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A Case Study of the Perceptions of Education Stakeholders of STEAM Integration in a K–8 Setting

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Abstract

As schools shift from STEM to STEAM schools, there is little research about STEAM school implementation to provide insight into the barriers, challenges and successes for educators. This qualitative case study explored the perceptions of K–8 education stakeholders of implementation of STEAM integration in their schools. The research sought to answer the question: how do K–8 educators in Oregon, perceive the implementation of STEAM integration in their schools. Convenience sampling was used to select three schools for this study. Eight educators were selected to provide maximum diversity in the sample. Through data collection that included questionnaires, interviews, and research notes, information was gathered to describe how administrators, teachers, and instructional specialists perceive the barriers and successes of implementing STEAM integration in K–8 settings. The case study for the participants selects revealed seven themes through data analysis. Education stakeholders have varied experiences first learning about STEAM integration. Administrators, teachers, and instructional specialists have different definitions of STEAM integration and similar components of high-quality STEAM integration. Education stakeholders share the perception STEAM integration provides many benefits for students and share a core set of beliefs about the value of integrating STEAM. Educators perceive similar challenges with STEAM integration and used similar strategies to begin implementing STEAM integration.

Keywords: educator perception, STEAM integration, K–8 education, teacher practice

Dedication

This dissertation is dedicated to all the educators who believe all students are capable of achieving their possible highest dream when given the opportunity to shine with real-world problems that are worth the time and energy to solve.

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Chapter 1: Introduction

Introduction

This qualitative study explores how educational stakeholders in Oregon perceive the implementation of STEAM integration in a K–8 setting. For the purpose of this study education stakeholders are administrators, classroom teachers, and instructional specialists in a K–8 setting. Guyotte, Sochacka, Constantino, Walther, and Kellem (2015) defined STEAM integration as integrating two or more of the disciplines of STEAM. Boy (2013) defined STEAM integration as integrating arts into STEM. Zimmerman (2016) defined STEAM as the integration of all disciplines of STEAM. Based on this research, this study uses Zimmerman's (2016) definition of STEAM integration. The study was conducted in Oregon, because Oregon is one of the few states with STEM hubs, a state education department funded program to serve as a connector between industry, K–12 educators, families, and postsecondary institutions, that have decided to implement STEAM schools as part of the goal to increase STEAM education in Oregon.

The achievement gap between the U.S. and other countries has caused concern in science, technology, engineering, and mathematics (STEM) fields to examine pedagogy for elementary and secondary STEM education (Beal, 2013). Zhao (2012) concluded that an effect of the focus on increasing access to STEM education has resulted in a "creativity crisis" due to an increase in IQ scores and a decrease in creativity scores. A creativity crisis is a problem because of the rising demand in STEM fields for people to be creative and innovative as well as have a strong content understanding (Zhao, 2012). Advocates for art education offered that adding the arts to STEM education would address the need to increase creativity and innovation (Oner, Nite, Capraro, & Capraro, 2016). Thus, STEM education has become STEAM (science, technology, engineering, arts and mathematics) education.

The increasing demand for student learning opportunities to integrate STEAM is a shift from the individual discipline-based education model used by most educator preservice programs to train teachers (Zimmerman, 2016). This preservice teacher training model means addressing educator perceptions of STEAM integration to determine how best to support educators in the transition to integrate STEAM (Zimmerman, 2016). Educators' perceptions are important to provide information on how to support teachers in implementing STEAM instruction.

The following sections of this chapter provide information about the background of the problem. Few studies have analyzed the perceptions of education stakeholders about implementing STEAM integration into schools. The problem statement, purpose statement, and research question are aligned to demonstrate the importance of exploring education stakeholders' perceptions of the implementation of STEAM integration in their schools. Finally, an overview of the methodology, design of the study, terms, delimitations, limitations and assumptions is provided to establish that this qualitative case study utilized core ethical and universal principles of research measures.

Background of the Problem

The demand for integrating STEAM education into schools has been increasing over the past decade (Maeda, 2013). As educators work to integrate STEAM into the classroom, there are challenges that have emerged during their endeavors. The first challenge is the different definitions for STEAM education. Some researchers define STEAM as the integration of arts into each of the disciplines of STEM (Boy, 2013). Other researchers define STEAM education as integration of two or more of the disciplines (Guyotte et al., 2015), and others define STEAM education as "transdisciplinary," the integration of all of the disciplines of STEAM (Zimmerman, 2016). The confusion on what is STEAM education and the lack of research of STEAM education has caused educators and researchers to struggle to describe high quality STEAM education (Henriksen, 2017). However, there are qualities of each discipline of STEAM that transect each other—project-based learning, critical and creative thinking, and utilizing community partnerships (Fulton & Simpson-Steele, 2016).

Educators have been working to integrate STEAM into their instruction, which has influenced research in STEAM to increase within the last 5 years (Watson, 2016). There are four known barriers to implementing STEAM practices into classrooms (Bell, 2015; Douglas, Rynearson, Yoon, & Diefes-Dux, 2015; Stubbs & Meyers, 2015; Zimmerman, 2016). The first is a teacher's awareness of STEAM pedagogy and instructional practices (Bell, 2015; Zimmerman, 2016). Secondly, how the decision is made to implement STEAM creates a barrier for implementing STEAM practices into the classroom (Douglas et al., 2015). Teacher content knowledge and experience within each STEAM discipline is the third barrier, particularly for elementary teachers (Bell, 2015). Finally, limited K–20 teacher knowledge on how to apply content knowledge to real-world situations impacts implementation of STEAM as well as pre-existing systems and structures of school (Stubbs & Meyers, 2015; Thurley, 2016). While these are known barriers for implementing STEAM practices for teachers, there is little research about STEAM schools.

Current STEAM research has been focused on educators describing their own experiences in implementing STEAM instructional practices (Kassaee & Rowell, 2016) and how students perceive their use of creativity in STEAM classes (Oner et al., 2016). The research about STEM instruction and STEM school implementation provides possible indicators about STEAM, but little research on how educational stakeholders perceive the implementation of STEAM integration. Based on the research of Oner et al. (2016) and Zimmerman (2016) on

STEAM education, there is evidence that there is a need to explore how educational stakeholders (teachers and administrators) in Oregon perceive STEAM in K–8 schools in regards to instructional pedagogy, practices, and barriers to implementation.

Problem Statement

The problem this study explored is how K–8 education stakeholders (teachers and administrators) perceive STEAM integration in their schools. Research regarding science and math achievement as compared to other countries in the world demonstrate that the U.S. is trailing behind several first world countries (Gurria, 2018). There is a rising demand in STEM fields for people to be creative and innovative as well as a strong content understanding (Walsh, Anders, & Hancock, 2013). Art provides the missing piece in STEM education to increase interest and creativity (Catterall, 2017). Thus, STEM education has become STEAM (science, technology, engineering, arts and mathematics) education and schools are experiencing a demand from families, the business communities, and students in implementing STEAM learning opportunities across K–20 (Herro & Quigley, 2016).

Purpose Statement

The purpose of the study was to explore how educational stakeholders (teachers and administrators) in Oregon perceive STEAM integration in the K–8 setting. This study has the potential to increase knowledge about how educational stakeholders implement STEAM integration. Additionally, this study could increase educator understanding of the challenges and opportunities of STEAM integration into classrooms. For practicing educators, the results may be used to inform teachers and administrators on how to increase capacity of their peers to integrate STEAM. For educators of preservice teachers, the results may be used to evaluate how preservice programs are preparing teachers to implement STEAM practices into their own future classrooms. Finally, the results of this study may help inform educators who provide professional development on STEAM practices to practicing educators to increase implementation of STEAM into classroom instruction.

Research Question

The following research question guides this study: How do educational stakeholders (teachers and administrators) perceive STEAM integration in the K–8 setting?

Rationale for Methodology

Qualitative research was selected instead of quantitative research because of the holistic nature of qualitative research. Qualitative research is done to understand multiple factors of a situation, create a sketch of the larger picture that emerges, and identify complex interactions of various factors in the situation (Creswell, 2013). Qualitative methods are used when a researcher seeks to understand viewpoints and perceptions of the participants. The research question focuses on the perceptions of the education stakeholders at STEAM schools, therefore qualitative research was the method because the researcher seeks to create a sketch of the larger picture of the perceptions of K–8 education stakeholders of STEAM integration. Additionally, the researcher is seeking to understand the phenomenon of implementing STEAM schools and the perceptions of the education stakeholders involved in the implementations rather than trying to confirm a hypothesis about the phenomenon (Creswell, 2013). The flexibility of qualitative research allows for the design to emerge as the research develops which provides opportunity for the researcher to ask probing questions to elicit deeper response from participants to better understand their perceptions of STEAM integration in a K–8 setting. Finally, qualitative research methods allow the researcher to look for meaning, motives, reasons, and patterns to create a deeper understanding of how K–8 education stakeholders perceive STEAM integration.

Quantitative research allows the researcher to make generalizations about a population or to test a hypothesis (Creswell, 2013). This research is not seeking to make a generalization of a population because the population size is very small. Quantitative methods are used to understand a problem through the use of numerical data (Creswell, 2013). The numerical data is used to be descriptive of the population; however, numerical data does not allow for interpretation. Numerical data was not used to understand the perceptions of K–8 education stakeholders integrating STEAM to allow for interpretation of educator perceptions of integrating STEAM.

Research Design

In social science fields, qualitative research is the method most commonly used, particularly in fields such as education. Case study research presents the opportunity for in-depth study of complex social phenomenon (Yin, 2014). A case study is used to explore and gain insights into a specific phenomenon to generate an analytical generalization (Yin, 2014). The phenomenon being explored is the perceptions of K–8 education stakeholders implementing STEAM integration in Oregon. A case study can be used when a researcher cannot influence the behavior of the participants involved in the study, when contextual conditions will be included as part of the study, and there is no clarity between the context and the phenomenon. Exploratory case studies are used to explore those situations in which the evaluated has no clear, single set of outcomes (Yin, 2014). The Oregon STEM Hubs' decision to support K–8 schools implementation of STEAM integration is new without a clear, single set of outcomes.

The phenomena explored in this case study was: how educational stakeholders in Oregon perceive implementation of STEAM integration in a K–8 setting. The case study was conducted at three STEAM schools in Oregon and were selected using a convenience sampling method because Oregon is one of the few regions with STEM hubs supporting STEAM instruction through the implementation of STEAM schools (More STEM hubs in Oregon, 2019). Data for the study was collected through questionnaires, semistructured interviews, and research notes to provide triangulation and to gain a better understanding of this problem. Open coding and axial coding were used during data analysis to uncover concepts and categories pertaining to STEAM integration.

Definition of Terms

For the purpose of this study, the following terms shall be defined:

Arts integration. This term is defined as a teaching approach that integrates performing and fine arts into literacy, social studies, math, and science (Maeda, 2013).

STEM integration. This term is defined as a teaching approach to integrate at least two more of the disciplines of STEM (Science Technology, Engineering, and Math) to reflect real-world experiences (Bell, 2015).

STEAM integration. This term is defined as a teaching approach to integrate all of the disciplines of STEAM (Science, Technology, Engineering, Arts, and Math) to reflect real-world experiences (Zimmerman, 2016).

Transdisciplinary. This term is defined as the integration of all of the disciplines of STEAM to provide rigorous, relevant, real-world learning experiences (Zimmerman, 2016).

Assumptions, Limitations, and Delimitations

The following assumptions are valid for this qualitative case study:

1. It was assumed that all education stakeholders in this study would answer all questions in the questionnaires honestly and accurately.

2. It was assumed that all participants would receive complete confidentiality to support honest and accurate answers.
3. It was assumed that all education stakeholders in this study would answer all of the interview questions with factual answers.

Limitations within this research study are listed below.

1. Research is specific to one geographic region.
2. Sample size is limited to three participants from each of the three sites, plus a district level STEAM curriculum specialist.

A delimitation, the intentional research boundaries created, is described below:

1. Convenience sampling is used as a result of the Oregon having one of the few STEM hubs, which is supporting STEAM school implementation. The sampling is focused to include different perspectives at each school—administrative, content teacher, and school STEAM instructional specialist.

Summary and Organization of the Remainder of the Study

Current STEAM research has been focused on educators describing their own experiences in implementing STEAM instructional practices (Kassaee & Rowell, 2016) and student perceptions of using creativity in STEAM classes (Oner et al., 2016). The recent increase of individual teachers implementing STEAM practices in the last five years has led to an increase in research about STEAM (Watson, 2016). The inconsistency in definitions of what is STEAM education has caused educators and researchers to struggle to describe high quality STEAM education (Henriksen, 2017). There are qualities of each discipline of STEAM that transect each other (Fulton & Simpson-Steele, 2016). The research about STEM instruction and STEM school implementation provides possible indicators about STEAM, but little research on how educational stakeholders perceive the implementation of STEAM integration, has been conducted. Qualitative case study research was the method used to research the question: How do educational stakeholders (teachers and administrators) perceive STEAM integration in the K–8 setting?

Chapter 2 explains the current research about STEAM instructional practices. Chapter 3 describes the details of the case study methodology used to research the question. Chapter 4 provides the discussion of data collected during research, and Chapter 5 analyzes the data and proposes insights into the perceptions of education stakeholders implementing STEAM.

Chapter 2: Literature Review

Introduction to the Literature Review

The purpose of this qualitative study is to explore how educational stakeholders in Oregon perceive the implementation of STEAM integration in a K–8 setting. This study is important to the field of education because educators' perceptions of STEAM education have not been addressed. Educators' perceptions are important to provide information on how to support teachers in implementing STEAM instruction. The increasing demand for student learning opportunities to integrate STEAM is a shift from the individual discipline-based education model most educator preservice programs used to train teachers, which means addressing educator perceptions of STEAM integration to determine how best to support educators in this transition.

The research that the U.S. is trailing behind other countries has sparked concern in science, technology, engineering, and mathematics (STEM) fields to critically examine pedagogy for elementary and secondary STEM education (Beal, 2013). Walsh et al. (2013) and Zhao (2012) concluded that a "creativity crisis" is evident in the increase in IQ scores and a decrease in creativity scores (Walsh et al., 2013; Zhao, 2012). A creativity crisis is a problem because of the rising demand in STEM fields for people to be creative and innovative as well as have a strong content understanding (Zhao, 2012). Advocates for art education advocated that adding the Arts to STEM education would address the need to increase creativity and innovation (Oner et al., 2016). Through the advocacy by art educators, STEM education has become STEAM (science, technology, engineering, arts, and mathematics) education.

The goal of this chapter is to provide a synthesis of the research regarding STEAM education. The research study uncovered opportunities and challenges of implementing STEAM into educational settings. The literature research used strategies to find, describe, and analyze information regarding the implementation of STEAM in K–12 education, post-graduate education, and informal educational settings. The literature uncovered a lack of agreement of the definition of STEAM, barriers to implementing STEAM practices into instruction, and teacher supports needed for implementing STEAM. Literature used in this chapter was located using the following terms: STEAM, STEM, arts integration, technology integration, project-based learning, problem-based learning, instructional specialists, teacher leadership, inquiry-based instruction, STEAM teaching, STEAM barriers, and STEM instructional specialists. A number of databases were utilized during the process, including ERIC, Google Scholar, Proquest, EBSCOhost, and Concordia University's Online Library.

Boy (2013) advocated for the arts and STEM to be integrated because teaching of the disciplines of STEM as isolated from each other is not helping to create understanding of the systems of the problems the world is facing. The understanding of systems is needed to develop creative solutions (Boy, 2013). Maeda (2013) stated shifting from STEM to STEAM in K–20 classrooms increases connections between disciplines and increase creative thinking ability needed to solve problems. Catterall (2017) added that STEAM education leads to innovation, which leads to creating a strong economy and increases empathy in students making them happier. Art provides the missing piece in STEM education to increase interest and creativity. Thus, STEM education has become STEAM education. STEAM education is rising in demand for schools to implement school-wide or as part of content and elective class offerings (Jolly, 2014). The Every Student Succeeds Act (U.S., 2017) contains language, which encourages states to create plans to integrate arts instruction into classroom instruction. This act requires states to create plans to address the goals of the U.S. Department of Education for public education.

Guyotte et al. (2015) described a STEAM unit as integrating multiple disciplines in STEAM focused on the social practices coming from the community. Zimmerman (2016) applied the term “transdisciplinary” to describe the integration of multiple disciplines in STEAM practices. Kim and Park (2012) stated STEAM reflects a view of education needs an emphasis on creativity, interdisciplinary, real world, and problem-based or project-based teaching and learning. While there is agreement about STEAM practices integrating multiple disciplines, attributes of high-quality STEAM education emerge when examining current research in each of the disciplines and common practices between the disciplines.

Theoretical Framework

STEAM education is founded on two theoretical frameworks: constructivism and culturally relevant pedagogy (CRP). Constructivism is a learning theory, which explains the way people learn is by creating their own meaning and understanding from their own experiences (Vygotsky, 1978). Students learn by doing rather than by listening and taking notes. Banks (1991) describes knowledge construction as the way teachers help students to investigate, understand, and determine how perspectives and bias within a discipline influence how knowledge is created. Students become critical consumers of knowledge by examining and valuing multiple perspectives (Banks, 1993). STEAM education focuses on engaging students in learning by doing and constructing their own knowledge through various learning experiences which integrate knowledge, skills, and practices of STEAM.

Culturally relevant pedagogy is creating challenging instruction relevant to student cultural and linguistic backgrounds (Hammond & Jackson, 2015). Ladson-Billings (2009) defined culturally relevant pedagogy as a pedagogy that empowers student to maintain cultural integrity, while succeeding academically. Students learn by having instruction that is meaningful and respectful of their culture. STEAM education recognizes the importance of connecting students’ learning experience with their own life experience. STEAM education begins with engaging students in what they know and are interested in to learn the skills needed to be able to solve problems in creative and innovative ways (Opperman, 2016; Thurley, 2016).

CRP focuses on changing instruction from a deficit model, a belief that students are unable to achieve because of their background, to a strength model, a belief that cultural differences add to learning and provide avenues for deeper understanding and connections (Hammond & Jackson, 2015). Additionally, CRP includes student cultural references, ideas, and experiences as important pieces of the learning process. CRP also recognizes the inequities in school culture and work to transform instructional practices to be affirming and inclusive of all students. STEAM integration is used to close the opportunity gap. The opportunity gap was created by school culture and teacher cultural perspectives and understandings impacting how they perceive not only students but what instructional strategies will impact student outcomes. For STEAM integration into schools to close the opportunity gap, teachers need support to address their own implicit bias about students and STEAM integration. CRP asserts that teacher addressing their own implicit bias is critical to closing the opportunity gap (Hammond & Jackson, 2015).

The theoretical framework describes the importance for students to learn by doing and for the learning activities to be culturally relevant to students. Additionally, the theoretical framework describes the importance of teachers confronting their own cultural perspectives and understanding and implicit bias to improve student outcomes. STEAM education is based in students engaging in active learning, relevancy for students, and viewing students using a strength model to help close the opportunity gap for students. The literature review discusses the different definitions of STEAM, how STEAM instructional methods have been implemented, barriers for STEAM implementation, and supports for teachers implementing STEAM instructional strategies.

Review of Research Literature and Methodological Literature

Defining STEAM. Educators have been struggling with understanding and defining STEAM education. This may be in part due to the lack of research in this area. However, the field of STEAM education has been growing rapidly since 2013 (Grant & Patterson, 2016). Additionally, the discussions regarding STEM and STEAM frameworks are more clearly defining the differences between the two. There is agreement that STEAM education includes 21st century skills, mindsets, performance assessment, and is student- centered (Opperman, 2016; Thurley, 2016). Herro and Quigley (2016) described STEAM education as a problem that needs to be solved using 1) project-based learning; 2) technology to some extent; 3) STEAM content knowledge as needed by the problem; and 5) collaborative problem-solving. Best practices in STEM, integrated arts and technology, project-based learning, and K–12 STEAM need to be examined in order to more clearly define that instructional practices which exemplify high quality STEAM education.

***Creative and critical thinking*.** STEAM instruction integrates creative and critical thinking. STEAM disciplines require not only critical thinking, but also creative thinking to ensure that final designs are aesthetically pleasing to consumers, particularly with products that are created for the consumer market. The American Association for the Advancement of Science (1997) has defined engineering as using creativity and logic, based in mathematics and science, to create contributions to the world while using technology. Critical thinking skills are important because examining the world through a thoughtful lens helps a person gain a better understanding of problems through different perspectives. Creative thinking is important to find innovative ways to communicate ideas, engage people in thinking about themselves and the world, and find solutions to problems. Seifter, Haley Goldman, Yalowitz and Wilcox (2016) found increased creative thinking skills among high school students when integrating arts into STEM-related fields. STEAM includes both critical and creative thinking.

Inquiry-based instruction. Inquiry-based instruction engages students in learning through discovering the answer to questions. There are different levels of how open the questions are and range from teacher provided questions to student developed questions. Inquiry-based instruction may include literature research only, building of models, and designing experiments (Crippen & Archambault, 2012). STEAM engages students in learning by asking questions and developing creative solutions through making connections between each of the disciplines.

Project-based vs. problem-based**.** Project-based instruction engages students in learning using long-term assignments that include putting information together from different sources together. Project-based instruction has several advantages for teaching and learning: (a) fosters connections among the disciplines, (b) sparks student creative imagination and curiosity, 3) encourage collaborative problem-solving, (d) fosters connections for students and teachers between thinking, doing, and learning, and (e) develops student ability to apply their knowledge (Asghar, Ellington, Rice, Johnson, & Prime, 2012). STEAM instruction is problem-based instruction, a nuanced form of project-based instruction. Problem-based instruction engages students in learning about a problem and designing solutions for the problem using the project model. The problems are focused on current real-world problems rather than problem-based instruction. Additionally, the problems utilize culturally relevant pedagogy in finding problems that are interesting and engaging to all students rather than to the instructor. Place-based instruction uses culturally relevant pedagogy to focus problem-based instruction that is within the community, which is relevant to students and families (Brown & Crippen, 2016). STEAM is place-based, problem-based, project-based learning because students and teachers engage in teaching in learning through projects to solve problems with are culturally relevant for the students' and families' communities.

Integrated arts and technology. A key part of STEAM instruction is integrating arts and technology. Sanders (2012) viewed STEM/STEAM education as intentionally integrating two-or more of the disciplines. Watson (2016) asserted STEAM is not arts integration, but a model where all the disciplines are equal. However, science and the arts share common processes such as: noticing, wondering, exploring, visualizing, and communication (Fulton & Simpson-Steele, 2016). Acosta (2015) asked students which classes better prepared them to be successful in college—a physiology class (STEM class) or the theater class (arts class). Students reported that the theater class better prepared them to be ready for college because it challenged them to work on skills the students felt were not strong. Acosta (2015) advocated that a course that integrated arts into STEM would prepare students not only with content but also the skills students identify as needing to be successful in college. Additionally, the arts in STEAM provide many opportunities for students to improve themselves in several areas. These areas are: (a) improvement of long-term memory, (b) development of cognitive growth, (c) enhancements of social growth, (d) increasing the appeal of STEM subject areas, (e) reduction of stress, and (f) promotion of creativity (Sousa & Pilecki, 2013). Hunter-Doniger (2018) stated the integration of art into STEM provides a pedagogical approach to increasing positive outcomes for student through increased engagement, comprehension, and retention of skills and content. Finally, the arts integrated into science fields could increase student interest in STEM fields (Kang, Jang, & Kim, 2013; Land, 2013).

Technology integration in STEAM has been used to be able to deliver personalized instruction in rural schools where access to STEM learning opportunities for students are inhibited by location of the school (Burton et al., 2014). Makerspaces have also been used as a method to integrate technology into the other STEAM disciplines to provide students opportunities to create a working model of a solution in a problem-based learning scenario (Maslyk, 2016). Makerspaces integrate technology into core content instruction through the design of a computer programmed device used to solve a problem or through digital art (Patton & Knochel, 2016). Digital art uses programming of sensors or lights to create interactive art for students to show their understanding of a science, math, or humanities topic. A part of STEAM is the intentional integration of arts and technology into teaching and learning.

Community partnerships. STEAM instruction includes strategic community partnerships for students and teachers to learn about real world applications of STEAM learning. STEAM partnerships may include formal and informal learning opportunities. Examples of informal learning opportunities with a partner are after-school at natural history museums and art galleries (Grant & Patterson, 2016; Mote, Strelecki, & Johnson, 2014). An examples of formal learning opportunities are through university education departments through practicum placements (MCGarry, 2018).

The characteristics of an effective STEAM community partnership have not been researched. However, research about effective STEM partnerships provides some insight into what are potential characteristics of effective STEAM partnerships Watters and Diezmann (2013) examined four case studies in different geographic areas to determine what makes effective partnerships in STEM. First, there needs to be a strategic plan targeting STEM for all stakeholders, which establishes a shared clear vision between the stakeholders. The plan also needs to include strategies to develop trusting relationships between all the stakeholders and a clear path for how to build capacity with all of the stakeholders (Watters & Diezmann, 2013).

Barriers to implementing STEAM practices. Little research about the barriers to implementing STEAM practices has been published due to the recent shift from STEM to STEAM. However, examining research about STEM provides insight into potential barriers for implementing STEAM practices. Teacher understanding of STEM education can be broken into four categories. First, teachers may have a limited awareness of STEM, feel STEM has been externally imposed upon them, fear, apathy, and apprehension. Second, teachers may have an awareness of STEM with an internal desire to learn more. Third, teachers may have STEM knowledge from professional development, which may include a developed personal definition of STEM, and some experience applying new STEM knowledge. Finally, teachers may have a complete understanding of STEM with a pragmatic approach to STEM education (Bell, 2015). All of the categories of teacher STEM knowledge exist within a single school and need support to improve their understanding of STEM education because the level of teachers' own comfort and understanding of STEM instruction and application impacts student learning (Bell, 2015). Henriksen (2017) cautioned about STEAM education only being focused on arts integration because science teachers often do not have artistic training and may be uncertain how to integrate arts into STEM. In addition, arts teachers may not have the knowledge about STEM. The above categories of STEM knowledge impacts implementation of STEAM for elementary, secondary, and higher education teachers.

Elementary teachers lack confidence in their conceptual understanding of science, artistic methods, and application of technology, which needs to be addressed as part of STEAM instruction (Teo & Ke, 2014). Elementary preservice teachers often have only one science teaching methods course and no technology or arts integration methods courses (Zimmerman, 2016). The lack of confidence comes from little personal experience with STEAM learning. Additionally, elementary teachers view STEAM education as task oriented where students do STEAM rather than STEAM as a pedagogy. The focus on STEAM education as a task to do creates teacher push back regarding not having enough time because of time restrictions from required content teaching. A task-oriented viewpoint of STEAM raises concern for teachers about classroom behavior management, time management, and motor-skill development (Jamil, Linder, & Stegelin, 2017).

Secondary teachers need support in understanding applications of concepts in real-world situations as well as how to implement project-based learning and student-centered learning and assessment (Stubbs & Meyers, 2015). The recent shift from STEM to STEAM has created a lack of research on what schools need to integrate STEAM. There are some insights that can be gathered from STEM research to provide an indication of where schools should start to support teachers in a shift to STEAM instruction. Saxton et al. (2014) determined that there is an important set of interconnected variables in complex school systems which impact the integration of STEM: leadership transformation, teacher efficacy, effective professional development in STEM, supportive teacher-student relationships, instructional practices in STEM, and application of STEM conceptual knowledge. English (2016) determined there are four issues regarding integrated STEM education. First, teacher perspective about STEM education on whether it is possible to maintain discipline integrity when integrating all disciplines of STEM. Second, teacher approaches to equally including all disciplines in STEM when integrating by making engineering and math a lower status than the other disciplines. Third, equity in access to STEM education by teachers who teacher students from underrepresented population because the teachers do not have access to the same amount of funds for materials and professional development as teachers of students of higher socioeconomic status. Finally, the pressure on teachers to extend STEM to STEAM may cause teachers to be overwhelmed by the demand to integrate arts into STEM.

Bruce-Davis et al. (2014) examined six STEM high schools to determine the student and teacher perceptions of the instructional strategies and practices and their perceptions of the learning environment. Teachers reported the importance of administration respecting teachers to allow them to make the necessary changes to curriculum to increase rigor and engagement. Both students and teachers shared the responsibility for the academic expectations of the classes and the hard work needed to be successful in the class. Additionally, teachers had high expectations of students and offered challenging work with explicit supports for students to be able to meet the high expectations. Finally, teachers increased their knowledge of several instructional strategies: project-based learning, questioning techniques, inquiry-based learning, guided independent research projects, improving academic discourse, and application of real-world problems. Secondary teachers implementing STEAM need support in the same areas as STEM teachers with the addition of support for arts integration.

Higher education teachers need support to collaborate beyond their discipline silos. Madden et al. (2013) examined undergraduate programs across the U.S. and found no program which uses integrated STEAM curriculum. STEAM instruction can be found in a few disciplines. Engineering undergraduate professors are using STEAM projects in courses, however; there is significant skepticism about moving from lecture-based instruction to student-centered, inquiry-based, and project-based instruction (Connor, Karmokar, Whittington, & Walker, 2014). Ghanbari (2014) studied two exemplary university programs, which had integrated arts into STEM. At the university, which had focused on systems of collaboration for professors and students to participate in hands-on, cross-disciplinary learning opportunities, students reported more connections between content and career opportunities and experiences.

Additionally, a barrier to implementing STEAM practices is requirements placed on classrooms outside of the school. Douglas et al. (2015) studied two schools in the same school district who participated in the same professional development program to implement STEM instruction and assessment. One school was able to integrate engineering into other subjects while the other school did not. The teachers at the school which was unable to integrate engineering reported barriers like: pressure to teach to the test, prioritization of tested subjects instructional time over engineering lesson from administration, and limited number of opportunities for the teachers to collaborate on planning the integrated engineering lessons. An administrator's understanding of what high quality instruction in science and mathematics looks and sounds like impacts STEAM instruction implementation. Lochmiller (2016) examined feedback from administrators to science and math teachers found administrator feedback was focused on general pedagogy and classroom management rather than content specific feedback, which is necessary for teachers to improve student outcomes and improve their own practice. Another barrier to high quality STEAM integration is how schools make the decision to implement STEAM instruction. When the decision is a top-down administrator level decision, teachers are less likely to engage in the collaborative inquiry needed to implement STEAM (Avramides, Hunter, Oliver, & Luckin, 2014).

Teacher supports for shifting to STEAM instruction and assessment. The shift to STEAM for teachers requires understanding transformational learning and what adults need in order to transform their pedagogical practice. Transformational learning involves determining assumptions, examining perspectives, and making new meaning. Mezirow (1991) described transformational learning theory as "the process of using a prior interpretation to construe a new or revised interpretation of the meaning of one's experience in order to guide future action" (p. 12). Willink and Jacobs (2012) further described transformational learning as an individual being willing to change oneself and adopt new ideas. Deep, long-term, adult learning requires application of transformational learning to develop professional development and school-based supports.

The transformational learning for teachers when learning to integrate STEAM into instruction and assessment needs more than a single year of support (Richard & Treichel, 2013). Additionally, education policy is often unsupportive of the messy creative practices teachers need to implement STEAM learning opportunities (Garvis & Pendergast, 2012; Henriksen, 2017; Wexler, 2014). Education policies such as a focus on increasing student achievement on high stakes tests by mandates to teach to the test or creating daily lessons that must be taught exactly as described by the author and/or publisher do not allow teachers the time to experiment and experience failure and success as teachers work to implement STEAM. Teachers need multiple years of instructional support to shift their pedagogical understanding to be able to implement STEAM instruction and assessment.

Hunter-Doniger and Sydow (2016) examined how integration of creativity and critical thinking through the arts influenced teacher practices and student engagement in the first year of a middle school transitioning from STEM to STEAM. Teachers received ongoing professional development over the course of the first year of the transition. A survey utilizing a Likert scale was administered at the beginning of the year and at the end of the year. Over the year, the percentage of teachers self-reporting integration of arts increased 32% and how often students were assessed using art increased 12%. In the same time period, student achievement on the state standardized assessment increased 8%. Another method for supporting teachers to integrate arts into STEM is to focus on learning through art making. Liao (2016) engaged undergraduate elementary education majors in an activity to integrate arts into STEM by creating 3-D interactive children's literature. The undergraduate elementary education students developed needed technical skills while creating a product. Teachers often feel uncertain of their own individual creative potential, which makes it difficult for teachers to integrate STEAM (Cropley, 2016). Hunter-Doniger, Howard, Harris, and Hall (2018) developed a five-session professional development experience, which integrated storytelling, arts, technology, fourth grade science standards, culturally relevant teaching practices, and participant worktime and showcase. The teachers were able to develop and showcase an integrated STEAM unit.

Professional Learning Communities (PLC) may offer a support structure for teachers integrating STEAM. Research on using PLCs to support teachers implementing STEAM has not been completed, but there is research on the impact of PLCs on integration of STEM teaching. Roehrig, Moore, Wang, and Park (2012) found that co-teaching and PLCs supportive of teachers to integrate engineering into either, science, math or technology classes. Teachers were given five days of professional development on how to write lessons that integrated at least two of the disciplines of STEM. Additionally, teachers met regularly in their PLC. The most successful integration happened between science and math teachers collaborating or co-teaching the lessons. The research examining the impact of PLCs on STEM integration provides an indication that PLCs could potentially have a positive impact on teachers' STEAM integration.

Classrooms in the U.S. have a diverse group of students as STEM and STEAM schools are created at public schools, students with disabilities are enrolled in STEM/STEAM courses.

Bargerhuff (2013) studied the primary supports of a student with disabilities at a secondary school to determine what was supportive of students with disabilities success at the STEM school. Six classroom teachers, the school counselor, and the assistant principal participated in the study. A teacher belief in that all students are able to learn, the importance of teachers knowing where all students are in their content knowledge, support of a special education teacher, and flexibility in the how students demonstrate their knowledge were the key areas that improved students with disabilities' student learning outcomes (Dunn, Rabren, Taylor, & Dotson, 2012).

Implementation of STEM or STEAM instruction may start with the award of a grant. Texas STEM reform programs initially began with a few grants awarded to schools. The success of the schools with the support of the grants provided encouragement for the state of Texas to make an effort to scale up the number of schools implementing STEM instruction. Young et al. (2016) examined the scale up of the STEM program in Texas to determine what was working in schools with improved student outcomes and what was lacking in schools that were not experiencing similar results. Three lessons were learned from the scale up. First, vision communication is important for the statewide program, but individual schools will focus on key pieces and interpret the vision in different ways. Second, teachers and administrators need technical assistance to implement STEM instruction, and third, external support networks and districts influence how much of the implementation is effective. In the study, schools that provided teachers with co-planning time to improve the rigor of STEM course and significant amounts of professional development to implement project-based learning (PBL) had improved student outcomes over four years.

Teachers who are geographically isolated have similar STEM/STEAM professional development needs as teachers who are more centrally located to urban areas. First, teachers need access to high quality example lessons which integrate best practices. Second, teachers need support in how to use data to identify student need and differentiate instruction. Next, teachers need support to develop content specific knowledge. Additionally, teachers need support to ensure compliance with school and district policies and procedures. Finally, teachers need emotional support as they take risks to shift their teaching practices (Jones, Dana, Laframenta, Adams, & Arnold, 2016).

A challenge for STEAM implementation at the postsecondary level is professors thinking that the types of instructional practice in STEAM (student-centered, inquiry-based, project-based learning) does not provide the content learning undergraduate students need to be prepared to enter into the careers upon degree completion (Connor et al., 2014). However, Madden et al. (2013) proposed a shift in the type of instructional strategies used at the postsecondary levels due to the indication from industry of the need for creative and innovative scientists and engineers. The indication from STEM industries is the need of creative and innovative thinkers is a reason for the shift from STEM to STEAM. Madden et al. (2013) indicated postsecondary educators need support to see the connection between content preparation and skills such as creative and critical thinking.

Another challenge with STEAM integration at the postsecondary level is current practices in colleges to support collaboration between the disciplines of STEAM. Research on STEM collaboration practice at the postsecondary level gives insight into potential challenges for STEAM collaboration at the same level. Frecthling, Merlino, and Stephenson (2015) looked at different practices and policies currently happening in colleges around collaboration about

STEM. The researchers were concerned with the current STEM education practices and institutional policies not improving student outcomes fast enough to deal with the STEM crisis. Grant awardees were examined on how the college was integrating and changing collaboration in STEM fields. Frecthling et al. (2015) determined that geopolitical, economic, and sociocultural contexts impact the change process and the outcomes. Constantino (2018) discussed several challenges for STEAM integration in higher education. First, the logistical challenges of scheduling common planning time and co-teaching of courses. Second, the intellectual challenges of collaborating with colleagues from a different department including different terms and inquiry methods. Another key piece of increasing integration from STEM and STEAM at the college level is the support of high-level administration if the integration is going to be sustainable.

Review of Methodological Issues

Several researchers used a case study methodology to examine impact of instructional experiences after receiving professional development to shift pedagogical or instructional practice (Avramides et al., 2014; Brown & Crippen, 2016; Bruce-Davis et al., 2014; Fulton & Simpson-Steele, 2016). Case studies have also been used to learn more about a STEM or STEAM practice (Burton et al., 2014; Connor et al., 2014; Ghanbari, 2014; Maslyk, 2016; Young et al., 2016). Researchers used case studies to gather information about an individual person or school experience (Bargerhuff, 2013; Dunn et al., 2012; Henriksen, 2017; Roehrig et al., 2012). Finally, case studies were used to reflect on using a new analysis method for examining teacher professional development (Crayton & Svihla, 2015).

Descriptive methods have also been used by researchers to examine STEM/STEAM integration. First, researchers have studied pedagogical and instructional practices (Brown &

Crippen, 2016; Catterall, 2013; Geimer, 2014; Grant & Patterson, 2016; Madden et al., 2013; Radziwill, Benton, & Moellers, 2015). Descriptive methodology is used to provide an explanation of why there is a need for a particular phenomenon to be examined or to provide an explanation of what is already known about a not-well studied experience (Yin, 2014). Descriptive research is dependent on the craft of the author's argument using a synthesis of existing observations but when compiled together provides new insights.

Researchers used descriptive methods to advocate for a particular development of a common measurement system to evaluate STEM identity for students and teachers (Saxton et al., 2014). Saxton et al. (2014) proposed a new conceptual framework to understand what impacts students to study STEM through the use of existing research; however, there is not any information on whether the conceptual framework focused on the development of a STEM-identity is representative of actual student experience or ways to measure STEM-identity. Descriptive methods were also used to describe the need to change from discipline specific teaching methods to interdisciplinary learning opportunities for students (Frecthling et al., 2015; Opperman, 2016 Thurley, 2016; Watson, 2016; Zimmerman, 2016). The rest of the studies using descriptive methods are focused on making the argument for STEAM education to be part of various levels of education.

Neil-Burke (2016) used participatory action research (PAR) to design a professional development experience for teachers to use STEM teaching strategies and investigate whether the teachers who participated in the professional development made changes in their teaching practice. Frideres (1992) critiqued participatory action research methods to have moving goals making analysis of the research difficult and participants are not always able to to have equal knowledge about current realities of the group of people the participants may represent. Neil-

Burke's (2016) research goals of developing a professional development experience for using STEM teaching strategies by classroom educators was focused on a small number of teachers with no questions about their interactions with other teachers using STEM teachers outside of the professional development. In addition, the assessment of the professional development was by feedback from the teachers about their own practice rather than by observation of the researcher in their classrooms.

Herro and Quigley (2016) used a second-order narrative approach to determine if incorporating STEAM requires learning new instructional strategies or if it is a remix of existing practices. The researchers examined two years of data from a 3-year study to support their idea that STEAM instructional strategies are a "remixing" of old strategies with new strategies. Instead of sharing each participant's story, only a select few were chosen for analysis in the research. The choice to not include all participant voices causes concern that there are other narratives that support other viewpoints of STEAM instructional strategies.

Bell (2015) examined teachers in various high school STEM classes to determine how STEM teachers understand STEM through phenomenography. Phenomenography studies a group of people who have experienced the same phenomena (Yin, 2014). In phenomenography, the researcher describes how participants were determined to have experienced the same phenomena. Bell (2015) described how the participants were chosen by whether or not the person taught a STEM class; however, there was no discussion on how the researcher determined what made a class a STEM class causing a lack of clarity on whether all the participants actually were experienced with the same phenomena.

Mixed methods are another method used by researchers to examine how various frameworks used in the individual disciplines within STEAM education can be used to evaluate

STEAM instructional practices (Jamil et al., 2017; Jones et al., 2016). Another area mixed methods were used by researchers was to evaluate how different strategies impact the field of STEM and STEAM education (Douglas et al., 2015; Richard & Treichel, 2013; Schuster et al., 2012). Mixed methods research is the intentional mixing of qualitative and quantitative methods (Yin, 2006). Hunter-Doniger and Sydow (2016) and Jones et al. (2016) observed classrooms and used an existing framework to quantify how often specified strategies in each study framework showed up in the observed instruction. While there was intentional mixing of the methods, the use of the frameworks did not give a deeper view of transdisciplinary STEAM instruction. The method provided analysis on whether a framework from one of the disciplines in STEAM was present in a STEAM class rather than whether there were multiple discipline specific frameworks present in STEAM instruction.

Jamil et al. (2017) surveyed early childhood educators using mixed methods about their teacher beliefs using the STEAM Classroom Assessment of Learning Experiences (SCALE) Model and interviews with selected early childhood educators. The SCALE model used in the study (Quigley, Herro, & Jamil, 2017) suggests a high-quality STEAM learning experience must use a set of instructional content and pedagogy. The surveys were conducted after a one-day professional development conference. Eight participants were then interviewed to learn about their STEAM experiences and needs. The study did not include teacher observations of any STEAM teaching by the participants to evaluate whether the STEAM professional development conference had any impact on their teaching practice.

Quantitative research in STEAM has been focused on high school students' perceptions of creativity when engaged in STEAM learning opportunities (Oner et al., 2016). Additionally, Kassaee and Rowell (2016) used quantitative research to study the impact of a summer bridge program focused on algebra skills and its impact on the retention of students in STEM majors. Oner et al. (2016) research quantified a Likert scale for students to quantify the amount of creativity they perceived they used in different learning activities over the course of a different lessons. However, there was no definition provided of how students defined creativity, which may cause an under-reporting or overreporting because there was not a shared understanding of what it means to use creativity while learning. Seifter et al. (2016) researched the impact of an arts-based innovation STEM training into a summer program demonstrated an increase in creative thinking skills, more collaboration, and more innovation processes and impoved innovation. No study included measuring student content knowledge growth and improvement in creative thinking skills. Kassaee and Rowell (2016) followed students who took a summer math course to see if the students were still in STEM classes after their first year of college. The research did not include any additional student experiences that may have impacted their enrollment in STEM classes only whether the student was still enrolled at the end of the year.

Synthesis of Research Findings

STEAM pedagogy and instructional strategies are based on constructivism and culturally relevant pedagogy. Gay (2010) stated CRP focuses on changing instruction from a deficit model to a strength model of student learning. Educators have been struggling with understanding and defining high quality STEAM education. The field of STEAM education has been growing rapidly since 2013 (Grant & Patterson, 2016). Opperman (2016) and Thurley (2016) state that STEAM education includes 21st century skills, mindsets, performance assessment, and is student-centered. Creative and critical thinking are an integral part of STEAM education to have students examine problems and phenomena using critical thinking skills and develop creative ways of solving problems or designing ways to help make better sense of phenomena.

Best practices in the STEM, integrated technology, integrated arts, project-based learning, and STEAM in K–12, college, and after-school environments provide more insight to clearly define that instructional practices which exemplify high quality STEAM education. Inquiry-based instruction is part of best practices in STEM and engages students in learning through discovery to answer questions (Crippen & Archambault, 2012). Project-based and problem-based learning are another piece of high-quality STEAM education to provide students in real-world place-based exploration of phenomena and problems. Additionally, high quality STEAM education includes integrating arts and technology as an equal part of all of the disciplines of STEAM (Watson, 2016). Science and the arts share many of the same processes used to make sense of the world (Fulton & Simpson-Steele, 2016). Finally, community partnerships are part of a high-quality STEAM education. Community partnerships help provide students with access to place-based problem-based learning opportunities (Watters & Diezmann, 2013).

One of the barriers to implementing STEAM pedagogy and instruction is the understanding of teachers of what is high quality STEAM education. Teachers within the same school may have different understandings of STEAM education and why students need STEAM instruction (Bell, 2015). Elementary teachers lack confidence in their conceptual understanding of science, arts, and technology, which are critical disciplines in STEAM education (Zimmerman, 2016). Secondary teachers need support to understand how concepts are applied in real-world situations and how to implement project-based and problem-based learning (Bruce-Davis et al., 2014). Higher education instructors need support to collaborate with instructors in other disciplines (Connor et al., 2014; Madden et al., 2013). Barriers outside of the classroom exist for implementation of high-quality STEAM education. Systems and schedules provide a barrier to the needed collaboration of educators to plan, teach, and assess STEAM learning opportunities for students (Douglas et al., 2015). Decision-making at the district and school level, when the decision is perceived as top-down by classroom educators adds additional barriers for STEM education (Avramides et al., 2014).

The acknowledgment and work to understand barriers of implementing high quality STEAM education has led to examining what supports are needed for teachers to make the transformational pedagogical and instructional shifts for STEAM teaching and learning. First, the supports for making the shifts need to be longer than a year (Richard & Treichel, 2013; Hunter-Doniger & Sydow, 2016). Co-teaching and Professional Learning Communities are also supportive of teachers working to implement STEAM instruction and assessments (Jones et al., 2016; Roehrig et al., 2012; Young et al., 2016). Educators also need support in developing methods to support students who have been historically underrepresented in STEM in the STEAM classroom (Bargerhuff, 2013). Finally, educators also need support to help high level administration understand the need for STEAM education and how STEAM education looks different and has different needs for resources (Connor et al., 2014; Frecthling et al., 2015).

Critique of Previous Research

The challenge of STEAM research first starts with different definitions of what is STEAM. Guyotte et al. (2015) defined STEAM as interdisciplinary focused on community social practices, and Zimmerman (2016) described STEAM education as “transdisciplinary” meaning integration of all of the disciplines of STEAM. There is no agreement in STEAM education as to what the definition is, making understanding what teachers need to implement STEAM education and how to evaluate student learning opportunities and knowledge a challenging endeavor.

In part because of a lack of agreement about what is STEAM education, STEAM pedagogy and instructional strategies are based on practices from STEM, arts, technology, effective community partnerships, and project-based learning. However, this has been dependent on the organization or person conducting the training for teachers. Herro and Quigley (2016) provided teachers with experiencing various STEAM lessons and then observed teachers as they took characteristics from their own STEAM learning experience to create and teach STEAM lessons. The resources and instructional strategies used by the teachers became the examples of what STEAM instruction looks like in the study instead of having a set of characteristics based on best practices from each of the disciplines to help teachers learn what are the components of STEAM education. Overland (2013), and Fulton and Simpson-Steele (2016) focused only on the integration of some part of arts into one of the other disciplines of STEAM. Watson and Watson (2013) and Catterall (2013) work focused on adding the arts into engineering education.

Hunter-Doniger et al. (2018) looked at whether the teachers who attended a multi-day professional development, which integrated arts with science standards were able to develop arts integrated curriculum units. The units were not analyzed using a rubric. Additionally, the teachers were not given a survey prior to the professional development to assess their current ability to integrate arts with science. Zimmerman (2016) and Kuhn (2015) examined elementary teachers' integration of arts in science instruction, and Geimer (2014) studied arts integration in elementary math instruction. Richard and Treichel (2013) examined secondary science teacher practice on integrating arts into their instruction. In the situations where more than two disciplines of STEAM were examined to determine what high quality STEAM education is, the research was focused on describing a project the researcher was engaged in to call attention to how all the disciplines were integrated rather than to what strategies were used to design these type of learning opportunities (Acosta, 2015; Connor et al., 2014; Crayton & Svihla, 2015; Madden et al., 2013; Mote et al., 2014; Radziwill et al., 2015).

Oner et al. (2016) researched student perceptions of the use of creativity during a STEM summer camp. The researchers claim that the use of creativity to solve problems in the STEM camp creates a STEAM learning environment. However, there was no development of what creativity meant to the students. Students self-reported the degree to which he or she perceived their own creativity was used in each of the learning experiences. Seifter et al. (2016) only taught the arts-based STEM innovation training to high school students and young adult STEM professionals to measure impact on creative thinking skills. The young adult STEM professionals did not show any improvement in their creative thinking skills. Additionally, the research did not include elementary or middle school students.

Schools are creating STEAM teams to implement instruction (Watson, 2016). A STEAM team typically includes an instructional specialist. While there has been research on STEM instructional specialists to understand their role, needs, and challenges, there is no research on the role of a STEAM instructional specialist in implementing high quality STEAM instructional practices, assessments, units, lessons, and projects.

Chapter 2 Summary

There is a rising demand in STEM fields for people to be creative and innovative as well as having a strong content understanding (Walsh et al., 2013; Zhao, 2012). Arts provides the missing piece in STEM education to increase interest and creativity (Boy, 2013; Catterall, 2017; Maeda, 2013). Thus, STEM education has become STEAM (science, technology, engineering, arts and mathematics) education and schools are experiencing a demand from families, the business communities, and students to implement STEAM integration across K–20.

The demand for integrating STEAM education into schools has several challenges. The first challenge is the different definitions for STEAM education. Some researchers define STEAM as the integration of arts into each of the disciplines of STEM (Boy, 2013). Other researchers define STEAM education as integration of two or more of the disciplines (Guyotte et al., 2015), and others define STEAM education as transdisciplinary (Zimmerman, 2016). The confusion on what is STEAM education and the lack of research of STEAM education has caused educators and researchers to begin to describe high quality STEAM education using the best practices of each discipline of STEAM.

The research demonstrates that there are barriers to implementing STEAM practices into classrooms. The first is a teacher's awareness of STEAM pedagogy and instructional practices Bell, 2015; Zimmerman, 2016). Secondly, the way the decision is made to implement STEAM whether by a teacher, building administration, or district administration (Douglas et al., 2015). Teacher content knowledge and experience within each STEAM discipline is another barrier (Bell, 2015). Finally, limited K–20 teacher knowledge on how to apply content knowledge to real-world situations impacts implementation of STEAM (Stubbs & Meyers, 2015).

Schools are implementing STEAM (Watson, 2016). Current STEAM research has been focused on educators describing their own experiences in implementing STEAM instructional practices (Kassaee & Rowell, 2016) and student perceptions of STEAM classes (Oner et al., 2016). The research about STEM instruction and STEM school implementation provides possible indicators about STEAM, but no research on what supports a school needs to implement STEAM. Therefore, based on the reviews of literature on STEAM education, which develops a conceptual framework using constructivism and culturally relevant pedagogy to understand STEAM education pedagogy, practices, and barriers to implementation, there is evidence that an investigation exploring how educational stakeholders (teachers and administrators) in Oregon perceive STEAM integration in the K–8 setting would yield socially significant findings.

Chapter 3: Methodology

Introduction

The purpose of the study is to explore how educational stakeholders (teachers and administrators) in Oregon perceive STEAM integration in the K–8 setting. Educators making the pedagogical shifts to integrate STEAM instructional practices need support prior to, during, and after implementation. This study has the potential to increase knowledge about how educational stakeholders implement STEAM integration in a K–8 setting. Additionally, educator's awareness of STEAM pedagogy and instructional practice increases fidelity of STEAM integration (Bell, 2015; Stubbs & Meyers, 2015; Zimmerman, 2016). This study could increase educator understanding of the challenges and opportunities of STEAM integration into classrooms. The results may be used to inform teachers and administrators on how to increase capacity of their peers to integrate STEAM. Finally, the results of this study may help inform educators, who provide professional development on STEAM practices to practicing educators, to increase implementation of STEAM into classroom instruction.

Statement of the Problem

School districts and schools are implementing STEAM (Watson, 2016). STEAM research in the last five years has been focused on implementation of STEAM for an individual teacher (Kassaee & Rowell, 2016) and student perceptions of STEAM classes (Oner et al., 2016). The research about STEM instruction and STEM school implementation provides possible indicators about STEAM. However, there is little research on what supports a school needs to implement STEAM (Watson, 2016). The goal of the study is to explore how educational stakeholders (teachers and administrators) in Oregon perceive STEAM integration in a K–8 setting.

Research Question

This study is designed to explore the following question: How do educational stakeholders (teachers and administrators) perceive STEAM integration in the K–8 setting?

Purpose and Design of the Study

The purpose of the study is to explore how educational stakeholders (teachers and administrators) in Oregon perceive STEAM integration in a K–8 setting. Oregon's response to the demand for students entering STEM degrees has been to create STEM hubs across the state (Oregon Education Office, 2018). Each STEM hub has been able to decide their own strategies to improve students' learning opportunities in STEM for K–12 education. Two of the STEM hubs have chosen to strategize increasing STEM/STEAM teacher leadership within their regions (More STEM hubs in Oregon, 2019). Both hubs have utilized grant funds to support schools in becoming STEAM schools.

This study has the potential to increase knowledge about how educational stakeholders implement STEAM integration. This study could increase educator understanding of the challenges and opportunities of STEAM integration into classrooms. For practicing educators, the results may be used to inform teachers and administrators on how to increase capacity of their peers to integrate STEAM.

Qualitative research was selected instead of quantitative research because of the holistic nature of qualitative research. Qualitative research is done to understand multiple factors of a situation, create a sketch of the larger picture that emerges, and identify complex interactions of various factors in the situation (Creswell, 2013). A case study was the research design for this study. Exploratory case studies are used to explore those situations in which the evaluated has no clear, single set of outcomes (Yin, 2014). The Oregon STEM Hubs' decision to support K–8 schools' implementation of STEAM integration is new without a clear, single set of outcomes. How educational stakeholders (teachers and administrators) in Oregon perceive STEAM integration in a K–8 setting is the phenomena for this case study.

Population and Sampling Method

Creswell (2013) described the choice of participants in a qualitative study is based on whether the participants could better inform the research questions and could provide a deep understanding of the study phenomena. The population was educational stakeholders (teachers and administrators) within Oregon STEM hubs' service area. Two STEM hubs support STEAM education in the regions of Oregon. (More STEM hubs in Oregon, 2019).

Each of the STEM hubs has schools they are working to implement STEAM integration in a K–8 setting. Teachers and administrators were selected using a convenience sampling method. Convenience sampling is used when there are limited resources or when there are a small number of cases (Patton, 1990). A convenience sample was used because the two STEM Hubs are two of very few STEM hubs in the country. Additionally, these STEM hubs are relatively new. Each school was from a different district. The selection criterion for the schools was: (a) full-time employment status within a district served by a STEM Hub, (b) willing to participate, and (c) the school identifies as a STEAM school. At each school, an administrator, a teacher, and the STEAM instructional specialist was interviewed. If the school district has a district level curriculum specialist, who has been supporting the school with STEAM integration, this person was interviewed. Confidentiality of the participants was maintained by assigning each participant a letter and a random number.

Sources of Data

The sources of data used to gather data for this study are: questionnaires (see Appendix A), semistructured interviews (see Appendix B), and research notes. One data source was teacher interviews with research notes. The other data source was administrator interviews with notes.

Questionnaires. The goal of the questionnaire is to gather information from the participants about their background experience in education. The questionnaire had eight questions. The questions focused on background educational experience: participants' teaching certifications, years in education, current job assignment, education level (see Appendix A). The questionnaires were used to select participants to represent a range of year teaching, content area taught, and grade level taught.

Interviews. Interviews allow the researcher to be able to compare data from each interview to identify and describe central themes between participants. A qualitative research interview is designed to uncover factual information as well as meaning level (Yin, 2014). Interviews are used to elicit the stories behind a participant's experience. Interviews were used to pursue in-depth information about the participant's experience implementing STEAM instruction in a K–8 setting.

An interview refinement protocol was used to strengthen the reliability of the interview protocol (Castillo-Montoya, 2016). The researcher created a list of questions, which came from theory and literature. The interview questions were pilot tested with 3–4 people who have similar characteristics as the sample, but are not part of the sample. The pilot test participants provided feedback on the clarity, writing, and understanding of the questions. Notes were taken about improving the interview protocol and changes made prior to the beginning the study.

During the interview the researcher signaled understanding by nodding or other gestures, ask clarifying questions, and express gratitude. When the researcher digs deeper during the interview by asking why, the researcher used the following sentence stems: what influences, what caused, what contributed to, or what shaped.

Interviews were conducted face-to-face at a location that was suitable for the participants and the researcher. Each interview was recorded and coded. The interview questions focused on having participants share their perceptions about integration and implementation of STEAM education in a K–8 setting. The first two questions focused on the process the school used to make the decision to become a STEAM school and to describe their experience learning about STEAM integration. The next five questions focused on guiding the participant to reflect on their experience about the successes, challenges and the impact of partnerships on integrating STEAM. Appendix B has the list of the open-ended questions that were asked in the interviews.

Research notes. Qualitative researchers use research notes to document nonverbal communication as well as documenting the setting, behaviors, and other engagement of the participants. Researchers use research notes to draw interpretations about perspectives and meanings about the participants (Yin, 2014). Additionally, Yin (2014) stated research notes provide a method for surveying the phenomena under study. Research notes should use thick, descriptive notes to reflect the event studied. Research notes were used to record reflective notes before, during, and after the interviews to track nonverbal cues, the physical environment, the participants, and any impact the researcher may have had on the interview. In addition, the research notes had unanswered questions or concerns that arise, insight that occurs, or speculation about why the specific phenomena occurred. Research notes were used for teacher interviews and administrator interviews. Analysis of the research notes occurred after they were written to foster self-reflection, which is important for meaning making in a research study. The research notes were used to add back critical nonverbal content after transcription of the interview. Additionally, the analysis of the research notes was used to identify any emergent themes. The emergent themes were used as a starting place for coding and analysis, while remaining open to new themes emerging.

Data Collection

Prior to starting data collection, approval from the research institution's and district's Institutional Review Board and permission from the school principal was obtained. Using the selected schools' websites, the researcher created a list of administrators and teachers with their emails. Participants were contacted via email to request them to take part in the study. Once the participants agreed to participate and signed the Participant Consent Form (see Appendix C), the questionnaire was emailed to each teacher and administrator. Participants completed and returned the form via email or in person prior to the interview. The researcher held the individual semistructured interviews at a time and location that is convenient for each participant's schedule. Each of the interviews was recorded. All interviews were confidential and secluded, with only the stakeholder and researcher present. Interviews are considered ideal for collecting data about perspectives, experiences, and personal histories (Yin, 2014). The semistructured interviews for this study contained open-ended questions to stimulate stakeholder perceptions of STEAM integration into instruction (see Appendix B). Each semistructured interview lasted nearly 60 minutes. A copy of the transcribed interview and the researcher's research notes was given to each participant for member checking.

Data was collected through questionnaires, semistructured interviews, and researcher notes. Prior to each interview a short questionnaire to gather background information was sent to each participant via an emailed link to a Google form (see Appendix A). Each semistructured interview had eight questions posed to each participant (see Appendix B). The interviews were recorded and transcribed at a later time for data analysis. Interviews occurred at a time and location that is suitable for the participant. During the interviews, the researcher took research notes to capture spoken words and body language. Yin (2014) described the importance for the researcher to establish and follow a protocol as well as to ask questions in a way that is unbiased.

Data Analysis Procedures

Case study research requires the "data analysis of examining, categorizing, tabulating, testing, or otherwise recombining evidence to produce empirically based findings" (Yin, 2014, p. 132). Additionally, Yin (2014) recommends a novice researcher to spend time playing with their data to discover patterns, emerging concepts, and themes because there is not a step-by-step process for analysis in case study research. The focus is on how educational stakeholders (teachers and administrators) in Oregon perceive STEAM integration in a K–8 setting. Data collection began once the participants returned a completed and signed consent form. Participants were then be coded into the study. For this case study, data collection and analysis began with tools available in Google Sheets and Google Docs. During the data analysis process, inductive reasoning analysis procedures were used.

In this study, the researcher used the online survey tool, Google Forms, to administer the participant questionnaire. The responses to the questionnaire were collected, analyzed, and coded using a simple spreadsheet tool, Google Sheets. The results were then categorized and tabulated using Atlas.ti (2017). These questionnaire tools provided information that creates a deeper understanding of the participant's background experience in education.

Next, preliminary emails were sent to initiate scheduling a time for the individual semistructured interviews. Interviews occurred at a time and location that works for both the participant and researcher. All interviews were audio recorded and replayed to ensure accurate transcription takes place. Each transcript was reviewed by the researcher at least three times to ensure the accuracy of the transcription. The transcribed participant interviews were presented for member checking by the participant via email. Member checking was used to clarify interpretations. Research notes were used for the researcher to take into consideration relevant gestures, sounds, or anomalies that occur during the interviews, which an audio recording cannot capture. The researcher utilized the research notes to keep a written log of immediate observable heading and themes to begin to make note of emerging similarities.

After member checking, data analysis of each participant interview began. Interviews were manually coded prior to using Atlas.ti (2017) to track codes and themes as data was collected and analysis began. First, open coding was used through repeated readings to uncover concepts and categories about the perceptions of STEAM integration to generate as many codes as seen in the data. The generated codes were then be organized into categories. Second, axial coding was used to code for relationships among the concepts and categories in the open coding method. The themes were compared to the emergent themes from the research notes and adjusted as new themes appear. The data relevant to each prospective theme was gathered and checked in relation to the coded citations and the whole data set. Another review of the data checked for additional themes. The researcher read and reread to continue identifying themes until no more themes emerge. A thematic analysis map was generated and refined with specifics from each theme.

Data storage and protection was incorporated from the beginning of the study. Using the researcher's password protected laptop, all computer data was securely stored. Folders for each participant was stored using participant pseudonyms with the data type to discern between multiple data sources. This made the access to information more structured and maintained confidentiality of the participants' information. All original paper, including the reflective journal, of the researcher, was securely stored in a locked file drawer at the researcher's office or at the researcher's home. Uploaded paper data and laptop data was securely stored through Atlas.ti (2017) for ease of access for data analysis.

Limitations of Research Design

There are two limitations with the research design of this case study. First, the sample size may limit the ability to find significant relationships from the data making it challenging to generalize to a larger population. Second, at the time of this research there was a lack of research studies about STEAM integration requiring the use of research on STEM integration and Arts Integration to inform the foundation of understanding the problem.

Validation

The first step to ensure credibility and dependability of data and the analysis was to complete practice interviews prior to beginning the case study. Creswell (2013) explained validation as "an attempt to assess the accuracy of the findings, as best described by the researcher and the participants" (p. 249). Merriam (2009) described data validation as a detailed description to show the researcher's conclusions and provide credibility to the analysis. This case study used several methods for validation, member checking, triangulation, to increase dependability and credibility of the research. Triangulation was done by comparing teacher interviews with research notes and administrator interviews with research notes to compare patterns in codes and themes from the data.

Credibility. In qualitative research, credibility is established by forming believability of research results from the viewpoint of the research participants. Yin (2014) advocated for triangulation of several sources of evidence to strengthen the credibility of a case study. Using several sources of evidence from multiple participants allowed the researcher to develop themes and patterns that were substantiated by several pieces of information. The use of member checking of the interview transcripts and field notes ensured accurate meaning behind the education stakeholders' interview data. The process of allowing the participants to clarify or add to any misinterpretations occurred by the review of data and interpretations by the participants. (Yin, 2014). Additionally, credibility was created using Atlas.ti (2017) as a case study database to organize the transcribed interviews, demographic data, and the research notes. Using research notes, the researcher created an audit trail capturing reflective thinking, questions, decision-making, ideas, and during data collection (Merriam, 2009).

Dependability. In qualitative research dependability is established by the consistency of the research findings. Clear procedures and guidelines were established for data collection, documentation, and results to include the critical pieces for a dependable study. Participants were selected to provide the most variation possible within the population (Merriam, 2009). The transcripts of the interviews were shared with the participants and each asked to describe the accuracy of the transcript. In addition, an initial analysis of each case was shared with the participant with a request for feedback on the accuracy, recommendations on how it could be improved and to reflect on the study participant's experience (Seidman, 2012). Additionally, different interpretations of the analysis were sought from the directors of the STEM hubs.

Creswell (2013) recommends creating a document trail by following a system of procedures, which employ rigorous standards and clearly identify the procedures. The research details were brought to life by the researcher providing a thick, rich narrative including information about the procedures, processes, and results.

Ethical Issues

This section describes the hypothetical ethical issues of this study. Merriam (2009) stated often with qualitative research ethical dilemmas commonly emerge in regards to the collection of data and dissemination of findings. Ethical issues were reviewed and the ethical soundness of the study protocol was confirmed through the review board of the school districts and the university institution (IRB).

Conflict of interest assessment. I am currently supporting work at a STEM Hub as designated by role as a K–12 Science/STEAM Teacher on Special Assignment (TOSA) for my school district. During the summer, an Oregon regional STEM Hub has paid for time to support teachers in my school district working on any of the projects the hub is working on during their current biennium. My current position also has me working with the directors of STEM hubs on implementing science courses and instructional practices aligned with Next Generation Science Standards (NGSS).

Researcher's position. The role of the researcher in this study was that of an inside researcher. Breen (2007) described the role of an inside researcher as a member of an organization who chooses to study a group that he or she belongs to. I am a district STEAM instructional specialist that works with STEM hubs and has provided mentorship, professional development, and collegial conversations with the population of this study. There are three advantages to being an inside researcher: (a) having and established rapport with the participants,

(b) a greater understanding of the phenomena being studied by knowing the politics of the institution and how it works, and (c) not altering the flow of social interactions (Breen, 2007). These advantages support the ease of the participants telling the truth and the inside researcher judging the truth. However, there are is a disadvantage that may be considered biases of an inside researcher (DeLyser, 2001). The familiarity of the researcher with the phenomena studied and the researcher's familiarity with the participants and their working environment may influence the objectivity of the participants and the researcher. While I have worked with the study's population, each school and school district does have its own politics and functions which are not well known to someone outside of the district. I have only worked within one of the school districts for which the study's participants are members.

Ethical issues in the study. One ethical issue of the study is that as part of the group being studied there may be concerns of confidentiality. The participants were described as Participant A, B, C, D, and so on. Any details that might make it possible for the participants to be identified were not be part of the study such as the district or school where they are employed. Additionally, as the researcher had the role of the inside researcher in this study, it was important to utilize participant verification and outside interpreters to ensure the limitation from being an inside researcher does not influence the analysis and interpretation of the data.

Summary

According to Watson (2016), school districts and school are implementing STEAM. While STEAM research in the last five years has been focused on implementation of STEAM for an individual teacher (Kassaee & Rowell, 2016) and student perceptions of STEAM classes (Oner et al., 2016), there is little research on what supports a school needs to implement STEAM (Watson, 2016). This chapter explained the qualitative case study methodology that were utilized to answer the following research question: How do educational stakeholders (teachers and administrators) perceive STEAM integration in the K–8 setting? The case study was conducted at three STEAM schools in Oregon and was selected for maximum variation in a small number of cases. Participants for the study were an administrator, school STEAM instructional specialist, and teacher from each school. If the school district has a district level curriculum specialist, this person was also interviewed. Data for the study was collected through questionnaires, semistructured interviews, and research notes to provide triangulation and to gain a better understanding of this problem. Open coding and axial coding was used during data analysis to uncover concepts and categories pertaining to STEAM integration in a K–8 setting. An analysis and interpretation of the several sources of data collected over the duration of this study is in Chapter 4.

Chapter 4: Data Analysis and Results

Introduction

The focus of this study was on how educational stakeholders (teachers and administrators) in Oregon perceived STEAM integration in a K–8 setting. The sources of data used for this study were participant questionnaires, semistructured interviews, and research notes. The study was conducted at a school district in the Oregon.

This study addressed the research gap about what supports a school needs to implement STEAM integration. Students, who participate in a STEAM class, experience instruction that is meaningful and respectful of their culture (Hammond & Jackson, 2015). An important piece of STEAM education is connecting students' learning experience with their own life experience. Teachers bring to their instructional practice cultural perspectives and understandings impacting how they perceive not only their students but what instructional strategies will impact student outcomes. The perceptions of education stakeholders in Oregon of STEAM integration were addressed in the study through semistructured interviews. Demographic questionnaires were also used to provide a description of the sample of the study for comparison purposes.

The findings of the study provided data on the perceptions of K–8 education stakeholders of STEAM integration through the use of demographic questionnaires, semistructured interviews, and a research notebook. A case study includes the triangulation of data from several sources to validate the research results (Yin, 2014). Triangulation of the data was done by using the teacher interviews, the administrator interviews, and the research notes, to determine if the findings from each draw similar conclusions. The description of the qualitative case study, the research design of the study, the coding methods used, and the findings obtained from the collected data was discussed in the chapter. The findings provided insight for answering the research question of the study about the perceptions of K–8 educator stakeholders of STEAM integration: How do educational stakeholders (teachers and administrators) perceive STEAM integration in the K–8 setting?

Chapter 4 is divided into five sections, which includes a description of the sample, research methodology and analysis, a summary of the findings, presentation of data and results, and the chapter summary. The description of the research population and participants samples used for the study is in the Description of the Sample section. A detailed synopsis of the methodology selected for this study is in the Research Methodology and Analysis Section.

This section also includes an explanation of how the selected methodology led to the analysis used to examine the collected data through the study. An overview of the themes that were garnered from the coding of the information gathered from the semistructured interviews is in the Summary of the Findings Section. The chapter summary emphasizes the main points the resulted from the study findings.

Description of the Sample

Potential participants. The sample was educational stakeholders within the Oregon STEM hubs service area. Each of the partnerships has schools they are working with to implement STEM/STEAM education. Schools were selected using a purposeful sampling method. One district within the two STEM partnerships gave approval for the research. All administrators at the STEAM schools within this district were sent emails introducing the researcher, the research proposal, and the methods for data collection. Four school administrators gave written permission for data collection at their schools.

The participants. All of the schools listed as STEAM schools on the Metro STEM Partnership website were sent an introduction email asking for a meeting to discuss the research project with the administration team. An email was also sent to the district STEAM instructional coaches introducing the research project and an inquiry for participation. Two of the three district instructional specialists indicated interest. The district instructional specialist was selected to represent the most diversity within the sample. Four administrators returned the email indicating interest in participating in the research. The researcher met with administration from three of the schools. A member of the administration team from the schools discussed their questions and concerns with the research and about participating in the study. One school administrator conferenced with the researcher over the phone. After the meetings all three, administration teams were interested in participating and signed consent to participate in the research.

Three STEAM schools were selected to reflect a range of the STEAM schools in the region. One school is a K–8 and two schools are middle schools. At each school the principal forwarded an introduction email from the researcher to recruit teachers. The researcher also attended two school staff meetings to present an introduction to the research project and answer any questions. Administrators and teachers who were interested in participating in the research at each school emailed the researcher.

The participants were selected to reflect a range of representation across the three schools. Factors considered in selection were: grade level currently teaching, content area(s) currently teaching, administrator position, and number of years at their current school. Nine participants were selected. Each participant was sent a consent form. When the consent form was returned with a signature, the researcher worked with the participant to set up an interview time and the link to the Qualtrics participant questionnaire was emailed to the participant.

Eight participants were interviewed. Three of the participants are STEAM teachers, two are administrators, one middle school teacher, one elementary school teacher, and one STEAM instructional coach. Due to the complete turnover of all administrators at one school, no administrator from that school participated in the data collection. Additionally, one of the teachers at the school who signed a consent form did not return any emails or phone calls to set up an interview time. The researcher then reached out to other teachers at the school who indicated interest in participating in the study, but no one returned any emails due to school being out for summer vacation.

Sample demographics. All of the participants provided demographic information through the Qualtrics participant questionnaire. The participants have been working in education between 5 to 25 years. One administrator has been working in education for over 20 years and at their current school for one year. The other administrator has been in education for 16 years and at their school for three years. The STEAM instructional coach has been in education for 16 years and working as a STEAM instructional coach for five years. The teachers have worked in education between 5 to 16 years. One of the teachers also worked as an educational assistant for six years prior to becoming a teacher.

Two participants have worked only in their current school district. Six participants have worked in at least two districts. All of the participants have worked at more than one school in their education career. One administrator has worked at four schools, and the other administrator has worked at eight schools. Three participants have been at their current school for one year. Two participants have worked at their current school for 3 years. One participant worked at their current school for 4 years, and two participants have worked at their schools for 5 years. One participant has been a certified educator for 5 years. Another has been an educator for 6 years, and two participants have been educators for 10 years. Two participants have been in education for 16 years, and one participant has been in over for 20 years.

The participants have a range of education endorsement/certification areas. Two participants have elementary certifications. One participant has a K–8 certificate. The two administrators have an administrator certificate. One administrator has a Special Education endorsement and the other one has secondary science and math endorsements. Two teachers have secondary math and science endorsements. One teacher has a English Language Arts endorsement.

Research Methodology and Analysis

This case study was designed to explore the perceptions of education stakeholders in Oregon perceptions of STEAM integration in a K–8 setting. Qualitative research was selected instead of quantitative research because of the holistic nature of qualitative research. Qualitative research is done to understand multiple factors of situation and identify complex interactions of the various factors in the situation (Creswell, 2013).

Participants were chosen based on who could best inform the research questions and provide a deep understanding of the study phenomena by using the questionnaire data to select participants who represented the most diverse sample of grade levels, content area expertise, and years of teaching experience. The participants of the study were from educators at STEAM schools in a Metro STEM partnership service area. A convenience sample was used because this Metro STEM partnership is one of the few STEM hubs in the country. Data collected from participants were participant questionnaires, semistructured interviews, and research notes. The data collected was analyzed using open-coding to determine themes and inform the findings of this study.

Case study design. A case study was used to address the research question. Yin (2014) explained case studies are used to explore situations in which the evaluated has no clear, single set of outcomes. The data was collected through questionnaires, semistructured interviews and research notes. Data analysis was done through open coding using Atlas.ti (2017) to track codes and themes. Semistructured interviews with teachers and notes and administrator interviews and notes and questionnaires used for selection purposes.

Interviews. Interview questions were created based on literature and theoretical framework. The interview questions were pilot tested with four people who had similar characteristics to the sample. Two of the pilot people were teachers at schools in a different school district. One of the pilot testers was a district administrator in the school district. The other was a retired administrator. None of the pilot testers had input about changing the questions. The feedback from the pilot helped to refine using the recording devices to keep them from stopping to record in the middle of the interview.

Interviews were conducted face-to-face at a location that was suitable for the participants and the researcher. All interviews were confidential, with only the stakeholder and researcher present. Each interview was recorded using the voice recorder app on the researcher's phone and two digital recording devices.

The interview questions focused on having participants share their perceptions about integration and implementation of STEAM education. The first question focused on what the participant knew about the process the schools used to make the decision to become a STEAM school. The second question had the participants describe their experience learning about STEAM integration. The next five questions for teachers were designed to help guide the participant through reflecting on their experiences integrating STEAM to learn about the successes, challenges, and benefits of STEAM integration. For administrators, the next five questions were designed to help reflection about the successes, challenges, and benefits their school has experienced with STEAM integration. The last two questions for teachers and administrator interviews provided the opportunity to give ideas on what to improve and surface the thoughts of the participants on what is important for others to know about STEAM integration. Appendix B has the list of the open-ended questions used in the interviews for teachers. Appendix C has the list of the open-ended questions asked in the administrator interviews. One of the interviews was 16 minutes. Seven of the interviews ranged in length of the interview from 27 minutes to 45 minutes. This is a limitation of the study.

The researcher transcribed each of the interviews using Microsoft. After the transcription was completed, the researcher listened to the interviews again while following along with the transcription to check for accuracy. The transcription was sent to the participant for member checking. Only one participant had feedback that language in the transcription was not language they would use. The researcher reviews the recordings of the interview and verified that the language in the transcribed interview was what the participant used during the interview.

Research notes. Research notes were used to record reflective notes before, during, and after the interviews to track nonverbal cues, In addition, the research notes have notations about participant statements while the participants were answering the questions to increase clarity about what the participant shared before asking the next question. The research notes were used to triangulate the data and were taken from interviews of teachers and administrators. These clarifications were about acronyms or references to an organization name or partnership project. The analysis of the research notes was used to identify any possible codes. The codes were used as a starting place for coding and analysis of the interviews. All of the interviews were transcribed and member checked. The transcripts of the interviews and researcher's notes were uploaded into Atlas(ti). These are the interview notes from teachers and administrators.

Protection of participants. Each participant was given a pseudonym to protect the identity of the participant. Administrators were assigned the letter "A" and then randomly assigned a number. Teachers were assigned the letter "T" and randomly assigned a number one through six. Using the researcher's password protected laptop, all computer data was securely stored. Folders for each participant were stored using participant pseudonyms. The researcher notes were securely stored in a locked file drawer at the researcher's home. These notes and other data files will be destroyed within 3 years of the study's publication.

Data analysis. The data collected from the interviews was coded using Atlas.ti (2017), a qualitative data analysis software. The software was used to help identify patterns, themes, and concepts in the data from the participant's responses to the interview questions. The first round of coding used codes surfaced during the interviews recorded in the research notes. The research notes had seven codes: frustration, STEAM integration, district administration, engagement, relevant, partnerships, and challenging. During the first round of coding more codes became apparent in the interviews. The researcher then read through all of the interviews and research notes another two times to code for these new codes. The researcher then reviewed the literature for possible codes. The transcribed interviews and research notes were read through two more times to using this list of codes. Using Code Manager in Atlas.ti (2017) the codes were reviewed and themes were created. Codes were then places into these themes using the Code Manager. The quotations of each code were then reviewed and subcategories were created. The data was then reread and placed into the subcategories within a theme. Using the Code Group Manager the quotes for each subcategory within a theme was reviewed to ensure the quotation and reflected the theme and the subcategory. Analysis was also done on the interviews and research notes from teachers and administrators.

Summary of the Findings

Below are the findings that are representative of educator perceptions of STEAM integration in a K–8 setting. Seven thematic codes were found from 138 individual codes. Each of the perceptions is addressed in the subsequent sections of this chapter.

Thematic Code Category 1: First exposure to STEAM integration varies widely

- Little professional development opportunities for admin
- Preservice training with little to no exposure
- Student teaching provided some experience
- Educator self-selection into professional development opportunity

Thematic Code Category 2: Educators have varying definitions of STEAM integration

- STEAM is transdisciplinary
- STEAM is interdisciplinary
- STEAM is not a new idea
- STEAM is integrating makerspace
- STEAM is an elective class

Thematic Code Category 3: Educators have similar components for high quality STEAM integration

- Students are at the center
- Project-based learning, problem-solving, and engaging in real-world situations,
- Hands-on learning
- Exposure to STEAM careers

- Students are at the center
- Purpose is to develop student creativity, calculated risk-taking

Thematic Code Category 4: STEAM integration provides many benefits for students

- Make connections between content area
- Provides the relevance for learning content
- Develop college and career readiness
- Empowers students
- Builds confidence and resilience
- Help students get out of their comfort zone

Thematic Code Category 5: Educators who integrate STEAM have a shared core set of beliefs

- Value of having high expectations for all students
- Increasing access for all students to rigorous, engaging curriculum
- Students need to learn the why and how learning is relevant to them.
- Real-world problems are engaging for students
- Integration is possible with content standards

Thematic Code Category 6: Educators experience similar challenges with STEAM integration

- Administrator capacity for leading change
- Educators need to develop their own comfort with risk-taking in their own teacher practice
- Time for collaboration with colleagues
- Inconsistent resources

- Balancing district initiatives
- Pressure of standards and high stakes testing

Thematic Code Category 7: Schools use similar strategies to begin implementing STEAM integration

- Helpful to talk to other educators who are implementing STEAM integration
- Develop community partnerships
- Start with early adopters at a school
- Take advantages of STEAM professional development opportunities

Presentation of Data and Results

Thematic Code #1: First exposure to STEAM integration varies widely. The findings indicate that educators receive little to no exposure in preservice educator training, little professional development for administrators, and first exposure happens in self-selection into a professional development opportunity to STEAM integration. Each participant shared their first exposure to STEAM integration. Constructivism learning theory (Vygotsky, 1978) stated that people learn by creating their own meaning and understanding of from their own experiences. Educator's first exposure to STEAM integration showed how participants first started to construct their own understanding of STEAM integration.

Little professional development opportunities for administrators. Administrators receive little professional development about STEAM integration or how to support teachers who are integrating STEAM. When asked what professional development the administrators received on STEAM integration, Participant A#1 responded, "Not in this district." Participant A#2 responded with "That would be about zero. About zero experience." Later the same participant followed up with additional explanation "Because, um, as an admin team the, um, teachers that I oversee are elective teachers and um, spEd, special ed." Administrators not having formal or informal opportunities to learn about STEAM integration make it challenging to provide feedback to teachers on how to integrate STEAM into their instruction.

Preservice training with little to no exposure. Teachers have almost no exposure to STEAM integration in their preservice training. Three of the teachers indicated no STEAM integration in their preservice training. Participant T#3, who is general education teacher, shared "So I have been teaching for 10 years, and in my preservice program there wasn't any discussion or classes about STEAM." This experience was also expressed by Participant T#1, a STEAM elective teacher, "I never was trained to integrate it into my STEM/STEAM or into my, my science curriculum rather." Finally, Participant T#5, a general education teacher, also responded "I mean not a lot. And not as anything specific only in the broader classes and we didn't have that many of those. We really stuck to our cohort, our language arts cohort."

The lack of exposure in preservice training for teachers could be due to STEAM integration as part of K–12 learning experiences have only surfaced since 2012. All of the participants have been teaching for over five years. This may be the reason why the teachers did not experience learning about STEAM integration.

Student teaching provided some experience. Student teaching placement is due to location, willingness of the cooperating teacher to volunteer, and who has the required amount of years of experience and endorsement to meet the state's laws for teacher licensure. Two of the teachers shared that their first exposure to STEAM integration was during their student teaching experience. Participant T#1 spoke about his cooperating teacher "I was lucky enough in my practicum to work at a high school with a teacher who had an engineering elective and this is about 10 years ago now." Student teachers are in a challenging position because they are often required to use the cooperating teacher's rules, classroom management plan, yearly scope and sequence, and instructional practice. Therefore, few student teachers are placed with cooperating teachers who integrate STEAM. Participant T#6 shared about having his cooperating teacher having two heart attacks and the trauma at the school led the participant to trying STEAM integration to engage his students.

> There were deaths. There were explosions. There were stabbings. There were people setting people on fire. There were windows shot out during the day. My mentor teacher had two heart attacks during the year during teaching. It was just. It was literally like trauma at the highest degree for me, um, going into education really for the first time and teaching and learning building and urban schools, and just this whole thing. And through that, kind of, what could be considered a catastrophe was birthed like I have to engage with students and communities in a new way because clearly the historical way that kids and families are interacting with the school experience is just, is, is problematic.

Educator self-selection into professional development opportunity. Currently in STEAM education there are many opportunities available to teachers to attend professional development from an organization, which claims to teach how to integrate STEAM. However, there is not an organized manner for educators to learn about these opportunities. Additionally, these opportunities require educators to use their own money and time to be able to attend the professional development. Two teachers discussed that their introduction to STEAM integration came because they took advantage of professional development opportunities made available to them often using their own money. Participant T#2 stated, "And then, I've chosen to go to a conference here and there on my own time and money to try an expand my own understanding." Later in the interview, Participant T#2 further explained, "But of all those were here is this thing.

I think I will go to this thing as opposed to it necessarily being presented as an opportunity, so I took advantage of it." Participant T#3 discussed the professional development opportunity, which introduced her to STEAM integration. "I was in a makerspace cohort, um, and we traveled to the different makerspaces in our district and, um, learned more about how to use the makerspace and how to integrate STEAM into the makerspace and taking your class there and things like that." Participant T#5 identified an arts integration professional development where he was first introduced to STEAM integration. "I am thinking about I have done the arts integration. I mean that would probably be the A. What's the name? You probably know it." The non-systemic method of teachers selecting to attend a professional development results in a wide- range of definitions of what is STEAM integration, how to integrate STEAM, and what high quality STEAM integration looks like in a K–8 setting.

Thematic Code #2: Educators have varying definitions of STEAM integration. Each participant has constructed his or her own definition of STEAM integration. According to constructivism this is to be expected because people construct their own meaning through their own experiences. Additionally, culturally responsive pedagogy describes how teachers bring to their instructional practice cultural perspectives and understandings impacting how they perceive not only students but what instructional strategies will impact student outcomes (Hammond & Jackson, 2015). Teacher perceptions of what instructional strategies is part of STEAM integration influence their definition of what is STEAM integration. None of the participants had the same definition of STEAM integration. Participants described STEAM integration as transdisciplinary or interdisciplinary. Another participant described STEAM integration as not a new idea. Other participants discussed the STEAM integration is integrating makerspace or technology or the arts. The different definitions from the participants could be because there is not agreement about what is STEAM integration. Additionally, many nonprofit and for-profit organizations claim that their professional development helps an educator integrate STEAM causing educators to use that experience to create their working definition of STEAM integration.

STEAM is transdisciplinary. Educators who view STEAM as transdisciplinary see themselves the connection between understanding how things are connected and the tools used to make sense of the ideas and to communicate their ideas to others. Participant T#6 shared his work integrating technology was not STEAM integration because it was not transdisciplinary.

> And that was just like getting devices into the classroom. That wasn't coding. That wasn't looking at specific apps to go about teaching and learning. That was just about what does it mean to have devices in the classroom. And that's one of the lowest levels as far as I am concerned. As far as using technology but the STEAM in general is this overarching, you know, we talk about this transdisciplinary learning and stuff like that was nowhere to be seen.

The participant expanded on his idea of STEAM as transdisciplinary when he shared his thoughts about how science is connected to everything.

> To make more efficient that which, um, I guess make more efficient teaching and learning versus digging deeper and understanding where science comes out. What I mean by that is, is I see and I am kind of going off track, I see teaching and learning as a science, and so I see a foundation of what we are doing as a scientific endeavor. When it can combine, when it can combine with a historical understanding of what science is and to also, um, and allow people to look at science in a different way with respect to innovating teaching and learning.

Educators often give an example rather than a definition to explain what is STEAM integration. Using an example to define STEAM integration occurs with educators because they learned about STEAM integration in a professional development on how to teach using a particular device, lesson, project, or unit. Participant T#3 did not state transdisciplinary in any part of the interview, but when explaining the successes the participant had integrating STEAM described a transdisciplinary unit.

> Yes, so, I am just thinking we just did a unit on habitats, um, relationships in ecosystems and we studied different habitats and we connected that with our writing. And, students did research on animals and habitats and we were able to connect that with the makerspace and students made models of the habitat and it just brought everything together and it felt like a really successful unit, cross-curricular.

STEAM is interdisciplinary. Educators, who describe STEAM integration as interdisciplinary, view learning as needing to engage students in understanding the connection between content areas. One of the participants either specifically spoke about interdisciplinary or explained STEAM integration using an example of an interdisciplinary project. Participant A#1 described the importance of interdisciplinary work for her students as what is now referred to as STEAM integration.

> And I found that with working with students who didn't make it within the regular school that interdisciplinary work was really important as far as their schooling and how their, their curriculum was laid out and how the year was laid out. And with that came and overlapping, even within my own practice, of which would now be called STEAM.

The participant expanded on this further stating "So, using art to tackle mathematics, using engineering to tackle mathematics, giving . . . teaching classes that are both physics and math credit options for kids and just layering those different classes on top of each other rather than segregate them and compartmentalizing them."

STEAM is not a new idea. Educators view the current move towards STEAM integration as a pendulum swing back towards career and technical education that was lost during lack of funding for education. Participant T#4 described STEAM as an old idea that has become new again with the STEAM acronym. "I think it is really exciting, but I don't think it is new." The participant further explained, "It has a new acronym and STEAM is stuff that has been taught for centuries and it has been a part education because we lost shop and we lost, you know, some of our hands-on project time." He also addressed how technology has made the old curriculum new again with STEAM. "It popped out as wait a minute we can't lose those things, and so, and so the new acronym and spruce it up with some new electronics and some new acronyms."

STEAM is integrating makerspace. Another definition of STEAM was shared by Participant A#1 of having a makerspace is part of STEAM integration. In the school district the participant works in makerspaces are now in the education specifications for new buildings. The buildings use the new makerspaces as the impetus to become a STEAM school. "And with the new build having the makerspaces made sense that we might have a . . .um . . .a STEAM focus given the spaces and some of the resources and supports that we have got." Additionally, the participant shared, "Um, and even in this new setting we have now with having makerspace available and with not just this space but the, the staff member attached to it."

STEAM is as an elective class. Schools offer electives as enrichment for students. Educators view offering STEAM electives as an opportunity to have the freedom for students to learn how to solve real-world problems that are unable to be addressed in content courses. Participant T#1 described STEAM integration as part of a separate class rather than content integration. “The STEAM integration into a non-STEAM class. I teach a STEAM elective so that part of it is separate from integrating it into science and math, which I have done in the past. “

Thematic Code #3: Educators have similar components for high quality STEAM integration. The perceptions of students’ experiences and their definition of STEAM integration influence how the participants describe the components of high-quality STEAM integration. According to Hammond and Jackson (2015) culturally relevant pedagogy focuses on creating challenging instruction relevant to students. Teachers bring their own cultural perspectives and understandings of students into implementing STEAM integration. The educators interviewed described high quality STEAM integration practices as being student-centered, project-based learning, problem-solving, engaging in real-world situations, hands-on learning, and important as a way to expose students to STEAM careers. Additionally, the educators feel the purpose of STEAM integration is to help students develop creativity, calculated risk-taking, and comfort making mistakes.

Students are at the center. Educators agree a focus of STEAM integration is to focus on student-centered learning. Student-centered learning focused teachers on developing learning that is relevant students and shifts the role of the teacher from teacher-led to teacher-facilitated teaching. Participant A#1 explanation of why STEAM is important focuses on making content relevant for students. “Um, [pause] so for me the grand idea of STEAM is to, is to pull together and make sense of . . .a lot of classes, a lot of the science and mathematical classes that students are in that are hard to understand why. Why are we studying the order of the planets? Why are we studying long division? What is . . .why are all these worksheets here?” Later in the interview, Participant A#1 continues with a focus on students stating “It helps students find meaning, and hopefully some kind of passion of their own, which is what education really should be able to do is to have kids, have students find a passion." When Participant T#6 shared about the experience that made him first interested in STEAM integration, Participant T#6 shared,

> And, so [pause] I just remember . . .it was really cool when I saw in this presentation that everything that was created and everything that was designed was done primarily through students . . .not through students, but student-led. Students led that charge with the help of their teachers. So, the teacher was really empowering students to make their experience their own. And that was really fascinating to me because there was an enormous amount of trust, but I also felt that was the most powerful way that these students could be learning.

Additionally, Participant T#6 expressed how STEAM integration focuses instruction on meeting the needs of students.

> And, um, those new things might be directly connected to literacy and that might be a literacy program that could be using technology, that could be using—integrating movement. Really just a culture of trying new things and discussing and reflecting and possibly integrating that into your practice but more so, um, really trying to devise different ways to go about meeting the needs of your students.

Participant T#5 discussed that the first piece he thinks about when lesson planning for STEAM integration is "What do you want kids to get out of this?" He continued to discuss why STEAM integration is engaging for his students stating, "It's learning a concept and you are turning it into a different idea. You are translating it. You are taking it from the thinking to the physical. I think that is really great for the kids. But also it breaks down their stiffness around the subject. I think it gets them more . . . it gets them more involved and in-tune with what we are doing—with the movement."

Project-based learning, problem-solving, and engaging in real-world situations. Educators described high quality STEAM integration as project-based, problem-solving experiences which engages students in learning about real-world situations. Four participants discussed how STEAM integration involved project-based learning opportunities for students. Participant T#6 explained he know he is integrating STEAM "If this is a project of two or more subjects." Participants T#1 talked about project-based learning as a place to start when first working to integrate STEAM. "Um, anytime you can do a project. I don't care what the class is. Anytime you an get the kids on the floor drawing something or putting something together or using their brains in different ways that is where I would start. Um, you know integrating STEAM, I, I guess." He continued to explain about specific instances of other teachers coming to him asking for his advice stating,

> Anytime a math teacher or a science teacher comes to me or is telling me about a unit that they are doing sometimes I do have projects I have done in the past because I am always thinking like that. I am always thinking how can we get the kids building something, so I try to share that with other science teachers at my school. And even the with the math teachers, because I had to do some, some teaching of math.

The shift to project-based learning is often a first step for educators into STEAM integration. When Participant A#1 shared about her own learning on how to integrate STEAM, she spoke about project-based learning as the starting point. "All the PD I did was around project-based learning which led itself to having the bones and the structure for STEAM integration in our setting." Participant A#1 commented about the importance of having a small group of teacher leaders at the school to speak about project-based learning. "But starting with a very small core group who have the technical expertise so they are not scared of math, scared of science, and also the momentum energy-wise to speak to project-based learning, and then starting to build from there and have teacher leaders—kind of like having train-the-trainer set of thing or train-the-training.

Participant T#4 discussed project-based learning four different times during the interview. First, Participant T#4 discussed how project-based learning is a passion for him for STEAM integration because of its effect on student learning. “And, to be place projects in front of students, whether it is online projects or hands-on projects in front of students that use all of the materials that they have been worksheeting is, is kind of passion with STEAM. And I hope that’s, of course, students are so varied that there isn’t one effect on student learning that can be pinpointed.” He also spoke about project-based learning when sharing the challenges he experienced integrating STEAM for himself. “And, that whole engineering process, and allowing that time for that whole to go through has been a steep learning curve.” In addition, the project-based learning was discussed as part of challenges students have with STEAM integration. “And then challenges with students handling open-ended, kind of self-motivated projects.”

Participant T#3 mentioned in his closing statements project-based learning. “That is why I like projects. Projects are world-based not worksheet-based, and it really pulls together school.”

STEAM educators find real-world connections important for students to engage in instruction. Four participants discussed STEAM integration as having real-world connections. Participant T#4 shared “But it is all great stuff in terms of getting people really ready for the world.” This participant also gave an example of real-world learning in his class “Um, every time I teach students about parts of an inch. Every time I see students who so many fraction blocks . . . with fractions blockades overcome when a tape measure is put in front of students.

And that happens time again and again and again. I love that part and find it to be a huge success.” STEAM integration having real-world connections is a core belief for Participant A#1 “What I—my belief around STEAM is that it provides a way to have a tie between this course content and what the real-world actually provides you as far as diverse experience and actually be the same.” When speaking about why STEAM brings out confidence in students, Participant T#1 stated, “Because it’s real, real-world based.” Participant T#6 discussed how real-world connections in STEAM integration helped him connect with students in his student teaching experience that were disconnected from school and experiencing trauma.

> It was literally like trauma at the highest degree for me, um, going into education really for the first time and teaching and learning building and urban schools, and just this whole thing. And through that, kind of, what could be considered a catastrophe was birthed like I have to engage with students and communities in a new way because clearly the historical way that kids and families are interacting with the school experience is just, is, is problematic. And I don’t know why and I don’t know how but I have to. The only time I was feeling successful is when I knew I was inspiring people and so I was not going to inspire people through going to a textbook page, and if I was it was more of a song and dance inspiration and being a good performer versus actually having,

Hands-on learning. High quality STEAM integration includes students engaging in hands-on learning. Hands-on learning with STEAM integration is making something tangible with your hands. Participant T#1 discussed he focuses on hands-on learning as an important part of STEAM integration. “What kinds of hands-on things can we do? What are different approaches to this other than an essay, or a test, or a, you know, whatever else they are usually doing? How can we get them building something?” Additionally, Participant T#1 discussed students using their hands to engage in kinetic learning as part of STEAM integration. "It's, it's getting them to, to use their hands to be kinetic to think about things to problem-solve, to—to use the knowledge that they've been building—um in a way that is actually applicable and fun."

Exposure to STEAM careers. STEAM integration includes exposure of students to STEAM careers. Students cannot be what they cannot see. The introduction of STEAM careers in high quality STEAM integration provides students the opportunity to not only see professionals who look like them in a STEAM career, but also provide students to experience success in doing work similar to what is done in that career. Two participants highlighted the importance of STEAM integration is to expose students to careers in STEAM fields and increase their interest in those fields. Participant T#1 shared how students he taught in elementary school were now middle school students wanting to become engineers.

> Um, and that was interesting, and actually that was way more successful than I think because I am now getting kids that I taught in the 4th and 5th grade at the middle school I am teaching at now who remember that as the greatest class they had. And now, they get to take it again and at a higher leveler. And they are already on this path to—they tell me they want to be an engineer and this or that.

Participant T#1 further elaborated about the importance of exposure to careers as part of STEAM integration stating,

> It's huge. Even the exposure alone. Um, gets kids thinking about things that they didn't think they could be a part of. Um, students of color, girls that just never has that as an option or never saw themselves in career, um, that use STEAM related. All of a sudden are like I can do this. I can be an engineer. I can be a fill-in-in-the-blank. Um, I love this stuff.

STEAM careers are also used to refer to jobs of the future that no one knows what they are yet, but know the problems the careers will be focused on solving. Participant T#5 shared at the interview that studying climate will be multidisciplinary and important for students in the future. “I think in the next 10 years studying climate is going to be multidisciplinary. It is going to have to happen. And so I don’t know if it is going to be in three years, five year, but definitely within the next 10 years it will be woven through education. A bunch of education.” Participant T#6 discussed that STEAM integration prepares student for their future careers.

> And I believe it is the best opportunity to develop skills and strategies that can be applied to their future careers and future endeavors that we know nothing about. And so, I see it as the most viable road education can possibly be on because it’s going to lead to, you know . . . 20 years from now is going to be the Jetson’s was for the 1950s people. You know—rock your world.

Participant T#2 stated as adults we know the future in STEAM and now students are starting to make the same connection as well.

> The grown-ups have said STEAM is the future, STEAM is the future, STEAM is the future, and I think from a how am I going to use this in the future, how is this going to improve my life standpoint I think that students are beginning to make those connections or perhaps because technology is so embedded in life before they come to school they see the connection.

Finally, Participant T#4 stated that the interesting part about STEAM is that it is unknown. “I will tell them that there is an interesting part about STEM right now that it is kind of unknown and I would say mysterious for principals and other teachers and I would encourage them to utilize that at this point.”

Students develop creativity and calculated risk-taking. STEAM integration includes multiple opportunities for students to develop creativity and calculated risk-taking. These skills are important professional skills for all students to develop as they move from school into college and careers. For Participant T#6, student development of calculated risk-taking is an important part of STEAM integration. First, Participant T#6 discussed part of STEAM integration is “That [it] embraces a mindset of taking chances.” Participant T#6 was the only educator to address STEAM integration as helping students to develop mindsets that will help them be successful in college and careers.

Thematic Code #4: STEAM integration and benefits for students. STEAM integration provides several benefits for students: providing relevance for learning content, develop college and career readiness, empowering students, building confidence and resilience, and helping students get out of their comfort zone. Constructivism (Vygotsky 1978) described that students learn by doing rather than listening and taking notes. Culturally relevant pedagogy (Hammond & Jackson, 2015) added how students learn by having instruction that is meaningful and connected to their own experiences. The participants identified the benefits for students of STEAM integration when relevant for students.

Students find their passions when engaged in STEAM integrated learning. Participant T#4 discussed how STEAM integration helps students find their passion. “It helps students find meaning, and hopefully some kind of passion of their own, which is what education really should be able to do is to have kids, have students find a passion.” Participant A#2 shared how STEAM integration provides a different way for students to experience success in school. “And, um, that’s how I see it benefiting students because it’s giving students another way to feel successful other than just writing an essay or reading a book, um, which has its merit as well.”

STEAM integrated learning opportunities help students feel successful in schools, particularly students who have not felt successful in traditionally taught classrooms. The positive student impact for helping students feel successful in school was also something Participant T#4 expressed in the interview. “But I have seen a lot of students who are struggling in other classes succeed in STEAM class. Um, struggling with fractions in sixth grade. Succeed in figuring out measurements and how to use a tape measure and then all the parts of an inch and kind of getting through the rest of the day to get to a class with a little less regiment to it.” Participant T#4 additionally discussed the importance of STEAM integration helping students see the relevance of attending school. “It’s really a class that can for some people really ignite ‘this is why I am going to school. This is why we do school.’ This gets them a little earlier than high school and college.”

Students’ feeling successful at school was also important piece of STEAM integration for Participant A#2. “Well, I know that there are students, especially with our music program, I know there are students that are at [School Name] and tend to be successful at [school name] because of the music program or because of [teacher name] STEM class.” Participant A#2 came back to the positive impacts for students later in the interview when discussing how STEAM integration is engaging for students; therefore, STEAM integration is helping close the opportunity gap.

> If what we are really doing is at closing the opportunity gap and different ways of engaging students—be they not being the traditional students. That’s what we are going to be able to do with STEAM and that’s why I think it is so important. It’s one more way for us to engage students that typically may not be engaged and may, realistically, drop

> out, before they get their diploma. It's, it's a way to engage students and ultimately narrow the opportunity gap.

Participant T#3 talked about positive student impact when discussing what she would share with someone who was thinking about implementing STEAM integration.

> I would share the positive experiences that we have had with STEAM and the positive experiences that students have had and the successes that I have seen in all students that might not see themselves as successful in other areas. That is has been a really meaningful and impactful experience for them.

STEAM integration has positive impact on students by engaging them in student discourse and incorporating language development. Participant T#3 explained how she knew STEAM integration has a positive impact on students. "I think that is has had a really positive impact. Whenever we do science, and I know that STEAM is more than just science, but, they, my students, thrive during that time." Participant T#3 later in the interview explained more about how she knew STEAM integration has a positive student impact. "Students were engaged, and they were talking and using language and high leverage science discourse and it just felt like a really positive experience for everybody."

Participant T#1 shared about how seeing students who haven't often felt successful in school feeling successful in the STEAM elective class is part of why he loves teaching using STEAM integration.

> Getting kids to who, who don't do anything else. Who don't, don't feel successful or find success in the traditional classroom setting. They get excited. They get, they get going. They have a billion ideas that seem to be bottled up for the last 12 years of their life and

> they finally get to . . . get to get their hands dirty and make something. So that's why I just kind of fell in love with it.

Additionally, Participant T#1 discussed how STEAM integration "brought out the best in some and others seemed to struggle that didn't struggle with the normal stuff." Participant T#1 offered an explanation as to why he thinks students experience success in his STEAM class versus other classes without STEAM integration.

> And so I think that is a big part of it is that you know we make them sit down and shut-up for hour upon hour upon hour for however many years they have been doing this and some of them are just—they can't or they're just done with it or they, they have been told they are not good at it. So, this just gives them an alternate path to, to feel successful.

STEAM integration has a positive impact on students because it helps reduce negative student behaviors. Participant T#1 elaborated on why he thinks students feel more successful when learning in STEAM classes. "Whether or not those students are doing all the work that I am asking them to or whether they are doing it at a high level, their behavior in my classroom tends to be better just because of what we are doing and how it is presented and how they can feel successful or not, just not a failure." Participant A#1 simply stated STEAM integration "has a massive positive impact." While Participant T#5 explained how he knows STEAM integration has positive student impact because "Where I was going is that it is the class where you would get the most buy in."

Provides the relevance for learning content. STEAM integration helps students and educators to understand the relevance for learning content. Current instructional practices have students engaging in learning activities that are not connected to bigger ideas or helping students to make sense of the world. Both administrators interviewed shared how STEAM integration provides relevance for students to learn content, which has been missing from current instructional practices. Participant A#2 stated, "It, um, so that arts and science although there is math involved and there should be math involved, there's the component of accessing, what I see as accessing different parts of the brain students are doing things with their hands, they are working in groups, um, they are just thinking of things differently." Additionally, Participant A#1 discussed the lack of relevancy in math education because it has been isolated from other subjects.

> I think one of the issues we have had with mathematics achievement is that we have kept it in its own little box and connected it to nothing. Um, thus the irrelevance has really impacted students being able to do well in it. Um, same with the sciences. Um, as long as they are compartmentalized into their own little departments, own little worlds, and because of that it can be dismissed in lieu of doing other things, um, then the irrelevancy will always trump the ability to do well in subjects.

Participant A#1 continued to share the impact of increasing STEAM integration helped increase the relevancy and engagement of students. "We, coming into this school year as a new principal and with my new AP, um, we noticed that there was a lack of focus on rigor and engagement in the building as an expectation. And, so when we hit that hard it led to opportunity for these STEAM activities because they are inherently more engaging and rigorous." Participant T#2 also discussed relevance in mathematics through STEAM integration. "So I feel like that, that need to make things relevant, that push for describing why learning linear equations is helpful or why . . . we don't have to spend as much time with that if it's effective STEAM because they can, the students inherently know that there is value to it than having it explained to them." Participant T#4 also spoke about the need for relevance in mathematics using STEAM integration.

> So for me the grand idea of STEAM is to, is to pull together and make sense of . . . a lot of classes, a lot of the science and mathematical classes that students are in that are hard to understand why. Why are we studying the order of the planets? Why are we studying long division? What is . . . why are all these worksheets here?

Develop college and career readiness. Another benefit of STEAM integration is that students can develop college and career readiness skills. These skills are often described as "soft" skills students need to be able to do to be successful, but current instructional practices do not provide the opportunity for students to develop these skills (Wood, 2018). Two participants discussed how STEAM integration helps students develop collaboration skills to be college and career ready. Participant T#4 how having students collaborate on a projects helps students with diverse talents contribute in a way that may not be seen in a traditionally taught content area.

> I also love the A in STEAM and how the students who might not be in group work we have people who are in charge of this problem-solving structure and solutions. And then someone else comes in and adds the art to it. And I think it's a . . . there's a lovely success of pulling really diverse talents with a project that has a lot of different parts to it. It's not a math project where the smartest math student is pulling the others along. It is really everybody gets to shine.

STEAM integration helps students learn how to collaborate with others. Students need to learn through multiple opportunities how to work with others with different perspectives and cultures in a manner that is respectful, and encourages dialogue. Participant T#6 discussed a critical piece for student growth is learning to collaborate. "But regardless if they can embrace the environment where they can embrace that environment and be willing to, to share and to collaborate and all those wonderful things."

Empowers students. STEAM integration empowers students to see themselves as change makers and the value of different perspectives. Four of the participants interviewed shared about how empowering students who have been historically underserved in STEAM fields is an important part of STEAM integration. Participant A#2 shared,

> Well, I know that there are students, especially with our music program, I know there are students that are at [school name] and tend to be successful at [school name] because of the music program or because of [teacher name] STEM class. It, um, so that arts and science although there is math involved and there should be math involved, there's the component of accessing, what I see as accessing different parts of the brain students are doing things with their hands, they are working in groups, um, they are just thinking of things differently.

Later in the interview, Participant A#2 spoke more about the importance of engaging all students in STEAM integration. Historically, there are students who have not been exposed to STEAM integrated learning experiences, which has perpetuated the opportunity gap in STEAM fields.

> If what we are really doing is at closing the opportunity gap and different ways of engaging students—be they not being the traditional students. That's what we are going to be able to do with STEAM and that's why I think it is so important. It's one more way for us to engage students that typically may not be engaged and may, realistically, drop out, before they get their diploma. It's, it's a way to engage students and ultimately narrow the opportunity gap.

Students need to see and hear from a diverse group of STEAM professionals to learn that the path to a STEAM career is not a direct high school to college to career pathway. Students need to learn that there are many different job in STEAM fields that require a range of different educational experiences. Participant A#1 discussed the importance of empowering students through exposure to professionals who like the students do.

> Like Architects in Schools is huge because kids get to see a career, um, the career aspect of it all, especially my students of color, um, where do you see a lot of people of color in the architect world and engineering world. So you have these professional come in. Um, if you are a school talking the right—talking the right talk, um, you can push those organizations to have people of color come into your schools rather than just white.

STEAM integration empowers students by valuing students' lived experiences. Various cultures seek to understand the world in different ways and these differences help to create better understanding of the world and better solutions to problems the world is facing. Participant T#6 discussed how respecting students' lived experiences through STEAM integration empowers and engages students.

> It was such a kind of like a war zone, and I had to figure out what was a way on how to be engaging that could be connected to student, students' experiences, but also really respecting the learners in the community. And I felt historically the respect, the respect was not there through the curriculum. And I feel like because you know like because we are a failing school we have to strip down your education experience to only foundational skill-based activities. And those were equivalent to being a ditch digger and like this is your job for life is to do this one simple task over and over. And so it really heightened my awareness of, of when you create certain kinds of educational environments, and they can be a place where kids can be dynamic and be able to, um, explore and invent in a dynamic way by using a lot of tools available.

Builds confidence and resilience. Another benefit of STEAM integration for students is helping to build confidence and resilience through experiencing failure and how to learn from failure. Participant T#4 “You know one of my favorites was a student who, you know, has been blowing out of all his classes. He’s got a trouble with you know executive control. There are doctors and medications but it isn’t all working all right. When he we were soldering a little control board for an underwater ROV project his focus was like he didn’t need the soldering iron because his eyes were melting the solder. He was so . . . and he was like pushing other students away and he was like to other students who were trying to bug him, “Back off! I’m trying to get this done.” And, um, the principal happened to come in and see it at that time. He just shook his head and couldn’t believe it. Unfortunately, that didn’t transfer to other projects as well as I wanted it to. Um, but even for a little bit he felt some success, and some . . . some gripping interest in something in school. Participant T#1 “And so, the exposure alone is amazing. The confidence building, um, like I said students that do very little outside of the STEAM classroom just come alive and just find . . . find all sorts of things to do.”

Helps students get out of their comfort zone. A benefit of STEAM integration is helping students to get out of their comfort zone. Students who take risks in their learning in safe places develop the confidence to be able to solve problems. Participant T#6 discussed how success at integrating STEAM as helping students be vulnerable and open. “I think, you know, that success is such a loaded word and what I would consider success is, um, is students making themselves vulnerable and open to ideas.” Participant T#6 continued to describe the process of students becoming more comfortable with taking chances:.

> I think, ultimately—it was little by little seeing kids come out of their shells taking just a little bit more of a chance. The next day taking a step forward or a step backward

whatever the case may be so that they hit a point where they were comfortable and being courageous. I mean that was it didn't necessarily have to do with scores it had to do with pursuits and being okay with being courageous.

Thematic Code #5: Educators who integrate STEAM have a shared core set of beliefs. Educators who integrate STEAM in a K–8 setting have a shared set of core beliefs. These core beliefs are important pieces for educators to continue to develop and think critically in order to continue developing their STEAM integration practice.

Value of having high expectations for all students. STEAM educators value having high expectations for all students. In addition, educators view their purpose of their jobs is to explicitly coach students to be able to achieve those high expectations and that all students are capable of achieving those high expectations. Two of the participants discussed the importance of educators having high expectations for students as part of STEAM integration. Participant A#2 discussed how students do a better job when they know their teachers have high expectations of them and think they are capable of learning rigorous curriculum.

> He has high expectations for students and I think that is a piece of it, too. I piece of it is to have you know to show up with rigorous, when you are a teacher to show up with rigor and show up with high expectations. And students get it. They know. They know when that is happening and they will rise to the occasion.

Participant A#2 explained how having teachers with high expectations of students is so important that as an administrator she is accepting of current teacher vacancies at the school because the teachers who left did not see the students as STEAM capable.

> This year we, as of right now, we only have two teacher vacancies. That's it. Um, and one of those. It's actually one and a half teacher vacancies, no it's two and a half teacher

vacancies. 0.5 in a math and a science teacher. Um, and those vacancies are actually ok because those are teachers we are ok with them leaving and so with moving forward because we have folks that have been at [school name] and are on-board and are

committed to seeing a change and to improving academic growth with our students.

STEAM integration is rigorous because STEAM learning requires students to engage in work that is multi-faceted to make sense of the problem and to find solutions. Participant T#6 discussed the importance of rigor in STEAM education through having students do work that is multifaceted.

> And if I see that reflected in my students where it is not a questions of yes or no, pass/fail, what do I do now if I don't cross that line then I'm a failure and it is just going to destroy my self-worth, um, we demand from our students every day that they try, hopefully, that they are trying something that they don't necessarily want to do and whether that is a worksheet or that is a challenge that is multifaceted.

Increasing access for all students to rigorous, engaging curriculum. Another core belief of educators who integrate STEAM is the importance of increasing access for all students to rigorous, engaging curriculum, STEAM educators believe that STEAM integration helps all students to learn regardless of perceived ability. Five participants focused on how STEAM integration increases engagement of students with rigorous curriculum. Participant A#1 expressed how focusing on student engagement increased access for all students to STEAM integrated instruction.

> We, coming into this school year as a new principal and with my new AP, um, we noticed that there was a lack of focus on rigor and engagement in the building as an expectation. And, so when we hit that hard it led to opportunity for these STEAM

> activities because they are inherently more engaging and rigorous. So that's been a good tie for us. And also, rigor and engagement is tied to the teacher evaluation. Um, so as long as we keep that in the kind of the center of our messaging and our work and expectation, then pulling in STEAM is—can be quite easy. Because teachers see that as inherently more engaging than the activities they do in their reading adoption or the writing adoption or whatever.

Participant T#3 when talking about what made a STEAM integrated unit successful, she shared, "Students were engaged, and they were talking and using language and high leverage science discourse and it just felt like a really positive experience for everybody." While Participant T#5 discussed the importance of STEAM integration as helping students see why they are attending school. "It's really a class that can for some people really ignite "this is why I am going to school. This is why we do school." This gets them a little earlier than high school and college." Participant A#2 also discussed STEAM integration as a way to help students stay connected to school. "It's one more way for us to engage students that typically may not be engaged and may, realistically, drop out, before they get their diploma."

STEAM integration leverages that natural curiosity of all students to build excitement for learning. Participant T#3 shared how her students who engaging in learning science content through STEAM integration are excited to learn.

> If for some reason I have had to deviate from the schedule, they're very upset if we do not do science. It is a very engaging time, and I have noticed that my students who may struggle in reading or writing or other areas, see themselves as being successful during science instruction or whenever we go to the makerspace. It's a time that kids can feel

> comfortable to explore and, ah, be creative and feel more successful when they may not always feel that way in more traditional academic subjects.

The participant continued with a description of the STEAM integrated unit and why students were engaged in the learning.

> And, students did research on animals and habitats and we were able to connect that with the makerspace and students made models of the habitat and it just brought everything together and it felt like a really successful unit, cross-curricular. Students were engaged, and they were talking and using language and high leverage science discourse and it just felt like a really positive experience for everybody.

The integration of STEAM focuses teachers on finding topics that all students can easily access and provides significant opportunity for students to demonstrate understanding of the topic. Participant T#5 shared about why using STEAM integration to teach is more engaging for students when he was discussing how he uses images to introduce students to a social justice issue they will learn more about while developing their literacy skills.

> I think it's for me my use has always been to frame their minds, and it's low stress. And it's more you can choose. I am thinking about the image one and not tableau. It's almost as if they can conceptualize it very easy if I were to give a multi-paragraph, even if it is short, it is hard to have much of an impact to get them to buy in. So, I think . . . and then tableau. It is a great way to de-stress. It's learning a concept and you are turning it into a different idea. You are translating it. You are taking it from the thinking to the physical. I think that is really great for the kids. But also, it breaks down their stiffness around the subject. I think it gets them more . . . it gets them more involved and in-tune with what we are doing—with the movement.

STEAM integration encourages students to develop their own ideas on how to solve problems and to make sense of their own learning. Participant T#1 talked about the excitement students, who have not found success in traditional classrooms, have to try their own ideas in STEAM integrated teaching.

> Getting kids to who, who don't do anything else. Who don't, don't feel successful or find success in the traditional classroom setting. They get excited. They get, they get going. They have a billion ideas that seem to be bottled up for the last 12 years of their life and they finally get to . . . get to get their hands dirty and make something.

He also shared, "Um, I just always knew that engineering and design and those types of things just kind of brought out—different things in kids." Then, he explained that "I just saw this organized chaos and everyone was doing something and everyone was engaged." At the end of the interview, Participant T#1 talked about how teachers will be more successful engaging students if they integrate STEAM. "And I can think you are going to find more success if you do it that way."

Students can be taught calculated risk-taking and resilience. STEAM educators believe students can and should be taught how to take calculated risks and how to develop resilience. For Participant T#6 students learning how to take calculated risks and learn from failure are important parts of STEAM integration.

> But regardless, they walked through those doors every day, you know, and the demand is that they . . . they comply with the fact that they are going to be asked to get out of their comfort zone. Whether it is, "I don't want to do this because it is totally boring." or " I don't want to do this because it's so active and so different that what I have learned and I feel uncomfortable talking to people." But regardless if they can embrace the

environment where they can embrace that environment and be willing to, to share and to collaborate and all those wonderful things.

He elaborates on how students learning to take risks is a process and takes time.

I think, ultimately—it was little by little seeing kids come out of their shells taking just a little bit more of a chance. The next day taking a step forward or a step backward whatever the case may be so that they hit a point where they were comfortable and being courageous. I mean that was it didn't necessarily have to do with scores it had to do with pursuits and being ok with being courageous.

Learning needs to be relevant to students. Current instructional practices engage student in learning that is not relevant to students. Educators who integrate STEAM believe students need to understand why learning a concept is important beyond because the educational standards state so. The learning also needs to be relevant to students to help students make connections and retain their learning for the future. Participant A#1 shared how STEAM integration was important for students at an alternative school where she had taught to help students.

And I found that with working with students who didn't make it within the regular school that . . . interdisciplinary work was really important as far as their schooling and how their, their curriculum was laid out and how the year was laid out.

Participant T#2 discussed how important relevance for students is while learning math content and how STEAM integration helps students see the relevance in what they are learning.

So I feel like that, that need to make things relevant, that push for describing why learning linear equations is helpful or why . . . we don't have to spend as much time with that if it's

> effective STEAM because they can, the students inherently know that there is value to it than having it explained to them

Participant T#4 also discussed the importance of student relevance for learning content, particularly in math and science classes.

> So for me the grand idea of STEAM is to, is to pull together and make sense of . . . a lot of classes, a lot of the science and mathematical classes that students are in that are hard to understand why. Why are we studying the order of the planets? Why are we studying long division? What is . . . why are all these worksheets here?

Additionally, Participant A#1 spoke about STEAM integration providing relevance in math and science classes.

> I think one of the issues we have had with mathematics achievement is that we have kept it in its own little box and connected it to nothing. Thus the irrelevance has really impacted students being able to do well in it. Same with the sciences. As long as they are compartmentalized into their own little departments, own little worlds, and because of that it can be dismissed in lieu of doing other things, then the irrelevancy will always trump the ability to do well in subjects.

Real-world problems are engaging for students. STEAM educators believe that real-world situations are engaging for students. Students need to understand how the real-world problems are relevant to their lives. Four participants discussed how STEAM integration reflects real-world problems, which are engaging for the students. Each of the participants when sharing about why STEAM is good for students, their eyes became bright and smiled showing excitement for the relevance students experienced with STEAM integration in the classroom. Additionally, Participant T#5 when discussing why STEAM integration is good for students stated, “But it is all great stuff in terms of getting people ready for the world.” Participant A#1 identified real-world connection as a belief about STEAM integration. “What I—my belief around STEAM is that it provides a way to have a tie between this course content and what the real-world actually provides you as far as diverse experience and actually be the same.” When Participant T#1 discussed what about STEAM integration brought out the confidence in students, he stated, “Because it’s real, real-world based.” Finally, Participant T#6 discussed using real-world problems that he and students could work on together was an important part of STEAM integration.

> The only time I was feeling successful is when I knew I was inspiring people and so I was not going to inspire people through going to a textbook page, and if I was it was more of a song and dance inspiration and being a good performer versus actually having, um, real world problems that we could tackle together and we could do it with humor and love.

Empower students to be creative problem-solvers. Another shared belief of educators who integrate STEAM is a responsibility to empower students to be creative, problem-solvers. Participant T#3 discussed how integrated the makerspace at the school helped students be more comfortable to explore creative solutions.

> If for some reason I have had to deviate from the schedule, they’re very upset if we do not do science. It is a very engaging time, and I have noticed that my students who may struggle in reading or writing or other areas, um, see themselves as being successful during science instruction or whenever we go to the makerspace. It’s a time that kids can feel comfortable to explore and, ah, be creative and feel more successful when they may not always feel that way in more traditional academic subjects.

Integration is possible with content standards. STEAM educators also believe STEAM integration is possible with content standards. Content standards provide what the students need to know. The craft of creating learning experiences which connect the content standards to real-world situations provides the why teachers continue to teaching. Two participants shared as part of their advice to teachers wanting to start integrating STEAM instruction into their teaching practice to start by looking at the standards. Participant T#1 stated he starts be looking at what projects can go with the standards. "Um, looking at the units and then looking at what can go along with the standards that I am supposed to be teaching." Participant T#6 shared that standards are there to help navigate what students need to learn and that STEAM integration is the how students can learn the content in the standards. "The standards were there to help people navigate what the entire experience was about. But that, it was more about exploration and invention and, and that can be done in a very simple way. It can be done in a very complex way."

Thematic Code #6: Educators experience similar challenges with STEAM integration. No matter the school or experiences of the educators, STEAM educators experience similar challenges with STEAM integration. Ladson- Billings (2009) defined culturally relevant pedagogy as instructional pedagogy that empowers students to maintain their cultural identity, while succeeding academically. Hammond & Jackson (2015) discussed that culturally relevant pedagogy focuses on shifting the instructional decisions of educators from a deficit model of students to a strength model. Additionally, STEAM integration changes the role of the teacher from teacher-directed to the focus on students learning from doing as described by Vygotsky (1978). These shifts presented challenges for educators with STEAM integration. Building administrators, teaches, and district curriculum specialists experience similar challenges when working to integrate STEAM into instruction: administrator capacity for change, educators developing their own comfort level with risk-taking in their own practice, finding time in the curriculum for project-based learning, having time to collaborate with colleagues, inconsistent access to resources, colleagues perceptions of STEAM integration, balancing district initiatives, pressure of standards and high stakes testing, community partnership maintenance, and staff turnover. These challenges provide insight on what needs to be considered and how to best support educators with STEAM integration.

Administrator capacity for leading change. Building administrators are expected to be the instructional leaders of the school. They are expected to facilitate district-led initiatives as well as coach teachers to continue to improve their teaching practices to improve outcomes for all students. Many factors influence an administrator's capacity to lead change. Participant A#2 shared about how with all the changes the school experienced in the last year, she was stretched for how much change she could lead at the school. The school was working on putting systems into place and working on STEAM integration was not something she had the capacity for.

> Well, to be totally honest. This last year was putting together basic systems. I mean we didn't even have a fire drill routine. So, I . . . lockers . . . how long did it take to get lockers off the ground? So, I don't know. So, I don't know what I would change because I don't know if I could, if that. When I do something, I want to go deep and I don't think that would have been a possibility for me this past year.

Participant A#2 expanded on this her capacity to lead change a little later in the interview, again.

> My brain literally would not have been able to hold. I mean physically, yah, it would not have been able to hold what for me would be important—the information and the space for me to connect with teachers and the space to oversee something like that would have been—I wouldn't have been able to this year.

Additionally, in the research notes Participant A#2 sat back and used her hand by her head from a fist to stretched out as though her mind was blown four different times in the interview as the participant shared their experience trying to lead change that year at their school. These actions with the statement “My brain literally would not have been able to hold” demonstrate how an administrator’s capacity for change impacts their ability to support teachers working to integrate STEAM. Towards the end of the interview, Participant A#2 shared how much having some systems in place has freed up her capacity to about how to instructionally engage students.

> I just think that this year . . . having the space to really think about school next year and think about instruction and not having to think about how to hire 12 people in four weeks really gives me and our team an opportunity to think about how, how we are going to—how we are going to best engage our students.

Administrator capacity for change is challenging when administrators change from year to year. Transformational change needed for teachers to integrate STEAM requires several years of consistent support from administrators. Participant T#5 spoke about how after experiencing different principals lead the school, STEAM integration did not happen if the leadership wasn’t supporting teachers in the work. “So never have the time, never had the leadership. If there is a leadership who wants to take that on, wants to have it—otherwise it probably won’t.”

Educators need to develop their own comfort with risk-taking in their own teacher practice. Another challenge educators experience is the space and time to develop their own comfort with risk-taking in their own teacher practice. Educators feel the pressure of having all students improve their learning over the course of the time they are in the classrooms or schools. Teachers need to feel safe to take risks, fail, learn from the failure, and to try again. Five participants discussed the challenge of teachers developing their own comfort level with taking risks in their own teachers. Administrator A#2 discussed challenges as an administrator she has seen with teacher integrating STEAM. “And then, I am sure there is a certain amount of skill and willingness and just thinking about our science teachers I would imaging there would be a willingness around that.” Participant T#3 expressed not knowing about resources or how to integrate STEAM was overwhelming. “Um, I think sometimes we might be overwhelmed with the task of integrating STEAM, just not knowing the resources or the way it can be integrated.” Additionally, Participant T#3 described further about how the technology in a makerspace can feel very overwhelming and make teachers nervous to try to integrate those tools with students when they do not feel confident themselves.

> Well, since my only professional development was the makerspace cohort that was the most useful to me because at first it seems kind of overwhelming. The makerspace has a lot of tools and technology and equipment that can be overwhelming to a lot of people so, dispel that nervousness and the unknown of all those resources that were in there.

Participant T#3’s advice to educators starting to integrate STEAM into their teaching practice.

> Don’t do this . . . I am thinking like maybe . . . in some, in the beginning we put like a lot of restrictions because it can be hard for a teacher to let go of that control, and but that is where the greatest learning and creativity happens in my opinion. And, if there is less parameters, so I would say not put so many restrictions on ideas and things that you have.

The development of risk-taking in educator practice is related to teacher capacity for change. If teachers are asked to change too many practices at once, they feel overwhelmed and nothing is done well. Participant A#1 discussed the challenge of helping teachers learn about project-based learning and using technology. “Being able to train and be that bridge for teachers, um, between, you know, equipment and stuff, to support project-based learning, which would be us having a STEAM focus.” Later in the interview, Participant A#1 about supporting teachers who are feeling overwhelmed with integrating STEAM.

> And so, my teachers though, they need to get comfortable in the new way of doing things, which isn’t so new for some. But as long as they are focused on that and feeling somewhat overwhelmed by it because it is all coming at once, including like MAP, like how to use MAP and the different kinds of intervention software and, like, all this new stuff.

Participant A#1 specified her largest challenge in integrating STEAM requires her to be cognizant of her teacher’s capacity for change. “Yah, I mean it is really parsing out the priority and learning what your teachers’ capacity is.” Teacher capacity for change was discussed again by Participant A#1 when talking about a partnership with a local university to support teachers with integration STEAM. “And we have a beautiful partnership with them and we are doing this work together and I am always very cautious in those meetings about signing on to too much, knowing my teachers might blow out.” As she further expressed her excitement about the partnership, Participant A#1 expressed her constant awareness of teacher capacity for change.

> There is a lot of cool stuff that can come out of that work and I, and I am very conscious that it is other work compared to what the teachers have been told to do, so that is one thing is knowing teacher capacity giving the current context, right? I think every teacher has capacity for STEAM. It is just that given the current context of this district and it’s messaging at the moment, I’m—I’m not sure that they do.

Teacher capacity for change was also part of Participant A#1’s advice for educators wanting to start integrating STEAM. “Looking at your teachers for capacity and leadership and expertise and really being careful about strategically rolling it out as far as, um, any new initiative, really.”

Educators need to become comfortable with taking risks in their own teaching practice. This is particularly important for teachers with more experience who may have developed learning opportunities, which are perceived to be good because students were complacent rather than engaged and demonstrated student learning. Participant T#6 discussed the challenge of integrating STEAM is becoming comfortable with being outside of your comfort zone.

> But regardless, it, it's having that growth mindset, and that has been incredibly difficult with new . . . I don't even want to call it innovation with that term being so overly used when it comes to trying something new or getting out of your comfort zone. It can be really, really difficult because there is a lot on the line to try something new or to modify their practice. My experience with incorporating STEAM means that you are re-evaluating a lot. And you are re-evaluating a lot of what means to be a teacher and a learner. And when you have to do that it takes an enormous amount of resources across the board. That is my biggest challenge.

Participant T#5 succinctly communicated the impact of stress on trying out new instructional practices like integrating STEAM. "And then if you are feeling too stressed to try something out, you don't do it."

Participant T#4 discussed how much teachers have to learn to integrate STEAM.

> Range from, um, not knowing what to do right away and just kind of the learning curve of teaching long term projects. Switching from a math teacher who was, you know, just motivated by curriculum, timelines and standards to opening that up and doing this balancing act of keeping students moving and interested, but allowing for, um, allowing the necessary time for failure, redesign, and retrial. And, that whole engineering process, and allowing that time for that whole to go through has been a steep learning curve.

Participant T#4 then described learning how to manage project-based learning, the engineering process, and allowing time for student mistake making, as “Those were all steep learning curves for me.” He also shared about what it was like for him when he first starting integrating STEAM.

> When I was doing this at [school name], I was just doing it by the seat of my pants. I was just kind of making it up. And while that was difficult, I learned a lot. And, I . . . I . . . creating that curriculum on the fly and on a shoestring budget all that has really helped keep my creative juices flowing and be able to... It has been a steep learning curve but it has been fun as well.

Additionally, Participant T#4 expressed becoming comfortable with trial and error in his own teaching practice when integrating STEAM. “Again, mostly just about trial and error and having a deep knowledge of science and math and then my own background in building has been a huge part of, of integrating my, my professional career into STEAM as well as how that integrates for the students.” Participant T#1 also expressed being comfortable with trial and error and making mistakes as he learns to integrate STEAM. “Um . . . yah . . . I just kind of do trial and error and kind of making a whole lot of mistakes along the way.”

Educators who feel safe to take risks in their teaching practice are more likely to try integrating STEAM. Participant T#6 discussed the importance of having a culture at the school that allowed him to make mistakes as he learned to integrate STEAM. “Really just a culture of trying new things and discussing and reflecting and possibly integrating that into your practice but more so, um, really trying to devise different ways to go about meeting the needs of your students.” Additionally, Participant T#6 discussed the importance of educators shifting from the gatekeepers of knowledge to students having more control of learning.

> If they completing owned it, and the only way they were able to completely own it was for the teacher to give up control or at least part of what would be considered the locus of control or . . . and also giving up historical message that the teacher has to be the head person that know everything that is the gatekeeper.

STEAM integration is more than having a variety of technology available to teachers and students. Teachers need time and professional development to understand how to use technology with students to increase student understanding rather than using technology because it is the new thing. Participant T#2 discussed her experience that people expect just providing the technology will get educators to integrate STEAM. However, Participant T#2's experience is that integrating STEAM doesn't happen with support for teachers to develop their own confidence levels with the technology and integrating it into instruction.

> Um, and so yah I think that. I think that there is an expectation with devices that itself fixes the problem without an understanding that if you don't the person, the educator how to use the device, if you don't provide enough examples of ways to use it, you know. I may learn how to use a certain computer program, but I only learn it in one context and therefore I will only ever use it in that context because I won't feel confident enough to be creative with that.

Participant T#2 shared that even though she is excited to integrate STEAM into the curriculum, she is going to make mistakes.

> And, you know, I'm the person that is like, "Yes! Let's do it!" but you gotta show me how. We've got to translate how we get to ground level from the 30,000 feet, um, and I am only just beginning to take that apart. I feel like unless, unless a shift in the focus of PD happens, it is going to take a few more years of me making mistakes and so forth and

> figuring it out and that is unfortunate, you know, as that is one person as opposed to all of the buildings that have this focus.

Additionally, Participant T#2 identified herself as still learning how to integrate STEAM. "Um, I would say that I am only just beginning to, to figure it out. I feel like I myself need more of a perspective shift to do it well in my class." Participant T#2 needed to feel safe to fail is also reflected in the research notes. Participant T#2 elected to have the interview in their classroom. The classroom has several current STEAM toys and games, but all were still in their cellophane wrapper sitting on a high shelf with dust on them. At the end of the interview, Participant T#2 offers advice to teachers that are just starting to integrate STEAM into their teaching practice. "So to just be brave. And if you are feeling like you are not ticking all those boxes it is better to check off any of them." Educators need similar learning conditions to integrate STEAM as students need to engage in STEAM learning: feeling safe to fail and encouragement to innovate. The process of learning to integrate STEAM is a continually repetitive cycle. New technologies will emerge, new understandings will be developed, and STEAM integration needs to stay relevant in these highly innovative areas.

***Time for collaboration with colleagues*.** In order to integrate STEAM into instructional practice, educators need time to collaborate with colleagues. The current way the school day is designed keeps educators isolated from each other. Educators often have to give up their personal time to find time to collaborate with their colleagues. Three participants discussed a challenge with integrating STEAM is finding time to collaborate with colleagues. Participant A#2 expressed a challenge of integrating STEAM is trying to find collaboration time with colleagues. "Um, and you know that I would say that time, time for collaborating, time for co-constructing lessons. That's always factors and so it's always starting to make me think about how do I create that time. How do I work with look at ways to create that time or making the time." Participant T#3 said," We have to come up with ideas, so it was a time to collaborate with her and we got some good ideas in place and were able to, um, move forward with them when we got back to our school. Additionally, Participant T#3 shared finding time to collaborate with colleagues made it difficult to integrate STEAM.

> That we had to, unfortunately, put STEAM and the makerspace integration on the back burner because, as I have mentioned earlier, it is on us to find the time to plan and to meet with the makerspace EA if we want to schedule time and we have to present the ideas and gather all the materials that we would need or at least a list so she could do that. So that has been a challenge to find the time as a team that we could meet and come up with ideas that will align with what we are doing.

Participant T#5 expressed similar challenges with finding time to collaborate with colleagues. "You would need to have specific time set aside, especially setting it up. And so where to get that. Is it a staff meeting time? On your own time? Where are you going to carve out the time?" Any time educators do have provided during their work day usually has other priorities for their time: calling parents, grading, meeting with intervention specialist, and filling out various reports and surveys. Educators do not have planning time with other teachers but are expected to be teaching the same content and evaluating student's ability to meet standards.

Inconsistent access to resources. Another challenge educators had integrating STEAM is inconsistent access to resources. Educators are unable to depend on consistent funding for resources from year to year, so they often have to re-invent a new STEAM integrated learning experience each year with different materials. Four participants talked about how challenging integrating STEAM is with inconsistent access to resources. Participant T#1 stated, "I mean money is always a barrier." Participant T#5 discussed having to find money to purchase materials to do projects each year.

> Materials have . . . there have been times when materials have really been a challenge and times when they have really been easy. That goes both ways. I found those underwater robots, ROVs, in the closet, and that was wonderful. And then, next year if I want to do that it will be challenge to find the money to get them or the parts on their own.

At times, Participant T#5 was able to receive grants to help with a lack of resources. I had to make table at [school name]. The math tables were too wobbly. There was no tools, but then there were grants." Participant T#3 shared about a lack of materials as well. "And, then also I think materials can also be a barrier, too. We will come up with ideas but then we will need foam or all these things that are not provided, so I think cost and materials have been a barrier." Participant T#2 has similar experiences with not having money for materials. "And, then also I think materials can also be a barrier, too. We will come up with ideas but then we will need foam or all these things that are not provided, so I think cost and materials have been a barrier."

Another resources educators lack is a place to find good STEAM project ideas to integrate into instruction. Currently, the internet allows teachers to access anything any person or organization uploads as a STEAM learning activity. Educators do not have a location where these materials are centrally located or a consistent method to evaluate the quality of these activities. Participant T#5 shared, "And then, um, you know, I dream of a, of a curriculum fandex or a way to create projects with their curriculum. Create, borrow, and share projects." Participant A#1 expressed a similar challenge in being able to come up with STEAM integration ideas. "I don't—because of the lack of resources and sometimes the creativity within your own building you have to learn on partners to be helpful in this work." Participant T#2 also spoke about access to STEAM integrated curriculum as a barrier. “So, I think the barriers—putting the technology and the lack of understanding from decision makers aside—one of the barriers for me is we, assert that we are a STEAM school, we assert that we are a STEAM district—and then there is this curriculum you have to go through. “

Additionally, educators often lack the financial resources to access professional development on STEAM integration. Participant T#2 spoke about spending her own money to attend STEAM integration professional development. “Like I have said everything I have done. I ‘ve done because I found it and I chose to do it and sometimes that meant I spent my money to do it.” STEAM integration professional development opportunities often require some financial commitment to be able to attend and without the financial resources educators need professional development to happen within the school district. Participant T#5 expressed, “I would love to have a training that is more geared towards the technical side and how to integrate that.”

Balancing district initiatives. STEAM educators are challenged by how to balance changing district initiatives from year to year. Three participants shared that a challenge with STEAM integration is how to balance district initiatives with STEAM integration. In the teachers and administrator research notes, the research noted each participant expressed frustration with different district initiatives prior to the interviewing starting by asking the researcher about an initiative that was begun during the school year. However, only three participants elaborated on their frustration in their interview answers. Participant T#3 said, “Definitely the time for planning, and, um, this year we were kind of bombarded by a lot of mandates from the district that were new for reading, writing assessments, and GVC and all this stuff that our planning and our PLC time went into that.” She then shared how now that she understands the new district initiatives she will have time to think about how to integrate STEAM. “I think . . . the planning piece my partner and I pretty much have a grasp on the new mandates this year. So, I think that we'll be able to move forward with better planning and integration with not having as much on our plate this year." Participant A#1 shared about disconnect between district initiatives.

> But there's been . . . there appears from the district especially, a big disconnect be in the GVC and expectations that are rolled out that are compartmentalized by subject. And then we have these other crew people saying that STEAM is important and we should do STEAM and my teachers are now in the GVC world all about reading adoption, writing adoption, math work, right, and that the messaging isn't through a STEAM lens at all or as a way of doing things. And so as long as that's happening and not that focusing on things isn't bad STEAM will always feel like another: and my rolling it out will feel like this different way of doing school when it could be just the way we do school.

Additionally, Participant A#1 views district-initiatives as a missed opportunity to encourage integrating STEAM.

> I mentioned the GVC's rollout has been in these compartmentalized subjects, um, and even though there are math compartmentalized, or, you know, science. And what a great thing to be able to roll that out as a STEAM GVC, um, alongside reading and writing, and those what feel like very fundamental things. If they could have come together congruently, that would have been really helpful. Um, and I don't see why not because the standards are the same, like there are still standards out there. You just roll them out differently. But it is because this didn't happen I feel like this is a barrier.

Participant T#6 shared a desire to have more understanding between central district initiatives and what is happening in schools.

> More opportunity, and I think it is more opportunity for teachers and students, principals to really understand what is, what is available to them and what the conversations are centrally. Um, because I feel like I have such awesome conversation and begin to work and get involved in really wonderful projects and the translation of that to schools becomes something different. So something happens between—not always. Something I would change may be being able to understand that and being able to work on that more but it's that idea of the language we use centrally and the practice we idolize centrally can often be very different what is happening in schools. Why is that important and what does that mean for how decisions are made. Clearly there is so much happening in schools, you know, challenging stuff and things we would consider successful.

He focused in on needing better communication as a way to stop having a disconnect between district initiatives and STEAM integration.

> And so just the logistical challenges at communicating it and understanding that you are not only communicating it but through that communication and through the process of making it real in showing up in instruction is going to take a long time, so how do you combat that with the fact the moment someone says GVC answers are being thought and answers that we may or may not have . . . or questions we may not have answers for that can really affect teaching and learning in the schools and can create fractionalism and can create all kinds of things.

STEAM educators are struggling with what integrating STEAM looks like in their classrooms. Participant T#2 also described the need for support at the district level for integrating STEAM because when teachers are figuring out how to integrate STEAM on their own there are often different understandings of what integrating STEAM looks like for students and teachers.

> Well, I think, I think that what I would change is, is it would have to be on the district level. I would, I would really expect those that are making the decisions on curriculum and instruction to start legitimately looking at it through a STEAM filter instead of . . . I feel like right now there is a lot of lip service paid to it and not a lot of practical applications that fall into STEAM, and partially because it is an all new thing. But, if we are, if we are not going to chuck curriculum and start with something that is designed to from a STEAM perspective, we are going to have to to design it ourselves. That's fine as an adaptive tool, but it's gotta start, you know, it's gotta start at the central location because one of the problems from building to building is that if you have two teachers that think they have figured out, they have done completely different things and they have completely different understandings of what STEAM integration even is. Then so you are back to the Wild West because everyone is trying their best to make it and evolve it but we end up with a different creature at every building.

Participant T#2 discussed her thoughts about STEAM integration being a top-down initiative. "If this is ever top-down because it feels so othered, it's going to feel like another initiative." Educators want to integrate STEAM but often feel it is in conflict to district-led initiatives, which have changed every time district leadership changes. However, STEAM educators are hesitant to have STEAM integration become a district-wide initiative because their history with district initiatives is that they change every couple of years.

Pressure of standards and high stakes testing. Educators face pressures to cover all of the standards as well as having students pass high stakes tests. The pressure to cover all of the standards with a shorter than average instructional day and year makes it difficult for educators to find the time needed for students to engage in STEAM integration. Participant T#2 said, "I think sometimes you have to check so many boxes throughout a lesson or a week or a curriculum that it's almost always like that art thinking is the last one that you never quite get to. Um, and so it was just how to change that, how to talk about it, and have changed the way we have prioritized time to include that, um, that was effective." Participant T#5 also shared about how pressure of standards and available instructional time impacts opportunity to integrate STEAM into instruction. "I mean when I dropped down to 45 minutes classes I lost half of the time I had last year. So I think with that kind of time, teachers are going to say no right off the bat." He further elaborated, "Like I have to get my standards done that I want to get done and to give that up for a project that has never been done or tested or whatever." Participant T#4 discussed the pressure to cover math standards made STEAM integration difficult.

> As a math teacher, testing barriers and curriculum barriers and timeline barriers. All these things where students don't understand a concept and you move on. The majority of the class doesn't and the solution is to be doing more of this, but it is hard. There are students way behind and students way ahead.

Additionally, the research notes during the interviews of all of the participants showed that when speaking about the pressure of standards and high-stakes testing, the participants used mannerisms that reflected their frustration. For example, Participant T#2 sat back in the chair with arms behind their head and blew their cheeks out with a large breath signaling frustration as they spoke about the pressure "to check so many boxes." Participant T#5 had threw his hands up as he spoke about having to give up projects in order to cover all of the standards in his math class.

Additionally, STEAM does not have any standards adopted by the state, so STEAM educators often deal with how other educators in the school think that because STEAM integration looks messy and lacks official standards that instruction is not rigorous. “Um, I do get perceptions from other teachers that we don’t do anything or that we just make messes or that we’re, you know, the rigor is not there.”

Thematic Code #7: Schools use similar strategies to begin implementing STEAM integration. Educators who have been navigating how to shift to constructivism (Vygotsky, 1978) and culturally relevant pedagogical practices (Hammond & Jackson, 2015) advised using similar strategies for other educators to begin implementing STEAM integration. Based on the their own experiences, STEAM educators have recommendations on strategies to begin implementing STEAM integration: (a) build support with building administrators, (b) develop community partnerships, (c) talk with educators who are integrating STEAM, (d) take advantage of STEAM professional development opportunities, (e) share your success stories and why STEAM integration is important, and (f) start with integrating a passion. The recommendations provide a scaffolding for schools to think through when beginning to integrate STEAM.

Build support with building administrators. Educators shared how helpful having administrator support is for STEAM integration. Administrator support is critical for teachers and building administrators to feel safe to take risks with their own teaching practices to try and refine integrating STEAM. Participant T#4 shared how having an administrator who is values STEAM integration has helped the school build their STEAM integration. Participant T#4 stated, “Um, I know that the current assistant principal is very pro-STEAM.” He then shared, “You know the school is just—the principal, you know, walks the walk. He says he’s STEAM focused and he has been. Whenever they are able to help me out, they do. Um, unfortunately the position has been a rotating one but the school is, is strong in STEM and STEAM.” Participant A#1 spoke about the importance of focusing on rigor and student engagement as an administrator team to encourage STEAM integration. "And also, rigor and engagement is tied to the teacher evaluation. Um, so as long as we keep that in the kind of the center of our messaging and our work and expectation, then pulling in STEAM is—can be quite easy." Finally, Participant T#6 shared how the principal at a school he worked at created a culture of innovating teaching by integrating STEAM that helped him start STEAM integration. "Um, so it was more like a living ongoing culture and it wasn't necessarily PD offering through within the school district or outside the school district."

Talk to other educators who are integrating STEAM. Educators discussed the importance of talking with other educators who are integrating STEAM to learn from their successes and challenges. These discussions helped the educators to understand how integrating STEAM is a continuous improvement cycle. Participant T#3 shared, "And it was my teaching partner and I both got to go so it was a useful time for us because we got to think about our curriculum and how we could, um, align the makerspace with our current curriculum we were using." Participant T#2 talked about how hearing from someone else helped her see how small shifts can make a difference in STEAM instruction. "Um, and then also that encouraged me to look for opportunities far as there is such a push to get through so much, especially with the science and math, there is such a push to get through that and the art piece can fall to the wayside."

The time to speak with other STEAM integration practitioners helps teachers new to integrating STEAM to see the value of the time spent in the classrooms on these learning activities. Participant T#2's actions to talk with other educators about STEAM integration helped her see STEAM integration as not wasting time.

> And so hearing this particular speaker really demonstrated that its, that it's not the extra 30, 30, 40 minutes on the extra art element that people are showing thinking in their own way or whatever that is, is not wasted time. 'Cause I think sometimes you have to check so many boxes throughout a lesson or a week or a curriculum that it's almost always like that art thinking is the last one that you never quite get to. Um, and so it was just how to change that, how to talk about it, and have changed the way we have prioritized time to include that, um, that was effective.

Educators who were able to spend time with other STEAM educators learned the importance of starting with a passion or interest to help sustain the focus on the work while working to hone the craft of integrating STEAM. Participant T#4 encourages educators to talk with each other and to start with integrating a passion into their curriculum.

> Keep it broad so that it is vaguely understood but never pinned down. I would, I would advise that teacher to really go towards their passion and how to integrate their passion into STEAM and how to, you know, that they would love to build and then go backwards and figure out the academics that surround that and make it a STEAM project. Um, [pause] I would tell them, I would advise them to talk with the other teachers next door and show off their work.

Finally, STEAM educators had advice for schools wanting to start integrating STEAM is to focus on a small group of early-adopting teacher leaders. Participant A#1 encouraged educators to start with early adopter and teacher leaders.

> But starting with a very small core group who have the technical expertise so they are not scared of math, scared of science, and also the momentum energy-wise to speak to project-based learning, and then starting to build from there and have teacher leaders—

> kind of like having train-the-trainer set of thing or train-the-training. I think that's the best way.

Teachers who are reluctant to integrate STEAM become more interested when they see what is happening in a classroom next to them with students who look like their students. Also teacher leaders typically have the respect of their fellow teachers and have established relationships to have trusted conversations about the trials of integrating STEAM. Additionally, Participant A#1 stated the importance of site visits to see what other schools are doing as important for STEAM integration.

> And I think also going to settings and doing site visits to other schools that are doing it is huge for teachers. I know, we got to do it as initiatives with some schools in LA and with different things, so that has been really helpful, and we are going to go do that again. Um, and I enjoy seeing it in the works successfully, right? And learning about their challenges once they've launched it. Um, when you do it, like, you don't know what you don't know, so if you're a new principal and you are not very STEAM focused yourself, but you want to do it. You need to have experts to lean on. Sometimes that is just another principal doing the work.

Participant T#3 also shared the importance visiting other makerspaces has on her starting to integrate STEAM. "I was in a makerspace cohort, um, and we traveled to the different makerspaces in our district and, um, learned more about how to use the makerspace and how to integrate STEAM into the makerspace and taking your class there and things like that."

Develop community partnerships. Community partnerships offer opportunities for all educators to start learning about STEAM integration. Community partnerships offer educators the opportunity to experience how STEAM integration can occur and then build off of that experience to create more STEAM integrated learning experiences. Participant A#1 expressed how partnerships are helping create momentum for educators to integrate STEAM.

> So, our partnerships are a lot of the community organizations that do a lot of different experiences and, um. It helped create momentum. It helped create excitement. Um, create comfort for teachers doing the work. And they need engagement and rigor, definitely. What I like is that these organizations are starting to not just be one-off experiences, but understand curriculum, and so you found that now. Where I did not see that 10 years or 5 years ago.

She explained how partnerships help teachers see the connection of STEAM to the standards. “Um, it gets kids to do fun experiences and they get to learn about it, and if teachers do it appropriately they can connect it into the curriculum—to the standards.”

Start with early adopters at a school. Early adopters help fellow educators to see what is possible with students. Participant T#6 expressed as an early adopter is to find inspiration and not worry about starting with the standards.

> So the least [pause] I think looking at STEAM first and foremost, for me, this is me as a learner and an applicant is learning and getting inspired to teach and learn through something that seems somewhat arbitrary if you start with it, which is the standards. I think that if I as a teacher and learner start specifically with standards it, it sullies it challenges my just, you know, challenges the ground level of beginning to learn.

The participant shared more about his first experiences integrating STEAM by working with a self-organized group of teachers. “So anybody who was interested, there was a small work group among my teaching residents, you know, folks going through the program that got together and had discussions and came up with some ideas at a grassroots level." He encourages starting with educators who opt into the opportunity.

> And that was this ongoing process, and so truly every week was a professional development opportunity if you choose to take it. And there were teachers at our school that totally took that and took advantage of it, and we had ongoing nerdy conversations about everything under the sun. Um, and there were other teachers who were like "I got this. I'm cool." like I'm still kind of grooving on the stuff that I have been doing and feeling successful at, but regardless, it was, it wasn't necessarily that innovation and that, that I don't know if I would call it an innovation cycle, but that idea of trying new things and understanding where it fits in.

Early adopters need to support to think differently than what has happened instructionally in a school. The educators who identify as early adopters need the opportunity to share their successes and challenges with the rest of the school.

Take advantages of STEAM professional development opportunities. Educators who integrate STEAM have taken advantage of different professional development opportunities offered to them even when it was outside of their comfort zone. Participant T#2 talked about professional development that has been helpful to her in integrating STEAM.

> I think that, that made the biggest impression on me was a speaker talking about art and perhaps because the standards." Sometimes the professional development did not specifically address STEAM integration but helped Participant T#2 understand content standards better to be able to integrate STEAM. Let's see what else . . . as far as professional development in it I have had professional development in science but not specific to STEAM. When I try to look at everything from how do I bring in those other

> pieces because in the training in the Next Gen Standards there is that emphasis on engineering and there is that emphasis on connecting all of those ideas and making those connections transparent to the students or making those clear to the students.

Participant T#2 shared to take advantage of opportunities that cross your path. "But all of those were here is this thing, I think I will go to this thing as opposed to it necessarily being presented as an opportunity. It crossed my path so I took advantage of it."

Chapter 4 Summary

The purpose of this study was to explore the perceptions of educators of STEAM integration in a K–8 setting. The data for this study was collected from the perspective of 8 educators representing building administrators, STEAM teachers, content teachers, and district curriculum specialists. The data collected included demographic questionnaires, face-to-face semistructured interviews, and a research notebook. The findings presented in this chapter are supported through the triangulation of data sources used in the study. Data analysis was completed using Atlas.ti (2017). The coding process started with open-coding using codes surfaced during the interviews recorded in the research notes and multiple reads of the data until no new codes emerged, gathering codes into themes, and then placing the themes into subcategories.

The analysis of the data revealed seven themes: (a) first exposure to STEAM integration varies widely, (b) educators have varying definitions of STEAM integration, (c) educators have similar components for high quality STEAM integration, (d) STEAM integration provides many benefits for students, (e) educators who integrate STEAM have a shared core set of beliefs, (f) educators experience similar challenges with STEAM integration, and (g) schools use similar strategies to begin implementing STEAM integration. Each of these themes is directly related to the question: how do educator stakeholders (teachers and administrators) in Oregon perceive STEAM integration in a K–8 setting. As further detailed in Chapter 5, the data demonstrated educators first exposure to STEAM integration is either through professional development opportunities or through student teaching. Some educators define STEAM integration as transdisciplinary or interdisciplinary; an old idea; or by integrating the arts, technology, or makerspace. Even though educators have different definition of STEAM integration, there is agreement on the components of high-quality STEAM integration. These components are: students centered instruction; project-based, problem-solving, engaging in real-world situations, hands-on learning, exposure to STEAM careers, and the purpose to develop creativity, collaboration, and calculated risk-taking.

Additionally, educators agreed how STEAM integration benefits students through making connections to content areas, providing relevance for learning content, developing college and career readiness, empowering students, building confidence and resilience, helps students get out of their comfort zone. Educators who integrate STEAM share a core set of beliefs. They value having high expectations for all students, the importance of increasing access for all student to rigorous, engaging curriculum, and students can be taught calculated risk-taking and resilience. Educators who integrate STEAM also believe students need to learn how and why content is relevant to them, real-world problems are engaging for students, and STEAM integration is possible with standards.

Educators have experienced similar challenges with STEAM integration. The first challenge is administrator capacity for leading change. Secondly, educators experience challenges with time in the curriculum for project-based learning and time to collaborate with colleagues. Additionally, educators experienced challenges with inconsistent access to resources and colleagues perceptions of STEAM integration as not rigorous. Finally, educators experience challenges with STEAM integration when trying to balance district initiatives and the pressure of standards and high stakes testing.

Finally, educators have used similar strategies to begin implementing STEAM integration. First, educators found it helpful to talk with other educators who are implementing STEAM into their teaching practice. Secondly, educators encourage starting with early adopters at the school to create momentum. Next, educators encourage people to take advantage of STEAM professional development opportunities. Finally, educators stated the importance of sharing your success stories and communicating why STEAM integration is important.

Chapter 5: Discussion and Conclusion

Introduction

The demand for students to be prepared to engage in a STEM- based workforce has increased over the last 5 years. There is a rising concern for students to also be creative problem-solvers (Kim et al., 2018). Schools have been adding the Arts to STEM to become STEAM to support students in developing creative problem-solving strategies. STEAM education leads to innovation, which leads to creating a strong economy and increases empathy in students making them happier (Catterall, 2017). STEAM education is rising in demand for schools to implement school-wide or as part of content and elective class offerings (Jolly, 2014). STEAM research has focused on implementation of STEAM for teachers (Kassaee & Rowell, 2016) and student perceptions of STEAM classes (Oner et al., 2016). The research about STEM instruction and STEM school implementation provides possible indicators about STEAM. However, there is no research on what supports a school needs to implement STEAM.

The purpose of this case study was to explore the perceptions of K–8 education stakeholders (teachers and administrators) of STEAM integration in Oregon. Exploring the perceptions of K–8 education stakeholders adds to the literature and provide direction on how the perceptions of K–8 education stakeholders influence STEAM integration in a K–8 setting. The chapter contains a summary and interpretation of the findings of the study. Additionally, the chapter discusses the limitations and the implications for teacher preparation programs, district administration, building administrators, teachers, and community partners.

Summary of the Results

The purpose of this study was to explore the perceptions of education stakeholders of STEAM integration in a K–8 setting. STEAM teachers, content teachers, and district curriculum specialists. The data sources included demographic questionnaires, face-to-face semistructured interviews, and a research notebook. The coding process started with open-coding and multiple reviews of the data until no new codes emerged, then grouping codes into emerging themes, and then placing the themes into subcategories. Data analysis was completed using Atlas.ti (2017).

The analysis of the data revealed seven themes: (a) exposure to STEAM integration varies widely, (b) educators have varying definitions of STEAM integration, (c) educators have similar components for high quality STEAM integration, (d) STEAM integration provides many benefits for students, (e) educators who integrate STEAM have a shared core set of beliefs, (f) educators experience similar challenges with STEAM integration, and (g) schools use similar strategies to begin implementing STEAM integration. Each of these themes is directly related to the question: how education stakeholders in Oregon perceive STEAM integration in a K–8 setting.

Discussion of the Results

The data demonstrated teachers, administrators and instructional specialists first exposure to STEAM integration is either through professional development opportunities or through student teaching. The teachers and administrators in the study defined STEAM integration as transdisciplinary or interdisciplinary; an old idea; or by integrating the arts, technology, or makerspace. There is agreement among the educators in the study on the components of high-quality STEAM integration. These components are: students centered instruction; project-based, problem-solving, engaging in real-world situations, hands-on learning, exposure to STEAM careers, and the purpose to develop creativity, collaboration, and calculated risk-taking.

Educators in the study agreed on the benefits of STEAM integration for students: making connections to content areas, providing relevance for learning content, developing college and career readiness, empowering students, and building confidence and resilience. Participants believe STEAM integration is important because STEAM integration increases access for all students to rigorous, engaging curriculum. Additionally, the findings indicated that STEAM integration is a method to teach students the calculated risk-taking and resilience skills to continue to work to solve challenging problems in the world. Teachers, administrators, and instructional specialists in the study also believe students need to learn how and why content is relevant to them, real-world problems are engaging for students, and STEAM integration is possible with standards.

K–8 teachers and administrators in the study have experienced challenges with STEAM integration. The first challenge is administrator capacity for leading change. Secondly, teachers in the study experience challenges with time in the curriculum for project-based learning and time to collaborate with colleagues. Participants interviewed in the study experienced challenges with inconsistent access to resources and colleagues' perceptions of STEAM integration as not rigorous. Another finding included the challenges with STEAM integration when trying to balance district initiatives and the pressure of standards and high stakes testing. For example, the district initiative to have all classes at a grade level and content area follow the same scope and sequence of standards and use the same end-of-unit assessments.

Educators have used seven strategies to begin implementing STEAM integration. First, teachers and administrators found it helpful to talk with other educators who are implementing STEAM into their teaching practice. Secondly, STEAM practitioners encourage starting with early adopters at the school to create momentum. Next, educators encourage people to take advantage of STEAM professional development opportunities. Finally, all the education stakeholders interviewed stated the importance of sharing your success stories and communicating why STEAM integration is important. The seven thematic categories are explained in detail in the following sections.

Theme 1: K–8 educators' first exposure to STEAM integration varies widely. K–8 teachers receive little to no exposure to STEAM integration in preservice educator coursework. Any professional development opportunities educators engage in are because the individual decided that the opportunity sounded interesting to them. The first exposure to STEAM integration is when teachers begin to construct their understanding of STEAM integration. These initial understandings of STEAM integration persist with educators, whether these understandings are accurate or not, unless they continue to engage in a variety of STEAM integration professional development. During student teaching experiences, teachers may be exposed to STEAM integration. However, this varies and is not something often considered in the qualification of a mentor teacher in student teaching placements. According to the administrator participants, administrators receive little professional development about STEAM integration or how to support classroom teachers in implementing STEAM integration. This makes it challenging for administrators to give effective feedback to teachers on integrating STEAM into instruction.

Teachers, administrators, and instructional specialists learned about STEAM integration from self-selecting into professional development opportunities. Some teachers in this study decided to attend STEAM integration professional development because they wanted to learn more about how to integrate STEAM. Other teachers in this study decided to participate in STEAM integration professional development because a respected fellow educator recommended the opportunity to them. While there are many STEAM integration professional development opportunities available to teachers, there is not a clear agreement in education research on what high quality STEAM integration looks like (Costantino, 2017; Liao, 2016). Additionally, these opportunities are not organized in a manner that is easy for teachers and administrators to learn about the opportunities. The non-systemic method of STEAM integration professional development contributes to the wide-range of definitions of STEAM integration, how to integrate STEAM, and a clear picture of what high quality STEAM integration looks like in K–8 settings. These varied definitions ultimately impact the learning experiences for students continuing inequitable education opportunities for underrepresented groups in STEAM.

Theme 2: K–8 educators have varying definitions of STEAM integration. Teacher and administrator perception of what instructional strategies are included in STEAM integration influence their definitions of STEAM integration. A teacher's definition of STEAM integration then influences what STEAM integration looks like in the classroom. None of the teachers, administrators, or instructional specialists in the study has the same definition of STEAM integration. This is problematic for systemic STEAM integration in schools and school districts because the professional development will need to first focus on developing a common definition of high quality STEAM integration before focusing on developing educator STEAM integration instructional practice, which is a significant investment in time, money, and materials. Students in the same school will have different learning experiences with STEAM integration impacting rigor and learning progressions. Some teachers in this study believe that STEAM integration is not a new idea. While other teachers in this study, view STEAM integration as a pendulum swing back towards valuing career and technical education again from a focus on content knowledge and skills.

One definition of the educators in this study is that STEAM is transdisciplinary. Zimmerman (2016) agreed with this definition of STEAM integration. However, this definition is often most problematic for educators because it is the integration of two or more disciplines of STEAM. Teachers in this study who view STEAM as transdisciplinary see their role in the classroom as helping students to understand the connection between ideas and concepts and the tools used to make sense of the concepts while communicating their ideas to others. Transdisciplinary STEAM integration presents challenges for teachers because they view themselves as single content experts and have a hard time planning learning experiences that integrate two or more disciplines (Roehrig et al., 2012). According to the educators in the study, transdisciplinary learning is challenging because of the pressure of standards and not enough time to explore anything in-depth.

Another definition is that STEAM is interdisciplinary. Guyotte et al., (2015) agree with this definition of STEAM integration. Teachers and administrators who use this definition of STEAM integration view learning as engaging students in understanding the connections between content areas. Interdisciplinary STEAM integration is the integration of two of the discipline areas of STEAM. This is the most common starting place for K–8 educators to begin integrating STEAM. This may be because integrating one more content area does not feel as intimidating as integrating multiple content areas. The lack of agreement of the definition of STEAM integration among the educators in this study reflects the lack of agreement within the education community.

Some teachers in this study define STEAM integration as integrating makerspace opportunities. Makerspaces are spaces in schools, which contain various tools and materials for students to use to construct an object to use for various reasons. In schools where classrooms have easy access to a makerspace, STEAM integration is using the makerspace. The challenge of defining STEAM integration with utilizing a makerspace is that the learning opportunities are often based on making a crafty display of knowledge rather than making connections between content (Patton & Knochel, 2016).

Finally, several teachers and administrators define STEAM integration as a STEAM elective class. Schools offer enrichment electives for students and view STEAM integration as something a student elects to learn about rather than an instructional pedagogy. Administrators and teachers shared that STEAM electives offer the opportunity to have students learn how to solve real-world problems that are not addressed in content courses. However, defining STEAM integration as a STEAM elective class perpetuates inequitable access to rigorous learning opportunities for all students.

Theme 3: K–8 educators have similar components for high quality STEAM integration. High quality STEAM integration practices identified by teachers, administrators, and instructional specialists in the study are student-centered instruction, project-based learning, problem-solving, engaging in real-world situations, and hands-on learning. Educators in the study view STEAM integration as a way to expose students to STEAM careers. The purpose of STEAM integration is to help students develop calculated risk-taking skills, creativity, and comfort making mistakes (Conradty & Bogner, 2018). Student-centered learning is focused on developing learning opportunities which are relevant to students and allow student choice. Additionally, student-centered learning shifts the role of the teacher from teacher-lead to teacher-facilitated teaching (Opperman, 2016; Thurley, 2016). However, many teachers in this study reported feeling uncomfortable with changing the role of the teacher in the classroom because this is something they were not taught how to do in their preservice teaching program and did not experience as a learner themselves.

Teachers and administrators in this study identified project-based learning that engages students in real-world problem-solving situations. In addition, STEAM integration includes opportunities for student to engage in hands-on learning. The teachers, administrators, and instructional specialists in this study defined hands-on learning as students making something tangible with their hands. Hands-on learning reflects Vygotsky's (1978) explanation that students learn by doing rather than listening and taking notes.

Another critical piece of STEAM integration is exposing students to STEAM careers. The top three areas students learn about careers are: (a) parents, (b) relatives or close friends of the family, and (c) teachers and counselors (Ginevra, Nota, L., & Ferrari, 2015). For students who do not have family or close friends in a STEAM career, they are less likely to choose a career in STEAM. STEAM integration is needed to support students to develop critical professional skills such as: creativity and calculated risk-taking skills as well comfort making mistakes. These skills are identified by industry as important professional skills for all students to develop regardless of their career choice (Opperman, 2016; Thurley, 2016).

Theme 4: STEAM integration benefits students. Teachers and administrators identified several benefits for students when engaged in STEAM integrated learning. STEAM integration provided relevance for learning content, develops college and career readiness, empowers students, builds confidence and resilience, and helps students get out of their comfort zone. Students learn by having instruction that is meaningful and connected to their own experiences (Hammond & Jackson, 2015). According to the educators in this study, STEAM integration has helped both educators and students understand the relevance for learning content by connecting to bigger ideas or helping students make sense of the world.

STEAM integration helps students find their passions and helps students feel successful in school, particularly students who have not felt successful in traditionally taught classrooms. Administrators and instructional specialists discussed how STEAM integration benefits students by engaging students in student discourse and incorporating language development. Teachers often see students who are often disengaged in school participating during STEAM integrated learning. Administrators and teachers reported the positive impact of STEAM integration on reducing negative student behaviors.

Educators described STEAM integration as an opportunity for students to develop college and career readiness skills. According to Wood (2018), these skills are often missing in current instructional practices. STEAM integration provides students multiple opportunities to learn how to collaborate with other who many have different perspectives and cultures in a way that is respectful and encourages dialogue. Additionally, STEAM integration helps students build confidence and resilience through experiencing failure and learning how to learn from failure. Learning from failure means students must also become comfortable with taking risks in learning. STEAM integration in a K–8 setting helps students take risks in learning in safe places to develop confidence in themselves to be able to solve a wide-variety of problems.

One of the areas administrators highlighted as one of the benefits of STEAM integration is how STEAM integration empowers students. STEAM integration empowers students to see the value of different perspectives and as change-makers. Students need to see and hear from STEAM professionals who look like the students and who have diverse paths to working in a STEAM career as well as that there are many different careers in STEAM fields that require a range of educational experiences. Additionally, teachers discussed how STEAM integration empowers students because STEAM integration values students' lived experiences and respect how different cultures seek to understand the world in different ways. STEAM integration empowers students to view these differences as an area of strength and critical to finding better solutions to the problems the world is facing.

Theme 5: K–8 educators who integrate STEAM have a shared core set of beliefs. Core beliefs are important for teachers and administrators to continue to re-evaluate as they continue to develop their STEAM integration practice. Administrators and teachers value having high expectations for all students, and view their jobs is to coach students to be able to achieve the high expectations. Additionally, teachers who integrate STEAM believe that all students are capable of achieving the high expectations. Administrators, teachers, and instructional specialists in this study believe STEAM integration engages students in rigorous learning because students are working to solve problems, which are multi-faceted and require students to understanding different perspectives to find solutions.

Administrators stated it is important for all students to be engaged in STEAM integrated learning regardless of perceived ability. STEAM integration leverages the natural curiosity of all students by finding topics that all students can easily access and provides significant opportunities and methods for students to demonstrate understanding of the topic. Students then develop their own ideas through examining their own understanding and how to use their knowledge and experience to solve problems. Through STEAM integrated learning opportunities, students are able to develop calculated risk-taking skills and resilience.

Finally, teachers, administrators, and instructional specialists in this study stated learning needs to be relevant to students by using two strategies. First, the educators in this study make learning relevant for students by helping students to understand why they are learning a concept is important. Second, educators in this study make learning relevant by helping students understand how concepts in that content area are connected to concepts in other content areas. STEAM integration helps students to make these connections and retain their learning for the future. Using real-world situations engages students by making learning relevant for students and empowering students to be creative problem-solvers. Content standards are not a barrier to STEAM integration. The content standards describe what students need to know. STEAM integration builds on a teacher's craft of creating real-world learning experiences and supports teachers to desire to continue to teach.

Theme 6: K–8 educators experience similar challenges with STEAM integration. A shift in the role of the teacher from teacher-directed to teacher-facilitated learning has been a challenge for teachers, administrators, and instructional specialists. Part of the challenge in the shifting teacher role is to shift to instruction from a deficit model to a strengths-based model of students. Teachers are trained to assess students to determine what students do not know in order to help students fill holes in their content understanding, but do not receive professional development on how to use student strengths to build learning opportunities for students.

Teachers experience challenges with develop comfort to take risks with their own teaching to integrate STEAM. Teachers feel the pressure to have all their students improve in their learning over time and find that pressure hard to balance with taking a risk in changing their teaching practice that does not feel familiar or comfortable. This is particularly important for teachers who have confused success with traditional teaching practices as students acting complacent and compliant. Teachers in this study also expressed feeling pressure from the perception of colleagues that STEAM integration is not rigorous and then to convince their colleagues otherwise. This exacerbates the fear of failure when trying to integrate STEAM because the teachers do not feel they have a safe environment to be open about their experiences integrating STEAM. Educators who feel safe to take risks in their teaching practice are more likely to try integrating STEAM. The shift to STEAM integration is also dependent on a teacher's capacity for change. If teachers are asked to shift too many practices at once, they feel overwhelmed and either nothing is done well or nothing is done at all.

Additionally, teachers and administrators described challenges of balancing district initiatives, the pressure of teaching all the standards, and project-based learning. Teachers within the same building have little time for collaboration with colleagues focused on instruction and learning. There is even less time for teachers to collaborate with colleagues in other schools. Administrators experience the least amount of time to collaborate with their peers about supporting STEAM integration. Both administrators and teachers commented on the capacity for administrators to lead change. Many factors influence an administrator's ability to lead change. One factor that influences administrator's ability to lead change is turnover of administrators from year to year. Each new administrator to a school has their own initiatives they would like to implement as well as the steep learning curve for district initiatives. The transformational change needed for teachers to integrate STEAM needs several years of consistent support from administrators, which is difficult when the administrators change every year.

Finally, teachers and administrators described STEAM integration challenges with developing and maintaining community partnerships, inconsistent access to resources, and staff turnover. Teachers often do not have consistent access to funding for resources. The lack of consistent funding makes it challenging to maintain community partnerships and materials. This causes educators to re-invent STEAM learning opportunities each year depending on what resources they have available, which takes time to do so with the workload teachers experience on a daily basis.

Theme 7: Schools use similar strategies to begin implementing STEAM integration. Teachers discussed the importance of building support with administrators to begin and continue integrating STEAM. Building administrators shared the importance of having district support for STEAM integration. Both teachers and administrators stated support from supervisors helped them to feel safer in taking risks with their own practice that happens when working to shift to integrated STEAM. A support strategy teachers and instructional specialists explained was helpful was having multiple professional development opportunities. When educators in this study at the same school are provided multiple professional development opportunities to engage in the process of integrating STEAM, they felt respected to change their own practice because to choose when to participate in the professional development as they felt they had the capacity change their practice. Teachers and administrators shared how utilizing common planning opportunities to talk with colleagues using a continuous improvement cycle helped improve STEAM integration practices. These opportunities do not need to be during the school day. The time to talk to colleagues helped educators find the courage to start with a passion and being integrating STEAM using that passion.

Schools also started integrating STEAM by working with a small group of early adopting teacher leaders. Teacher leaders often have the respect of their fellow teachers and developed trusting relationships to begin having conversations about the trails of STEAM integration. Teachers who are reluctant to being integrating STEAM become more interested when they see what is happening in a classroom next door with students who are similar to their students. The opportunity for early adopters to share their successes and challenges with the rest of the school helps encourage them to continue as teacher leaders.

Finally, schools included community partnership development as part of the initial efforts with integrating STEAM. Community partnerships can offer the opportunity for teachers to see the impact of STEAM integration on student engagement and learning in a low-risk setting. Classroom teachers can then build off of the experience with the community partnership to create more STEAM integrated learning experiences.

Discussion of the Results in Relation to the Literature

There are qualities of each discipline of STEAM that transect each other—project-based learning, critical and creative thinking, and utilizing community partnerships. These qualities are what K–8 educators use to describe STEAM integration. Teachers, administrators, and instructional specialists agree with Oner et al. (2016) about how STEAM integration helps students develop creativity. K–8 educators described high quality STEAM integration as place-based, problem-based instruction through project-based learning opportunities that are culturally-relevant for the students. However, teachers and administrators in Oregon did not include integration specifically as parts of STEAM integration.

The perceptions of K–8 educators on the barriers to STEAM integration are similar to those teachers and administrators experienced integrating STEM. Bell (2015) found in STEM education teachers in a single school need support to improve their understanding of STEM because of their own comfort levels with STEM integration. The K–8 STEAM teachers in the same school in this study have different levels of knowledge and experience with integrating STEAM and need differentiated support to integrate STEAM into their instructional practice.

K–8 teachers and administrators in STEAM schools in this study, expressed the need for supports to integrate STEAM, which reflect current research from Hunter-Doniger and Sydow (2016), Jones et al. (2016), and Young et al. (2016). Professional development needs to be longer than a year (Hunter-Doniger & Sydow, 2016). Teachers need structures during their workday to have collaborative time with their peers to discuss STEAM integration (Jones et al., 2016; Young et al., 2016). Teachers also need support in developing engaging, rigorous instructional practices that are culturally relevant for diverse groups of students (Bargerhuff, 2013). Stubb and Meyers (2015) reported secondary teachers needing support on how to apply conceptual understanding to project-based learning. The K–8 teachers in the study also need supports to understand how to apply conceptual understanding to create place-based, problem-based, integrated projects. Teachers also need support to help supervisor understand the need for STEAM integration (Connor et al., 2014; Frecthling et al., 2015). Finally, the study indicates K–8 teachers, administrators, and instructional specialists in STEAM schools experience similar challenges to integrating STEAM because of requirements outside of the classroom as found by Douglas et al. (2015). Both classroom teachers and administrators referenced district initiatives that were perceived by them as pedagogically opposed to STEAM integration.

Limitations

While this study provided insight into the perceptions of educators of STEAM integration in a K–8 setting, the study was limited to K–8 STEAM schools in one school district. The school district where the case study was conducted could be representative of school districts across the country. For example, the school district is a large, urban district, which has similar student and staff demographics to other large, urban districts in the country. In addition, the K–8 and 6–8 school configurations in the district are similar grade configurations of schools in the state and country. The researcher encountered other limitations during the sample and data collection phases of the research.

Sampling limitations. The study was limited by the small size of the sample with only four schools in one district volunteering for the study. The school sample was diverse by school configuration with one K–8 school and two 6–8 schools. The participant sample was diverse by the number of years of experience, grade level taught, and courses taught.

Scheduling challenges. During the study, the school year ended. While participants had been selected prior to the end of the school, there were challenges with scheduling due to the demands on the end of school year and then educators being on summer vacation. In order to accommodate the participants, the interviews were conducted in locations that were convenient for the participants while still allowing for participant privacy. Additionally, one of the selected participants left the school district and was unable to be reached to schedule an interview.

Interview length. Interviews were conducted for each participant. Seven interviews ranged in length from 27 minutes to 45 minutes. One of the interviews was 16 minutes. The short length of the interviews did not provide an in-depth understanding of the participant's perception of STEAM integration. However, the researcher was still able to glean insights from the interview during data analysis.

Implication of the Results for Practice, Policy, and Theory

STEAM integration by K–8 educators into instructions is continuing to rise (Jolly, 2014). The participants' perceptions in this study and the literature reviewed help provide insights into K–8 teachers', administrators', and instructional specialists' STEAM integration practices. The implications in this study are not generalizable to all K–8 educators integrating STEAM. However, there are several findings, which provided insights into the perceptions of STEAM integration by K–8 teachers and administrators.

Practical implications. The findings of this study have practical implications about what educators need to integrate STEAM in a K–8 setting. District and building administrator support for STEAM integration is important for students to engage in high quality STEAM integration learning opportunities. In order to support the implementation of STEAM integration by teachers, administrators need to engage in professional development for STEAM integration with their teachers. The district needs to develop cohorts for administrators to learn how to support the instructional shifts needed for STEAM integration and to talk with administrators who have led this change to learn about the challenges that may occur. Administrators need opportunities to see what STEAM integration looks like at different grade levels. District and building administrators need to support professional development that is multi-year and utilizes a coaching model.

Teachers need similar learning conditions to integrate STEAM as students need to engage in STEAM learning: feeling safe to fail and encouragement to innovate. The process of learning to integrate STEAM is a continually repetitive cycle. New technologies will emerge, new understandings will be developed, and STEAM integration needs to stay relevant in these highly innovative areas. STEAM integration is more than having a variety of technology available to teachers and students. Teachers need time and professional development to understand how to use technology with students to increase student understanding rather than using technology because it is the new thing. District administrators need to create a place with open-source STEAM instructional materials that have been vetted, so building administrators, instructional specialists, and teachers have multiple examples of what is high quality STEAM integration.

Teachers working to integrate STEAM need to participate in every opportunity to learn about careers in different STEAM fields. Educators often do not have a clear understanding of the different career but rather a general idea of a STEAM field, which is called a career. For example, in the biomedical field, teachers talk about careers as doctors or nursing, but there are a number of high-wage, high-demand careers in the biomedical field than a doctor or a nurse.

Community partnerships are important part of high quality STEAM integration. Community partnerships need to be able to articulate their definition of STEAM integration and have a method that evaluates whether teachers are using that definition after the professional development opportunity. Community partners need to consider how to incorporate teachers in STEAM career externships.

Policy implications. Schools are deciding to implement STEAM integration school-wide (Watson, 2016). This means teacher preparation programs need to make changes in their programs to ensure preservice teachers are prepared to teach using integrated STEAM practices. Teacher preparation courses need to include instruction on how to design instruction, which integrates STEAM. STEAM integration is more than having a variety of technology available to teachers and students. Teachers need time and professional development to understand how to use technology with students to increase student understanding rather than using technology because it is the new thing. Teacher preparation programs need to include gathering some type of evidence from co-operating teachers to ensure preservice teachers have student teaching experiences with teachers who are shifting from teacher-led to teacher facilitated instruction and assessment. Finally, teacher preparation programs need to integrate into all coursework examination of personal privilege, power, and implicit bias and how that influences instructional practices and our views of our students.

Theoretical implications. Constructivism and CRP were the two theoretical frameworks for the study. Participants share the belief that students learn by doing rather than by listening and taking notes, which aligns with constructivism learning theory (Vygotsky, 1978). Additionally, educators describe STEAM integration having a critical cultural relevancy component. STEAM education focuses on students engage in learning by doing and constructing their own knowledge through various learning experiences.

CRP is creating challenging instruction relevant to student cultural and linguistic backgrounds (Hammond & Jackson, 2015). STEAM education recognizes the importance of connecting students' learning experience with their own life experience, which is aligned with Hammond and Jackson's (2015) description of culturally relevant pedagogy. However, teachers experience challenges with STEAM integration when trying to shift to constructivism and culturally relevant pedagogy from other more teacher-centered instructional frameworks.

Additionally, the theoretical framework of constructivism (Vygotsky, 1978) and CRP (Hammond & Jackson, 2015) may need to include a theoretical framework about transformational change (Mezirow, 1991). Transformational learning involves determining assumptions, examining perspectives, and making new meaning. Deep, long-term, adult learning requires working through the parts of transformational theory. Transformation learning is examined from a variety of perspectives to closely examine how important transformational learning is for adult learners (Mezirow, 1991).

Recommendations for Further Research

The findings of the study have future implications for STEAM integration implementation and research. Teachers and administrators use integrating makerspace as their definition of STEAM integration. Maker education has increased in a similar timeline as STEAM integration. However, it is rarely in literature about STEAM integration. Future research will need to examine if and how maker education connects with STEAM integration.

Schools are creating STEAM teams to implement into instruction (Watson, 2016). This study did increase understanding of K–8 educator perceptions of STEAM integration. Their perceptions of the challenges with STEAM integration provide insight into potential research areas of possible intervention designs to support teachers and administrators to implement STEAM integration school-wide. Teachers, instructional specialists, and administrators in the study discussed the challenge of colleagues viewing STEAM integration as less rigorous and the challenge of inconsistent funding. Future research will need to examine why teachers not implementing STEAM integration have this perception in order to design more effective professional development to support the skeptical teachers in a STEAM school. Finally, future research will need to examine the impact of different district-led initiatives have on the capacity for administrators to lead change and teachers' capacity for STEAM integration.

This study could be replicated to gain greater understanding of the perceptions of education stakeholders of STEAM integration in a K–8 setting. The limitations and delimitations of this study could be mitigated in several ways. For instance, the study could increase the geographical area for the study. Since the start of this study, several schools have decided to integrate STEAM. The study could be expanded to include more participants are a broader definition of education stakeholders to include students, parents, or industry.

Conclusion

The purpose of this study was to explore the perceptions of education stakeholders in Oregon of STEAM integration in a K–8 setting. In order to gain better understanding of the perceptions of teachers, administrators and instructional specialists implementing STEAM integration, this study asked the research question: How do educational stakeholders (teachers and administrators) perceive STEAM integration in the K–8 setting? Obtaining these insights could prove to be helpful to understand what supports schools need to implement STEAM integration.

All the participants in the study are K–8 educators working at a STEAM school. The participants include teachers, instructional specialists, and administrators to provide perspectives from different educational stakeholders. This case study used several data collection methods to gather information about the participants' perceptions. The data was coded and categorized using Atlas.ti (2018) software. Using the emerging patterns, the researcher was able to determine perceptions of K–8 educational stakeholders of the definition, characteristics of high-quality instructional practices, benefits for students, and challenges with STEAM integration.

Watson (2016) described a trend in more schools deciding to implement STEAM integration school-wide. Understanding educator's perspectives, based on their lived experiences, of STEAM integration helps future schools to learn from fellow educators to have a more successful experience integrating STEAM. In addition, this information on the perceptions of education stakeholders helps researchers understand better what is working, what are the challenges with STEAM integration, and areas of research to focus on to help educators with STEAM integration.

References

Acosta, A. (2015). Macromolecules and monologues: How science and arts classes motivate students for college. *Steam, 2*(1), 1–23. doi:10.5642/steam.20150201.25

American Association for the Advancement of Science. (1997). *Project 2061: Science literacy for a changing future: Update 1997*. Washington, DC: American Association for the Advancement of Science.

Asghar, A., Ellington, R., Rice, E., Johnson, F., & Prime, G. M. (2012). Supporting STEM education in secondary science contexts. *Interdisciplinary Journal of Problem-Based Learning, 6*(2), 85–125. doi:10.7771/1541-5015.1349

ATLAS.ti. (2017). ATLAS.ti qualitative data analysis [software]. Retrieved from http://atlasti.com/

Avramides, K., Hunter, J., Oliver, M., & Luckin, R. (2014). A method for teacher inquiry in cross-curricular projects: Lessons from a case study. *British Journal of Educational Technology, 46*(2), 249–264. doi:10.1111/bjet.12233

Banks, J. A. (1991). Multicultural literacy and curriculum reform. *Educational Horizons, 69*(3), 135–140

Banks, J. A. (1993). Multicultural education: Historical development, dimensions, and practice. *Review of Research in Education, 19*, 3–49. doi: 10.2307/1167339

Bargerhuff, M. (2013). Meeting the needs of students with disabilities in a STEM school. *American Secondary Education, 41*(3), 3–20.

Beal, S. (2013). Turning STEM into STEAM: Why science needs the arts. *The Huffington Post*. Retrieved from http://www.huffingtonpost.com/stephen-beal/turn-stem-to-steam_b_3424356.html

Bell, D. (2015). The reality of STEM education, design and technology teachers' perceptions: a phenomenographic study. *International Journal of Technology and Design Education, 26*(1), 61–79. doi:10.1007/s10798-015-9300-9

Boy, G. A. (2013). From STEM to STEAM. *Proceedings of the 31st European Conference on Cognitive Ergonomics - ECCE 13*. doi:10.1145/2501907.2501934

Breen, L. J. (2007). The researcher 'in the middle': Negotiating the insider/outside dichotomy. *The Australian Community Psychologist*, *19*(1), 163–174.

Brown, J. C., & Crippen, K. J. (2016). The growing awareness inventory: Building capacity for culturally responsive science and mathematics with a structured observation protocol. *School Science and Mathematics, 116*(3), 127–138. doi:10.1111/ssm.12163

Bruce-Davis, M. N., Gubbins, E. J., Gilson, C. M., Villanueva, M., Foreman, J. L., & Rubenstein, L. D. (2014). STEM high school administrators', teachers', and students' perceptions of curricular and instructional strategies and practices. *Journal of Advanced Academics, 25*(3), 272–306. doi:10.1177/1932202x14527952

Burton, E. P., Kaminsky, S. E., Lynch, S., Behrend, T., Han, E., Ross, K., & House, A. (2014). Wayne School of Engineering: Case study of a rural inclusive STEM-Focused high school. *School Science and Mathematics*, *114*(6), 280–290. doi:10.1111/ssm.12080

Castillo-Montoya, M. (2016). Preparing for interview research: The interview protocol refinement framework. *The Qualitative Report*, *21*(5), 811–831. Retrieved from http://nsuworks.nova.edu/tqr/vol21/iss5/2

Catterall, J. (2013). Getting real about the E in STEAM. *Steam*, *1*(1), 1–7. doi:10.5642/steam.201301.06

Catterall, L. (2017). A brief history of STEM and STEAM from an inadvertent insider. *Steam*, *3*(1), 1–13. doi:10.5642/steam.20170301.05

Conradty, C., & Bogner, F. X. (2018). From STEM to STEAM: How to monitor creativity. *Creativity Research Journal*, *30*(3), 233–240. doi: 10.1080/10400419.2018.1488195

Connor, A. M., Karmokar, S., Whittington, C., & Walker, C. (2014). Full STEAM ahead a manifesto for integrating arts pedagogics into STEM education. 2014 IEEE International Conference on Teaching, Assessment and Learning for Engineering (TALE). doi:10.1109/tale.2014.7062556

Costantino, T. (2017). STEAM by another name: Transdisciplinary practice in art and design education. *Arts Education Policy Review*, *119*(2), 100–106. doi: 10.1080/10632913.2017.1292973

Crayton, J., & Svihla, V. (2015). Designing for immersive technology: Integrating art and STEM learning. *Steam*, *2*(1), 1–7. doi:10.5642/steam.20150201.8

Creswell, J. W. (2013). *Qualitative inquiry and research design: choosing among five approaches* (3rd ed.). London, England: Sage.

Crippen, K. J., & Archambault, L. (2012). Scaffolded inquiry-based instruction with technology: A signature pedagogy for STEM education. *Computers in Schools*, 29, 157–173.

Cropley, D. H. (2016). *Creativity in engineering. Multidisciplinary contribution to the science creative thinking.* New York, NY: Springer Singapore.

DeLyser, D. (2001). “Do you really live here?” Thoughts on insider research. *Geographical Review*, *91*(1), 441–453.

Douglas, K. A., Rynearson, A., Yoon, S. Y., & Diefes-Dux, H. (2015). Two elementary schools' developing potential for sustainability of engineering education. *International Journal of Technology and Design Education*, *26*(3), 309–334. doi:10.1007/s10798-015-9313-4

Dunn, C., Rabren, K. S., Taylor, S. L., & Dotson, C. K. (2012). Assisting students with high-incidence disabilities to pursue careers in science, technology, engineering, and mathematics. *Intervention in School and Clinic*, *48*(1), 47–54. doi:10.1177/1053451212443151

Education at a Glance 2016 (Summary in English). (2016). doi:10.1787/033aaa9d-en

English, L. D. (2017). Advancing Elementary and Middle School STEM Education. *International Journal of Science and Mathematics Education*, *15*(S1), 5–24. doi: 10.1007/s10763-017-9802-x

Frecthling, J. A., Merlino, F. J., & Stephenson, K. (2015). The call to transform postsecondary STEM educational practices and institutional policies. *American Journal of Education Studies*, *7*(1), 27–42.

Frideres, J. S. (1992). *A world of communities: Participatory research perspectives*. North York, Ontario: Captus University Publications.

Fulton, L., & Simpson-Steele, J. (2016). Reconciling the divide: Common processes in science and arts education. *Steam*, *2*(2), 1–8. doi:10.5642/steam.20160202.03

Garvis, S., & Pendergast, D. (2012). Storying music and the arts education: The generalist teacher voice. *British Journal of Music Education*, *29*(1), 107–123.

Gay, G. (2010). *Culturally responsive teaching: Theory, research, and practice* (2nd ed.). New York, NY: Teachers College Press.

Geimer, E. (2014). The efficacy of mathematics education. *Steam, 1*(2), 1–11. doi:10.5642/steam.20140102.14

Ghanbari, S. (2014). *Integration of the arts in STEM: A collective case study of two interdisciplinary university programs* (Unpublished doctoral dissertation). California State University, San Marcos.

Ginevra, M. C., Nota, L., & Ferrari, L. (2015). Parental support in adolescents career development: Parents and children's perceptions. *The Career Development Quarterly, 63*(1), 2–15. doi: 10.1002/j.2161-0045.2015.00091.x

Grant, J., & Patterson, D. (2016). Innovative arts programs require innovative partnerships: A case study of STEAM partnering between an art gallery and a natural history museum. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, *89*(4–5), 144–152. doi:10.1080/00098655.2016.1170453

Guyotte, K., Sochacka, N., Constantino, T., Walther, J., & Kellem, N. (2015). STEAM as social practice: Cultivating creativity in transdisciplinary spaces. *Art Education*. *67*(6), 12–19.

Gurria, A. (2018). *PISA 2015 Results in Focus*[PDF]. Washington, DC: Organization for Economic Cooperation and Development.

Hammond, Z., & Jackson, Y. (2015). *Culturally responsive teaching and the brain: promoting authentic engagement and rigor among culturally and linguistically diverse students*. Thousand Oaks, CA: Corwin.

Henriksen, D. (2017). Creating STEAM with Design Thinking: Beyond STEM and Arts Integration. *Steam, 3*(1), 1–11. doi:10.5642/steam.20170301.11

Herro, D., & Quigley, C. (2016). Innovating with STEAM in middle school classrooms: Remixing education. *On the Horizon, 24*(3), 190–204. doi:10.1108/oth-03-2016-0008

Hunter-Doniger, T. (2018). Art infusion: Ideal conditions for STEAM. *Art Education*, *71*(2), 22–27. doi: 10.1080/00043125.2018.1414534

Hunter-Doniger, T., Howard, C., Harris, R., & Hall, C. (2017). STEAM through culturally relevant teaching and storytelling. *Art Education*, *71*(1), 46–51. doi: 10.1080/00043125.2018.1389593

Hunter-Doniger, T., & Sydow, L. (2016) A journey from STEM to STEAM: A middle school case study. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, *89*(4–5), 159–166. doi: 10.1080/00098655.2016.1170461

Jamil, F. M., Linder, S. M., & Stegelin, D. A. (2017). Early childhood teacher beliefs about STEAM education after a professional development conference. *Early Childhood Education Journal*, *46*(4), 409–417. doi: 10.1007/s10643-017-0875-5

Jolly, A. (2014). STEM vs. STEAM: Do the arts belong? *Education Week: Teacher*. Retrieved from http://www.edweek.org/tm/articles/2014/11/18/ctq-jolly-stem-vs-steam.html

Jones, G., Dana, T., Laframenta, J., Adams, T. L., & Arnold, J. D. (2016). STEM TIPS: Supporting the beginning secondary STEM teacher. *TechTrends*, *60*(3), 272–288. doi:10.1007/s11528-016-0052-5

Kang, M., Jang, K., & Kim, S. (2013). Development of 3D actuator-based learning simulators for robotics STEAM education. *International Journal of Robotics, Education, and Art*, *3*(1), 22–32.

Kassaee, A. M., & Rowell, G. H. (2016). Motivationally-informed interventions for at-risk STEM students. *Journal of STEM education*, *17*(3), 77–84.

Kim, Y., & Park, N. (2012). Development and application of STEAM teaching model based on the Rube Goldberg's invention. *Computer Science and its Applications*, (pp. 693–698), New York, NY: Springer Singapore.

Kim, Y. E., Morton, B. G., Gregorio, J., Rosen, D. S., Edouard, K., & Vallett, R. (2019). Enabling creative collaboration for all levels of learning. *Proceedings of the National Academy of Sciences*, *116*(6), 1878–1885. doi: 10.1073/pnas.1808678115

Kuhn, M. (2015). Encouraging teachers to W.A.I.T before engaging students in next generation science standards STEAM activities. *Steam*, *2*(1), 1–6. doi:10.5642/steam.20150201.15

Ladson-Billings, G. (2009). *The dreamkeepers: Successful teachers for African-American children* (2nd ed.). San Francisco, CA: Jossey-Bass.

Land, M. H. (2013). Full STEAM ahead: The benefits of integrating arts into STEM. *Procedia Computer Science*, *20*, 547–552.

Liao, C. (2016). From interdisciplinary to transdisciplinary: An arts-integrated approach to STEAM education. *Art Education*, *69*(6), 44–49. doi: 10.1080/00043125.2016.1224873

Lochmiller, C. R. (2016). Examining administrators' instructional feedback to high school math and science teachers. *Educational Administration Quarterly*, *52*(1), 75–109. doi:10.1177/0013161x15616660

Madden, M. E., Baxter, M., Beauchamp, H., Bouchard, K., Habermas, D., Huff, M., & Plague, G. (2013). Rethinking STEM Education: An interdisciplinary STEAM curriculum. *Procedia Computer Science*, *20*, 541–546. doi:10.1016/j.procs.2013.09.316

Maeda, J. (2013). STEM Art = STEAM. *Steam*, 1(1), 1–3. doi:10.5642/steam.201301.34

Maslyk, J. (2016). *STEAM makers: Fostering creativity and innovation in the elementary classroom*. Thousand Oaks, CA: Corwin/A SAGE Company.

McGarry, K. (2018). Making partnerships with STEAM. *Art Education, 71*(2), 28–34. doi: 10.1080/00043125.2018.1414535

Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation*. San Francisco, CA: John Wiley & Sons.

Mezirow, J. (1991). *Transformative dimensions of adult learning.* San Francisco, CA: Jossey-Bass.

Organization for Economic Cooperation and Development (OECD). (2016). *PISA 2015 Results (Volume I): Excellence and Equity in Education*, OECD Publishing, Paris. doi: http://dx.doi.org/10.1787/9789264266490-en

More STEM Hubs in Oregon. (2019, December 3). Retrieved April 20, 2020, from https://oregoncoaststem.oregonstate.edu/our-story/stem-hubs-oregon

Mote, C., Strelecki, K., & Johnson, K. (2014). Cultivating high-level organizational engagement to promote novel learning experiences in STEAM. *Steam, 1*(2), 1–9. doi:10.5642/steam.20140102.18

Neil-Burke, M. B. (2016). *Toward the design and implementation of STEM professional development for middle school teachers: An interdisciplinary approach* (Unpublished doctoral dissertation). Morgan State University.

Oner, A., Nite, S., Capraro, R., & Capraro, M. (2016). From STEM to STEAM: Students' beliefs about the use of their creativity. *Steam*, *2*(2), 1–14. doi:10.5642/steam.20160202.06

Oregon Education Office. (2018). STEM/CTE. Retrieved from http://education.oregon.gov/stem-cte/

Opperman, A. (2016). Maker education: The STEAM playground. *Steam*, *2*(2), 1–5. doi:10.5642/steam.20160202.04

Overland, C. T. (2013). Integrated arts teaching: What does it mean for music education? *Music Educators Journal*, *100*(2), 31–37. doi:10.1177/0027432113497762

Patton, M. Q. (1990). *Qualitative evaluation and research methods* (2nd ed.). Newbury Park, CA: Sage Publications.

Patton, R. M., & Knochel, A. D. (2016). Meaningful makers: Stuff, sharing, and connection in STEAM curriculum. *Art Education*, *70*(1), 36–43. doi: 10.1080/00043125.2017.1247571

Quigley, C. F., Herro, D., & Jamil, F. M. (2017). Developing a conceptual model of STEAM teaching practices. *School Science and Mathematics*, *117*(1-2), 1–12. doi: 10.1111/ssm.12201

Radziwill, N., Benton, M., & Moellers, C. (2015). From STEM to STEAM: Reframing what it means to learn. *Steam*, *2*(1), 1–7. doi:10.5642/steam.20150201.3

Richard, B., & Treichel, C. J. (2013). Increasing secondary teachers' capacity to integrate the arts. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, *86*(6), 224–228. doi:10.1080/00098655.2013.826488

Roehrig, G. H., Moore, T. J., Wang, H., & Park, M. S. (2012). Is adding the E rnough? Investigating the impact of K–12 engineering standards on the implementation of STEM integration. *School Science and Mathematics*, *112*(1), 31–44. doi:10.1111/j.1949-8594.2011.00112.x

Sanders, M. (2012). Integrative STEM education as 'best practice'. *Explorations of Best Practices in Technology, Design, and Engineering Education, 2*, 102–117.

Saxton, E., Burns, R., Holveck, S., Kelley, S., Prince, D., Rigelman, N., & Skinner, E. A. (2014). A common measurement system for K–12 STEM education: Adopting an educational evaluation methodology that elevates theoretical foundations and systems thinking. *Studies in Educational Evaluation, 40*, 18–35. doi:10.1016/j.stueduc.2013.11.005

Schuster, D., Buckwalter, J., Marrs, K., Pritchett, S., Sebens, J., & Hiatt, B. (2012). Aligning university-based teacher preparation and new STEM teacher support. *Science Educator*, *21*(2), 39–44.

Seidman, I. (2012). *Interviewing as qualitative research: A guide for researchers in education and the social sciences.* New York, NY: Teachers College Press

Seifter, H., Haley Goldman, KI., Yalowitz, S., & Wilcox, E. (2016). *The impact of arts-based innovation training on the creative thinking skills, collaborative behaviors, and innovation outcomes of adolescents and adults*. National Science Foundation. Retrieved from: http:/www.artofsciencelearning.org/wp-content/uploads/2016/08/AoSl-Research-Report-The-Impact-of-Arts-Based-Innovation-Training-release-copy.pdf

Sousa, D., & Pilecki, T. (2013). *From STEM to STEAM: Using brain-compatible strategies to integrate the arts.* Thousand Oaks, CA: Corwin.

Stubbs, E. A., & Meyers, B. E. (2015). Multiple case study of STEM in school-based agricultural education. *Journal of Agricultural Education*, *56*(2), 188–203. doi:10.5032/jae.2015.02188

Teo, T., & Ke, K. J. (2014). Challenges in STEM teaching: Implication for preservice and inservice teacher education program. *Theory into Practice*, *53*(1), 18–24.

Thurley, C. (2016). Infusing the arts into science and the sciences into the arts: An argument for interdisciplinary STEAM in higher education pathways. *Steam*, *2*(2), 1–8. doi:10.5642/steam.20160202.18

U.S. Department of Education. (2017, October 24). *Elemenatry and Education Act of 1965*. Retrieved from https://legcounsel.house.gov/Comps/Elementary%20And%20Secondary%20Education%20Act%20Of%201965.pdf

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes* (M. Cole, V. John-Steiner, S. Scribner & E. Souberman., Eds.) (A. R. Luria, M. Lopez-Morillas & M. Cole [with J. V. Wertsch], Trans.) Cambridge, MA.: Harvard University Press. (Original manuscripts [ca. 1930–1934])

Walsh, E., Anders, K., & Hancock, S. (2013). Understanding, attitude and environment. *International Journal for Researcher Development ,4*(1), 19–38. doi:10.1108/ijrd-09-2012-0028

Watson, A. D. (2016). Revving up the STEAM engine. *Art Education*, *69*(4), 8–9.

Watson, A. D., & Watson, G. H. (2013). Transitioning from STEM to STEAM: Reformation of engineering education. *The Journal for Quality and Participation, 36*(3), 1–4. Retrieved from http://asq.org/quality-participation/2013/10/bonus-article-transitioning-stem-to-steam-reformation-of-engineering-education.pdf

Watters, J. J., & Diezmann, C. M. (2013). Community partnership for fostering student interest and engagement in STEM. *Journal of STEM Education*, *14*(2), 47–55.

Wexler, A. (2014). The Common Core "State" Standards: The arts and education reform. *Studies in Art Education*, *55*(2), 172–176.

Willink, K., & Jacobs, J. (2012). Teaching for change: Articulating, profiling, and assessing transformative learning through communicative capabilities. *Journal of Transformative Education, 9*, 143–164. Retrieved from http://jtd.sagepub.com/content/9/3/143

Yin, R. K. (2006). Mixed methods research: Are the methods genuinely integrated or merely parallel? *Research in the Schools*, *13*(1), 41–47.

Yin, R. K. (2014). *Case study research: design and methods* (5th ed.). London, England: Sage Publication.

Young, V. M., House, A., Sherer, D., Singleton, C., Wang, H., & Klopfenstein, K. (2016). Scaling up STEM academies statewide: Implementation, network supports, and early outcomes. *Teachers College Record*, *118,* 1–26.

Zhao, Y. (2012). *World class learners: Educating creative and entrepreneurial students*. Thousand Oaks, CA: Corwin Press.

Zimmerman, A. (2016). Developing confidence in STEAM: Exploring the challenges that novice elementary teachers face. *Steam*, *2*(2), 1–9. doi:10.5642/steam.20160202.15

Appendix A: Participant Questionnaire

1. How many years have you been an educator?

2. What are your endorsements and or certification areas?

3. How many school districts have you worked at?

4. How many schools have you worked at?

5. How long have you been at your current school?

6. What grade levels have you taught?

K	7
1	8
2	9
3	10
4	11
5	12
6	

7. What subjects/classes do you currently teach?

8. What is your current job title?

Appendix B: Interview Questions for Teachers

1. Describe what you know about how your school decided to become a STEAM school.
2. Describe your experience learning about STEAM integration.
    a. Describe your experience in your teacher preservice program learning about STEAM integration.
3. Describe the professional development you have participated in to learn about STEAM integration.
    a. What professional development experience was the most helpful to you in learning about STEAM integration? Why?
    b. What professional development experience was the least helpful to you in l earning about STEAM integration? Why?
4. What impact do you think integrating STEAM instruction has on student learning? Why?
5. Describe successes you have experienced integrating STEAM.
6. Describe challenges you have experienced integrating STEAM.
7. Describe the barriers you have experience integrating STEAM.
    a. What, if any, of the barriers did you overcome?
    b. How did you overcome these barriers?
8. What would you change about your experience integrating STEAM if you could?
9. If another teacher asked for your advice about integrating STEAM, what would you share?
10. What additional thoughts, comments, opinions, or questions would you like to share?

Appendix C: Interview Questions for Administrators

1. Describe the process of how your school decided to become a STEAM school.
2. Describe your experience learning about STEAM integration.
3. What impact do you think integrating STEAM instruction has on student learning? Why?
4. Describe successes your school has experienced integrating STEAM.
5. Describe challenges your school has experienced integrating STEAM.
6. Describe the barriers your school has experienced integrating STEAM?
    a. What barriers, if any, has your school overcome?
    b. How did you overcome these barriers?
7. What would you change about your experience integrating STEAM if you could?
8. If another principal asked for your advice about integrating STEAM, what would you share?
9. Describe the partnerships your school has that are connected to STEAM.
    a. How have these partnerships impacted STEAM integration?
10. What additional thoughts, comments, opinions, or questions would you like to share?

Appendix D: Participant Consent to Participate in the Study

Research Study Title:	Perceptions of K–8 Education Stakeholders of Implementation of STEAM integration
Principal Investigator:	Kristin Moon
Research Institution:	Concordia University–Portland
Faculty Advisor:	Dr. Donna Graham

Purpose and what you will be doing:
The purpose of this survey is to explore how education stakeholders in Oregon perceive the implementation of STEAM integration in a K–8 setting. We expect approximately 12 volunteers. No one will be paid to be in the study. We will begin enrollment on March 1, 2019 and end enrollment on March 15, 2019. To be in the study, you will:

Email signed consent form to researcher
Complete online questionnaire
Participate in a 30–45 minute in person recorded interview
Read transcribed interview and describe accuracy of the transcription.

Doing these things should take less than 60 minutes 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 the personal file cabinet. Sessions will be audio recorded. Audio recordings will be deleted immediately following transcription and member-checking. All other study-related materials will be kept securely for 3 years from the close of study, and will then be destroyed. When we or any of our investigators look at the data, none of the data will have your name or identifying information. We will only use a secret code to analyze the data. We 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 we conclude this study.

Benefits:
Information you provide will help increase understanding of the perceptions of educators implementing STEAM integration. There are no direct benefits to you by participating in the study.

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 us abuse or neglect that makes us seriously concerned for your immediate health and safety.

Right to Withdraw:
Your participation is greatly appreciated, but we acknowledge that the questions we are asking are 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, we 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, Kristin Moon, 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: Kristin Moon email: [redacted]
c/o: Professor Donna Graham
Concordia University–Portland
2811 NE Holman Street
Portland, Oregon 97221

Appendix E: 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*.

___________Kristin Moon____
Digital Signature

_______________Kristin Moon____
Name (Typed)

_________________04-04-2020____
Date