies involving non-STEM teachers. Hence, as situated in this review of the relevant literature, I planned to help illuminate the process of how teachers transition to teaching a STEAM curriculum through a multiple case study.

Chapter 3: Methodology

Qualitative research acknowledges that multiple realities may exist, including those of the researcher and participants. Guided by a social constructivist philosophy, the STEM to STEAM transition provides the basis for the conceptual framework that supports a teacher's decision to integrate STEM and arts content matter in lieu of the traditional curriculum. This study included the multiple realities of participants within one school district in Maryland. A multiple case study approach provided a look into the transition processes of the teacher participants.

Insights into how specific content teachers transition to STEAM adds to the literature that supports teachers who decide to make the transition from STEM to STEAM. Methodology for a qualitative study is often exploratory and inductive (Creswell, 2013). This approach was suitable because the qualitative study led to deep, rich descriptions of phenomena or processes that have not been widely explored. As such, I conducted a case study to add a closer look at how different content teachers transition to STEAM.

This chapter contains a detailed description of how the study was conducted, including the research question, study purpose and research design, choice of research design, the context of this study, along with the research population and sampling method, instrumentation, data collection, and data analysis methods and procedures. Finally, limitations and delimitations of the research design, validation, including credibility and dependability, and the expected findings, ethical issues, and chapter summary are provided.

Purpose and Research Question

The STEAM movement supports teachers being able to provide learning opportunities for students that allows them to obtain the necessary skills to achieve academic and career goals in the 21st century (Maeda, 2013). Mezirow's (2000) transformational learning theory supports the process that teachers went through in deciding to transition to STEAM. In efforts to represent my framework, and to help with a clearer picture of how a teacher transitioned to STEAM, the following research question was explored: How do content teachers transition to teaching a STEAM curriculum?

The purpose of my research was to discover how teachers from different content areas in a Maryland school district transitioned from teaching a traditional to a STEAM curriculum. Teachers within the school district are encouraged to use creativity, yet they are not required to provide instruction from the STEAM approach. Teachers experienced different challenges and successes as they transitioned to STEAM. Insights were gained by looking at the process of how teachers of different content areas moved from their respective traditional content-style of teaching to the integrated version of STEAM.

Research Design: Case Study

Qualitative research has an existential and constructivist epistemology (Stake, 2010), which reflects an interpretive philosophical approach. Approaches to research, according to Creswell (2013), are influenced by four philosophical assumptions: ontological (nature of reality), epistemology (how knowledge is acquired), axiological (values and biases), and methodology (research methods and procedures). Interpretivists, in some cases known as social constructivists, generally believe in multiple realities where knowledge is gained through understanding the process or experience while acknowledging the researcher’s values and biases used in observations and interpretations of phenomenon (Carr & Kemmis, 1986). My research was influenced by social constructivism as I consider multiple descriptions of reality from varying perspectives such as art, science, and math teachers.

Qualitative research has its own set of practices for developing rigor in a study. Definitions and characteristics of qualitative research evolve and vary by author, but common characteristics tend to be research conducted in a natural setting and the involvement of complex reasoning between inductive and deductive processes (Creswell, 2013). Distinctive characteristics of qualitative research include flexible designs, the use of triangulation with data sources, and the ability to address questions that may be difficult to answer especially in the absence of the researcher-participant relationship (Roller, 2013).

Herro et al. (2016) used a case study to explore the STEAM implementation practices of two middle school STEM teachers following an intensive STEAM course in efforts to help others conceptualize STEAM. This qualitative case study involved two participants from different STEM contents who taught in different schools in the same school district. Although they both completed the same graduate courses on STEAM, the research findings noted some variation in their views on STEAM-related instruction aspects such as transdisciplinary education. They both were unsure about student collaboration success, yet they each approached the inclusion of technology in the lessons in the same manner. Taking a similar approach, my research was conducted through a case study that explored how teachers of different content areas, including the arts, transitioned to STEAM. Insights gained from this study may help to clarify how content teachers transition from teaching a traditional content-based curriculum to a STEAM curriculum.

Based on this philosophical approach, my choice of research design stemmed from my purpose and research question. A research design, according to Yin (2009), should be based on three criteria: the type of question posed, the extent that the researcher has over behavioral events, and the degree of focus on contemporary versus historical events. Yin (2009) also suggested that *how* and *why* questions could be addressed through various methods; however, a case study is the best choice when the researcher has no control over behavioral events and those events are contemporary. As I investigated *how* content teachers transitioned to teaching a STEAM curriculum in their classrooms, I had no control over the existing behaviors and practices of the subjects involved with this modern phenomenon. Yin's (2003) multiple case study and Stake's (2003) collective case study allowed me to analyze within and across the case settings. Therefore, a multiple case study was a suitable approach.

Multiple case studies are similar to conducting multiple experiments where each participant is an individual case that comprises the larger study (Yin, 2003). A single case study would have been appropriate for a unique situation such as only looking at the transition process of an art teacher. Creswell (2013) prefers selecting unusual cases and maximizing variation as a means to describe multiple perspectives. The multiple case allowed each content teacher's transition process to be discovered individually as well as across the other cases.

Another factor that Yin (2003) posited is the use of the replication approach as opposed to the sampling logic which would look at the prevalence or frequency of respondents surveyed. Each case had some obvious contradictions to the expected results which Yin (2003) referred to as theoretical replication. I expected teachers to have some similarities in their transition process for implementing a STEAM curriculum, but obvious distinctions existed based on the grade level and content areas that teachers taught.

Research Population and Sampling Method

Data collection for qualitative studies involves several steps including locating sites or individuals (Creswell, 2013). The target population for this case study were STEAM teachers in a diverse eastern U.S. school district. Obtaining access and rapport to a site can be challenging in qualitative research; therefore, I attempted to identify and gain access to schools where teachers were known to use STEAM instruction in the district by contacting the science content specialist with whom I have had previous interactions and rapport as well as through recommendations from other teachers.

Once STEAM teachers were identified by the science content specialist and other teachers, contact began being made to seek tentative approval to access sites to conduct research. After necessary approvals were obtained the Institutional Review Board (IRB) and the district's Department of Research and Assessment, the principals were contacted via emails seeking permission to use their sites in the case study. As a stranger, *outside researcher,* to the institution or school site, pertinent information should be provided to help address concerns that leaders may have (Bogden & Biklen, 1992). The leaders were informed that their site was chosen due to its use of STEAM instruction, and that I planned to conduct interviews with STEAM teachers which may take place in the school setting. My presence would present minimal disruption and the data would be reported anonymously. Following approval to recruit and conduct research at the sites, recruitment emails were emailed to potential candidates along with a letter of consent (see Appendix A) to participate further detailed the purpose, rights, risks, and benefits associated with the study should participants agree to take part (Creswell, 2013).

Purposeful sampling was utilized during this case study to provide an in depth look at how a teacher transitioned to STEAM. Stake (2003) and Yin (2009) agree that case studies can be conducted in the form of single or multiple cases depending upon the focus. Creswell (2013) recommended that the number of cases, in this case study, school sites, not exceed four or five which should be sufficient to identify individual and cross-case themes. Hunter-Doniger and Sydow (2016) used one case site as they looked at a middle school's journey from STEM to

STEAM. Embedded in a larger longitudinal case study, Herro and Quigley (2016) used one case site to explore how a middle school teacher implemented STEAM instructional practices and in a similar case, Herro, Quigley, and Dsouza (2016) used two sites. Similarly, I chose to use at least two case sites with at least one teacher each representing science, math, and art content areas so that I could identify individual and cross-case themes.

As a part of recruiting participants, I specified how their ultimate selection was to be conducted. Selective criteria was used to determine the most relevant candidates for participation. Specifically, these criteria included:

- Three or more years of credentialed teaching in a public school;
- Used to teach a STEM or arts course, but currently teaches in a STEAM content area;
- At least one year of teaching in a STEAM curriculum.

A purposeful sampling strategy was used to identify participants who would “best inform the researcher about the research problem under examination” (Creswell, 2013, p. 147). As previously stated, participants were initially identified by the science content specialist at the school district’s board of education. The participants identified as teaching STEAM also needed to be a content teacher in one of the STEAM content areas: science, technology, engineering, arts, or mathematics. The number of years in which the participants have been teaching added to variation amongst the participants; however, participants needed to have more than one year teaching experience as this study was bounded by the transition to STEAM from traditional teaching. Teachers who have not taught in a traditional manner would not have been good informants for this study, since they would not have experienced a transition to STEAM.

Instrumentation

In order to triangulate data, semistructured interviews, a focus group, and documentation review were implemented. I also designed a five-question questionnaire designed as a pre-assessment tool used to gather basic information about the participants (see Appendix B). Having such information helped me to gain an understanding of the teacher's background with regards to STEM, art, and STEAM. The questionnaire would have also served as a tool, if needed, to assist with the purposeful selection process of the participants.

Whereas the questionnaire allowed me to have a quick glimpse of a STEAM teacher's years of teaching and background with STEM and the arts, the semistructured interview allowed me to gather more specific details about how they transitioned to STEAM curricula instruction. Open-ended and closed-ended questions are two formats that may be used to elicit responses, open-ended questions are considered to be more qualitative in nature because they allow the participant to provide answers in their own words (Adams & Lawrence, 2015). The first seven open-ended questions, used for data collection and analysis, were the main interview questions designed so that teachers could provide specific details regarding how they implemented STEAM and any transitional processes they used to move from traditional to STEAM instruction (see Appendix C). Five to seven research questions are recommended for interviews along with an interview protocol which contains enough space between each question to record interviewees' responses (Creswell, 2013; Kvale & Brinkmann, 2009). The last question was a general question that allowed the participant to add any other information that they felt was relevant to the interview. Interview responses were audio recorded with permission and recorded via an interview protocol (see Appendix D).

In addition to one-on-one interviews, a focus group was used to increase the breadth and depth of the responses to the same interview questions. Focus groups are beneficial when data collection time is limited, individuals have similarities and cooperate with each other, and one-on-one interviewees may have been hesitant with responses (Krueger & Casey, 2009; Stewart & Shamdasani, 1990). Types of focus groups include single, two-way, and respondent moderator (Sincero, 2012). The traditional single focus group format was used in this case study as the interactions between various content teachers may have help the participants to think more deeply about their own experiences and add more details to the discussion.

Data were not only be collected from teachers' direct responses, but I also collected data in the form of reviewing key documents or archival records (Creswell, 2013). According to Yin (2009), archival data are a common data collection source for case studies; however, caution should be taken as participants may provide material that supports their existing bias. Potential sources of documents and archival records that were expected included emails, lesson plans, professional development certificates and other corroborating sources of evidence that would coincide with the scope of this study. A document review protocol was used to record specific information about the artifact (see Appendix E).

Data Collection Methods and Procedures

While appropriate instruments were needed to collect data, the data collection process involved more activities than just conducting interviews and making observations (Creswell, 2013). Locating sites, gaining access, and developing rapport with the gatekeepers and participants were just as much a part of the process as purposeful sampling, collecting data, recording data, resolving field issues, and storing data. As such, I will discuss the data collection methods that I used for this case study (Creswell, 2013).

In order to locate a case study site, I initially contacted the science content specialist at the district level to identify which schools were known to practice STEAM. I emailed the principals of the identified schools to make initial contact and attempted to establish a rapport before gaining access to qualifying sites. Approval from Concordia University's IRB, district, and site principals were obtained before I officially began recruiting participants or collecting data.

Once approval for the case study sites were approved, I engaged in purposeful sampling as discussed in the Research Population and Sampling Method section. The case study population was chosen based on sites that possessed teachers who provided STEAM instruction and met the participation criteria, and who were willing and able to participate in each of the data collection methods. The expected number of qualifying participants was five, due to scheduling conflicts some teachers were unable to participate. The respondents who consented to participate each met the minimum criteria so they were all accepted in the study.

Interviews

Interviews are a form of basic inquiry that allow people to tell their stories in their own words (Seidman, 2006). Teachers who transitioned from teaching their content area in a traditional manner to a STEAM method were likely to have individual stories to share. By conducting interviews in an appropriate manner, teachers were able to provide rich insights into their experiences of how they prepared and implemented a STEAM curriculum. Seidman further posited that interviews allow behaviors to be put into context. The transition process for one teacher may have been different from another teacher's process and part of those differences could have stemmed from the various perspectives that teachers possessed as they approached STEAM instruction.

Some interviews were time-consuming, but allowed the researcher to gather human insights that purely quantitative data would not have been able to provide. Another possible draw-back of one-on-one interviews is having participants who are not forth-coming with responses to the interview questions. Open-ended questions helped to diminish this possible disadvantage by allowing participants to provide answers that were beyond a yes/no or closed-ended response.

Procedures. Once participants were selected, the process for preparing and conducting the one-on-one interviews commenced. Participants were provided a consent form which contained standard elements: the right to voluntarily withdraw at any point, main purpose and procedures for data collection, protection of confidentiality, known risks associated with the study, expected benefits for participants, and signatures of the participants and researcher (Creswell, 2013). I used Concordia University's basic consent form as it contained all of the required sections (see Appendix A). Simultaneously, participants received a participant information form which contains basic contact information and best times to call; the form serves the purposes of facilitating communication and recording information that may help in the final participant selection process (Seidman, 2006).

Preparation is a key factor for facilitating a successful interview. To help ease the flow of the interview process, a pre-interview meeting was conducted with individual participants (Seidman, 2006). The initial meeting was held via a phone call and lasted no more than 30 minutes and help to foster a rapport with the participant and to establish a time and location for the actual interview. Further preparation steps included making necessary arrangements to secure a location that was conducive to the interview, including comfortable seating, temperature, lighting, and reduced distractions such as noise level or high traffic areas.

At the time of the interview, an interview protocol was used to guide the interview session (Creswell, 2013). The protocol assisted with maintaining consistency between each of the interviews. The first few minutes of the session was spent exchanging greetings and having a brief general conversation with the interviewee. Next, I described the purpose of the research along with how the data would be collected and used. I reiterated the participant's confidentiality and explained that she would have a chance to review and clarify responses that were shared after I transcribed the interview session. The participant was also asked for permission to allow me to audio record the interview. Next, I asked the participant to read and sign the consent form. The interview questions were guided by the protocol with additional questions being interjected as topics arose that called for clarification or elaboration. Semistructured interviews allowed a certain level of freedom during the interview process without being completely unstructured or having the risk of venturing off topic (Creswell, 2013; Seidman, 2009). At the conclusion of the session, I thanked the participant and provided my contact information. The total time for each one-on-one interview lasted no more than 45 minutes.

Transcripts were provided via secure email to the participants following the interview so that member-checking could be performed by allowing the participant to verify that an accurate account of the interview was provided and the data analysis is acceptable. Member-checking also provided participants an opportunity to relay any missing details that should have been added which could have helped with thick, rich descriptions.

Focus Group

Similar to the one-on-one interviews, focus groups were another method used to interview participants. In this case, a single focus group was used, allowing all available participants to be placed in one group where the topic was interactively discussed (Sincero, 2012). Focus groups may allow interviewers to collect more in depth data than from a one-on-one interview by building upon each other's responses, adding to the "richness" of the data being collected (Sincero, 2012).

Even though focus groups can provide more depth to the stories of how teachers transition to STEAM, some potential disadvantages may arise. If the participants are unfamiliar or uncooperative with each other, then responses may be limited (Creswell, 2013; Kreuger & Casey, 2009). The participants and opinions may not be representative of the larger population (Sincero, 2012). Discussions also run the risk of being over-dominated by more loquacious participants while other participants may not respond due to shyness (Creswell, 2013). As with the case of one-on-one interviews, the interviewer's skills in facilitating the interview session helps reduce the disadvantages associated with focus groups (Seidman, 2009).

Procedures. Focus group participants were selected based on their prior participation in the one-on-one interview session. Each participant had previously signed a participant's consent form that was reviewed and they were reminded of the study's purpose and data collection methods. Contact was made with the participants to determine a convenient meeting time and location to participate in the focus group session. After, a scheduled meeting time was established, participants were contacted for confirmations and reminders.

After the focus group participants agreed upon a date and time, I worked on locating an accommodating meeting location. Similar aspects were considered as with the one-on-one interviews, including seating, lighting, temperature settings, and areas with minimal outside distractions. Based off of the one-on-one interviews, I designed the seating arrangement chart based on the appearance that one participants may have been more dominating, so I sat her near me while those who may have needed more encouragement to participate were sat across from me (Kreuger, 2015).

On the day of the focus group, I arrived a few minutes early to meet with the building facilitator to make sure that everything was set up properly in the meeting room. As participants arrived, they were provided with name tags to be worn throughout the focus group session. After all of the participants were in place, I reiterated the purpose of the study and the participants' rights as described on the consent to participate forms. I also reminded them that the session would be recorded. Next, I went over the basic rules of the focus group including the fact that answers would not be regarded as right or wrong, respect would be shown during the focus group, that it would be okay to disagree with responses without being disagreeable, that the person one person would speak at a time, and to be mindful that others may want to respond to the same question.

After setting the stage for the focus group, I had the participants introduce themselves to each other. I asked the interview questions in order, taking notes on the protocol form as the participants respond to the questions. As with the one-on-one interviews, the format was semistructured so that, where applicable to explore more in depth responses, the discussion elicited prompts from me to ask for clarification or elaboration of emergent themes. I acted as a facilitator, primarily listening to responses while encouraging active participation from all participants, and being mindful of the time. Affirmations of active listening were provided as I asked related follow up questions or restated for clarification purposes, the natural tendency to nod or make facial expressions was curbed to reduce inadvertently leading the participants in their responses (Seidman, 2009). Participants were thanked again at the close of the focus group session and informed that the responses would be transcribed for review. The approximate time for the focus group session was a little longer than the one-on-one interview sessions, approximately 60 minutes, which allowed for multiple responses from and discussions amongst the participants. The member-checking process was again conducted as with the one-on-one interviews.

Key Documents / Artifacts

Documents and artifacts were used in addition to the one-on-one interviews and focus groups as a way to triangulate data. Photographs of student work, journals, and certificates were a few examples of documents and artifacts that were collected during the case study. This form of data was used to support the verbal forms of data collected from the participants.

Yin (2009) listed the benefits and weakness of documents and artifacts which for the most part overlap between the two sources. The data sources are unobtrusive, may contain detailed information, and are stable allowing for repeated review. On the other hand, certain documents or artifacts may be difficult to retrieve and bias may be involved with the participant's or author's presentation of the data including withholding certain information.

Procedures. School websites were perused to ascertain any evidence of STEAM education provided at the participating sites. Additionally, the individual participants were asked to gather documents and artifacts that supported evidence of the transition process which the participants went through to provide a STEAM curriculum. Participants were asked to submit via Google Docs supporting artifacts or to provide a time when I could collect, view, and if allowed make copies or take pictures of the documents and artifacts. Digital copies of the documents and artifacts were stored on a flash drive for on-going review and analysis throughout the study.

Data Analysis Methods and Procedures

Data analysis is an emergent, iterative process that affords deconstruction and reconstruction in order to provide a narrative for the case (Baxter & Jack, 2008). The purpose of data analysis is to bring order and understanding to research (Taylor-Powell & Renner, 2003). Qualitative analysis, unlike quantitative analysis, is completed without the use of numbers. Therefore, a creative and systematic process should be followed during qualitative analysis. While the basis of data analysis is to organize and prepare data so that it can be categorized into themes, the approaches to this process may vary depending on the research. Creswell (2013) presented three authors with opposing approaches to data analysis: Madison (2005) representing an interpretive framework, Miles and Huberman (1994) represent a systematic approach, and Wolcott (1994) uses a more traditional approach. In my analysis of data gathered for this case study, I incorporated a systematic and traditional approach.

Even though I followed a systematic approach with my data analysis, the process occurred in more of a cyclical or spiral shape as opposed to a linear process (Creswell, 2013). For each set of data gathered, I read, organized, coded, identified themes, interpreted and represented the meanings or themes from the data. This process occurred multiple times until final themes were drawn both within and across the case studies (Yin, 2009). Five to seven general themes are recommended by Creswell (2013). The ultimate aim was to ensure that the data were "converged in an attempt to understand the overall case, not the various parts of the case, or the contributing factors that influence the case," (Baxter & Jack, 2008, p. 555).

Procedures

As part of the spiral process, data analysis occurred in conjunction with data collection. An initial read through of the material occurred immediately after the data was collected from the one-on-one interviews and focus groups, respectively. Reviewing the data closer to the time of the event allowed me to report my initial reactions. Similarly, artifacts and documents were read and assessed immediately upon collection. As the data is being read and reviewed, it was also coded and organized using the comments option in Microsoft Word

In order to make better sense of the data, I needed to re-read the material multiple times, taking notes and jotting down ideas in the margins during each iteration. The notes and memos assisted in developing codes for the data as I noticed patterns in and across the data. Codes arose from the descriptions that were made regarding the participants, environments, and activities gathered in each case (Creswell, 2013). Similar codes were chunked together into categories which were broken down into subcategories as needed upon closer inspection. Labels for each code were created based on the type of data that begins to stand out as being relevant for developing themes. Code labels resulted from sources such as direct wording used by participants or terminology related to STEAM instruction. Taylor-Powell and Renner (2003) suggested the use of preset categories to help identify common themes; however, preset categories were not be appropriate for the discovery approach of this multi-case study.

Throughout the data analysis process, I worked closely with the data through constant comparison analysis (Glaser & Strauss, 1967) to identify themes. Themes were developed from several codes combined to form a common idea presented as a broad unit of information (Creswell, 2013). Themes were further broken down into subthemes that are presented in the final narrative of the case study. I took caution to ensure that emerging themes were relevant to the purpose of discovering how content teachers transitioned to STEAM. At the same time, some data was deemed irrelevant and discarded during the analysis process (Wolcott, 1994).

After the codes were reduced to themes, the themes were induced to form direct interpretations. Insights gained during the analysis of the case studies were used to expand the themes into broader abstractions known as interpretations (Creswell, 2013). Herro et al. (2016) used correspondence to analyze and interpret data by looking for patterns and consistency within certain settings. My interpretations were based on commonalities and correspondence observed amongst the participants in the case studies to generalize the processes of how teachers transitioned to STEAM from traditional teaching methods.

Finally, the data and interpretations were represented through narrative and tables. A table will be used to show the relationship amongst categories and the cases. As suggested by Yin (2009), words can be displayed in the table representative of themes from the individual cases allowing for comparisons and differences amongst the cases to easily be identified. The narrative moved from direct descriptions of the individual cases to naturalistic generalizations. Naturalistic generalizations included what could be learned from the multi-case study that may help other teachers learn about the process that is taken to move from traditional teaching to STEAM instruction.

Limitations of the Research Design

The purpose of this research was to explore how content teachers transition to STEAM teaching. In the process of conducting this research, certain limitations arose hindering a more robust exploration. Time constraints, sample size, and setting were factors that may have imposed limits to this case study. Delimitations will be described to provide reasons for the choices made which bound this study.

Time Constraint Limitations

Qualitative research can require a considerable amount of time. Case studies, in particular, typically rely on multiple sources of data used for triangulation. Each set of data required time to be sorted, analyzed, interpreted, and represented. A considerable amount of time was needed to be put forth with the exploration of how teachers transition to STEAM, approximately three months.

One of the main sources of data were the descriptions and responses obtained during the one-on-one interviews. Seidman (2006) supported the use of a three-interview process where participants establish the context, reconstruct details, and reflect on the phenomena to provide a robust description. Each participant would ideally sit for three 60 to 90 minute sessions which require the researcher to coordinate schedules with multiple participants. A common concern with teachers is the lack of time to perform numerous professional duties; therefore, it was anticipated that teachers would have been reluctant to sit for three separate interviews. Seidman (2006) conceded that variations to the three interview series could be sufficient to establish the necessary rapport and ability to gather information from the participants.

In lieu of three separate one-on-one interviews, multiple encounters occurred with the participants where data was sufficiently gathered via reduced time frames. A pre-interview meeting was planned where a researcher-participant rapport could be established and the context of the teacher's decision to teach STEAM, in some cases, surfaced. Following the 45 minute one-on-one interview, another chance to speak directly occurred in the focus group setting. The time period for the focus group was a little longer than the individual interviews, but the number of participants somewhat hindered individual talking times for the participants.

Time was also a concern during the data analysis stage of the research. The use of color coded highlights for chunking data and numbered coding helped to save time by quickly identifying related codes that emerged during the analysis process.

Sample Size Limitations

In addition to time constraints, the sample size posed limitations on the study. The sample population was pulled from a location where the school district has not mandated that teachers incorporate STEAM into their instruction. Given the option, many teachers decide to go with the status quo and teach in the traditional manner in which they are accustomed to teaching. Therefore, the actual numbers of teachers who decided to transition to STEAM was limited

Out of the available population, teachers who were willing to participate in the phases of the study also affected the sample size. Less than the expected amount of participants were available, so data may not have led to as an extensive level of discovery of how teachers transitioned to STEAM. Time to establish a rapport between the researcher and participants appeared to also be reduced when common connections were established during discussions such as knowledge of district procedures, policies, and stakeholders. These factors appeared to help the participants to trust me and to feel more comfortable participating in the interviews and focus group.

As previously mentioned, the sample size was a limitation due to the fact that this school district has not set aside certain schools as being STEAM schools. Individual teachers are afforded the flexibility to be creative with their teaching styles as long as the established curriculum is covered. While STEAM is piquing interest and growing in momentum amongst educators, the actual number of teachers within the setting of this school district who have decided to transition to STEAM may not have reached its full potential yet.

Validation

Despite the limitations, precautions were taken to enhance the validity of this multi-case study. Validation and its place in qualitative research have been interpreted differently by various researchers (Creswell, 2013). Wolcott (1990) posited that the focus should be placed more on understanding the phenomenon than on validation and finds no use for validation in his qualitative research. Angen (2000), however, referred to validation as "a judgment of the trust-worthiness or goodness of a piece of research" (p. 387). Lincoln and Guba (1985) recommended more naturalistic, alternative terms to promote trustworthiness; accordingly, steps were taken to address credibility, dependability, and transferability in this study.

Credibility

Credibility refers to the level of accuracy and trustworthiness, and is considered the primary criterion for evaluating qualitative studies (McMillan, 2012). Numerous strategies can be used to support credibility, including triangulation, establishing researcher's bias, member checking, and writing with rich, thick description (Creswell, 2013). Each of the aforementioned strategies were used throughout the data collection, analysis, and description of the explorative multiple-case study.

Triangulation uses multiple data collection sources to seek a convergence of findings (McMillan, 2012). In order to obtain information as to how teachers transitioned to STEAM instruction, data was collected through one-on-one interviews, a focus group, and through key documents. Each set of data was analyzed individually to identify themes and findings from the study. Themes and findings collected from each of the data sources were compared to see if corroboration existed between more than one of the sources. Triangulation existed when the findings were the same.

Credibility is also strengthened when the researcher's bias is clearly stated and positioned in the study. McMillan (2012) contended that good researchers know that their subjectivity influenced by their background, values, status, and bias will influence their expectations and interpretations. The researcher's position is stated in the ethical issues section of this study so that readers may understand how perspectives were shaped and influenced during this explorative study.

Another step in providing credibility was the use of member checking. Participants were asked throughout the case study to review and verify the data and findings, also known as member checking (McMillan, 2012). For instance, after each one-on-one interview, the data were transcribed by the researcher and sent to the participant to verify that the information was recorded accurately. Likewise, as themes were developed in relation to how teachers transitioned to STEAM instruction, they were shared with the participants who were asked to provide input as to the fairness or precision of the findings. The focus group potentially served as a venue where member checking occurred as participants were asked to comment on the existing themes and analysis drawn from the previous interviews (Creswell, 2013). Member checking was also another way in which the researcher's bias could be checked throughout the study.

Rich, thick descriptions served as a tool to enhance credibility. Triangulation and member checking both contributed to the overall findings described in the study. Extensive time and focus were given to the data collection and analysis processes to ensure that ample details could be used to describe each case and the development of the collective themes. Additionally, direct language was used from the participants to accentuate authenticity.

Dependability

Dependability, like reliability in quantitative research, was used to show that the results were consistent and repeatable (Lincoln & Guba, 1985). An external audit of the research process is recommended by Lincoln and Guba (1985) to substantiate dependability; however, that is not always a feasible option. Dependability may also be created in conjunction with establishing credibility. Triangulation, for example, provided credibility when results were confirmed through more than one data source. Evidence of consistent and repeatable results established through triangulation also supported dependability. Even member checking supported dependability when the participants verified transcribed interviews and confirmed the fairness of the reported findings and themes.

Transferability

Transferability refers to the ability to apply the results to other contexts and settings (Lincoln & Guba, 1985). If another researcher chooses to use the findings of this study to apply it to a different setting and context, then that researcher will have decided on the generalizability of this study (McMillan, 2012). Thick, rich descriptions of the setting, contexts, participants, and data collection procedures may be used to determine whether or not this study is appropriate to use for transferability. For example, a teacher considering transitioning from traditional to STEAM instruction, may find the results of this study beneficial and applicable provided that the teacher is placed in a comparable context and position as the participants who were used in this study. Hence, it was important to provide details about the participants, setting, and particular curriculum used for STEAM.

Expected Findings

The purpose of my research was to discover how teachers transition from traditional teaching methods to implementing STEAM instruction. I enjoyed gathering and categorizing data until emergent themes were formulated and presented. However, “Good qualitative researchers know that their subjectivity may influence results,” (McMillan, 2012, p. 304). As viewed through my own biases and predispositions, I expected that time would be an issue for teachers, and collaboration among teachers and administrators would be an important transitional step.

Being in the educational field for nearly 20 years, I have observed that a lack of time is one of the biggest concerns for teachers. I anticipated that time would surface as a theme in this case study. As teachers transition to implementing STEAM, a period of research and discovery may exist for knowing exactly what STEAM entails, STEAM lessons would need to coincide with the district’s curriculum, and a learning curve of discovering what would work best in the classroom and what did not may ensue. Each of these factors may be time consuming. Herro et al.’s (2016) case study reported that teaching STEAM was time consuming, but worthwhile.

Collaboration was expected to be very helpful to teachers when trying to implement STEAM as an integrated subject. STEM and art teachers who were only accustomed to instructing their respective content matter, may have found it necessary to consult with a teacher from the other department to ensure that concepts were appropriately incorporated into STEAM lessons. Transdisciplinary collaborations between colleagues have proven to provide worthwhile STEAM lessons (Herro et al., 2016; Leysath, 2015; Simpson Steele, Fulton, & Fanning, 2016).

Ethical Issues

Ethical issues should be addressed throughout research to ensure that aspects such as integrity, honor, and professionalism are followed throughout the process. Federal guidelines of how research should be conducted are reflected in the principals and codes of ethics for the American Association of Psychologists (APA), the American Sociological Association (ASA), and the American Educational Research Association (AERA; Ngay Hesse-Biber & Leavy, 2011). Also as a result of federal guidelines, IRB's were established to monitor research proposals dealing with humans and animals- making sure that the benefits outweigh the risks (Ngay Hesse-Biber & Leavy, 2011). As I approached this research study, I tried to make ethical issues transparent by adhering to the APA's principles and code of ethics, making known my positions and biases, and having the approval of Concordia University's IRB.

Conflict of Interest Assessment

In following the APA's (2017) fidelity and responsibility principle, I attempted to manage conflicts of interest which could lead to exploitation or harm. I have had a professional association with the school district where I conducted my research. Due to this fact, I had previously met those in supervisory positions of some participants. I did not disclose any information discovered about the participants during data collection sessions to supervisors. An exception would have been the case where I inadvertently discovered a situation in which I was ethically or legally bound to disclose information such as the safety or well-being of students who may have been jeopardized by the participant. Furthermore, the only value gained from this study for the researcher was intrinsic. Financial gain was not afforded to the researcher or participants. Results discovered in this study may assist teachers who decide to transition to STEAM by having an idea as to what the process may look like including expected challenges and successes.

Researcher's Position

As previously stated, researcher bias can influence the lens with which data collection, analysis, and findings are conceived. My experiences as a Black, female, public high school science teacher, and dance instructor may have influenced my opinion of STEAM in general. I am an advocate for students, especially minorities, developing scientific and artistic skills. I have used arts in some of my science lessons, but I do not yet consider myself as an authentic STEAM teacher.

Upon learning about the STEM to STEAM movement, my interest was piqued. Experts who argue for and against STEAM have presented valid points as to whether arts and STEM should be integrated. My aim in this study was to seek how teachers who chose to implement STEAM made that transition.

My role was the principal investigator in this multiple case study. I was an interviewer for one-on-one and focus group sessions. While in the role of interviewer, I obtained direct quotes and language used by the participants that helped to shape the presentation of the case study. Self-reflection, member checking, and triangulation played a vital role in presenting authentic and trustworthy findings in this study. These and other practices previously discussed in the credibility, dependability, and transferability sections helped to reduce biases and opinions that I may have had throughout this study, thus affording as much objectivity as possible.

Ethical Issues in the Study

Transparency and consent were incorporated as much as possible throughout this study to address ethical issues. The design of this multiple case study did not pose any mental or physical risks to the participants. The participants were informed of the purpose of the study and procedures for the data collection process. Opportunities were also be included for the participants to make sure that their voice was heard correctly through member checking.

Upon agreeing to participate in the study, participants signed a consent to participate form. They were made aware of their ability to withdraw at any point from the study. Benefits were in the form of intrinsic value such as knowledge gained from self-reflection and sharing information that may be useful for other educators. Confidentiality was provided allowing participants to speak freely in regards to their personal experiences during the transition process to teaching STEAM.

Appropriate administrators and principals approved the request to conduct research and use their sites. Teachers were allowed to make the decision to hold the interviews in the confines of their own classrooms or at a public venue, while focus group required the use of a conference at an agreed upon public library location. Observations of artifacts were conducted at the interview sites or received through email. Proof of permission was provided to the Concordia University's IRB and approval to conduct research from Concordia's IRB was provided to the school district and site's principal. Digital data was stored on a flash drive and placed in a locked file box with other data sources such as artifacts and documents- all of which will be destroyed three years following publication of this paper in accordance with CU IRB requirements.

Summary

Research design and methods are informed by the purpose and questions posed. The purpose of this research was to address the question of how teachers transition to STEAM instruction. STEAM is a comparatively new method of teaching; therefore, new aspects of STEAM are still being investigated and discovered. A multiple case study was appropriate for this study so that triangulated data from the various cases could be compared and synthesized (Yin, 2009). A thick, rich description of what the process of transitioning to STEAM instruction looked like based on the participants of this study was presented in the form of a narrative (Creswell, 2013). Steps were taken to ensure the trustworthiness of the findings of this study, including ways that enhanced credibility, dependability, and transferability (Lincoln & Guba, 1985). Additionally, ethical considerations were made and followed throughout the entire research process. The intrinsic benefits of this research were expected to outweigh any risks.

Chapter 4: Data Analysis and Results

A multiple case study was conducted to explore the question of how traditional content teachers transitioned to implementing a STEAM curriculum, which guided data collection and analysis. This chapter is organized by a description of the sample, research methodology and analysis, summary of the findings, presentation of the data and results, and a summary of the chapter. While intrigued by the STEAM concept, I approached this research, as much as possible, as an outside observer. Constant comparison was used during the analysis process to identify internal and cross case codes and themes which are presented through data tables and narration.

Sample Description

The research population for this study was taken from a school district in the eastern United States. The district's website, at the time of this study, indicated approximately 2,000 teachers. The gender composition was approximately 25% males and 75% females. The ethnic/racial composition was approximately 20% Black, 75% White, 2% Latino/Hispanic, and 3% other. My recruitment targeted the same demographic population with certain inclusion criteria. Teachers needed to be credentialed in a public school for a minimum of three years, had experience teaching a STEM or arts course, presently taught STEAM content, and had taught STEAM for at least a year.

Due to an anticipated low number of teachers meeting the inclusion criteria, the expected enrollment count for the sample was five participants. The actual number of participants that enrolled in the study was four. Participant 1 had been teaching at the middle and high school levels for 29 years in the areas of English and theater arts. Participant 2 had been teaching at the middle school level for 13 years in the art content area. Participant 3 had been at the high school level for 8 years in the areas of computer science, engineering, and technology education. Participant 4 had been teaching at the elementary and middle school levels in public education for 7 years in the areas of general education and most recently science.

Research Methodology and Analysis

An iterative process was used to analyze data in this multiple case study which sought to explore how teachers transition to teaching a STEAM curriculum. Themes were not pre-selected because the story of how each participant transitioned to STEAM is an individualized experience. However, close inspection of the data collected throughout the research allowed commonalities to be observed and grouped into codes and themes presented in a narrative form later in this chapter.

Case Study

The STEM to STEAM Movement is a relatively new phenomenon (Bequette & Bequette, 2012; Jones, 2014) as discussed in Chapter 2. The case study approach, because it's appropriate when addressing "how" questions (Yin, 2009), was used to explore how teachers of different content areas transitioned to teaching a STEAM curriculum. Each participant, one STEM and one arts teacher from the two sites, provided data through multiple sources. Data gathered through individual interviews, a focus group, as well as through documents and artifacts, supplied evidence to identify commonalities amongst the individual and collective cases.

It is important to note that whereas each participant participated in an individual interview session as well as provided corroborating documents or artifacts to support data collected throughout the study, Participant 3 was unable to physically participate in the focus group due to an unforeseen scheduling conflict. In order to minimize the impact of Participant 3 being unable to physically share in the focus group, her direct quotes and sentiments expressed during her pre-interview and individual interview sessions were shared throughout the focus group session. This allowed the other participants to still learn about Participant 3's journey to STEAM and to comment on her process and beliefs as it related to their own experiences and beliefs.

Coding and Thematic Procedures

Data collection and analysis were conducted on an on-going basis throughout the case study. Notes taken via the interview protocol, and transcripts from the audio recorded interviews, were read and re-read. Additional notes were taken during each read-through to identify data that directly answered each interview question and contributed to the main question of how content teachers transition to teaching a STEAM curriculum. A similar process was used to collect data via the focus group protocol and transcript as well as from the protocols used to describe the artifacts and documents that the participants provided. Because analysis occurred during and at the end of the data collection process, each data source was reviewed and underwent an initial analysis very close to the time that the data was collected.

Chunking was conducted from the notes of each transcript and protocol and codes were eventually developed through the use of constant comparison of the data. After a number of codes were developed, themes began to emerge from the data collection. The iterative process of identifying codes and themes was conducted throughout the data collection and analysis processes until a saturation of data (Fusch & Ness, 2015) had been collected and appeared to address the guiding question of this case study.

Raw data was collated, organized, and is presented in summary form in the next section. Some data was discarded if deemed irrelevant to the focus of this particular case study (Wolcott, 1994). Examples of the data collection protocols are in the appendices.

Summary of Findings

The analysis process led to patterns being recognized amongst the data collected. Twenty-two codes and sub codes were identified from the data. Upon a closer look, the codes were grouped into clusters which became the four themes that emerged from the data. Below, Table 1 previews the codes and themes which are discussed in greater detail in the next section.

Table 1

Identified Themes and Supporting Codes

Theme	Code	Description
1		Develop a mindset to teach from a STEAM perspective.
	C1	Use a transformational learning moment to embrace STEAM
	C2	Identify ways that STEAM is already embedded in lessons
	C3	Plan lessons through framework of transdisciplinary teaching
	C4	Think about the end goal
		Overcome Challenges:
	C5	Teacher apathy towards STEAM
	C6	Personal fears
2		Start small and build up.
	C7	Add elements of art to routine classroom activities
	C8	Start with one STEAM project or lesson
	C9	Incorporate various forms of art in lessons
		Challenges:
	C10	Resources to enhance STEAM lessons may not be available
	C11	Students may initially resist STEAM
3		Collaborate as a process for transitioning.
	C12	Collaborate with a transdisciplinary teacher in the same school
	C13	Collaborate with teachers from other schools
	C14	Collaborate with professionals to produce STEAM lessons
	C15	Challenge: Time may be an issue for collaborators
4		Participate in and application of on-going professional development
	C16	Attend STEAM-related professional development seminars
	C17	Attend workshops to increase STEAM knowledge
	C18	Read STEAM-related materials to increase STEAM knowledge
		Use online research as a key resource
	C19	Use websites to obtain STEAM resources
	C20	Use websites to gather ideas for STEAM projects
	C21	Use STEAM websites to enhance student learning
	C22	Challenge: Learning/re-learning skills to teach other content areas

Theme 1- Develop a Mindset to Teach from a STEAM Perspective

This theme seemed to be the major determination for each teacher's decision to transition to and embrace STEAM. Here, the term "mindset" means teachers believe that their teaching ability and style is not fixed, they believe that they can improve by overcoming challenges and continually learning new teaching methods (Dweck, 2015). Teachers typically had at least one memorable encounter which resulted in transformational learning where their old mindsets about teaching were changed. As they transitioned to STEAM, these teachers looked at their existing curriculum and noticed where STEAM may have already been embedded. They additionally planned more intentional transdisciplinary lessons as they moved toward the end goal of a STEAM curriculum. Challenges that were related to this theme included encountering other educators who may have been apathetic to STEAM and overcoming personal fears in making the risk to transition to STEAM.

Theme 2- Start Small and Build Up

The second theme was based on the discovery that teachers took small steps during the transition to STEAM. These steps included adding elements of art into routine classroom activities such as adding elements of art to taking notes. Instead of jumping completely into STEAM, teachers chose just one STEAM lesson or project to implement first. Additionally, they incorporated a variety of art forms such as painting, drawing, theater, and sculptures. Challenges to this theme were that teachers may have lacked necessary resources and teachers encountered some resistance from students in respect to interdisciplinary instruction.

Theme 3- Collaborate as a Process for Transitioning

The third theme considered collaborative efforts that were made during the transition to STEAM. Teachers initially started from within by working with other transdisciplinary teachers in their own school buildings. They also collaborated with educators outside of their school to expand their pool of resources and ideas. The last collaborative relationship was that between the teachers and other professionals in the field which allowed teachers to include more authentic STEM topics and art forms to be included in their curriculum. Time was noted as the main challenge related to this theme as it pertained to scheduling conflicts between collaborators.

Theme 4- Participate in Ongoing Professional Development

The fourth theme discussed the ongoing professional development that teachers participated in to increase their knowledge of STEAM and to improve their efforts of implementing such a curriculum. Teachers regularly attended professional development seminars and workshops which gave them greater insights to the need for STEAM and meaningful ways to implement it in the classroom. Teachers also read various materials and used online resources to increase their knowledge, look for STEAM resources, obtain ideas for projects, and enhance student learning experiences. The main challenge which did not seem too major for teachers was the fact that they had to learn or re-learn cross content material to effectively implement STEAM.

Presentation of Data and Results

The resulting themes address the purpose of this multiple case study by presenting how content teachers transition to teaching a STEAM curriculum. The four previously identified themes along with the corresponding codes (see Table 1) are explained in detail in this section. The themes have been ordered in a chronological manner for a clearer presentation of the process; however, the practices which support these themes may occur in an arbitrary process throughout the transition to STEAM. The themes are as follows: (a) embrace a mindset to teach from a STEAM perspective, (b) start small and build up, (c) collaborate as a process for transitioning, and (d) participate in on-going professional development.

Theme 1: Develop a Mindset to Teach from a STEAM Perspective

The teacher's decision to teach STEAM outside of a mandatory requirement appeared to begin with a conscious mental choice, which became critical to their transition away from a traditional STEM or arts approach. This section will describe how teachers began to embrace a STEAM mindset. The topics used to support this first theme include: (a) use a transformational learning moment to embrace STEAM, (b) identify ways that STEAM is naturally embedded in lessons, (c) plan lessons through a framework of transdisciplinary teaching, (d) think about the end goal, as well as (e) overcome challenges of (1) teacher apathy towards STEAM and (2) personal fears.

Use a transformational learning moment to embrace STEAM. Data collected in this case study showed that teachers underwent a moment when their traditional view of teaching arts or STEM was altered and they began to embrace STEAM. Each participant described a different time when the idea of teaching STEAM seemed to make sense. During her interview, Participant 1 discussed how her inspiration to teach STEAM started when she began to question, "the idea of which is more important, the process or the product that is created." As she started looking at different ways to put instructional components together, she also began hearing about and attending workshops on changing from STEM to STEAM. The workshops seemed to "fit in perfectly" with her altering perspective. Participant 1 vividly recalled listening to a keynote speech by Eric Booth entitled "Learning and Yearning," where he described traits and characteristics of what the 21st Century workforce employers wanted, which included right- and left-brained thinking skills "and so that started me on this process."

Participant 2 also attended a workshop that enlightened her, where she recalled, during her interview and focus group sessions, hearing the speaker state that a mistake was made when they came out with the acronym for STEM because the arts should have been included all along for STEAM. Next, Participant 2 attended a professional development workshop where the superintendent of the school district informed the educators that the activities, which they were going to participate in, involved a lot of art, so while listed as STEM, the focus was actually STEAM. Finally, Participant 2 realized how important STEAM was when she noticed that the popular children's educational series, Sesame Street, even transitioned from STEM to STEAM. She remarked, "So, like everywhere in the world it's going to become STEAM not STEM." The awareness of an increasing shift from STEM to STEAM piqued Participant 2's interest enough for her to intentionally embark on a path of educating from a STEAM perspective.

Similar to Participant 2, Participant 3 became more aware of STEAM after attending a succession of Project Lead the Way (PLTW) trainings and participating in a curriculum writing initiative through NASA. After discussing her trainings, Participant 3 shared certificates documenting her trainings and participation in the PLTW and NASA sessions. Participant 3 always valued the importance of aesthetics in her engineering and design courses, but she admitted, "my computer science (course) has changed some . . . we do talk a lot about aesthetics and design."

Unlike the other participants, Participant 4 discussed during her interview and the focus group session how she was inspired to transition to STEAM because of the art teacher in her building (Participant 2 in this study). Participant 2 approached Participant 4 with the idea of working collaboratively on a STEAM project by describing the success of the project with the science teacher who preceded Participant 4 at the school. Participant 4 was already aware of the project because she witnessed the impact that it had on her own child who was a former student of the art teacher. Participant 4 clearly reiterated more than once that the art teacher, Participant 2, was her inspiration to transition to STEAM. “When she approached me, I was like ‘yeah,’ because I remember my son doing this too!” Participant 4 recalled that her decision was influenced not only as an educator but also as a parent. All the participants had a moment of epiphany when they realized that STEAM would become part of their instructional focus.

Identify ways that STEAM is already embedded in lessons. After acknowledging various transformational learning moments when teachers began to embrace STEAM, teachers identified ways that STEAM was already occurring in the classroom. A transformed mindset allowed the participants to recognize that, even if on a basic level, STEAM was already a part of their curriculum. At the beginning of her one-on-one interview, Participant 2 stated that it’s very hard to teach art without teaching math, science, and English. Later, when asked how her planning differs when teaching STEAM, she replied, “I think we subconsciously do it naturally.” She explained that teaching depth and perspective includes teaching students about distance, volume, and how to use rulers. Similarly, she noted during her interview and the focus group that she teaches tessellations, a natural bridge between art and the mathematical concept of shapes.

Further corroboration of the concept of identifying STEAM components that were already embedded in curriculum continued to show up from the art teachers’ perspectives. Participant 1 equated during the focus group, “I think that we have always kind of put these things together. I think that’s what cross-curricular education was once upon a time.” Participant 1 also provided supporting evidence of this from a journal entry she shared based on reflective notes from a theater workshop. She listed skills for argumentation as: recognize their own position on an issue, recognize faulty reasoning, recognize fact from opinion, defend a position with proof, and organize the argument in logical form. While the workshop intended to provide insights for improved improvisational skills for theater students, Participant 1 pointed out that these skills are transferrable to language arts and science as well.

Just as the arts teachers recognized components of math and science in their curriculum, the STEM teachers recognized that arts components are embedded in their curriculum. Participant 3 discussed how her students have to do a lot of designing and building for projects. She would explain to her students, “if you don’t want to live in an ugly house, then don’t design one that way.”

Participant 4 noted at the end of the one-on-one interview that she had been discussing about how she integrated arts into science, so she added, “but I do think it comes naturally.” She continued with her realization that even when she taught STEM camps, “we did a lot of art projects and different components within that.” Each of the four participants provided evidence to demonstrate how the two content areas already exist in a fluid manner.

Plan lessons through framework of transdisciplinary teaching. In addition to recognizing how STEAM was already a part of their existing curricula, teachers also specifically planned transdisciplinary STEAM lessons. When asked during the individual interviews how planning for a STEAM lesson differed from planning for a traditional lesson, three of the four participants responded in some variation that no real difference existed. Participant 1 during her one-on-one interview stated that she started by asking herself, “what do I want them to do, what do I want them to create?” She then used a hierarchy scale of learning such as Maslow’s to plan. She added during the focus group, “It’s a different mindset, not a different amount of time or something like that.”

In order to intentionally incorporate transdisciplinary lessons, Participant 2 obtained curriculum topics from other content departments. She shared a 17-page document that she created listing the curriculum topics and corresponding time frames of when the topics are covered for content areas including language arts, math, science, history, and art. Participant 2 explained that she used the document "numerous amounts" of time to create themes and STEAM lessons that coincide with lessons from transdisciplinary content areas.

More details were provided about preparing for a STEAM lesson when the participants were asked what steps were taken to prepare for integrating the arts and STEM. Participant 1 mentioned reading books and attending workshops. Participant 2 also referenced workshops and classes that she attended. During the focus group, Participant 2 added that she used scholastic magazines and videos to help plan for the STEAM project which was completed with Participant 4. Participant 3 made sure that she integrated aesthetic components into her class assignments and projects. Participant 4 initially relied on collaboration with the art teacher and having access to her materials. Each participant's planning process for STEAM will be elaborated upon in subsequent sections on the themes regarding collaboration and participating in professional development. These activities influenced the participants' mindsets while providing ideas for a STEAM focused curriculum.

Think about the end goal of STEAM. Teachers wanted to improve the learning experiences for their students and kept this in mind as they made the transition to STEAM. Participant 1 commented, "And the STEAM route is the best way to make sure that you are addressing the process, getting to the end, but then also being able to evaluate the end product." The idea that STEAM could positively impact students' learning experiences is the driving force for each of the participants. This includes notions of increasing student engagement and better preparing them for the future.

Both participants from the middle school site viewed STEAM as a means to increase student engagement and interest in learning. During the pre-interview with Participant 2, she recalled a moment during her collegiate years when she realized that she had learned or understood more about science through her college art class than she did in high school. This recollection influenced her teaching style. Participant 2's shared a document describing her teaching philosophy which includes the statement, "Art stimulates the mind to see new worlds and possibilities." She adds that the stimulation helps students to be well-rounded and more expressive in their lives. STEAM is the method that Participant 2 found to stimulate the students in her arts classes.

Participant 4 initially witnessed as a parent the impact that STEAM had on her own child's interest in STEM. When she began teaching at the middle school, she encountered a number of students who like her own child were excited about the STEAM projects they completed with their art and math teachers. These revelations along with reflections of how her previous students were engaged in STEM projects that involved arts motivated Participant 4 to teach with the hopes of continuing to engage students in STEM.

For the high school participants the end goal was to better prepare students for career readiness. "When you teach students how to design they need to have that in mind because in the future when they go become an engineer, architect, or civil engineer, they have to think about the aesthetics," commented Participant 3. As previously stated, she often reminds her engineering and computer science students that aesthetics of designs are just as important to consider during the designing process. By incorporating STEAM into the curriculum, Participant 3 believes that students will be better prepared to perform their jobs when entering the work force.

Similarly, Participant 1 considered the 21st Century skills that the job force is said to be looking for in students. Based on books, articles, and workshops, Participant 1 was inspired to use STEAM as a method to equip her students with those required skills. One journal entry for an AP workshop that Participant 1 attended has the word "content" circled in the middle of the page and surrounded by the words "critical thinking, collaboration, creative problem solving, and communication." This diagram is listed as "21st Century Skills." During the interview, Participant 1 stated, "the idea of adding in design and creativity and all of those things is what is allowing us to advance in the area of STEM." The end goal for the high school participants is to have students prepared to advance in STEM fields by using art skills. All of the participants had a particular goal in mind that they were trying to accomplish through STEAM.

Overcome challenges. In order to embrace STEAM, old thought processes may need to be discarded. In the transition to STEAM obstacles do occur. Participant 1 noted that businesses are not receiving the level of skilled workers that they need, in part, due to "adults who are kind of afraid to take that risk or are apathetic about doing more than what I need to do in some ways." Some STEAM teachers suggested that challenges can include trying to work with other teachers who are apathetic towards STEAM as well as overcoming their own fears for trying something new.

Teacher apathy towards STEAM. Participant 1 cautioned against just blaming students for not putting effort in to do what is needed to obtain the skills needed to be successful in the workforce. She believed that some educators are not as vested in taking the extra steps needed to adequately prepare students with the 21st Century skills. Although a previous superintendent acknowledged that the district was actually sponsoring STEAM professional developments under the guise of STEM, Participant 2 expressed concern that the district still had not adequately transitioned to promoting STEAM.

Personal fears. Along with Participant 1, Participant 3 believed that some teachers face the challenge of having a personal fear towards implementing STEAM. Participant 3 would advise those considering the transition to STEAM, "Don't be afraid to implement the arts because it's important!" She continued that even if you don't consider yourself to be an artist, you have to incorporate it because it matters. Each participant became aware of challenges that existed during their move to STEAM, yet their determination led them to successfully make the transition.

Theme 1: Summary. Teachers in this study underwent a shift in their paradigm to realize that the traditional ways of teaching can be improved by transitioning to STEAM. Inspirational moments that made them aware of the benefits of STEAM and led them to the ultimate decision to move in direction of implementing STEAM. The revised mindsets even allowed them to notice how STEAM was already existent within parts of their curriculum. The new perspective; however, also led them to be more intentional in planning transdisciplinary STEAM lessons. Ultimately, it was the end goal that teachers wished to achieve which kept them on the STEAM path. The middle school teachers considered increased engagement as the end goal while the high school teachers considered career readiness. The teachers also had to overcome working with other educators who were not so much in the transition to STEAM and even their own personal fears with making the needed adjustments to implement STEAM.

Theme 2: Start Small and Build Up

Once a teacher decided to transition to a STEAM curriculum, the next step was to begin implementation. Due to the fact that STEAM covers a broad domain of the transdisciplinary instruction, the participants felt the need to initially incorporate STEAM in a small manner. Participant 2 suggested during her interview that "newbies" to STEAM "do baby steps." Participant 4 reflected on a collaborative project completed with a transdisciplinary teacher, "We just did one lesson, but we built up to it," and the lesson turned into a project. This theme was supported by the following examples of starting small: (a) adding elements of art to routine classroom activities, (b) starting with one STEAM project or lesson, (c) incorporating various forms of art into lessons, and (d) overcoming challenges; such as, (1) unavailable resources and (2) student resistance to STEAM.

Add elements of art to routine classroom activities. One way teachers took a "baby step" towards STEAM was to add an art component to an existing routine class activity. Instead of taking notes on standard lined paper, Participant 2, recommended that STEM teachers give students "a blank piece of paper and have them use colored pencils or bring in that visual journaling." Participant 1 is an avid visual journal supporter and she provided evidence of how notes, analysis, and other student directed activities can be taken in a visual journal which was highlighted with multiple colors, visual graphics, and pictures to enhance learning. Participant 1 also wrote in her journal about a "new definition for doodle" as making spontaneous marks to help you think, keep you focused, and help with problem solving. Colorful notes and visual journaling appeared to bridge STEM with the arts.

Teachers also altered routine assessments. Participant 3 integrated art in her engineering course by having students to complete a "one-pager." Students demonstrated content knowledge by responding to the teacher's prompt on a single sheet of computer paper. Along with student's written responses, they had to use at least three different colors and include a relevant picture on the one-pager. This informal assessment not only allowed the teacher to quickly observe what students were learning, but the students also were able to learn from each other as they observed each other's work during a "gallery walk" of the displayed one-pagers.

Start with one STEAM project or lesson. Another way teachers transitioned to STEAM was by trying one STEAM lesson or project. Participant 2 referred to this process as "STEAMing it up"! In addition to promoting aesthetics in her engineering course, Participant 3 gave students acting roles in a group design project. The students had to conduct research then demonstrate content knowledge during a presentation while acting in the role of a specific type of engineer or inspector. After teaching students about pendulums, Participant 4 had students to build a pendulum, and then add paint to the apparatus. The paint allowed students to create artwork based on the movement of the pendulum.

Art was also infused with STEM on projects. After students learned about space in their science class, Participant 2 discussed how she had them to create badges as a form of advertisement for planets. Participant 1 noted how technology was heavily incorporated into a theater arts lesson. Students watched YouTube videos as a "critical thinking resource" so that the students could analyze and critique various theatrical performances.

Incorporate various forms of art in lessons. Additionally, teachers started small by incorporating various forms of art. Some have already been mentioned previously in this section through data description; however, participants demonstrated that a variety of ways to incorporate art during the transition to STEAM are possible. Participant 2 reminded during her interview, "Arts are not just the visual arts like I teach." She continued with the example of playing music in the background to set the tone and focus. Participant 1 had a print out of the National Core Arts Standards in her journal which referenced; “dance, media arts, music, theater, and visual arts.” Each participant throughout the study discussed multiple art forms that they used.

Visual arts appeared to be the most widely used art form. Participant 1 readily incorporated painting into theater arts by having students to paint sets. Participant 3 interjected visual arts when her students used colored pencils to complete their one-pager assignments and when they painted their architectural design projects. Participant 4 also used paints during her pendulum projects.

Digital art was mentioned by more than one participant. Participant 3 intentionally incorporated arts into her computer science course as she progressed toward STEAM. Participant 2 acknowledged adding a digital art component to her curriculum after attending a workshop conducted by a digital artist. Digital arts provided a good example of fusing technology and arts in STEAM.

Media arts were also used by participants. Participant 1 incorporated the use of YouTube videos into her theater arts course. Participants 2 and 4 collaborated on a STEAM project where they each mentioned students using magazines and watching videos as learning resources to engage students in the projects.

Theater arts even played a role in the transition to STEAM by participants. While this art form was a given for Participant 1 who taught drama and language arts, it was an arts addition to Participant 3’s engineering course. As mentioned earlier, Participant 3 used role-playing as part of a project where students had to act is if they were various types of engineers or inspectors during their presentation of proposed building design.

Start-up Challenges. Even with starting small, challenges were noted in making the transition to STEAM. Participants encountered obstacles that provided some resistance while moving towards STEAM. Ultimately, barriers did not heed their transition to STEAM. Unavailable resources and student resistance were two notable challenges that support this subtheme.

Resources to enhance STEAM lessons may not be available. While some teaching materials are standard across all content areas, others tend to be more content specific. When asked about challenges during her interview, Participant 4 pointed out, "you just need to gather a lot more materials than you do with a normal STEM lesson," and she added that some she wouldn't typically have in her classroom. Participant 2 responded to the same question by commenting on the fact that she was in a small school where it was "only so much you could do" as she referenced trying to reach out to other teachers to obtain resources.

Students may initially resist STEAM. Not only did a lack of available resources prove to be challenging, but teachers also encountered student resistance with the transition to STEAM. Participant 1 commented, "It is risky for students to create, and so trying to convince them that it's a safe place to do that is sometimes the challenge." Most of the participants reported observing some form of resistance from the students when they began implementing STEAM.

During their individual interviews, Participants 1, 2, and 3 each discussed their encounters with students. The biggest challenge was "student apathy" according to Participant 1. She continued, "They have to buy into it- they have to be willing to work in a different way." Similarly, Participant 3 observed, "You know students don't like to draw even with encouragement," so she tried to get them started with just using stick figures or describing how a design would be painted. Even the art teacher, Participant 2, stated her challenge as being "to figure out what my students like—how to pique their interest and creativity." She recalled being amazed at an elementary school art teacher's display of student projects which was on a more advanced scale of what she tried to get her middle school students to accomplish. Each participant seemed to indicate with time that the student resistance decreased.

Theme 2: Summary. In making the transition to STEAM, teachers chose to make the move in small steps and build up. The easiest method of transition was to add elements of art to routine classroom activities such as taking notes and informal assessments. A slightly larger step involved the act of actually teaching an entire lesson or designing a project through the use of STEAM. At all levels of taking steps towards and implementing STEAM, teachers used a variety of art forms including music, performing, digital and visual arts. One challenge that teachers encountered as they made small steps toward STEAM were that resources were not always readily accessible. Another challenge was that while some students initially resisted the concept of transdisciplinary learning styles in a particular content area, they did not expect to have art included in STEM or STEM included with art instruction.

Theme 3: Collaborate as a Process for Transitioning

As teachers made their progression towards STEAM, collaboration was a beneficial component of the process. Just as STEAM incorporates transdisciplinary content material to enhance learning, transdisciplinary content teachers collaborated to facilitate and enhance the transition. During the focus group, Participant 1 stated that "talking to other teachers" was one of her main resources used to transition to STEAM. Each participant verified that they collaborated with other teachers during their transition to STEAM. This section is supported by teachers' demonstration of collaboration with (a) a transdisciplinary teacher in the same school, (b) teachers from other schools, (c) other professionals, and (d) the challenge of time is discussed.

Collaborate with a transdisciplinary teacher in the same school. A convenient resource during the transition process was for teachers to collaborate with transdisciplinary teachers located in their school. Participant 3 mentioned that she “networks” with other teachers in her school especially to find ways to integrate art into her curriculum. Other content teachers know the “student clientele” as noted by Participant 2, so that helps with being able to find materials suitable for their interests and learning needs. Transdisciplinary collaborators appeared to come up with some interesting projects.

Participant 3 worked with art teachers in her school on various projects. She shared examples of her students designing and cutting out the school letters or initials made from wood or Styrofoam, then the students would be led under the direction of the art teacher to paint and decorate the letters. In one instance, the finished product from such a collaboration was used to decorate the high school’s graduation ceremony venue.

Like Participant 3, Participants 2 and 4 also collaborated to create a transdisciplinary STEAM project. Participant 2 had previously collaborated with a science teacher who worked at the school to develop a STEAM project which fit both of their curriculum standards. The two decided on a project inspired by Andy Goldsworthy, an environmentalist and artist. Students were tasked to create a three-dimensional art piece using objects found in nature, such as, sticks, stones, and leaves. Participant 2 continued this collaboration with Participant 4 when she took over the former science teacher’s position at the school. During our pre-interview meeting, Participant 1 showed off the students’ “Earth Works” projects which were on display in the school’s media center. Many students created living quarters such as cabins and teepees, while others created decorative wall art and baskets amongst other artifacts.

Collaborate with teachers from other schools. Collaboration experiences also occurred as teachers reached out to other teachers beyond the walls of their own school buildings. This allowed teachers to reach a greater pool of educators to exchange ideas and resources. Participant 2 noted that her school was "small," so she tried to "venture out" to as many other schools as possible.

Collaboration with other teachers sometimes occurred at educational events. For Participant 3, one such event was at a curriculum writing session sponsored by NASA. She commented, "We did a lot of STEAM work!" Participant 2 mentioned that she attended a lot of arts workshops with a science teacher from another middle school. She noted the mutual collaborative relationship developed into her helping the science teacher locate appropriate art supplies, and she received various "hands on activities" in return.

Collaborate with professionals to produce STEAM lessons. In addition to collaborating with other teachers, some participants collaborated with other industry professionals. Participant 2 explained that she tried "keeping up to date with as many artists as possible" to "keep in the swing of things." This sentiment was also reflected in Participant 3's collaborative experience discussed above.

Participant 2 noted that she attended a workshop at a museum where she learned about a new digital artist and began to use his works to update her curriculum. Likewise, Participant 3 was able to incorporate fresh ideas from her curriculum writing event at NASA because she not only collaborated with other educators, but also other professionals. By collaborating with professionals, participants were able to integrate current real world scenarios with their STEAM curriculum.

Challenge- Time may be an issue for collaborators. Although teachers benefited from collaboration as a resource during their transition, they encountered a challenge with the time involved with collaboration. "We were co-teaching, so finding the time to sit down," posed a challenge according to Participant 4. The act of teaching, whether individually or through a co-taught model, involves the use of time to plan, gather resources, implement the lesson, and assess the lesson. Of these, one participant noted that time was an issue at the beginning and ending of the collaboration process.

Teachers have different schedules and planning periods which led to a timing issue for some participants. Participants 2 and 4 collaborated on a STEAM project as was mentioned earlier in this section. These two teachers "had separate planning periods" and had to find time to work together after school to plan together and later to grade together. Participant 2 mentioned that her own children were involved in extra-curricular activities, so the lack of common planning time during the day was a challenge for her.

Theme 3: Summary. Collaboration proved to be a beneficial resource for teachers. Models of collaboration included collaboration with transdisciplinary teachers within one's own school, collaboration with teachers from other schools, and collaborating with industry professionals. Collaboration allowed teachers to expand their pool of resources, such as, instructional materials and lesson planning or project ideas. The main challenge noted under this theme was finding mutually agreeable times to collaborate.

Theme 4: Participate in On-going Professional Development

Throughout the transition towards STEAM, teachers relied heavily on professional development opportunities. During the focus group, Participant 1 relayed, “going to really good professional development is the best way” to transition to STEAM. Each participant provided evidence of their commitment to acquire new knowledge that lent itself to the advancement of STEAM. This theme is supported by the following subthemes: (a) attend STEAM-related professional development seminars, (b) attend workshops to increase STEAM knowledge, (c) read STEAM-related materials to increase STEAM knowledge, (d) use online resources as a key resource including: (1) use websites to obtain STEAM instructional material, (2) use websites to gather ideas for STEAM projects, (3) use websites to enhance student learning, and (e) the challenge of learning or re-learning other content area skills.

Attend STEAM-related professional development seminars. By listening to interesting keynote speakers at seminars, participants became more enlightened about STEAM. As stated in the evidence provided under the first theme, Participants 1 and 2 both had transformational learning moments when they heard certain speakers relay information about STEAM. These moments occurred because the participants took it upon themselves to attend a professional development seminar.

The information gathered at the seminars helped to frame the teachers’ perspectives in the manner for which they viewed and implemented STEAM. For example at the theater arts workshop that Participant 1 attended, she wrote in her journal the new job title which the keynote speaker bestowed upon the audience as “Agent of Artistic Experience.” She also wrote the following quote, “Art lives in the individual’s capacity to perform this amazing human act of expanding our sense of the way the world is or might be.” This quote resonated with her new found desire to prepare students for the 21st century job skills through the use of STEAM.

Comparably, Participant 2 recalled attending a professional development seminar where the guest speaker stated that STEM should have been referred to as STEAM from the beginning. By attending this seminar, Participant 2 became more aware of her role in linking art with STEM. She was so inspired from the seminar that she obtained the curricula for other transdisciplinary content areas and used the information to find new themes from those content areas to combine with her traditional art curriculum.

Attend workshops to increase STEAM knowledge. Teachers also attended workshops to increase their understanding and ability to implement STEAM. Participants reported receiving new insights and ideas of how to implement STEAM through attending workshops. During her interview, Participant 1 referred to herself as a "workshop junkie" as an indication for how often she attends workshops. Each participant mentioned multiple workshops or trainings that assisted with their transition to STEAM.

Some workshops that participants attended were mandatory for their position. Participant 1 was required to attend an Advanced Placement workshop, and she was able to hear once again about the 21st century job skills that students would need in the future. She also noted ideas that she received of how to integrate arts techniques into lessons which would support STEAM. Participant 3 was required to attend various trainings and workshops based on her position as a Project Lead the Way teacher. She provided numerous training certificates that she received over the years from these trainings and workshops. Like Participant 1, Participant 3 was provided with lessons that aligned with the qualities of STEAM.

Other workshops, Participants chose to attend on their own. Participant 2 pointed out while she likes to attend workshops at art museums, it was a space foundation workshop that she "really got into." She discussed these workshops throughout her interview and the focus group.

Participant 2 provided her resume which listed over two pages of workshops that she has attended related to art and STEAM specifically. Participant 1 also provided a "workshop journal" in which she regularly wrote visual notes on the numerous theater arts and other professional development workshops which many "discussed the 21st century jobs skills and STEAM related concepts."

During the focus group session, workshops remained one of the central concepts discussed. Participant 4 announced towards the end of the session that she had just attended the science institute's workshop two days prior, and so ideas such as integrating art into the engineering design process were still "fresh" in her head. Participant 2 added that she was taking a workshop over the summer at the National Museum of Women in Arts, and was "excited" to see what it entailed as the workshop was opened to all teachers and involved book making.

Read STEAM-related materials to increase STEAM knowledge. Along with attending seminars and workshops, teachers indicated that reading various materials also helped to increase their STEAM knowledge. The materials that the participants read allowed them to learn more about the topic of STEAM and as planning resources. Participants indicated that reading was used to benefit the students' knowledge as well as their own.

Reading materials provided insights and inspiration to move in the direction of STEAM. So inspired by the keynote speaker, Eric Booth, who she heard at a workshop, Participant 1 noted that she reached out to the convention planners because she missed some notes and had questions. They responded by sharing a "digital link" to the presenters materials and an article that he wrote entitled "Learning and Yearning." Participant 1 added, "I read "A Whole New Mind" by Daniel Pink which led me into even more understanding" of how creativity and technology played a role in preparing students for STEM related jobs. In her journal, Participant

1 also pasted an article entitled, “What Theatre Teaches” by Krin Brooks Perry where the main points were: problem-solving, decision making and divergent thinking, abstract thinking, and creative expression. Each of these reading sources helped to prepare this participant on her move toward teaching a STEAM curriculum.

The middle school teachers indicated using reading materials such as scholastic magazines. The magazines served as a resource for them to enhance their lessons. The magazines also allowed students to learn more about the lesson topics. For instance, the magazines allowed students “to learn about the history” of the artists and style of art that they were using for their collaborative STEAM projects.

Use online research as a key resource. Aside from attending professional development seminars, workshops, and reading various materials, teachers found online sources to be beneficial to their transition to STEAM. Online resources allowed teachers to conduct research and gather ideas at their own pace. Participants used online resources to gather instructional materials, ideas for STEAM projects, and to enhance student learning.

Use websites to obtain STEAM instructional materials. Websites provide a large array of information. When asked during the focus group about the resources they used to transition to STEAM, Participant 1 slightly amended her response from her interview about attending workshops to include talking to others and “using online resources.” Participants 2 and 4 reiterated their affinity for Pinterest and Participant 4 included the general use of Google searches too.

Instructional materials, such as lesson plan ideas, seemed to be readily available online through various sites. Participant 2 in addition to using Pinterest shared that the Smithsonian Museums had a website which contained online learning materials. Teachers Pay Teachers was also mentioned during the focus group as a site noted to have available lesson plans which teachers could adjust to their students' needs.

Use websites to gather ideas for STEAM projects. In addition to instructional materials, websites can be used to gather ideas for STEAM specific projects. Participant 2 stated, "Pinterest is my go to for everything!" She explained that she references the site for lesson plan materials and project ideas. "Like you can just put in a topic that you want to do and I'll look and I don't always click on the full website and I'll just see all of these pictures and ideas," commented Participant 4 during the focus group. Participant 4 also shared via email several links that she's used for science project ideas which included a kaleidoscope, rainbow paper, symmetrical snowflakes, and a do-it-yourself (DIY) robot hand.

Use websites to enhance student learning. Teachers additionally used websites to enhance student learning. The use of websites helped to contribute to the technology piece that is a part of STEAM. As she referenced the Smithsonian website again, Participant 2 commented "if you want to search for something it's there." This feature allowed students to conduct online research for lessons and projects. Participant 2 and 4 also mentioned that students were able to use websites to look up ideas for the collaborative Earth Works project.

Challenge- Learning or re-learning skills to teach other content areas. A STEAM curriculum involves the use of transdisciplinary instruction which posed a slight challenge for some teachers. "I don't think there were that many challenges other than familiarizing myself or refreshing myself with those terminologies," commented Participant 4 during her interview. Teachers are certified in specific content areas, so the inclusion of unfamiliar content practices and terminology warranted extra effort to re-acclimate with the necessary knowledge.

In the process of implementing STEAM, participants 1, 3, and 4 noticed possible challenges that they or other teachers may have incurred. Participant 3 suggested that STEAM teachers have a knowledge of design "so that you are not teaching not necessarily the wrong thing, but so that you know what to teach what content to teach, what skills." She continued that while she is not an artist, she is able to teach her students how to draw. Along the same lines, Participant 4 recommended STEAM teachers know "some of the art techniques and forms."

During their interviews Participants 1 and 4 relayed slight obstacles which they personally had to overcome. Participant 1 noted during her interview that especially compared to STEM teachers, teaching through "inquiry" did not come as natural to her. Whereas, Participant 4 was more comfortable with the STEM components, during her co-taught project with the art teacher, but she had to re-learn about "color, lines, and spacing" as they related to perspectives in art.

Theme 4: Summary. Teachers reported regularly participating in ongoing professional development in order to successfully transition to STEAM. The main sources of ongoing professional development included attending seminars and workshops. Teachers described being inspired from such events to go into STEAM and to continue on that path. Teachers also read a variety of materials to stay abreast on STEAM education. Finally, they used online resources to assist with obtaining instructional materials, project ideas, and enhancing student learning. In addition to increasing their knowledge on STEAM, some teachers indicated a slight challenge when they also had to learn or re-learn about terminology and processes related to transdisciplinary content which was included in their STEAM curriculum.

Chapter 4 Summary

Teachers transitioned to STEAM through nonlinear steps which were presented chronologically for fluidity. Data was obtained and corroborated via individual interviews, relevant artifacts and documents, and a focus group with three of the four participants. Themes were: embrace a mindset to teach from a STEAM perspective, start small and build up, collaborate as a process for transitioning, and participate in ongoing professional development.

Theme one showed that teachers went through a transformational learning process where their mindset changed to teach from a STEAM perspective. They realized that STEAM already existed in parts of their curriculum, but still intentionally planned transdisciplinary lessons with an end goal in mind. Some teachers overcame obstacles of encountering unsupportive educators or facing their own fears of the potential risk associated with making the transition to STEAM.

The second theme showed that teachers chose to start small and build up. They added small elements of art to routine activities and worked up to implementing a complete STEAM project or lesson. Various art formats were used as teachers transitioned to STEAM; however, they were faced with the challenges of limited resources and a lack of initial student buy-in.

The third theme involved teachers using collaboration as a resource during the transition to STEAM. Teachers attempted to collaborate with transdisciplinary teachers within their schools, teachers outside of their schools, and industry professionals. Collaboration allowed teachers to expand their access to instructional materials and ideas, but lack of time was an issue.

The fourth theme involved teachers' continual participation in professional development opportunities. Teachers frequently attended workshops in addition to seminars, reading and using online resources for professional development. Teachers increased their own comprehension of STEAM and found tools to enhance student learning. Teachers noted learning or re-learning certain processes and terminology associated with transdisciplinary content, which was embedded in their STEAM curriculum as a challenge.

Chapter 5: Discussion and Conclusion

This chapter is a discussion along with the implications and conclusions from the results found during the study, evaluating the results of Chapter 4 through personal insights and interpretation. Connections are made between the results of this study and existing literature. Limitations encountered during this study are also discussed in terms of their impact on the study. Implications of how the results are connected to practice, policy, and theory are shared. Finally, recommendations for further research are provided followed by study conclusions.

Summary of the Results

This research sought to explore how content teachers transitioned to implementing a STEAM curriculum. The conceptual framework used to guide this study was a combination of Mezirow's (1991) transformational learning theory and the STEM to STEAM movement (Maeda, 2013). The transformational learning theory for adult learners was used as a basis to support the teachers' decisions to transition. The STEM to STEAM movement arose in the early 2000's as a means to better prepare students with the necessary job skills needed for the 21st century workforce along with improving their creativity and innovation skills. This research may be beneficial for those who decide to move from teaching a traditional curriculum toward teaching a STEAM curriculum.

STEAM is a relatively new form of curriculum that is increasingly being used throughout schools in the United States and globally. Research has primarily looked at the benefits of STEAM, and a few case studies have looked into how teachers implement STEAM (Herro & Quigley, 2016; Herro, Quigley, & Dsouza, 2016; Hunter-Doniger & Sydow, 2016; Quigley & Herro, 2016). Two different longitudinal case studies were conducted to look at how middle school teachers implemented STEAM practices after receiving STEAM professional development through their district and individual school respectively. Both studies also considered teacher perspectives during the initial study in addition to observing the practices used (Herro & Quigley, 2016; Hunter-Doniger & Sydow, 2016).

The longitudinal studies conducted by Herro et al. (2016) consisted of teachers who participated in professional development courses that covered project based learning and technology integration. The researchers approached their study through the lens of identifying practices that are associated with STEAM. Results showed that STEAM practices include the use of project based learning, technology integration, transdisciplinary teaching, and the teacher as a guide in authentic problem solving.

The longitudinal study conducted by Hunter-Doniger and Sydow (2016) also contained participants who went through a school-wide STEAM professional development. This study decided to use a conceptual framework based on the “studio thinking framework” that is widely used among art instructors. Results indicated that teachers who initially integrated arts into instruction began to significantly increase the frequency of integrating arts. Those who only began to use arts integration after professional development observed that students were more engaged. Overall, the school’s standardized STEM scores improved by 8% on their pre- and post-test scores. This result may not have been a causality of the integration of arts, but it coincided with the arts integration after the school suffered from no increase in scores for the prior years when only the STEM focus operated at the school (Hunter-Doniger & Sydow, 2016).

Whereas, the longitudinal case studies previously discussed explored teacher practices used to implement STEAM after the participants went to a district or school implemented professional development, my multiple case study explored how teachers transition to STEAM in a district that does not require STEAM instruction. Certain commonalities were found in the data from the longitudinal studies that were also observed in this case study. Challenges such as teacher fears of the unexpected in making the transition to STEAM, lack of instructional materials, student resistance, and other teacher's resisting the move toward STEAM. Some common teacher practices were also observed between each of the studies such as the need for professional development to improve a teacher's ability to implement STEAM, the use of project based learning, and incorporation of various arts forms. Each study approached the case studies with a different theoretical framework which included the STEM to STEAM Movement; the frameworks led to varying conclusions based off similar data.

Data collected in this multiple case study came from individual interviews, a focus group, and observations of supporting artifacts and documents, thus providing triangulation. This study found four major themes that showed how teachers transition from STEM to STEAM. Teachers, namely, (a) developed a mindset to teach from a STEAM perspective, (b) they started the transition in small ways then built up, (c) collaboration was used in the process of transitioning, and (d) participation in and application of ongoing professional development was a key factor.

Discussion of the Results

Interpretations of the results, supported by findings from Chapter 4, are discussed in this section. The results of this study are significant because they can add insights into how teachers may transition from implementing a traditional STEM or arts curriculum to implementing a STEAM curriculum. This multiple case study collected data from a STEM and an arts teacher at two different sites, a high school and middle school, within the same school district. No teachers were required to implement STEAM instruction by either their school or district. At some point in their careers, each of these teachers made the decision to implement a STEAM curriculum. This study explored how they made the transition to STEAM.

The process was unique for each individual teacher; however, as data was analyzed, a pattern and general description of the process began to form. The process is not strictly linear, but the discussion will occur in a sequential format because the themes appeared through data collection and analyses to build upon each other. The discussion will also include methodological errors and limitations that may have affected the results of the study. Results presented in Chapter 4 will be discussed in this section by providing a narrative describing how teachers transition to STEAM.

Theme 1: Develop a Mindset to Teach from a STEAM Perspective

The first step in making the transition to STEAM was to make a conscious decision to implement a STEAM curriculum. Most of the data for this first theme came through the one-on-one interviews. During the interview sessions and in some cases the pre-interview, teachers shared their stories of how they became aware of STEAM and developed a positive disposition towards the concept. An outside influence connected to STEAM led the teacher to question the existing curriculum and identify flaws or a possibility for improvement. Once, teachers made the decision to move toward using a STEAM curriculum, their overall perspective began to change. Teachers both identified ways that STEAM seemed to already exist in their curriculum and they intentionally planned transdisciplinary lessons. The end goal which they hoped to accomplish through a STEAM curriculum was a motivating factor which also helped the teachers to overcome challenges that arose during their transition.

Use a transformational learning moment to embrace STEAM. Adults learn “by elaborating existing frames of reference, by learning new frames of reference, by transforming points of view, or by transforming habits of mind” (Mezirow, 2000, p. 19). Each teacher described some event where they learned more about STEAM and as a result transformed their points of view towards the curriculum that they used. Participant 1 stated that "it was a keynote speech called 'Learning and Yearning' where she learned about the traits and characteristics of 21st century job skills students needed and about educating students through a "combination of right and left-brained thinking." She added during the focus group that she couldn't take all the notes that she wanted, "It was a very powerful experience and it kind of changed the way that I looked at students, at teaching, at my lesson planning, and all of those things and um it just changed a lot."

Although the participants understood that this study's intent was to explore how teachers transitioned to using a STEAM curriculum, both participants 2 and 3 during their interviews suggested that they always taught a STEAM curriculum. In the next subtheme, the idea of how components were already embedded in curricula is discussed. Additional probing and notes taken during the pre-interview sessions allowed these participant to reflect more and realize where their perspective toward STEAM had transformed.

During her pre-interview, Participant 2 shared that she had never really been good at science, yet it was through an undergraduate art course that she felt she "learned the most about science" because her art teacher infused science concepts throughout the art course in a way that made sense to her. This experience most likely affected her teaching practices even if subconsciously. She noted several times throughout the interview, focus group, and included artifacts documenting her attendance at a Space Foundation workshop which also impacted her as a teacher. She believed that what she was doing "finally had a name for it," but she also realized that she primarily incorporated math in her curriculum, and these workshops led her to collaborate with science teachers so that she included the sciences more as well.

Participant 3 also believed that she always incorporated “aesthetics” in her engineering and design courses, so she did not initially identify a transformational moment which impacted her curriculum. When probed to see if her college engineering courses seemed to be STEAM oriented and may have impacted her disposition towards STEAM, she replied “no.” As the interview continued, Participant 1 did mention that after going through NASA trainings and working with other professionals that she did begin to incorporate the arts more into her computer design course. While, not as impactful as the other participants’ experiences, Participant 3 did have an experience that changed her perspective for the manner in which she taught computer science.

Participant 4, like Participant 1, readily identified her impactful moment of transitioning towards STEAM as working with her school’s art teacher (Participant 2) on a STEAM collaboration project. However, through further discussion, Participant 4 realized that she “agreed so quickly to work with the art teacher” because the previous year she recalled how “excited” her own child was upon completing the same STEAM project. By witnessing the impact that STEAM had on her own child, a positive impression was made. By the end of her interview, Participant 4 further noted that her student teaching had been conducted at an arts integration school which most likely also impacted her decision to transition toward STEAM.

Critical reflection also applies to Mezirow’s (2000) transformational learning theory. Each participant during this study demonstrated critical reflection where they recognized the events that began to change their perspectives from a traditional instruction perspective towards a STEAM perspective. This step marked the beginning of how the transition process occurred.

Identify ways that STEAM is already embedded in lessons. Once teachers formed a STEAM perspective they began to view their existing curriculum in an enlightened framework.

Teachers recognized that the some elements of STEAM were already present in their curriculum. Teachers shared similar comments supporting the revelation that STEAM was already a part of their curriculum. The art teacher readily recognized how math concepts were supported by her curriculum and the engineering teacher shared that aesthetics was encouraged with her design instruction. Participant 1 commented “I think we have always kind of put these things together” as she reflected upon cross-curricular instruction. Participant 2 noted “I think we subconsciously do it naturally” referring to implementing STEAM. Similar comments were also made by Participants 3 and 4. This step was actually a mental move which suggested that they were already going in the direction of STEAM.

Plan lessons through framework of transdisciplinary teaching. Even though teachers recognized how STEAM was already embedded somehow in their instruction, they took another step towards STEAM by intentionally planning transdisciplinary lessons. In order to “STEAM Up” lessons as Participant 2 described it, teachers relied upon various resources to obtain ideas. The participants all participated in ongoing professional development and engaged in collaborative experiences to gain ideas of how to increase STEAM. The arts teachers indicated using more technology in their lessons and the STEM teachers indicated adding more artistic components such as visual journals.

Think about the end goal of STEAM. By continuing to move in the direction of STEAM, teachers appeared to have an end result that they wanted to achieve. The middle school teachers both discussed STEAM in relation to students’ interest and increased engagement. Participant 2 worked diligently to collaborate with others in order to find interesting topics that would reinforce STEM concepts through her art class. Participant 4 noted how students, including her own children, appeared to be more engaged through STEAM projects. For the high school teachers, the end goal was attached to career readiness. Participant 3 wanted students to be able to implement artistic and creativity skills in their future STEM careers, which was included under the umbrella of the "21st Century" job skills that Participant 1 used as her focus for STEAM. Teachers continued their transition to STEAM as they focused on the desired end goal which served as an intrinsic motivation to teach STEAM.

Overcome challenges. The transition towards STEAM came with some obstacles that the teachers had to overcome. Whether being surrounded by others who did not support STEAM or trying to overcome one's own personal fears, teachers made the decision to continue with STEAM regardless of the potential mental blocks. This demonstrated a level of belief in the use of STEAM that was worth making a risk.

Teacher apathy towards STEAM. Just as these teachers were encouraged to teach STEAM from another professional or peer, they could have been just as easily dissuaded to teach STEAM from their peers. Both Participants 1 and 2 noted that not all teachers were in favor of teaching STEAM. Participant could have decided not to teach STEAM knowing that progress she made through teaching her students a STEAM curriculum may have been negated as those students entered another teacher's classroom who negated the concepts of STEAM. Likewise, Participant 2 could have decided to abandon her ambition to teach STEAM as she encountered peers who did not want to support who as she transitioned to STEAM.

Personal fears. In addition to other teachers, sometimes a teacher had her own reasons to think that they may not be able to achieve their goals of implementing STEAM. For instance, Participant 3 knew that she was "not a good artist" but she decided to show her students that even stick figures is a way to begin demonstrating creativity. The unknown can be a fearful place, but these teachers all pressed on despite challenging thought that arose during the process.

Theme 2: Start Small and Build Up

After teachers developed the mindset to teach STEAM they continued on the transitional journey by not taking on too much at one time. Each of the teachers in describing their STEAM experiences indicated that the journey was completed in incremental steps. Teachers took “baby steps” which allowed them to continually reflect on their transition steps and to make adjustments accordingly.

Add elements of art to routine classroom activities. By adding art components to routine classroom activities, teachers essentially made this a smoother transitional experience for students as well as themselves. Teachers did not have to go too far away from their traditional teaching practices to add art to classroom activities such as notetaking or informal assessments. This type of small step most likely reduced the possible resistance from students as well who may have complained that their engineering class was not an art class.

Start with one STEAM project or lesson. Some proponents of STEAM will say that adding art to an activity is not exactly STEAM (Gess, 2017), so the next move towards STEAM was to implement an actual STEAM lesson or project. Again these teachers were not in a school where they were required to teach STEAM, so they were left to their own devices to develop or adapt a STEAM curriculum to their existing curriculum. By starting with just one lesson, they were able again to identify areas that worked well or needed to improve. They were also able to determine what additional steps they needed to make or materials to gather in order to satisfactory implement a STEAM lesson.

Incorporate various forms of art in lessons. The “A” in STEAM is not just for visual arts; therefore, the use of various art forms helps to expand the instructional possibilities that can be accomplished through STEAM. In addition to visual art mediums, teachers indicated the use of music, theater, sculpture, and digital media to transform a traditional lesson to a STEAM lesson. As Participant 1 shared that she considered, Maslow's hierarchy of leaning when designing her STEAM curriculum, the various forms of art can be used to demonstrate different levels of learning. Practicing with a variety of art forms also adds to a teacher's arsenal of tools to pull from when implementing future STEAM lessons.

Challenges. The small steps that were used by the teachers to transition to STEAM were met with challenges some typical challenges were met some expected challenges. Teachers had to incorporate the use of additional resources that were not readily available and they dealt with some students' resistance. These challenges could easily apply to a normal teaching; however teachers discussed these challenges during the interviews, and in considering the transition process it is worth noting what other teachers may expect.

Resources to enhance STEAM lessons may not be available. A lack of resources has been a long standing concern in public schools. So as teachers made their transitional steps towards STEAM, some noted that needed additional materials to implement STEAM. When possible, teachers used resources from other content teachers in their buildings who were willing to share, items such as art supplies. Otherwise, teachers needed to make arrangements to procure the items on their own or make adjustments to original plans. As a certified teacher of a specified content area, one may normally know where to obtain instructional materials for her class, but implementing instruction from another content area created extra effort and time to locate and obtain the necessary resources.

Students may initially resist STEAM. As part of the profession, teachers may encounter students who do not have a positive attitude toward learning or who may not easily adjust to change. As teachers transitioned to STEAM, most indicated that they witnessed some initial resistance from students. No one indicated that the majority of students resisted the STEAM approach to learning; therefore, this challenge did not seem to stand out as a major obstacle. Teachers may have found it beneficial to inform students about the changes in learning environment to prepare the students for the upcoming changes. Other ways to ease student resistance were noted as Participant 3 encouraged her students to draw stick figures and as Participant 2 sought out to find her students' interests to infuse them with her transition to STEAM. These practices seemed to help encourage initial student buy-in.

Theme 3: Collaborate as a Process for Transitioning

Collaboration was another step that each teacher used during her transition to STEAM. Collaboration took the form of working with other teachers within one's school, with teachers outside the school, or with other professionals. Collaboration overall seemed to be a logical step since teachers needed to be aware of concepts, techniques, and practices used in transdisciplinary content areas.

Collaborate with a transdisciplinary teacher in same school. The most convenient place to collaborate may be within one's own school. One benefit of this step appeared to be the convenience of being located in the same building and perhaps having an established rapport with the collaborating teacher. Additionally if this process is done in a manner that includes co-teaching such as Participants 2 and 4 employed on a STEAM project, then it can be used as a modeling technique to demonstrate how collaboration should occur between the students.

Collaborate with teachers from other schools. Collaboration with teachers from other schools was another step used in the transitional to STEAM. This step seemed to occur after collaboration between intra-school teachers had taken place. While the access to location may not have been as convenient with teachers in the same school, collaboration between teachers at different schools allowed for a more expansive pool to gather new ideas and resources.

Collaborate with other professionals to produce STEAM lessons. Collaboration with other professional seemed to be one of the most appropriate steps during the transition to STEAM. STEAM is designed to equip students with the necessary skills and knowledge that they will need when entering the work force, so the ability to work with industry professionals can gave advantages for this purpose. Teachers are able to ascertain what existing industry problems exist or techniques and practices are being used. This information along with assistance from professionals can be channeled into the design of relevant and practical lessons and projects to be used for instruction.

Challenge- time may be an issue for collaborators. A noted challenge with collaboration was the lack of common available time. This study recorded evidence that described a lack of common planning and grading time between the two collaborating middle school teachers which posed a challenge because the teachers had to make sacrifices with their free time after school. The challenge could potentially exist as well in other collaborating scenarios. The use of technology may help to reduce travel time needed to collaborate when not located in the same building as the other party. While emails may experience a delay in responses, Skype or other digital meeting places may help to reduce this obstacle.

Theme 4: Participation in and Application of Ongoing Professional Development

Along with teachers developing a mindset to teach from a STEAM perspective, participation in and application of what was learned from professional development is one of the most important steps in the transition process. Teachers participated in numerous professional development opportunities throughout their transition to STEAM. This one step while discussed at the end of the line is actually a common thread that can be found interweaved throughout all parts of the transitional progression toward STEAM.

Attend STEAM-related professional development seminars. Seminars are a great way to hear from industry professionals and to learn about new theories and practices. After attending STEAM-related seminars, both Participants 1 and 2 were so impacted that they began their journey towards the use of a STEAM curriculum. Since STEAM is still considered a new educational approach, seminars are a practical way to begin on the path towards STEAM by learning from others who helped to shape and promote the theories and practices that are used to implement STEAM.

Attend workshops to increase STEAM knowledge. By attending STEAM workshops, teachers were able to gain a deeper understanding of STEAM and various methods for implementing STEAM. This step was one that seemed to be used the most by the participants overall. Workshops most likely provided take aways that could be readily implemented. Workshops also tend to more interactive than seminars, so teachers were more likely to interact with like-minded people who teachers could network and collaborate with in the future.

Read STEAM-related materials to increase STEAM knowledge. Another step taken by teachers was to read STEAM-related materials. This particular step is a convenient one that can completed at one’s own pace and when time permitted itself. As mentioned throughout this study, STEAM is still a novel practice; therefore, a tremendous amount of materials may not be available to read. Yet, as STEAM instruction continues to gain traction, the number of sources available in print and online have increased for teachers to read and increase their STEAM-literacy.

Use online research as a key resource. Online research was yet another convenient step that teachers took to increase breadth of STEAM knowledge and practices. Online resources allowed teachers to acquire personal knowledge as well as gain ideas that could inform their STEAM instructional practices. Certain online resources were available for teachers to share with their students, thus allowing technology to be incorporated with STEAM lessons and activities.

Use websites to obtain STEAM instructional materials. As teachers tried to build their STEAM program, they reported a lack of necessary materials as a challenge. Online resources were able to provide an avenue where teachers could obtain instructional materials such as lesson plan ideas. Mentioned by more than one Participant, Pinterest seemed to be a local favorite where teachers could obtain useful resources. Websites such as Pinterest and Teacher Pay Teachers seemed to be a practical step in the transition process because they could have possibly saved teachers a great deal of time planning lessons from the beginning.

Use websites to gather ideas for STEAM projects. Similar to using websites to gather instructional materials, websites were also used to obtain ideas for STEAM projects. Sometimes just a simple "picture of a project" as mentioned by Participant 4 was enough to spark creative ideas for teacher's to turn into STEAM projects. In the same vein as the other online subthemes, it is practical to believe that teachers were able to save time by using existing resources that were available on the web to replicate existing projects or build upon ideas that existed on the websites.

Use websites to enhance student learning. So far online resources were discussed in ways that assisted teachers in planning and preparing lessons. They additionally used websites as a way to enhance student learning by finding websites where students could use the sites to enhance their STEAM-related learning. Technology is major component in STEAM; therefore, this step is just as relevant as the discussions on the use of art integration in STEAM. As long as students have access to the internet this transitional step could easily be used by all STEAM content teachers.

Challenge- learning/ re-learning skills to teach other content areas. In relation participation in and applying professional development, teachers noted that learning or re-learning a transdisciplinary content was a challenge. Teachers were certified in their original areas of specialty, so as they transitioned to implementing STEAM, they had to themselves become more knowledgeable of the transdisciplinary terms and practices. While this challenge or additional step may have been another time-consuming factor, it allowed teachers to learn and retrain their minds in the manner which they hoped to train their students. In the end, this step made teachers better STEAM teachers.

Discussion of the Results: Conclusion

This multiple case study was designed to gain an understanding of how content teachers transition to STEAM. Through interviews, a focus group, and review of artifacts and documents, the narrative was developed for the overall process used to describe how teachers make the transition. Teachers developed a mindset that altered their perspective of teaching from a traditional manner to one that was STEAM-focused. It is believed that the new mindset was developed through transformational learning events that altered their old schema for teaching. After teachers decided to implement STEAM, they began the transition in an incremental manner. They appeared to make the transition in a cautious manner by starting small and building up to increased STEAM use. Collaboration was useful process which allowed teachers to exchange knowledge and ideas with peers and other professionals in designing and implementing STEAM lessons. Collaboration is a process that is connected to STEAM, so it was apropos that teachers also engage in the same skills that they expected their students to practice. Finally, teachers transitioned to STEAM by continuously participating in professional development and applying what they learned. Professional development was in some instances the catalyst that started teachers on the journey to STEAM, and this practice allowed teachers to grow and develop along their journey.

Discussion of the Results in Relation to the Literature

STEAM is a relatively new approach to instruction that has been increasing in its popularity and use (Jolly, 2014). This study sought to explore how content teachers transition from a traditional teaching curriculum to a STEAM curriculum. Research has investigated the practices used by STEAM teachers following professional development (Herro & Quigley, 2016; Herro et al., 2016; Hunter-Doniger & Sydow, 2016; Quigley & Herro, 2016). Available research has also considered the benefits of STEAM such as increasing student innovation and creativity for STEM students (Bequette & Bequette, 2012; Jones, 2014; Sharapan, 2012). Results of this multiple case study observed corroborating evidence that appeared in other case studies that explored the practices used by teachers following a STEAM professional development intervention (Herro et al., 2016; Hunter-Doniger & Sydow, 2016). Because the focus of this case study was to look at the overall process that teachers went through to transition to STEAM without the requirement of a professional development intervention, the results varied from previous research.

Theme 1: Develop a Mindset to Teach from a STEAM Perspective

The first theme in this study discussed how teachers made a decision to teach STEAM. Stakeholders in the STEM to STEAM process “must be aware that learning is a dynamic process that is reflective and continuously evolving" (Hunter-Doniger & Sydow, 2016, p. 160). Teachers had to initially learn about STEAM before they could make the informed decision to transition. One "lesson learned" in the Herro and Quigley (2016) case study was that "STEAM teaching does not mean prior teaching techniques are abandoned, but instead rethought or revised (p. 1504)." The second subtheme in this case study supported this lesson because it discussed how teachers reflected and were able to *identify ways that STEAM is already embedded in lessons*. In a separate study, a teacher was reported as having "a shift in her mindset" after she realized that she didn't have to directly teach math during each step of a transdisciplinary project because students would "discover much of it on their own" (Quigley& Herro, 2016, p. 422). This is supported by the third and fourth subthemes where teachers planned transdisciplinary lessons and thought about the end goals of STEAM.

Challenges presented under this theme were also supported by data from the existing literature. One obstacle noted in this study was that other teachers may show apathy towards STEAM. The case study conducted by Hunter-Doniger and Sydow (2016) discussed teachers who were "skeptical" and due to a lack of complete teacher "buy-in" presented an obstruction during the school's transition to STEAM. Other educators' opposition to STEAM could have a negative impact on the transition process. Another challenge presented in this study was teachers overcoming their personal fears. Herro's and Quigley's (2016) participant "believed he might lose control and not know what each student was learning if he lectured and quizzed students less often" by teaching STEAM (p. 1501). A teacher's self-doubt can also provide resistance to a smooth transition to STEAM.

Theme 2: Start Small and Build Up

The second theme in this study discussed how teachers chose to start their transition to STEAM in small incremental ways. One study found that teachers blended "new and traditional pedagogical approaches" which allowed them to effectively test new ideas and approaches to STEAM (Herro & Quigley, 2016, p. 1505). Participants in this study, as well, discussed ways in which they started their transition to STEAM by slowly adding respective STEAM elements to their traditional practices. The second subtheme discussed teachers starting with one lesson or project was also support by evidence reported in other case studies (Herro & Quigley, 2016; Herro et al., 2016; Hunter-Doniger & Sydow, 2016; Quigley & Herro, 2016). One teacher reported that her colleagues used "daily used drama and dance" for routine vocabulary assignments (Hunter-Doniger & Sydow, 2016). This supported the subthemes of *adding elements of art to routine classroom activities* and *incorporating various forms of art in lessons*.

Again the challenges associated were the second theme were also corroborated through other studies. The first subtheme, *resources to enhance STEAM lessons may not be available*, was supported by teachers' concerns that tablets purchased for technology integration were outdated and would hinder that portion of the STEAM initiative (Hunter-Doniger & Sydow, 2016). The second subtheme, *students may initially resist STEAM,* was evidenced when a teacher discussed that a small number of students gave up early "when challenged" which led to off-task conversations and behaviors.

Theme 3: Collaborate as a Process for Transitioning

The third theme discussed the collaboration encounters that teachers used during their transition to STEAM. Collaboration between teachers in the same school was a subtheme that was supported in the Hunter-Doniger and Sydow (2016) case study where a STEAM leadership team was formed to research and provide professional development for teachers to assist with transitioning from a STEM to STEAM focused school. This theme also observed that teachers additionally collaborated with teachers from other schools and industry professionals. The context in which Querro et al.'s longitudinal case study was conducted involves a school district who partnered with a local university to provide professional development training and courses for teachers in the district. Their study explored the various collaborative experiences between the researchers and teacher participants.

Theme 4: Participate in and Application of Ongoing Professional Development

The fourth theme discussed the various ways that participants participated in professional development and applied what they gained into their curriculum. This theme was readily supported by the seminal studies used in this section as they each were predicated on the premises that participants had been a part of a required STEAM professional development. Researchers then examined the practices that teachers implemented following the STEAM professional development intervention (Herro & Quigley, 2016; Herro et al., 2016; Hunter-Doniger & Sydow, 2016; Quigley & Herro, 2016). One teacher conducted "a good deal of research online and in books to find new directions" to expand STEAM in the classroom (Herro & Quigley, 2016, p. 1504). This supported the other subthemes which discussed teachers reading and using online resources to increase their understanding and use of STEAM. The same participant mentioned from the previous study also noted that it was time-consuming to conduct the research and to develop transdisciplinary curriculum. This supported the challenge that participants noted in this study of taking time to learn or relearn skills and practices associated with other content areas.

Limitations

As discussed in Chapters 1 and 3, several limitations existed in this study. Case studies are known to be time consuming and was an expected limitation in this study (Creswell, 2014). In addition to time, the sampling posed limitations that may be improved upon in future studies.

Time Constraints

Time constraints were present throughout this study. Typical time-consuming issues of collecting, analyzing, and presenting data during the time frame allotted posed a challenge due to the iterative processes involved with constant comparison analysis. An additional time constraint arose during the recruitment process. Upon contacting the school district to obtain permission to conduct this study, the researcher was informed that individual school principals were the direct points of contacts to gain permission. After receiving permission from the IRB, contact was made with principals to begin recruitment; however, one principal referred the request to the district board. At that time, I was informed that a separate process was actually required which included applying and receiving permission from the district first. The initial misinformation caused a time delay in the beginning stages. Approval was granted, but during the last month of the school year.

Sample Size

The district used in this study is growing, but not considered large in the states where it is located. Additional restrictions required for the participants in this study further reduced the available sample size. Teachers were required to have previously taught an arts or STEM course, been a certified public school teacher for at least three years, and taught STEAM for at least one year. In addition to the four participants that were involved in this study, at least two other participants were identified and initially expressed interest in participating in the study but were unable to participate because of the aforementioned timing issue of the project starting at the end of the school year. One of the four participants had to expectantly leave town at the time of the focus group session which occurred after the school year officially ended.

This study could have been strengthened by decreasing where possible, time constraints, and increasing the sample size. School districts have different requirements for allowing research to be conducted within their district. One of the time constraints presented in this study may have been avoided by requesting a written copy of the district's policy of allowing research to be conducted opposed or in addition to a verbal description. Also, using a larger school district may allow render of larger pool of eligible participants from which to recruit.

Implications of the Results for Practice, Policy, and Theory

This multiple case study was conducted to explore the process of how content teachers transition from implementing a traditional to a STEAM curriculum. Results from this study were specific to the two participants at each of the case sites used in this study; however, they were also supported by existing research as sown in the previous section which related the results to the literature. Teachers presented a process of how they transitioned to STEAM as one where they developed a mindset to teach from a STEAM perspective, then made small steps toward implementing STEAM, supplemented by collaborating with other educators and professionals, and participating in professional development activities that could inform their teaching practices along the way. These results may have implications that could inform educators about the process involved with transitioning to STEAM in terms of practice, policy, and theory.

Practice

STEAM instruction is described as way to teach students skills associated with STEM while incorporating creativity and innovation supported by the arts. Benefits associated with

STEAM has caused an increase in the number of educators who choose to support STEAM. A STEAM curriculum is an educational approach that is transdisciplinary in nature allowing students to equally use arts and STEM to engage in learning while using design to solve engaging realistic problems (Dell'Erba, 2019; Herro & Quigley, 2016). Common teaching practices include collaboration between students, technology integration, and a more facilitated learning environment (Herro & Quigley, 2016).

Results from my research did not specifically seek to explore the individual teaching practices used in the classroom so much as the practices involved for the teacher to implement a STEAM curriculum. The most notable practice was to participate in on-going professional development and to apply what was learned in those venues to the teacher's instructional approach. Professional Development opportunities are thoroughly evidenced in other case studies that explored the teaching practices used by STEAM teachers (Herro & Quigley, 2016; Herro et al., 2016; Hunter-Doniger & Sydow, 2016; Quigley & Herro, 2016). Other common practices were to start small and to collaborate with other teachers and professionals to inform techniques and practices used in the classroom. As these practices were also found in other research (Herro et al., 2016; Hunter-Doniger & Sydow, 2016), it is possible that a guide for other teachers who choose to transition to STEAM may be established. The most imperative step would be to engage in meaningful STEAM-related professional development. Teachers may also consider finding other like-minded professionals with whom they can collaborate on STEAM lessons and projects. In the beginning stages, it may be wise to start with small steps to better ascertain what works well and what practices need modifications to successfully implement a STEAM curriculum.

Policy

Three objectives of the STEAM movement include: transform policy so that art and design are at the center of STEM, encourage art and design integration in K–20 education, and to encourage the hiring of artists and designers to drive innovation (RISD, 2018). STEAM is the current vehicle that is being used increasingly to address the educational and employment concerns for the 21st century job skills that employers will require. On the national level and in several states, policies are being developed to address funding and descriptions for what STEAM education should entail (Dell'Erba, 2019). These policies will assist with funding to educate teachers, and in turn allow a larger number of students to receive a quality STEAM education.

The results from this study show that even in schools or districts where STEAM has not completely been implemented, more educators are finding the benefit and the desire to transition to STEAM. Teachers in this study were able to participate in some district provided STEAM professional development opportunities, but most often, they embarked on the journey to educate and prepare themselves for a transition to STEAM on their own accord. As more data becomes available and supports the STEAM movement, perhaps a greater number of states and districts will address STEAM in their policies. By having policies in place, teachers such as those in this study may have increased access to professional development opportunities, materials, and other resources. This type of support could possibly reduce the amount of personal time and funds that teachers use to improve the quality of education which they provide their students.

Theory

The guiding theories which framed this study were the STEM to STEAM Movement and Mezirow's (1991) Transformational Learning Theory. STEM is a driving force for the economic success of this country in the 21st century; however, the skilled workforce is endangered due to a lack of skills and available workers (Jones, 2014). Students will now be required to not only have critical thinking and problem solving skills associated with STEM, but they will also need to have innovation, creativity, and design skills associated with the arts for the country to remain competitive. Proponents of the STEAM movement believe that the existing educational focuses of having students learn in isolated content areas will not adequately prepare them for future careers in the STEM workforce (Maeda, 2013). This is a potential problem.

Transformational learning process is a process where adult learners identify a problem, use critical reflection and learning through discourse to challenge their existing perspectives and eventually develop a new or evolved perspective (Mezirow, 1991). Just as teachers in this study demonstrated transformational learning as they changed their perspectives to the approach of teaching by transitioning to STEAM, the entire STEM to STEAM movement could be considered a reflection of transformational learning. STEM once seemed to have the nation on track for being a leader in the 21st century global economy, but as professionals and policy makers notice a decline in the capable and available workforce, reflection has occurred leading to a new perspective from which to prepare students in the educational institutions, STEAM.

Recommendations for Further Research

An exploration of how content teachers transition to STEAM was conducted in this study. The process started with changing one's mindset to approach a curriculum from a STEAM perspective. Teachers also reported that they initially made small changes as they began their transition to STEAM. Collaboration was a valuable resource as they worked with other teachers and professionals. Participating in ongoing professional development opportunities was another big step addressing how the teachers transitioned to STEAM. Results from this study were supported by evidence from previous studies that explored teacher practices used when transitioning to STEAM (Herro & Quigley, 2016; Herro et al., 2016; Hunter-Doniger & Sydow, 2016; Quigley & Herro, 2016).

This study was somewhat unique in that the teachers volunteered to transition to STEAM, and did not undergo a particular professional development provided by the school or district. Each of the seminal studies supporting this research involved case studies where participants went through a specified professional development established by the school or district. Further research could be conducted to explore how other teachers have prepared themselves to transition from implementing a traditional curriculum to a STEAM curriculum.

Additionally, this study intentionally included teachers from both the arts and STEM content areas. Herro et al. (2016) noted future research expansions to include a “variety of STEAM classrooms and contexts” such as art, music, and other specialties (p. 339). This inspired the use of a theater arts and language arts teacher, as well as an art teacher. Much of the research on STEAM looks at interventions provided in math and science courses. As STEAM continues to increase in its popularity, non-STEM courses should be addressed in future research as the arts are just as equal in STEAM as STEM.

Other studies could also look at how educational leaders make the decision to transition a school’s focus from one curricular approach to another or to collaborate with local universities. The factors that inform such a decisions could be explored. The process of how changes in educational approaches are implemented could also be explored. Insights would inform how best educational practices are identified, chosen and implemented.

Conclusion

The purpose of this study was to explore how content teachers transitioned from teaching a traditional curriculum to teaching a STEAM curriculum. Data was collected through one-on-

one interviews, a focus group, and through observation of supporting artifacts and documents. Two sites were used in this study with a STEM and an arts teacher from each school. It is significant to note that these teachers were not required to teach STEAM, but they made efforts on their own accord to transition to teaching STEAM. Analysis of the data led to the formation of four general themes that explained how teachers transitioned to STEAM which included developing a new mindset, making the transition in small steps, collaborating with others, and continually participating in professional development to inform their teaching practices.

Change is not always easy, but it may be necessary to remain relevant. These teachers made the decision to transition from their prior approaches to implementing their curriculum to a STEAM approach. On their journey to using STEAM, they had to research, collaborate, and decide on the best resources, materials, and practices to use in order to reach their goal. They went through a similar experiential learning process that they took their students through. While their intent was to provide an enhanced educational experience for their students, these teachers appeared themselves to become more engaged with the teaching experience.

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Appendix A: Consent to Participate Form

Research Study Title: How Teachers Transition to STEAM
Principal Investigator: Leslie Scruggs
Research Institution: Concordia University–Portland
Faculty Advisor: Dr. James Therrell

Purpose and what you will be doing:
The purpose of this survey is to explore how teachers transition to STEAM instruction. I expect approximately 6–10 volunteers. No one will be paid to be in the study. We will begin enrollment on __________ and end enrollment on ___________. To be in the study, you will be asked to participate in a pre-interview meeting me where I will clarify in more detail the process involved in my research. We will follow up with a more formal face-to-face interview where I will ask you questions about your process of transitioning from traditional teaching methods to teaching through STEAM. I would also like to spend time observing you during a relevant activity such as your planning period or instructional activity. Finally, you will be asked to participate in a focus group setting where the other participants and you will discuss answers to some of the same questions which you were asked during the face to face interview. Doing these things should take less than 5 to 6 hours of your time.

Risks:
There are no risks to participating in this study other than providing your information. However, we will protect your information. Any personal information you provide will be coded so it cannot be linked to you. Any name or identifying information you give will be kept securely via electronic encryption or locked inside a filing cabinet in my house. When I look at the data, none of the data will have your name or identifying information. I will only use a secret code to analyze the data. I will not identify you in any publication or report. Your information will be kept private at all times and then all study documents will be destroyed 3 years after I conclude this study.

Benefits:
Information you provide will help other educators learn more about STEAM and the processes it may take to become a STEAM teacher. You could benefit from this by learning during reflective conversations with me and gaining new insights from your colleagues during the focus group.

Confidentiality:
This information will not be distributed to any other agency and will be kept private and confidential. The only exception to this is if you tell me about abuse or neglect that makes me seriously concerned for your immediate health and safety.

Right to Withdraw:
Your participation is greatly appreciated, but I acknowledge that the questions I am asking may be personal in nature. You are free at any point to choose not to engage with or stop the study. You may skip any questions you do not wish to answer. This study is not required and there is no penalty for not participating. If at any time you experience a negative emotion from answering the questions, I will stop asking you questions.

Contact Information:
You will receive a copy of this consent form. If you have questions you can talk to or write the principal investigator, Leslie Scruggs at email [redacted]. If you want to talk with a participant advocate other than the investigator, you can write or call the director of our institutional review board, Dr. OraLee Branch (email obranch@cu-portland.edu or call 503-493-6390).

Your Statement of Consent:
I have read the above information. I asked questions if I had them, and my questions were answered. I volunteer my consent for this study.

______________________________ ___________
Participant Name Date

______________________________ ___________
Participant Signature Date

______________________________ ___________
Investigator Name Date

______________________________ ___________
Investigator Signature Date

Investigator: Leslie Scruggs; email: [redacted]
c/o: Professor James Therrell, Ph.D.
Concordia University–Portland
2811 NE Holman Street
Portland, Oregon 97221

Appendix B: Pre-Interview Questionnaire

The following questions have been designed to collect back ground data for my case study which asks the question: How do content teachers transition to teaching a STEAM curriculum?

Background Questions:

1. How long have you been teaching? In a public school?

2. What grade levels and what subjects have you taught?

3. What is your background with STEM?

4. What is your background with the arts, whether as a teacher or personally?

Appendix C: Interview Questions

The following questions have been designed to collect data for this case study which asks the question: How do content teachers transition to teaching a STEAM curriculum?

Teacher Semistructured Interview Questions

1. What inspired you to transition to a STEAM curriculum?

2. What steps did you take to prepare for integrating the arts and STEM content?

3. What resources have you used to implement STEAM instruction? (Books? Online? Other teachers? Training/workshops?)

4. What specific skills or practices did you need to learn and use in order to implement a STEAM curriculum?

5. How does your teaching plan differ for a STEAM lesson compared to a traditional lesson plan?

6. What have been some challenges for you while transitioning to or implementing a STEAM curriculum?

7. What motivated you to transition to STEAM and continue to use a STEAM curriculum?

8. Are there any other insights or comments about your transition to a STEAM curriculum that you could share at this time?

Appendix D: Interview Protocol

Interview Protocol: How do content teachers transition to teaching a STEAM curriculum?

Time of interview:

Date:

Place:

Interviewer:

Interviewee:

Position of interviewee:

Brief description of the project:

Teacher Semistructured Interview Questions

1. What inspired you to transition to a STEAM curriculum?
2. What steps did you take to prepare for integrating the arts and STEM content?
3. What resources have you used to implement STEAM instruction? (*Possible probing type questions: "Who did you talk with?" "What did you read?")*
4. How does your teaching plan differ for a STEAM lesson compared to a traditional lesson plan?
5. What specific practices do you need to learn and use in order to implement a STEAM curriculum?
6. What have been some challenges for you while transitioning to or implementing a STEAM curriculum?
7. What motivated you to transition to STEAM and continue to use a STEAM curriculum?
8. Are there any other insights or comments about your transition to a STEAM curriculum that you would like to share at this time?

Appendix E: Document/ Artifact Protocol

Document/ Artifact Title: Date Obtained:

Source Obtained From:

Descriptive Notes	Reflective Notes

Appendix F: Statement of Original Work

The Concordia University Doctorate of Education Program is a collaborative community of scholar-practitioners, who seek to transform society by pursuing ethically-informed, rigorously-researched, inquiry-based projects that benefit professional, institutional, and local educational contexts. Each member of the community affirms throughout their program of study, adherence to the principles and standards outlined in the Concordia University Academic Integrity Policy. This policy states the following:

Statement of academic integrity.

As a member of the Concordia University community, I will neither engage in fraudulent or unauthorized behaviors in the presentation and completion of my work, nor will I provide unauthorized assistance to others.

Explanations:

What does "fraudulent" mean?

"Fraudulent" work is any material submitted for evaluation that is falsely or improperly presented as one's own. This includes, but is not limited to texts, graphics and other multi-media files appropriated from any source, including another individual, that are intentionally presented as all or part of a candidate's final work without full and complete documentation.

What is "unauthorized" assistance?

"Unauthorized assistance" refers to any support candidates solicit in the completion of their work, that has not been either explicitly specified as appropriate by the instructor, or any assistance that is understood in the class context as inappropriate. This can include, but is not limited to:

- Use of unauthorized notes or another's work during an online test
- Use of unauthorized notes or personal assistance in an online exam setting
- Inappropriate collaboration in preparation and/or completion of a project
- Unauthorized solicitation of professional resources for the completion of the work.

Statement of Original Work (continued)

I attest that:

1. I have read, understood, and complied with all aspects of the Concordia University–Portland Academic Integrity Policy during the development and writing of this dissertation.

2. Where information and/or materials from outside sources has been used in the production of this dissertation, all information and/or materials from outside sources has been properly referenced and all permissions required for use of the information and/or materials have been obtained, in accordance with research standards outlined in the *Publication Manual of The American Psychological Association.*

Leslie S. Scruggs

Digital Signature

Leslie S. Scruggs

Name (Typed)

November 22, 2019

Date