IDENTIFYING STEM AWARENESS OF SECONDARY ART EDUCATORS:

A STATEWIDE ASSESSMENT

by

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Dedication

The time and effort of this dissertation is dedicated to Dawit, Justice, and Baeza Moya. These 157 pages represent the time I have missed with you all.

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ABSTRACT

IDENTIFYING STEM AWARENESS OF SECONDARY ART EDUCATORS:

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The advent of STEAM programs could be a product of budget cuts and lower student enrollment within the arts. However, art educators, typically, possess minimal training in STEM related fields. The lack of training is especially true for secondary art educators due to the specificity of their degrees required to teach in their respective institutions. The purpose of this mixed method study aims to measure of the extent of STEM awareness in secondary art educators, In the state of Texas, 211 secondary art educators completed the *STEM Awareness and Community Survey.* The data collected from the secondary art teachers revealed perception differences in regards to teacher educational background and teacher certification training. Follow up interviews with participants revealed teacher's perceptions of the benefit of art within STEM in terms of creativity, communication, and visualization of concepts. The data concluded the necessity for educational leadership to implement more STEM related training for their arts faculty in order to ensure meaningful integration of STEAM based curriculum.

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CHAPTER I:

INTRODUCTION

The advent of STEM (science, technology, engineering, and mathematics) as an educational framework presents several challenges. Connecting content and pedagogical practices with real-world applications remains significantly difficult in defining a STEM framework (Kelley & Knowles, 2016). Disagreement in its academic execution, applicable definition, community awareness, and economic importance contribute to a slow progression of STEM education within public and private educational systems (Breiner, Johnson, Harkness, & Koehler, 2012). A current discussion regarding the integration of visual arts within STEM education involves examining the viability and benefit of art and STEM (Daugherty, 2013). The integration of visual arts within STEM creating STEAM (science, technology, engineering, arts, and mathematics) presents similar challenges to STEM education like the lack of awareness among academic and industrial stakeholders, and the practical execution of curricula. This study will seek to discover the level of awareness art educators possess regarding STEM as an educational framework, and how this awareness transitions into advocating for STEAM.

Research Problem

While the challenges of implementing STEM education programs are numerous, one area for improvement involves the lack of STEM awareness among K-12 teachers, higher education faculty, and business community members (Sondergeld, Johnson, & Walten, 2016). Sondergeld et al. (2016) maintain large scale or statewide STEM education reforms can bring about a heightened sense of awareness to STEM stakeholders. In order for STEM education to maintain its growth, the correlating level of awareness and understanding of administrators and teachers must also increase (Brown, Brown, Reardon, & Merrill, 2011).

The advancement of STEM programs over the last 17 years has spurred the recent trend of arts integration (Daugherty, 2013). The integration is being implemented from K-12 programs to notable higher education art campuses like the student led initiative at the Rhode Island Institute of Design, which attempts to unite art and STEM with universities like Brown, Yale, Harvard, and the Massachusetts Institute of Technology (Wynn & Harris, 2013). The trend to incorporate art within STEM education may originate from the downsizing of art programs, but STEAM appears to bring new vitality to the arts by facilitating student interest in STEM (Sochacka, Guyotte, & Walther, 2016). The arts were traditionally perceived as being reserved for the privileged or talented, but recent studies reveal a utilitarian aspect the arts provide in enriching a STEM based learning experience (Daugherty, 2013; McGrath & Brown, 2005). Universities and organizations all over the United States have begun supporting a STEAM based initiative via workshops, professional development opportunities, academic literature, and conferences (Wynn & Harris, 2013).

Advocates of STEAM maintain the integration of arts with STEM provides students with the ability to think spatially, increase cognition, facilitate social growth, and promote creativity (Sousa & Pilecki, 2013). However, a concern for the consideration of arts in STEM education calls into question the reciprocity of benefits between the arts and STEM (Guyotte et al., 2015). As an example of the arts benefitting STEM, a case study conducted at the university level revealed STEM students who participated in the university's ArtScience program felt their experience with a STEAM related curriculum allowed for an increase in creativity, expanse of perceptions, and the self-discovery of new abilities (Ghanbari, 2015). Likewise, the arts could also benefit from a connection with STEM in terms of funding, as STEM historically has been an initiative that has enjoyed abundant corporate and governmental financial support (Ghanbari, 2015).

Furthermore, the arts appear to facilitate a sense of enjoyment in STEM students possibly resulting in improved cognition (Rinne, Gregory, Yarmolinskaya, & Hardiman, 2011). As the awareness of potential benefits of STEAM education increases among educators (Daugherty, 2013), and the inclusion of the arts becomes more applied (Ghanbari, 2015), this question is raised: how can STEM and art integration further develop? Perhaps the answer lies within the STEM awareness levels of art educators.

If advocates of the STEM to STEAM discussion expect to see more integration of the arts, then an increase of STEM awareness among art educators is necessary. By identifying disparities of STEM awareness, STEAM stakeholders position themselves to improve those facets through advocacy and curricula development. Therefore, the research problem of this study is two-fold. While there are means of measuring STEM awareness for the community, (Sondergeld & Johnson, 2014) there are no current studies to identify facets of STEM awareness in relation to art educators. In addition, a gap exists in building an understanding of varying levels of STEM awareness in STEAM stakeholders. Nonetheless, instruments are being developed that could serve as starting points for measuring and identifying STEM awareness in communities which are advocating for STEAM (Sondergeld & Johnson, 2014). The reasoning for focusing on STEM instead of STEAM awareness among art educators builds upon the notion that the arts are adopting the STEM framework, and therefore, require measuring awareness of the preexisting STEM framework in order to identify areas of STEM awareness growth and/or strength. Furthermore, if any STEAM program is to progress, then STEM educators and stakeholders require development of practicing communities, as outlined by Bernstein-Sierra & Kezar (2017), to develop professionally in terms of content knowledge and pedagogical practices.

The literature contains an abundance of research pertaining to STEM, but little research exists regarding the STEM awareness of secondary and postsecondary art educators. Art educators could benefit from improved beliefs and awareness about STEM engagement and community involvement, which can result in supporting initiatives in STEM reform and preparing students for future careers (Sondergeld, Johnson, & Walten, 2016). The STEM initiative started on the premise that the U.S. was falling behind in the areas of science, technology, engineering, and mathematics, and therefore, a national mandate like the Competes Act and STEM Education Act sought to promote STEM related educational programs (Wynn & Harris, 2013). Proponents pushing for STEM education believe such programs will create students who are STEM-competent, STEM-competitive, and well positioned to enter STEM careers (Brown et al., 2011). Student workforce preparedness relies on the support and STEM awareness of secondary and postsecondary teachers as they can expose students to career resources and possible job opportunities (Sondergel et al., 2016). While STEAM gains progress and popularity, the need for awareness among stakeholders remains the same, but can now be extended to art K-12 teachers, art higher education faculty, and art business community members (Bequette & Bequette, 2012). Therefore, this study aims to identify facets of STEM awareness including knowledge of STEM resources, STEM workforce, and STEM career and college preparedness of secondary art educators.

Significance of the Study

STEM related educational programs are needed to produce well prepared secondary students who are ready to move into college level STEM coursework and to produce postsecondary STEM students who are well prepared to move into STEM careers, meeting the demands of a global STEM economy (Sondergeld, Johnson, & Waltens, 2016). The usefulness or effectiveness of arts integration to STEM becomes paramount for STEAM advocates to build a case for supporting students in academic and vocational pursuits. The information from this study might assist administrators and policy makers in identifying growth areas for STEM awareness to create a more holistic STEAM based programs and art educators. Without the integration of visual arts, students could potentially be missing out on the long-term retention of content, which is essential for building a competent STEM student (Rinne, Gregory, Yarmolinskaya, & Hardiman, 2011). With the continued struggle of retaining STEM majors (Henderson, Beach, & Finkelstein 2011), it becomes imperative to find a solution to motivate future students in pursuing and maintaining a STEM emphasis; perhaps the integration of visual arts might be the solution. The awareness of STEM related areas might promote future advocacy of STEM from art educators, and even reinforce STEAM based ideas and applications.

Research Purpose and Questions

The purpose of this study was to identify STEM awareness of secondary art educators. The following research questions will guide this study:

1. To what extent are secondary art educators aware of STEM and STEM resources?
2. To what extent are secondary art educators aware of student success in college and careers related to STEM?
3. To what extent are secondary art educators aware of the STEM careers and workforce?
4. How do secondary art educators perceive the benefits of art in relation to STEM?

Definitions of Key Terms

Industry Engagement in STEM Education (IE): Industry and engagement in STEM Education refers to the level of involvement by community and business members with educational organizations. The level of participation includes: partnerships, event funding, volunteers, guest speakers, internships, and co-ops (Sondergeld & Johnson, 2014).

Preparation of Students for Success in College and Careers (PR): Preparation of students for success in college and careers refers to perspectives: (a) of student preparedness, (b) student knowledge of STEM careers, (c) schools effectiveness of teaching STEM, (d) whether standardized assessments adequately asses STEM knowledge and skills, (e) whether K-12 schools equip students to b critical thinkers, and (f) community partners making real-world connections with K-12 STEM education (Sondergeld & Johnson, 2014).

Regional STEM Careers and Workforce (CW): Regional STEM careers and workforce involves awareness regarding: (a) STEM business' provision of incentives to promote STEM careers, (b) STEM job availability, (c) STEM career availability for women and minority groups, (d) fulfillment of skilled workers in STEM fields, (e) STEM career availability for local K-12 students, (f) access to STEM education, and (g) STEM careers as priority for local schools (Sondergeld & Johnson, 2014).

Secondary art educator: Secondary art educator refers to individuals teaching an art making content or art history course for 9th, 10th, 11th, and/or 12th grade in a public-school system.

STEAM education: STEAM education refers to the integration of the creative arts (not limited to: visual, theatrical, musical, and dance) as they relate to the philosophical framework of STEM (Bequette & Bequette, 2012). The integration of the arts allows for incorporating of functional design and aesthetic thinking to STEM (Bequette & Bequette, 2012).

STEM awareness and STEM resource awareness (AR): STEM awareness focuses on the level of mindfulness and importance regarding STEM education, which includes school districts, local schools, and parents (Sondergeld & Johnson, 2014). STEM resources regarding the awareness of availability of STEM resources, which includes scholarships, websites, vocational career opportunities, recruitment, and other online tools (Sondergeld & Johnson, 2014).

STEM education: According to Gonzalez & Kuenzi (2012) of the Congressional Research Service, STEM education is defined as fields and educational activities related to science, technology, engineering, and mathematics ranging from all grade levels, both formal and informal.

Visual-spatial Learning: According to Howard Gardner (2011), visual-spatial learning entails the development and ability to perceive the world, mentally imagine, and eventually apply perceived visual connections.

Conclusion

The debate on whether or not the arts belong within STEM might not be concluded any time soon. However, based on current research suggesting the benefits of the arts within STEM (Daughtery, 2013), the arts are gaining traction in its integration of STEM to create STEAM. The aim of this study is measuring and identifying college preparedness, and career workforce in STEM awareness among art educators. In addition, this study looks to report secondary art teachers' perspectives on how visual art relates to the STEM awareness facets.

CHAPTER II:
REVIEW OF LITERATURE

Printmaking allows for the dispensation of original works of art to the masses. From intaglio to reductive block printing, the techniques may differ but the idea remains the same: design, duplicate, and disperse. Artists design compositions in their sketchbooks, doodles, or even scrap pieces of paper looking for the compositional sweet spot. The composition is then transferred onto a matrix like wood, linoleum, and even stone, all in preparation to duplicate the eventual masterpiece. After numerous artist proofs and experimentation, the printing begins. Tens, dozens, hundreds, thousands of prints to fulfill the artist's desire and vision. Once the edition or series limit has been reached, the artist prepares his or her social platform to disperse for others to contemplate. Creating meaningful and practical connections of art and STEM is quite similar to the printmaking process. Developing a conceptual framework is like the designing stage which directs the artists' vision. Sketching out the current Art and STEM trends allows the artist to develop a better understanding of the potential composition. Reviewing current literature reflects the duplication process as the successes and shortcomings of Art and STEM programs are examined for effectiveness and application. Finally, once all the nuances of the composition are in place, then the work is ready to be dispersed.

In regards to the STEM and Art discussion, advocates remain heavily involved in the design process trying to figure out the best practices of creating meaningful connections among disciplines. Improving STEM awareness in K-12 educators, higher education faculty, and business community members requires further investigation as organizations attempt to implement STEM-based reforms (Sondergeld et al., 2016). The current situation is further complicated as advocates for STEAM strive to integrate arts in existing programs and to create new ones. Even though research in STEM and STEAM related fields are growing, there is room for further research in regards to awareness, especially regarding secondary art educators. As art educators vie for a piece of the STEM pie, their attempt to connect curriculum, college preparedness, and career workforce creates a host of challenges (Colucci-Gray et al., 2017).

However, secondary art educators are in a unique position as they reach diverse populations of both STEM and non-STEM interested students. Therefore, this literature review will highlight studies integrating arts within STEM, and address other challenges with secondary STEM education. Discussion regarding art and STEM was outlined along four key themes: (a) STEM awareness and STEM resource awareness, (b) preparation for student success in college and careers, (c) STEM careers and workforce, and (d) benefits of art in STEM.

Designing a Conceptual Framework

A printmaker, or any artist, is in constant pursuit of an idea that will manifest into a work of art. A sketch from personal experience, a scribble of observation, preponderance on the meaning of beauty, and before long a composition becomes evident. Creating meaningful art and STEM connections in the educational realm require inspiration in order to design a conceptual framework which leads to duplication and disbursement.

Concepts from 21st century skills as outlined by Partnership 21 (Partnership for 21st Century Skills, 2009) and studio thinking (Hetland et. al, 2007), provide a multitude of domains useful for understanding art and STEM education. The 21st century skills are typically outlined as three domains: a) life and career skills, b) learning and innovation skills, and c) information, media and technology skills (cite). The overall goals of 21st century skills are to create learning environments aligned with the real world, facilitate integrative curricular practices, and eventually develop effective citizens for future workforces. The 21st Century Skills framework is critiqued as being product-centric and negligent of the application of artistic inquiry (Logsdon, 2013), yet the framework does focus on holistic or life-long learning education. By introducing aspects of studio thinking, 21st century skills will benefit from supplemental artistic underpinnings.

Studio thinking or studio habits of mind is an experienced driven framework dedicated to open-ended inquiry, critical thinking, re-designing, and exploration (Hetland et. al, 2007). The framework consists of eight domains: a) develop craft, b) engage and persist, c) envision, d) express, e) observe, f) reflect), g) explore, and h) understanding the art world. While some domains might appear to be mutually exclusive to art, like develop craft and understanding the art world, a deeper examination proves otherwise. Under studio thinking, to develop craft refers to the use of tools and materials to attain mastery, so whether the tool is a color pencil or microscope the user requires consistent practice to develop needed skills. In addition, understanding the artworld does not merely consist of discussing feelings regarding an abstract painting, but investigating the innovations, trends, movements, and contributions within the art world. Understanding the history of photography could augment a graphic designer's application of digital tools. Unpacking the life of DaVinci might bring inspiration to a young would-be medical doctor as he or she gazes upon illustration after meticulous illustration of the famous artist-scientist-inventor.

As the printmaker fine tunes his or her design in preparation to duplicate the composition, a certain level of excited uncertainty exists. Before creating an edition, a series of preliminary prints known as artist proofs are created in order to correct compositional undesirables. The mixing of 21st century skills and studio thinking feels much like an artist proof. The potential of creating an engaging educational composition brings spirit to the art and STEM discussion. The formation of the 21st century skills (Partnership for 21st Century Skills, 2009) has offered a common ground for art and STEM educators to create curriculum addressing transferable skills required for any student to achieve both academically and professionally (Logsdon, 2013). Studio thinking offers creative promise in terms of supplementing and augmenting STEM principles found in 21st century skills (Daugherty, 2013). With an auspicious design in place, the printmaker prepares his or her handmade paper, loads a brayer with even ink, and charges the printing plate in hopes of duplicating an edition worthy of framing.

A Sketch of STEM and Art Trends

The current discussion regarding art education in K-12 involves integration within STEM (Daugherty, 2013). Advocates for integration of arts into STEM, or STEAM, suggest critical aspects of visual art making conforms with STEM incorporation (Ghanbari, 2015). STEAM advocates claim visual arts belong in STEM due to the design process, technical performance, and creative planning aspects (Guyotte, Costantino, Kellam, Sochacka, & Walther, 2015). Moreover, STEAM advocates compare the design process to the engineering or science processes (Bequette & Bequette, 2012). The experimental or prototyping stages are typically a point of connection as both processes entail a level of abstract thinking and creativity in order to realize the final product.

Daugherty (2013), outlines the current state of STEM as one of the largest educational movements in contemporary times. Daugherty (2013) provides a review of programs attempting to integrate arts within STEM curriculum with one aspect regarding studio thinking. Studio thinking provides an expressive way to approach creative aspects necessary for students to flourish in STEM fields (Daugherty, 2013). Furthermore, the prospect of art in STEM referred to by Daugherty includes the notion for art to improve cognition in STEM education (2013). The benefit of integrating art does not stop at increased comprehension or cognition, but aids in creating a palatable take on STEM curriculum by means of applying elements of the design process. The design aspect of art provides augmentation to the limits of the scientific and engineering processes (Daugherty, 2013), and thus fills a void vital to current STEM curriculum by introducing creative thinking to technical problem solving.

A collective case study by Ghanbari compares two university programs integrating arts within a STEM field, and reports the learning experiences of the students (2015). The study focused on an ArtScience Program and an ArtTechnology Program in which students were asked open ended questions about their involvement with each program (Ghanbari, 2015). Students' responses revealed an overarching theme of appreciation for the collaborative nature of the programs, an enjoyment of learning, influence on career interests, and broadening of perspective as they fused arts with a STEM related discipline (Ghanbari, 2015). The study concluded that future higher education STEAM programs, and even K-12 schools, could best serve students by strengthening intrapersonal skills, increasing creativity, and application of experiential learning (Ghanbari, 2015).

While the arts integration aspect of STEAM remains the popular narrative, others aim to view art as supplemental to STEM (Guyotte et al., 2015; Land, 2013). In the intrinsic case study of Guyotte (et al., 2015), the authors take a far different approach in determining arts' place within STEM. While the majority of art educators vie to prove arts holds a place in STEM, Guyotte (et al., 2015) contemplates the benefits of STEM in relation to art-based curriculum. The study focused on three students' experiences in the transdisciplinary design studio. Utilizing narrative inquiry consisting of semi-focus groups, visual journals and a reflective written assessment, Guyotte (et al., 2015) found the students realized collaboration is not an integral part of traditional art studio education. In addition, the collaborative nature of the transdisciplinary design studio allowed students to experience empathy with others, fostered critical reflection of their own creative process, and allowed for the application of visual-verbal narrative analysis with respect to student experience (Guyotte et al., 2015). The transdisciplinary design studio is regarded as a primary example of a proper STEAM based learning experience because the disciplines were intertwined, and not merely referenced to each other (Guyotte et al., 2015). Another example of successful integration of arts, but in a secondary education setting, involved using a glassmaking studio to teach 6th-12th grade students about aspects of geoscience. The Department of Earth and Environmental Sciences at Rutgers University–Newark, and a non-profit glass studio, GlassRoots, collaborated to create a STEAM experience for 140 students (Gates, 2017). Students were brought to the studio, underwent safety training for using acetylene torches, were allowed to create Pele tears (molten glass drops), and studied the properties of the simulated lava. The study revealed a 49% increase in interest among the 6th-8th grade students, and an increase of 20% in interest among 10th–12th grade, gleaned from student responses after participating in the workshop (Gates, 2017). Furthermore, teachers were interviewed revealing that they too observed an increase in student participation, especially in the art inclined students and their interest in science (Gates, 2017). Perhaps even more impressive is the increase of knowledge regarding learning objectives with the exception of lava's texture as it cools, but the researchers note that the outcome was not observed by the students further reinforcing the importance of hands-on activities (Gates, 2017). This study invites future STEAM advocates to think more abstractly about partnerships that can lend to unique and meaningful learning experiences for students. As more STEAM-based research emerges, the constructs of STEM awareness could possibly take new shape to incorporate arts into STEM educational frameworks. In the following sections a basis for STEM awareness is provided along with its specific community-based constructs.

Duplicating Successes in STEM Awareness

In order to better understand the challenges of integrating arts into STEM, it is important to examine the current challenges of addressing STEM awareness with educators and stakeholders. A study conducted by Sondergeld and Johnson (2014) developed an instrument (STEM awareness and community survey – SACS) and outlined a means to define constructs related to STEM awareness. More specifically, the purpose of the study was to create a means to develop a better understanding of STEM awareness and engagement of community members (Sondergeld & Johnson, 2014). The study utilized a convenience sample of 72 STEM stakeholders, which included 39 K-12 teachers, 17 higher education faculty, and 16 business community members (Sondergeld & Johnson, 2014). The study strategically used an open-ended questionnaire to develop four themes: industry engagement in STEM education (IE), STEM awareness and STEM resource awareness (AR), preparation for student success in college and careers (PR), and regional STEM careers and workforce (CW) (Sondergeld & Johnson, 2014). The data collected in the creation of the SACS reveals points of STEM awareness and engagement allowing further researchers to identify areas of strength and weakness as it relates to the measured STEM community.

A compelling study to reveal the possibility of improving STEM awareness involved a quasi-experimental study comparing cohorts of teachers participating in the Teachers and Researchers Advancing Integrated Lessons in STEM (TRAILS) project. The researchers sought to evaluate which aspects of professional development could help promote awareness specifically in STEM Careers (Knowles, Kelley, & Holland, 2018). The experimental group underwent a two-week professional development institute, which required the implementation of integrated STEM lesson plans. The experimental and control groups were given a pre and post-test in the form of the T-STEM Survey, which was used to measure STEM career awareness. The STEM career awareness improved within the experimental group, especially within the science teachers as noted by an effect size of 0.8 (large) (Knowles, Kelley, & Holland, 2018). A viable option to improve awareness of STEM careers is through the use of professional development, specifically geared towards 21st century skills and STEM integration.

In a similar study using professional development to increase STEM content knowledge and skills in K-12 educators, researchers discovered an increase in comport of teaching STEM and connections of STEM and 21st century skills (Nadelson & Seifert, 2013). The pretest of the study indicated participants maintained a modest level of engagement with teaching in STEM, which could be indicative of the areas call to promote STEM initiatives (Nadelson & Seifert, 2013). By implementing a STEM-based professional development opportunity, perceptions and practices of educator’s can be improved if the PD is broad and multifaceted. However, a traditional PD format might not be the only to improve STEM awareness and STEM resource awareness. Researchers from Queensland University and James Cook University implemented a multi-level STEM resource, referred to as STEM Hubs, consisting of public schools, STEM-related businesses, and museums and additional community organizations (King et al, 2018). Pre-service teachers were charged with working with university faculty and STEM-based business stakeholders to create STEM curriculum emphasizing ‘real world’ connections (King et al, 2018). Developing STEM awareness and STEM resource awareness experiences with pre-service teachers shows promise in creating future teachers with knowledge and experience in STEM education relatable to their students.

Understanding STEM awareness and STEM resource awareness covers a broad range of domains from teacher education to STEM resources available online. A need exists for further research measuring STEM awareness and STEM resource awareness from a variety of demographics (Sondergeld & Johnson, 2014). PD programs focusing on STEM could improve teacher practice and knowledge (Knowles, Kelley, & Holland, 2018; Nadelson & Seifert, 2013). Furthermore, creating multifaceted programs could be instrumental in creating a system which produces teachers who are STEM aware and are knowledgeable of available STEM resources (King et al, 2018).

Duplicating Student Success in College and Careers

The nature of secondary education places secondary eductaors at a crucial junction leading into the future success of their students as they prepare for college and potential career trajectories (Bottia et al., 2015). A variety of STEM programs seek to further develop this critical aspect of a student's academic life by implementing various initiatives. For example, a quantitative study aimed to discover researcher, teacher, and student perspectives on a STEM college and career after attending a STEM related event (Angle et al., 2016). Ninety-four participants consisting of 17 researchers, 10 teachers, and 54 students completed an exit survey consisting of open-ended and Likert scale-based questions (Angle et al., 2016). The study participants revealed an appreciation for heightened awareness of the limitation of high school teacher's resources, issues regarding standardized testing, and access of resources in rural schools (Angle et al., 2016). A majority of teacher participants agreed their students would benefit from an increase of exposure of STEM majors and careers (Angle et al., 2016). Students expressed a heightened response to National Lab Day (NLD), which emphasized selecting a major in STEM, assistance in preparation for university, and general decision making regarding selection of a content major (Angle et al., 2016). Furthermore, this study shows the implementation of a STEM centered awareness event has positive effects on STEM community stakeholders, which could have a lasting impact on career readiness for students.

Any secondary-based STEM program aims to improve interest in hopes of winning over students to seek future STEM careers. In an effort to promote equity among unrepresented minority groups (URM) in STEM majors and careers, Finkel (2016) performed a longitudinal study (over 3 years) involving 40 high school students who participated in a program to promote STEM participation. In addition, undergraduate students who were involved in the Community Engagement and Leadership in Science (CELS) program completed surveys to identify interest in pursuing teaching in a STEM related discipline (Finkel, 2016). In comparison to the first two years of being involved in the program, participants showed an increase interest in considering teaching as a profession, pursuing teaching as a profession, or a definitive decision in solidifying teaching as a career (Finkel, 2016). Moreover, URMs who participated in the summer internship showed an increase in STEM related applications and an increase of overall URM participants in the CELS program (Finkel, 2016). However, URM persistence after the second year of the program revealed 4 out of the 5 sites had a 100% drop out rate all consisting of URMs (Finkel, 2016). The study sought to promote the interest and teaching of STEM disciplines among URMs (Finkel, 2016).

Researchers aimed to develop a statistically reliable instrument to identify teacher's expectations regarding pre-college instruction, preparation, and success among STEM high school teachers (Nathan et al., 2010). The participants consisted of 143 STEM teachers throughout the Midwest. A second nation-wide sample of STEM teachers was surveyed with a total of 82 participants. Participants were given the EEBEI (Engineering Education Beliefs and Expectations Instrument), which consisted of 70

Likert scale items (5 and 7-point scales), 16 items based on four vignettes, and 16 demographic items (Nathan et al., 2010). The vignettes consisted of fictitious student profiles that were submitted to the teachers to advise regarding pre-college engineering course enrollment, and predictions of student success in advanced engineering studies and future careers (Nathan et al., 2010). The researchers used Cronbach's alpha in order to establish reliability, which resulted in the instrument proving to be well-designed (Nathan et al., 2010).

To better promote STEM awareness in high school students, more effective means to generate interest requires STEM integration within their coursework (Sadler, Sonnert, Hazari, & Tai, 2014). A compelling retrospective cohort study, which consisted of 4,691 college students randomly selected from 34 universities, aimed to discover the relationship between advance placement (AP) coursework and student interest in STEM careers (Sadler et al., 2014). A control was established by dividing students into two categories, those who retrospectively held an interest in a STEM career, and those who did not. A 50-item survey was created and underwent various means of validation, which included focus groups with teachers and researchers, pilot surveys, and a test-retest of 96 students to establish a reliability of 0.70 (Sadler et al., 2014). Using descriptive statistics, the study revealed 27.2% of high school students possessed STEM career interest at the start of high school, and by the end of high school the statistic went up to 28.3% (Sadler et al., 2014). The study revealed students who took AP calculus, chemistry, or physics did not have an increased interest in STEM careers, however, there was a correlation between the number of years students took calculus, chemistry, or physics courses and increased STEM career interest (Sadler et al., 2014). The findings suggested students who participated in advanced math and science coursework were more likely to show interest in STEM careers, but AP coursework participation showed no significance in generating a notable increase of STEM career interest (Sadler et al., 2014).

Researchers at the University of Cincinnati designed a qualitative research study to investigate conceptions of STEM in their local university (Breiner, Harkness, Johnson, & Koehler, 2012). Two open-ended questions (What is STEM? and How does STEM influence and/or impact your life?) were emailed to the university's full-time faculty with a response rate of n = 222 (Breiner et al., 2012). After the data was coded, grounded theory was used in the inductive analysis of the data with three highlighted themes: 1) null relationship to STEM, 2) personal reasons, and 3) social issues (Breiner et al., 2012). The findings showed 72.5% of full-time faculty knew what STEM stood for, but of the 72.5% only 57% knew the exact acronym (Breiner et al., 2012). In regards to how STEM impacts their lives, 36% of respondents said there was no known impact or influence of STEM on their lives, 50% provided personal reasons, and 21% provided social reasons. (Breiner et al., 2012). The study revealed no mainstreamed conceptualization of STEM among the participants revealing the prevailing notion of the existence of silos among the disciplines (Breiner et al., 2012). The researchers recommended in order to promote more continuity in conceptualizing STEM, stakeholders should strive to find areas of commonality in regards to the shared notion of STEM's role in making the United States workforce competitive globally (Breiner et al., 2012).

Duplicating Awareness of STEM Careers and Workforce

Identifying the needs of STEM stakeholders in career and workforce requires stakeholder engagement with local schooling systems (Sondergeld, Johnson, & Walten, 2016). In an effort to assess STEM education reform, STEM stakeholders were surveyed to identify areas of STEM awareness with one area being STEM careers and workforce. In this study, a longitudinal research design utilizing the SACS, a 39-question four-point

Likert scale instrument, was given to 4,159 participants consisting of K-12 teachers, higher education faculty, and business community members (Sondergeld, Johnson, & Walten, 2016). A baseline was established in 2012 with a follow-up in 2014 to identify statistical differences in the noted groups. As it relates to careers and the workforce, business community members and K-12 teachers showed an increase in awareness, however higher education faculty showed a slight decrease (Sondergeld, Johnson, & Walten, 2016). This disagreement in higher education faculty could signify a need to realign K-12 learning objectives and the professional expectations of community business members. Overall, the study revealed statewide STEM reform can have a positive effect in promoting STEM awareness among its community members (Sondergeld, Johnson, & Walten, 2016). In order to combat the gaps in STEM and workforce, new strategies, programs, and models are being developed (Reider, Knestis, & Malyn-Smith, 2016).

One such model is referred to as the STEM workforce education logic model, which is closely tied to the domains of the pre-existing National Science Foundation's (NSF) Innovative Technology Experiences for Students and Teachers (ITEST) program (Reider, Knestis, & Malyn-Smith, 2016). The logic model was applied in an exploratory survey study, which aimed to create a rating scale to evaluate ITEST and future STEM workforce education programs. The researchers identified 250 ITEST projects and filtered the projects to only include projects that focused on secondary and STEM professional programs, which yielded a new pool of 32 possible programs. (Reider, Knestis, & Malyn-Smith, 2016). Out of the 32 programs, only 6 were selected with an addition of 6 other programs associated with the authors of the study (Reider, Knestis, & Malyn-Smith, 2016). The scale the researchers created were based off the *helix* model of ITEST and included the following six dimensions: teacher professional development content (PDCON), professional development career (PDCAR), partnerships content

(PartCON), partnerships career (PartCAR), cultural context content (Cultural CON), and Cultural context career (CulturalCAR) with content and career referring to a STEM-based nature (Reider, Knestis, & Malyn-Smith, 2016). The programs were assessed on a four-point scale over the aforementioned dimensions, and a mean rating was calculated for each dimension for the total sample (n = 11) (Reider, Knestis, & Malyn-Smith, 2016). The study revealed programs emphasized STEM content over STEM career, which might not be surprising since programs typically start with content, but then quickly or passively address the career components (Reider, Knestis, & Malyn-Smith, 2016). The authors hope current and future program planners will examine their respective programs to include more developed components of STEM career awareness (Reider, Knestis, & Malyn-Smith, 2016). The newness of this study reveals further research is required in order to not only identify the success of STEM workforce programs, but for programs to make the appropriate changes in order to better promote STEM workforce awareness.

In addition, STEM community business stakeholders are simply not buying into the educational aspects of STEM. However, in the qualitative heavy study by Watters and Diezmann (2013), a comprehensive case study showed community industry partnerships with various schools focusing on secondary education. The purpose of the study was to highlight areas of success and identify growth opportunities between industries and their relationships with local schools. Interviews, focus groups, and classroom observations served as means to collect the data (Watters & Diezmann, 2013). The study revealed a mutually beneficial relationship between a high school and local industry as teachers underwent professional development, which enhanced their expertise and promoted student success in STEM (Watters & Diezmann, 2013). The noted industry benefited through the promotion of their products and facilities and utilize their expertise with the high school to advance their commercial agenda. Education administrators and industry leaders proved to work supportively in creating genuine STEM learning experiences, which could possibly lead to facilitating STEM interest in students (Watters & Diezmann, 2013).

Dispersing the Benefits of Art in STEM

The merits of visual arts are diverse and transferable into other disciplines in addition to STEM. Examining the benefits of art allows for its application in answering some of the challenges of STEM. The arts are reported to engage the interest and attention of students while fostering success in the sciences (Root-Bernstein et al., 2008). Captivating students in an imaginative way in STEM classes could allow for increased motivation within the STEM fields (Rinne et al., 2011). Therefore, creating learning experiences in educational settings possesses the potential of creating well-rounded individuals suited for the STEM workforce. Especially since employers often seek out candidates who are able to think abstractly, creatively, and critically (Land, 2013). The introduction of arts looks to improve cognition with other disciplines even within STEM (Land, 2013; McGrath & Brown, 2005).

Creativity is the initial print, or artist proof, which allows the artist to examine the composition and address any ideas which does not fully reflect the views of the artist. Creativity has been described as either inherited, or developed (DeHaan, 2009). Implementing studio thinking practices in STEM courses could help students develop and hone creativity skills (Hetland et al., 2007). Moving beyond the classroom, STEM professionals believe creativity contains aspects of problem-solving which connects abstract to real-world challenges (Root-Bernstein, 2015). In addition, creativity often works in conjunction with critical thinking within the sciences as a way of opening up pathways to understanding the physical world (Braund & Reiss, 2019).

One study aimed at training STEM faculty members to incorporate more visual methods of communication reported such practices can assist in developing problem-solving skills, alternative ways of thinking, and enhanced learning in regards to science and engineering (McGrath & Brown, 2005). The researchers concluded that visual learning is a compliment to analytical and verbal methods of learning, especially with the addition of drawing and sketching components integrated into the curriculum (McGrath & Brown, 2005). Furthermore, the use of visual imagery in addition to text is considered a more effective method of helping learners process and retain information rather tha just utilizing text alone (McBride & Dosher, 2002; Rinne et al., 2011). While art maintains its own merits, the literature points to its positive impact when integrated with STEM and other disciplines.

Summary of Findings

Current research shows the use of SACS within STEM community stakeholders allows for identifying areas of growth in promoting STEM awareness (Sondergeld & Johnson, 2014). Closer community partnerships between educational administrators and industry leaders can create genuine STEM learning experiences, which could possibly lead to facilitating STEM interest in students (Watters & Diezmann, 2013). In terms of STEM awareness and STEM resource awareness, student interest in STEM related careers can be increased by participating in advanced science and math coursework, and additional STEM advocacy programs (Sadler et al., 2014; Angle et al., 2016). Awareness of STEM related careers can be improved in teachers by providing STEM related professional development opportunities (Knowles, Kelley, & Holland, 2018). In addition, developing STEM awareness and STEM resource awareness among pre-service teachers is useful by allowing for a broader application of STEM integration within curriculum planning and teaching practices (King et al, 2018).

Student preparation for college and career success in STEM fields is improved by facilitating student interest and participation in STEM related programs (Angle et al., 2016; Finkel, 2016). STEM programs primarily emphasize STEM content over STEM career awareness; therefore, an integrative approach of career and content is necessary to stimulate interest in STEM related fields for college bound students (Reider, Knestis, & Malyn-Smith, 2016). Professional development opportunities utilizing local industry enhance educator expertise and promote student success in STEM (Watters & Diezmann, 2013). STEM conceptualization needs to be streamlined in order to build and strengthen the U.S. STEM workforce (Breiner et al., 2012). Moreover, statewide STEM education reform can have a positive role in promoting STEM awareness, however, higher education faculty may require more intervention to improve their relationship with K-12 schools and community business members (Sondergeld, Johnson, & Walten, 2016).

Theoretical Framework

The emerging nature of STEM awareness allows for a creative application of theoretical frameworks. Therefore, the theoretical framework utilized involved a combination of visual-spatial intelligence and visual culture arts education (VCAE). Visual-spatial intelligence is one aspect of the multiple intelligences theory as outlined by Howard Gardner (2011). Multiple intelligence theory postulates people learn through a variety of modalities with an emphasis on the content and processes of learning (Gardner, 2011; Snyder, 1999). Visual-spatial intelligence entails the ability to perceive the world, mentally imagine, and eventually apply perceived visual connections (Gardner, 2011). Therefore, the visual nature of art allows for the application of visual-spatial intelligence even within STEM disciplines. The use of visual-spatial intelligence in relation to STEM awareness could promote enhanced understanding of STEM aspects, like models, 3-D renderings, charts, etc. (Bahrum et al., 2017; Cook, 2006; Sochacka et al., 2013). For example, an educator might possess limited knowledge regarding an aspect of STEM awareness, which could then be augmented through the use of a visual such as an infographic; the teacher's level of STEM awareness could be impacted through the application of the visual-spatial intelligence theory. In addition to visual-spatial intelligence, visual culture considers the *type* of visual artifact and *contextualizes* it within the culture (Duncum, 2001). The application of visual culture could prove useful in comprehending the teacher's perceptions of STEM awareness and connection to the arts.

In regards to this study, the application of VCAE considers not only the potential learning of students, but the learning of the educators. As educators navigate the variety of modalities in receiving information, his or her knowledge, understanding, or awareness could be affected. Visual objects such as infographics, drawings, and advertisements, challenge the perceptions of the viewer causing reflection and even acceptance of the visual objects content. Therefore, teachers' experiences with visual objects contextualized within a STEM professional development might augment STEM awareness and STEM resource awareness within the educator.

One of the earliest works related to visual culture was *Ways of Seeing* by John Berger (1972). Berger noted seeing as the only sense which precedes words; and thereby serves as a means to establish oneself in reality (1972). Whether practical or expressive arts, viewers of art are also consumers of visual imagery, which is used to contextualize one's value system (Lanier, 1982). Chapman takes the notion of the visual impact on a person a step further stating, "on the scale of a culture or subculture, patterns of response to visual forms are inseparable from life styles" (1978). That is to say a person is what they continually see. Therefore, visual culture art education aims to convene a student's perception of the world with a product that communicates the experience of a group at a specific point of time (Stein, 1953). Multiple intelligence theory and visual culture art education provide not only a means to understand pedogeological practices, but can potentially offer insight as to how educators develop in their awareness based on the world around them.

Conclusion

This chapter outlined a review of current literature pertaining to the development STEM and Art trends, successes in STEM awareness and STEM resource awareness, student success in college and careers, awareness of STEM careers and workforce, and dispersing the benefits of Art in STEM. Four constructs of STEM awareness were covered as they relate to STEM community stakeholders, but emphasizing secondary and post-secondary education. The theoretical frameworks of multiple intelligences with an emphasis in visual learning in conjunction with Visual Culture Based Art Education. Chapter III will cover the methodological aspects of this dissertation.

CHAPTER III:

METHODOLOGY

The purpose of this study is to identify STEM awareness of secondary art educators. This mixed methods study collected survey and interview data from a purposeful sample of secondary art educators in the state of Texas. Quantitative data, collected from the *STEM Awareness and Community Survey* (SACS), was analyzed using descriptive statistics (frequencies and percentages). An inductive coding process was used to look for themes that may emerge from the participants' interview data. This chapter presents an overview of the research problem, operationalization of theoretical constructs, research purpose and questions, research design, population and sampling selection, instrumentation to be used, data collection procedures, data analysis, privacy and ethical considerations, and the research design limitations of the study.

Overview of the Research Problem

In light of the growth of STEM programs over the last 17 years, a relatively recent trend occurred in the attempt to integrate the arts within STEM. The trend to incorporate art within STEM education may originate from the downsizing of art programs, but STEAM appears to bring new vitality to the arts by facilitating student interest with STEM (Sochacka, Guyotte, & Walther, 2016). However, a concern for the consideration of arts in STEM education calls into question the reciprocity of benefits between the arts and STEM (Guyotte et al., 2015). In contrast to STEAM, the STEM initiative started on the premise the U.S. was falling behind other developed countries in the areas if science, technology, engineering, and mathematics, and therefore, a national mandate like the Competes Act aimed to promote STEM related educational programs was initiated (Wynn & Harris, 2013). Proponents pushing for STEM education believe such programs will create prepared and competitive students to enter into a growing STEM related workforce (Brown et al., 2011). Student workforce preparedness relies on the support and awareness of secondary and postsecondary teachers as they can expose students to career resources and possible job opportunities (Sondergeld et al., 2016).

Operationalization of Theoretical Constructs

The study consisted of four constructs: (a) STEM awareness and STEM resource awareness (AR), (b) success in college and careers (PR), (c) STEM careers and workforce (CW), and the benefits of art and STEM. STEM awareness and STEM resource awareness (refers to: (a) the availability of STEM resources, (b) scholarships, (c) websites, (d) vocational career opportunities, (e) recruitment, and (f) other online tools. Preparation of students for success in college and careers refers to perspectives: (a) of student preparedness, (b) student knowledge of STEM careers, (c) schools effectiveness of teaching STEM, (d) whether standardized assessments adequately asses STEM knowledge and skills, (e) whether K-12 schools equip students to be critical thinkers, and (f) community partners making real-world connections with K-12 STEM education (Sondergeld & Johnson, 2014). Careers and workforce in STEM awareness regarding: (a) STEM business' provision of incentives to promote STEM careers, (b) STEM job availability, (c) STEM career availability for women and minority groups, (d) fulfillment of skilled workers in STEM fields, (e) STEM career availability for local K-12 students, (f) access to STEM education, and (g) STEM careers as priority for local schools (Sondergeld & Johnson, 2014). These constructs were measured by using the *STEM Awareness and Community Survey* (SACS).

Research Purpose and Questions

The purpose of this study was to identify STEM awareness and perceptions of secondary art educators. The study addressed the following research questions:

1: To what extent are secondary art educators aware of STEM and STEM resources?

2: To what extent are secondary art educators aware of student success in college and careers related to STEM?

3: To what extent are secondary art educators aware of the STEM careers and workforce?

4: How do secondary art educators perceive the benefits of art in relation to STEM?

Research Design

For this study, the researcher employed a sequential mixed-methods design (QUAN→qual). A mixed methods study allows for capturing participant's point of view, offset weaknesses of one research modality, and offer a comprehensive collection of data. A purposeful sample of secondary art educators in the state of Texas were solicited to complete the *STEM Awareness and Community Survey* (SACS), which assesses STEM awareness at multiple levels of STEM related industries and educational communities. In addition, semi-structured interviews were conducted with participants to discover art educator's view on the benefits of art as it relates to STEM. Collected survey data was analyzed using descriptive statistics (frequencies and percentages), and two-tail independent t-tests.

Population and Sample

The population for this study was based on 2017-2018 employed fine arts teacher demographics reported by the Texas Education Agency (TEA). The total number of teachers categorized as fine arts teachers was 38,980. Table 3.1 reports gender with 74.25% (n = 28,943) indicating they were female, and 25.75% (n = 10,037) indicating they were male. In regards to race/ethnicity there were: 7.04% (n = 2,745) African

American, 29.98% (n = 11,686) Hispanic, 60.04% (n = 23,404) White, 0.34% (n = 461) American Indian/Alaska Native, 1.18% (n = 461) Asian, 0.01% (n = 51) Pacific Islander, and 1.29% (n = 501) two or more races/ethnicities. Certification training experience is reflected in Table 3.3. In regards to teacher certification, 76.41% (n = 28,943) were certified through a university program and 23.59% (n = 10,037) obtained certification through an alternate program. A purposeful sample of secondary art educators in the state of Texas was solicited to participate in this study. The inclusion criteria called for the participants to be art educators who teach in public school settings, full time, and certified in EC-12 art.

Table 3.1

Texas Employed Teacher Demographics (Gender)

Category	n	%
Female	28,943	74.25
Male	10,037	25.75
Totals	38,980	100.00

Table 3.2

Texas Employed Teacher Demographics (Race/Ethnicity)

Category	n	%
Black/African American	2,745	7.04
White	23,404	60.04
Hispanic/Latino	11,686	29.98
Asian	461	1.18
American Indian/ Alaska Native	132	0.34
Pacific Islander	51	0.01
Two or more ethnicities	501	1.29
Totals	38,980	100.00

Table 3.3

Texas Employed Teacher Demographics (Certification)

Category	n	%
Standard	28,943	76.41
Alternate	10,037	23.59
Totals	38,980	100.00

Participant Selection

Participants who are members of the Texas Art Educators Association (TAEA) were selected for this study. Participants must be art educators currently teaching in the state of Texas at the secondary level. The demographic portion of the survey was used to filter participants who reflected the studies' requirements. The interviewees were selected based on their diverse professional and educational backgrounds. Professionally, interviewees possessed teaching certification from an accredited program through a university certification program or alternative certification route. Participants represented a range of teaching experience from new teachers to veteran teachers (20 years or more). In regards to educational backgrounds, interviewees held either bachelor's or master's level degrees.

Instrumentation

The STEM Awareness and Community Survey (SACS), developed by Sondergeld and Johnson (2014) is a validated survey, which measures STEM awareness using 4 subscales. The SACS measures: (a) industry engagement in STEM education (IE), (b) STEM awareness and STEM resource awareness (AR), (c) preparation for student success in college and careers (PR), and (d) regional STEM careers and workforce (CW) (Sondergeld & Johnson, 2014). The purpose of the SACS was to build community awareness and support regarding STEM investments. The constructs for the instrument was initially developed by sending out 8 open-ended questions to K-12 participants.

The initial development of SACS utilized three parallel versions to assess K-12 teachers, higher education faculty, and members from the business community in order to determine their beliefs toward STEM awareness and support. Initially all surveys use for pilot were with their appropriate audiences. The initial development used a convenience sample of 72 participants: (a) 39 K-12 teachers, (b) 17 higher education faculty, and (c) 16 business community members.

The initial surveys contained 63 items on a traditional 1–5 point Likert-scale (strongly disagree, disagree, neutral, agree, strongly agree). The 63 items included demographic and opened-ended questions, which would later be revised after the subsequent pilots. After the initial survey, the first pilot utilized the Rasch rating scale model and was used to achieve unidimensionality, item and person fit, and general scale functioning. The use of Rasch modeling scale resulted in the collapse of: (a) disagree and (b) neutral making the SACS a 1-4 point Likert scale (strongly disagree, disagree, agree, strongly agree). The second pilot consisted of 39 items, which would eventually end up as the final version of the SACS.

Rasch measurements were used over classical test theory because it can used for a much larger population. The use of Rasch measurements called for raw scores from the pilot survey to be converted into logits utilizing the SACS ruler variable map. In regards to internal consistency, "mean square infit and outfit of .6-1.4 are acceptable" (Sondergeld & Johnson, 2014, p. 590). The final version of SACS is a 39-item survey with four subscales: (a) 8 items - IE, (b) 13 items - AR, (c) 6 items - PR, and (d) 12 items - CW. The final SACS used a 4-point Likert-scale (1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree).

Data Collection Procedures

Quantitative

Prior to data collection, the researcher gained approval from the University of Houston-Clear Lake's (UHCL's) Committee for the Protection of Human Subjects (CPHS). Next, a database consisting of Texas secondary art educators' emails was compiled using the email database of TAEA. The researcher disseminated an electronic link containing access to the SACS survey through the use of Qualtrics. The purpose of the study, voluntary participation, the timeframe for completing the survey, as well as ethical and confidentiality considerations was communicated to participants through email cover letter.

An outline for consent was created and submitted to participants requiring an electronic signature to confirm their participation. A demographic information survey was requested to be completed at the discretion of the participant. The approximate time to complete the demographic information and SACS was approximately 15-20 minutes. Teachers were provided with an electronic link survey which also contained the survey cover letter.

The survey responses were collected over a six-week period. The initial survey was disseminated to teachers at the end of September 2019. Follow-up emails were sent to teachers at the two- and four-week mark during the data collection time period. Upon receipt of the survey responses, the data was entered into quantitative research software Statistical Package for the Social Sciences (SPSS) for further analysis. All data was secured in a password-protected folder on the researcher's computer and in the researcher's office within a locked file cabinet at all times. At the conclusion of the study, the data will be maintained by the researcher for five years, and then destroyed.

Qualitative

Teachers were purposefully selected in order to get a varied range of diverse demographics. Years of service, educational background, professional experience, and type of certification program was taken into consideration in the selection of participants. The participants were emailed the Consent to Participate in Research forms via email, and asked to email the signed forms to the investigator prior to participating in the interview portion of the study. In the survey cover letter, the interviewees were informed topics to be covered during the interview (college and career preparedness, STEM awareness and STEM resource awareness, STEM workforce, and the benefit of art and STEM). Participants were given pseudonyms from famous artists to insure confidentiality.

The individual interviews took place face to face. The interviews were recorded on two devices to ensure recording. 15 interviewees were selected from high schools based on their survey responses. The interviews lasted approximately 30 to 45 minutes. The interviews were transcribed through a digital service, and later edited by the researcher for accuracy. The transcribed documents were saved by the interviewees initials and uploaded into NVivo for analysis.

Data Analysis

Quantitative Analysis

In order to answer research questions 1-3, SPSS was used to analyze the collected quantitative data survey. Descriptive statistics (frequencies and percentages) were used to calculate participant awareness regarding STEM and STEM resources (AR), student success in college and careers related to STEM (PR), and STEM careers and workforce (CW). To determine if there was a statistically significant mean difference between teacher's awareness and (a) teacher's educational background and (b) certification training, a two-tailed independent t-tests was conducted. The independent variable for educational background was divided into two groups: (a) bachelor's degree and (b) master's degree. The independent variable for certification training was divided into two groups: (a) university certification program and (b) alternative certification program. The dependent variables: (a) STEM and STEM resources (AR), (b) student success in college and careers related to STEM (PR), and (c) STEM careers and workforce (CW) was continuous in measurement. Cohen's d and the coefficient of determination (r^2) were used to determine the effect size. A significant value of 0.05 was used to determine the statistically significance.

Qualitative

Following the analysis of the quantitative data, the findings were utilized to develop interview questions in an attempt to understand how art teachers perceive the benefits of art and STEM. To answer research question four, qualitative data was gathered from the interviews, examined, analyzed, and coded for themes. The data was sorted and categorized by themes. The coding process utilized NVivo and inductively creating categorical codes. After identifying the appropriate codes, emphasis was placed on the searching deductively for themes and patterns from the data (Coffey & Atkinson, 1996). Once the categories are established, codes were organized into subcategories. Themes were supported by participant responses and compared to their survey responses for analysis. In addition, participants interview responses were compared to their survey responses and recorded for discrepancies.

Qualitative Validity

In regards to qualitative data, internal validity was established using triangulation and member checking. Triangulation was achieved by comparing interview responses with initial responses from correlating survey data. Member checking was accomplished by submitting the completed transcribed interviews to the participants for review. Participants resubmitted any changes regarding their responses to best reflect their views. External validity was established by ensuring variation of participant selection. Through survey responses, each selected participant represented a variety of educational backgrounds, teaching experiences, age, and ethnicities.

Privacy and Ethical Considerations

Prior to the collection of any data, the researcher gained approval from the UHCL's CPHS. The researcher asked and received written approval for the use of the pre-existing SACS instrument. Participants were given a survey cover letter (See appendix B), informing them they have been selected to participate in the STEM Awareness in Art Educators study. The survey cover letter was sent via email. The survey cover letter informed them to participate in a survey and an interview. Prior to participating in the study, participants were required to fill out and submit the Informed Consent to Participate in Research form (See appendix F), which includes consent to participate in the survey and the interview. The participants were emailed the Consent to Participate in Research forms, and asked to email the signed forms to the investigator prior to participating in the study. The data collected will remain securely locked in a cabinet and encrypted on a flash drive in the researcher's office. The researcher will maintain the data for 5 years as required by the CPHS. After the deadline has passed the researcher will destroy all data files associated with the study.

Research Design Limitations

There are several potential limitations to the design of this research. First, the level of honesty in the individual interviews effects the validity of the findings. If interview data does not honestly portray participants perspectives then validity can be skewed during triangulation. Second, there were no guarantee all secondary art educators received correspondence in order to complete the SACS. The contact information compiled relied on public contact email addresses to be up to date as it relates to the employment of the institution's art educators. Third, sample bias might exist since the participants were only selected from TAEA. A comprehensive list of contacts from specific regions or districts could have ensured a deeper sense of coverage. Fourth, survey items might have been too broadly applicable to education, therefore, not capturing specifics of STEM education.

Conclusion

The purpose of this study is to identify STEM experiences of secondary art educators. This chapter identified the need to further examine the relationship amongst the constructs. In order to better understand the art educator's awareness of STEM as it relates to the community, both the quantitative and qualitative findings were essential to the study. In Chapter IV, surveys and interviews were analyzed and discussed in further detail.

CHAPTER IV:

RESULTS

The purpose of this study was to identify STEM experiences of secondary art educators. This chapter highlights the quantitative and qualitative data findings. The participants' demographics are first described, followed by results of the data analysis. This chapter presents the data analysis for each of the four research questions, and concludes with a summary of the findings.

Participant Demographics

The *STEM Awareness and Community Survey* (SACS) was e-mailed to secondary art teachers across the state of Texas. Out of the 2,633 art teachers included in the distribution list, 352 responded to the survey resulting in a response rate of 13.4%. Out of the 352 respondents, 141 were removed due to missing data (25% or greater of responses were unanswered). Table 4.1 provides specific demographic data for the participants of the study. Of the 211 participants, 209 indicated a gender based on data obtained from the survey. One hundred fifty-six teachers indicated they were female (73.9%), 50 teachers indicated they were male (23.7%), and three indicated other (1.4%). Of the 211 teacher participants, 209 indicated their race/ethnicity: five (2.4%) African American, 43 (20.4%) Hispanic, 141 (66.8%) White, one (0.5%) Native American, three (1.4%) Asian/Pacific Islander, eight (3.8%) two or more ethnicities, and eight (3.8%) indicated other.

Table 4.1

Gender and Race/Ethnicity of All Participants

	Frequency (*n*)	Percentage (%)
Total Participants	211	100
Male	50	23.7
Female	156	73.9
Other	3	1.4
Missing	2	0.9
African American	5	2.4
Hispanic	43	20.4
White	141	66.8
Native American	1	0.5
Asian/Pacific Islander	3	1.4
Two or more	8	3.8
Other	8	3.8
Missing	2	0.9

Educational experience was also recorded in the demographic section of the survey and reflected in Table 4.2. For the highest degree held, 59.2% (n = 125) were Bachelor's degrees, 39.3% (n = 83) were Master's degrees, and 0.5% (n = 1) held a Doctoral degree. Certification training experience is reflected in Table 4.3. In regards to teacher certification, 65.4% (n = 138) were certified through a university program, while 33.6% (n = 71) obtained certification through an alternate program.

Table 4.2

Educational Experience of the Participants

Degree	Frequency (*n*)	Percentage (%)
Bachelors	125	59.2
Masters	83	39.3
Doctorate	1	0.5
Incomplete	2	0.9

Table 4.3

Certification Training Experience of Participants (%)

Certification Program	Frequency (*n*)	Percentage (%)
University Program	138	65.4
Alternative Program	71	33.6
Incomplete	2	0.9

In regards to interviewee demographics, of the 10 participants, nine indicated a gender based on data obtained from the survey. Seven teachers indicated they were female (70.0%), one teacher indicated they were male (10.0%), and one indicated other (10.0%). All 10 teacher participants indicated their race/ethnicity; two teachers (20.0%) indicated Hispanic, seven teachers (70.0%) indicated White, and one (10.0%) indicated two or more ethnicities. In terms of educational background, six teachers (60.0%) earned bachelor’s degrees and four (40.0%) teachers held master’s degrees. In addition, six teachers (60.0%) earned teacher certification in EC-12 through a university program, and four (40.0%) were certified through an alternative certification program.

Table 4.4

Gender and Race/Ethnicity of Interviewees

	Frequency (*n*)	Percentage (%)
Total Participants	10	100
Male	1	10.0
Female	7	70.0
Other	1	10.0
Missing	1	10.0
Hispanic	2	20.0
White	7	70.0
Two or more	1	10.0

Table 4.5

Educational Experience of Interviewees

Degree	Frequency (*n*)	Percentage (%)
Bachelors	6	60.0
Masters	4	40.0

Table 4.6

Certification Training Experience of Interviewees

Certification Program	Frequency (*n*)	Percentage (%)
University Program	6	60.0
Alternative Program	4	40.0

Research Question One

Research question one, *To what extent are secondary art educators aware of STEM and STEM resources?*, was answered by using descriptive statistics and a two-tailed independent t-test. The survey section relating to *STEM awareness and STEM resource awareness* included 13-items using a 4-point Likert scale (1 = *Strongly Disagree,* 2 = *Disagree,* 3 = *Agree,* 4 = *Strongly Agree*). Table 4.4 and Table 4.5 respectively display the percentages and frequencies of art educator's responses in expanded and collapsed form on perceptions related to STEM awareness and STEM resource awareness. Table 4.4 shows the collapsed results of the *STEM awareness and STEM resource awareness* portion of the survey to examine the frequencies and percentages. The responses related to *STEM awareness and STEM resource awareness* are provided below.

Art educators (90.0%) *Agreed/Strongly Agreed* their school district and region understands the importance of STEM education. Moreover, 85.3% *Agreed/Strongly Agreed* more work needs to be completed to spread awareness of STEM education. Art educators (90.5%) *Agreed/Strongly Agreed* that increasing the STEM talent pool is necessary for economic vitality. In terms of student success, 91.5% of art educators *Agreed/Strongly Agreed* STEM skills were essential. In addition, 86.2% *Agreed/Strongly*

Agreed students with postsecondary education are more likely to secure a career in a STEM field, with 83.9% responding *Agree/ Strongly Agree* higher education institutions offer scholarships for students to pursue STEM degrees in their region. Art educator's (78.2%) believed STEM education web sites were available in their region. Furthermore, 74.4% of art educators reported information on regional STEM career opportunities were available online. The highest level of disagreement (49.3%) was in regards to local organizations recruitment of STEM talent online.

Table 4.7

Expanded Responses to STEM Awareness and STEM Resource Awareness (AR) for All Participants (%)

Survey Item	Strongly Disagree	Disagree	Agree	Strongly Agree
1. My school district understands the importance of STEM education.	1.4 (n = 3)	8.5 (n = 18)	54.5 (n = 115)	35.5 (n = 75)
2. The schools in this region understand the importance of STEM education.	0.9 (n = 2)	9.0 (n = 19)	64.5 (n = 136)	25.6 (n = 54)
3. Parents in this region understand the importance of STEM education.	7.1 (n = 15)	37.0 (n =78)	43.6 (n = 92)	12.3 (n = 26)
4. More work needs to be completed to spread awareness of STEM education.	4.7 (n = 10)	10.0 (n = 21)	50.2 (n = 106)	35.1 (n = 74)
5. STEM skills are integral to student success today.	1.4 (n = 3)	7.1 (n = 15)	51.2 (n = 108)	40.3 (n = 85)
6. Increasing the STEM talent pool is necessary for economic vitality.	1.9 (n = 4)	7.6 (n = 16)	54.0 (n = 114)	36.5 (n = 77)

7. Students with postsecondary education are more likely to secure a career in a STEM field.	1.4 (n = 3)	12.3 (n = 26)	52.1 (n = 110)	34.1 (n = 72)
8. There are higher education institutions that offer scholarships for students to pursue STEM degrees in my region	0.5 (n = 1)	15.6 (n = 33)	66.4 (n = 140)	17.5 (n = 37)
9. There are STEM education Web sites available for this region that include activities for teachers and students.	1.9 (n = 4)	19.9 (n = 42)	67.8 (n = 143)	10.4 (n = 22)
10. Information on regional STEM career opportunities is available online.	1.9 (n = 4)	23.7 (n = 50)	64.0 (n = 135)	10.4 (n = 22)
11. Local organizations recruit STEM talent online.	3.8 (n = 8)	45.5 (n = 96)	45.5 (n = 96)	5.2 (n = 11)
12. Information related to STEM opportunities in my region is available online.	3.3 (n = 7)	30.3 (n = 64)	58.3 (n = 123)	8.1 (n = 17)
13. There are other STEM online tools available to this region.	2.8 (n = 6)	27.0 (n = 57)	63.5 (n = 134)	6.6 (n = 14)

Table 4.8

Collapsed Responses to STEM Awareness and STEM Resource Awareness (AR) for All Participants (%)

Survey Item	Strongly Disagree/Disagree	Agree/Strongly Agree
1. My school district understands the importance of STEM education.	9.9 (n = 21)	90.0 (n = 190)
2. The schools in this region understand the importance of STEM education.	9.9 (n = 21)	90.0 (n = 190)
3. Parents in this region understand the importance of STEM education.	44.1 (n = 93)	55.9 (n = 118)
4. More work needs to be completed to spread awareness of STEM education.	14.7 (n = 31)	85.3 (n = 180)
5. STEM skills are integral to student success today.	8.5 (n = 18)	91.5 (n = 193)
6. Increasing the STEM talent pool is necessary for economic vitality.	9.5 (n = 20)	90.5 (n = 191)
7. Students with postsecondary education are more likely to secure a career in a STEM field.	13.7 (n = 29)	86.2 (n = 182)

8. There are higher education institutions that offer scholarships for students to pursue STEM degrees in my region.	16.1 (n = 34)	83.9 (n = 177)
9. There are STEM education Web sites available for this region that include activities for teachers and students.	21.8 (n = 46)	78.2 (n = 165)
10. Information on regional STEM career opportunities is available online.	25.6 (n = 54)	74.4 (n = 157)
11. Local organizations recruit STEM talent online.	49.3 (n = 104)	50.7 (n = 107)
12. Information related to STEM opportunities in my region is available online.	33.6 (n = 71)	66.4 (n = 140)
13. There are other STEM online tools available to this region.	29.8 (n = 63)	70.1 (n = 144)

Teachers with Bachelor's Degrees

Art educators with bachelor's degrees (91.2%) *Agreed/Strongly Agreed* their school district understands the importance of STEM education, and 89.6% of schools in the region understood the importance of STEM. However, responses were split in regards to parents understanding the importance of STEM with 49.6 reporting *Strongly Disagree/Agree*. A majority of teachers (87.2%) *Agreed/Strongly Agreed on* more work needs to be completed to spread awareness of STEM education. *Agreed/Strongly Agreed perceptions* (92.0%) indicated increasing the STEM talent pool is necessary for economic vitality. In terms of student success, 91.4% of art educators *Agreed/Strongly Agreed* STEM skills were essential, 89.6% *Agreed/Strongly Agreed* students with postsecondary education are more likely to secure a career in a STEM field, and 84.8% responding *Agree/ Strongly Agree* higher education institutions offer scholarships for students to pursue STEM degrees. A majority of teachers (77.6%) believed STEM education web sites were available in their region. Furthermore, 77.6% of art educators reported *Agree/Strongly Agree* regarding information on regional STEM career opportunities available online. Finally, art educators (50.4%) responded *Strongly Disagree/disagree* in regards to local organizations recruitment of STEM talent online.

Teachers with Master's Degrees

Art educators with master's degrees (88.0%) *Agreed/Strongly Agreed* their school district understands the importance of STEM education, and 90.3% of schools in the region understood the importance of STEM. *Strongly Disagreed/Disagreed* perceptions (31.6%) were recorded regarding parents understanding the importance of STEM. Art educators (83.1%) *Agreed/Strongly Agreed* more work needs to be completed to spread awareness of STEM education. In addition, art educators (89.1%) *Agreed/Strongly Agreed* that increasing the STEM talent pool is necessary for economic vitality. In terms of student success, 92.8% of art educators *Agreed/Strongly Agreed* STEM skills were essential, and 80.7% *Agreed/Strongly Agreed* students with postsecondary education are more likely to secure a career in a STEM field. Only 18.1% *Strongly Disagreed/ Disagreed* higher education institutions offer scholarships for students to pursue STEM degrees in their region. *Agree/Strongly Agree* perceptions (78.3%) believed STEM education web sites were available in their region. Furthermore, 67.4% of art educators reported *Agree/Strongly Agree* regarding information on regional STEM career opportunities available online, but 51.8% *Strongly Disagreed/Disagreed* in regards to local organizations recruitment of STEM talent online.

Comparison of Teachers' Educational Backgrounds

Overall, the majority of art teachers *Agreed/Strongly Agreed* with the items on the survey. The only exception was teachers with bachelor's degrees who *Strongly Disagreed/Disagreed* with local organizations recruitment of STEM online. The largest difference between groups showed teacher's with master's degrees (63.9%) reporting *Agree/Strongly Agreed* in regards to parents understanding on the importance of STEM compared to teacher's with bachelor's degrees (50.4%). Tables 4.6 and 4.7 present the percentages and frequencies of teacher's responses related to the subscale of STEM awareness and STEM resource awareness per teacher educational background.

Table 4.9

Participant Responses to STEM Awareness and STEM Resource Awareness per Teacher Educational Background (%)

		Strongly Disagree	Disagree	Agree	Strongly Agree
1. My school district understands the importance of STEM education.	Bachelor	0.8 (n = 1)	8.0 (n = 10)	59.2 (n = 74)	32.0 (n = 40)
	Master	2.4 (n = 2)	9.6 (n = 8)	47.0 (n = 39)	41.0 (n = 34)
2. The schools in this region understand the importance of STEM education.	Bachelor	0.8 (n = 1)	9.6 (n = 12)	67.2 (n = 84)	22.4 (n = 28)
	Master	1.2 (n = 1)	8.4 (n = 7)	60.2 (n = 50)	30.1 (n = 25)
3. Parents in this region understand the importance of STEM education.	Bachelor	9.6 (n =12)	40.0 (n = 50)	40.0 (n = 50)	10.4 (n = 13)
	Master	3.6 (n = 3)	32.5 (n = 27)	49.4 (n = 41)	14.5 (n = 12)
4. More work needs to be completed to spread awareness of STEM education.	Bachelor	2.4 (n = 3)	10.4 (n = 13)	49.6 (n = 62)	37.6 (n = 47)
	Master	8.4 (n = 7)	8.4 (n = 7)	51.8 (n = 43)	31.3 (n = 26)

5. STEM skills are integral to student success today	Bachelor	0.8 (n =1)	8.8 (n = 11)	48.8 (n = 61)	41.6 (n = 52)
	Master	2.4 (n = 2)	4.8 (n = 4)	54.2 (n = 45)	38.6 (n = 32)
6. Increasing the STEM talent pool is necessary for economic vitality.	Bachelor	1.6 (n = 2)	6.4 (n = 8)	52.8 (n = 66)	39.2 (n = 49)
	Master	2.4 (n = 2)	8.4 (n = 7)	56.6 (n = 47)	32.5 (n = 27)
7. Students with postsecondary education are more likely to secure a career in a STEM field.	Bachelor	1.6 (n = 2)	8.8 (n = 11)	52.0 (n = 65)	37.6 (n = 47)
	Master	1.2 (n = 1)	18.1 (n = 15)	53.0 (n = 44)	27.7 (n = 23)
8. There are higher education institutions that offer scholarships for students to pursue STEM degrees in my region	Bachelor	0.8 (n = 1)	14.4 (n = 18)	65.6 (n = 82)	19.2 (n = 24)
	Master	0.0 (n = 0)	18.1 (n = 15)	67.5 (n = 56)	14.5 (n = 12)
9. There are STEM education Web sites available for this region that include activities for teachers and students.	Bachelor	0.8 (n = 1)	21.6 (n = 27)	68.8 (n = 86)	8.8 (n = 11)
	Master	3.6 (n = 3)	18.1 (n = 15)	67.5 (n = 56)	10.8 (n = 9)

10. Information on regional STEM career opportunities is available online.	Bachelor	1.6 (n = 2)	20.8 (n = 26)	66.4 (n = 83)	11.2 (n = 14)
	Master	2.4 (n = 2)	28.9 (n = 24)	59.0 (n = 49)	9.6 (n = 8)
11. Local organizations recruit STEM talent online.	Bachelor	4.0 (n = 5)	46.4 (n = 58)	45.6 (n = 57)	4.0 (n = 5)
	Master	3.6 (n = 3)	44.6 (n = 37)	44.6 (n = 37)	7.2 (n = 6)
12. Information related to STEM opportunities in my region is available online.	Bachelor	2.4 (n = 3)	32.0 (n = 40)	58.4 (n = 73)	7.2 (n = 9)
	Master	4.8 (n = 4)	27.7 (n = 23)	59.0 (n = 49)	8.4 (n = 7)
13. There are other STEM online tools available to this region.	Bachelor	2.4 (n = 3)	28.8 (n = 36)	63.2 (n = 79)	5.6 (n = 7)
	Master	3.6 (n = 3)	24.1 (n = 20)	63.9 (n = 53)	8.4 (n = 7)

Table 4.10

Collapsed Participant Responses to STEM Awareness and STEM Resource Awareness per Teacher Educational Background (%)

		Strongly Disagree / Disagree	Agree / Strongly Agree
1. My school district understands the importance of STEM education.	Bachelor	8.8 (n = 11)	91.2 (n = 114)
	Master	12.0 (n = 10)	88.0 (n = 73)
2. The schools in this region understand the importance of STEM education.	Bachelor	10.4 (n = 13)	89.6 (n = 112)
	Master	9.6 (n = 8)	90.3 (n = 75)
3. Parents in this region understand the importance of STEM education.	Bachelor	49.6 (n = 62)	50.4 (n = 63)
	Master	36.1 (n = 30)	63.9 (n = 53)
	Bachelor	12.8 (n = 26)	87.2 (n = 109)

4. More work needs to be completed to spread awareness of STEM education.	Master	16.8 (n = 14)	83.1 (n = 69)
5. STEM skills are integral to student success today	Bachelor	9.6 (n = 12)	91.4 (n = 113)
	Master	7.2 (n = 6)	92.8 (n = 77)
6. Increasing the STEM talent pool is necessary for economic vitality.	Bachelor	8.0 (n = 10)	92.0 (n = 115)
	Master	10.8 (n = 9)	89.1 (n = 74)
7. Students with postsecondary education are more likely to secure a career in a STEM field.	Bachelor	10.4 (n = 13)	89.6 (n = 112)
	Master	19.3 (n = 16)	80.7 (n = 67)
8. There are higher education institutions that offer scholarships for students to pursue STEM degrees in my region	Bachelor	15.2 (n = 19)	84.8 (n = 106)
	Master	18.1 (n = 15)	82.0 (n = 68)
9. There are STEM education Web sites available for this region that include activities for teachers and students.	Bachelor	22.4 (n = 28)	77.6 (n = 97)
	Master	21.7 (n = 18)	78.3 (n = 65)

10. Information on regional STEM career opportunities is available online.	Bachelor	22.4 (n = 28)	77.6 (n = 97)
	Master	31.3 (n = 26)	68.6 (n = 57)
11. Local organizations recruit STEM talent online.	Bachelor	50.4 (n = 63)	49.6 (n = 62)
	Master	48.2 (n = 40)	51.8 (n = 42)
12. Information related to STEM opportunities in my region is available online.	Bachelor	34.4 (n = 43)	65.6 (n = 82)
	Master	32.5 (n = 27)	67.4 (n = 56)
13. There are other STEM online tools available to this region.	Bachelor	31.2 (n = 39)	68.8 (n = 86)
	Master	27.7 (n = 23)	72.3 (n = 60)

Teachers with University Certification

Art educators with university certification training (92.0%) *Agreed/Strongly Agreed* their school district understands the importance of STEM education, 92.8% *Agreed/Strongly Agreed* schools in the region understood the importance of STEM, but 39.1% *Strongly Disagreed/Disagreed* parents understanding the importance of STEM. In addition, 83.4% *Agreed/Strongly Agreed* more work needs to be completed to spread awareness of STEM education. *Agreed/Strongly Agreed* perceptions (89.8%) indicated increasing the STEM talent pool is necessary for economic vitality, 91.3% *Agreed/Strongly Agreed* STEM skills were essential, and 86.9% *Agreed/Strongly Agreed* students with postsecondary education are more likely to secure a career in a STEM field. Moreover, 85.5% responding *Agree/Strongly Agree* higher education institutions offer scholarships for students to pursue STEM degrees in their region. *Agree/Strongly Agree* perceptions (78.2%) believed STEM education web sites were available in their region. Furthermore, 73.2% of art educators reported *Agree/Strongly Agree* regarding information on regional STEM career opportunities available online, but 51.5% responded *Strongly Disagree/Disagree* in regards to local organizations recruitment of STEM talent online.

Teachers with Alternative Certification

Art educators with alternative certification (85.9%) *Agreed/Strongly Agreed* their school district understands the importance of STEM education, and 84.5% of schools in the region understood the importance of STEM. However, responses were higher in regards to parents understanding the importance of STEM with 54.9% reporting *Strongly Disagree/Disagree*. Art educators (91.3%) *Agreed/Strongly Agreed* more work needs to be completed to spread awareness of STEM education. Moreover, art educators (92.9%) *Agreed/Strongly Agreed* that increasing the STEM talent pool is necessary for economic vitality. In terms of student success, 91.6% of art educators *Agreed/Strongly Agreed* STEM skills were essential, and 84.5% *Agreed/Strongly Agreed* students with postsecondary education are more likely to secure a career in a STEM field. Only 19.7% *Strongly Disagreed/Disagreed* higher education institutions offer scholarships for students to pursue STEM degrees in their region. A majority of teachers *Agreed/Strongly Agreed* (77.5%) that STEM education web sites were available in their region, and 76.0% of art educators reported *Agree/Strongly Agree* regarding information on regional STEM career opportunities available online. Furthermore, 52.1% of teachers reported *Strongly Disagree/Disagree* in regards to local organizations recruitment of STEM talent online.

Comparison of Teachers' Certification Training

Overall, the majority of art teachers *Agreed/Strongly Agreed* with the items on the survey. The only exception was teachers with alternative certification training who *Strongly Disagreed/Disagreed* with parents understanding the importance of STEM. The largest difference between groups showed teacher's with university certification degrees (60.9%) reporting *Agreed/Strongly Agreed* in regards to parents understanding on the importance of STEM compared to alternatively certified teachers (45.0%). Tables 4.8 and 4.9 present the percentages and frequencies of teacher's responses related to the subscale of STEM awareness and STEM resource awareness per teacher certification.

Table 4.11

Participant Responses to STEM Awareness and STEM Resource Awareness per Teacher Certification (%)

		Strongly Disagree	Disagree	Agree	Strongly Agree
1. My school district understands the importance of STEM education.	University	1.4 (n = 2)	6.5 (n = 9)	50.7 (n = 70)	41.3 (n = 57)
	Alternative	1.4 (n = 1)	12.7 (n = 9)	62.0 (n = 44)	23.9 (n = 17)
2. The schools in this region understand the importance of STEM education.	University	0.7 (n = 1)	6.5 (n = 9)	61.6 (n = 85)	31.2 (n = 43)
	Alternative	1.4 (n = 1)	14.1 (n = 10)	70.4 (n = 50)	14.1 (n = 10)
3. Parents in this region understand the importance of STEM education.	University	3.6 (n =5)	35.5 (n = 49)	46.4 (n = 64)	14.5 (n = 20)
	Alternative	14.1 (n = 10)	40.8 (n = 29)	38.0 (n = 27)	7.0 (n = 5)
4. More work needs to be completed to spread awareness of STEM education.	University	5.8 (n = 8)	10.9 (n = 15)	49.3 (n = 68)	34.1 (n = 47)
	Alternative	2.8 (n = 2)	7.0 (n = 5)	52.1 (n = 37)	38.0 (n = 27)

5. STEM skills are integral to student success today	University	1.4 (n = 2)	7.2 (n = 10)	52.2 (n = 72)	39.1 (n = 54)
	Alternative	1.4 (n = 1)	7.0 (n = 5)	47.9 (n = 34)	43.7 (n = 31)
6. Increasing the STEM talent pool is necessary for economic vitality.	University	2.2 (n = 3)	8.0 (n = 11)	53.6 (n = 74)	36.2 (n = 50)
	Alternative	1.4 (n = 1)	5.6 (n = 4)	54.9 (n = 39)	38.0 (n = 27)
7. Students with postsecondary education are more likely to secure a career in a STEM field.	University	1.4 (n = 2)	11.6 (n = 16)	50.7 (n = 70)	36.2 (n = 50)
	Alternative	1.4 (n = 1)	14.1 (n = 10)	54.9 (n = 39)	29.6 (n = 21)
8. There are higher education institutions that offer scholarships for students to pursue STEM degrees in my region	University	0.7 (n = 1)	13.8 (n = 19)	67.4 (n = 93)	18.1 (n = 25)
	Alternative	0.0 (n = 0)	19.7 (n = 14)	64.8 (n = 46)	15.5 (n = 11)
9. There are STEM education Web sites available for this region that include activities for teachers and students.	University	0.7 (n = 1)	21.0 (n = 29)	68.1 (n = 94)	10.1 (n = 14)
	Alternative	4.2 (n = 3)	18.3 (n = 13)	67.6 (n = 48)	9.9 (n = 7)

10. Information on regional STEM career opportunities is available online.	University	0.0 (n = 0)	26.8 (n = 37)	60.9 (n = 84)	12.3 (n = 17)
	Alternative	5.6 (n = 4)	18.3 (n = 13)	69.0 (n = 49)	7.0 (n = 5)
11. Local organizations recruit STEM talent online.	University	2.2 (n = 3)	46.4 (n = 64)	46.4 (n = 64)	5.1 (n = 7)
	Alternative	7.0 (n = 5)	45.1 (n = 32)	42.3 (n = 30)	5.6 (n = 4)
12. Information related to STEM opportunities in my region is available online.	University	2.9 (n = 4)	30.4 (n = 42)	58.7 (n = 81)	8.0 (n = 11)
	Alternative	4.2 (n = 3)	31.0 (n = 22)	57.7 (n = 41)	7.0 (n = 5)
13. There are other STEM online tools available to this region.	University	2.2 (n = 3)	24.6 (n = 34)	65.9 (n = 91)	7.2 (n = 10)
	Alternative	4.2 (n = 3)	32.4 (n = 23)	57.7 (n = 41)	5.6 (n = 4)

Table 4.12

Collapsed Participant Responses to STEM Awareness and STEM Resource Awareness per Teacher Certification (%)

		Strongly Disagree / Disagree	Agree / Strongly Agree
1. My school district understands the importance of STEM education.	University	7.9 (n = 11)	92.0 (n = 127)
	Alternative	14.1 (n = 10)	85.9 (n = 61)
2. The schools in this region understand the importance of STEM education.	University	7.2 (n = 10)	92.8 (n = 128)
	Alternative	15.5 (n = 11)	84.5 (n = 60)
3. Parents in this region understand the importance of STEM education.	University	39.1 (n = 54)	60.9 (n = 84)
	Alternative	54.9 (n = 39)	45.0 (n = 32)
4. More work needs to be completed to spread awareness of STEM education.	University	16.7 (n = 23)	83.4 (n = 115)
	Alternative	9.8 (n = 7)	90.1 (n = 64)

5. STEM skills are integral to student success today	University	8.6 (n = 12)	91.3 (n = 126)
	Alternative	8.4 (n = 6)	91.6 (n = 65)
6. Increasing the STEM talent pool is necessary for economic vitality.	University	10.2 (n = 14)	89.8 (n = 124)
	Alternative	7.0 (n = 5)	92.9 (n = 66)
7. Students with postsecondary education are more likely to secure a career in a STEM field.	University	13.0 (n = 18)	86.9 (n = 120)
	Alternative	15.5 (n = 11)	84.5 (n = 60)
8. There are higher education institutions that offer scholarships for students to pursue STEM degrees in my region	University	14.5 (n = 20)	85.5 (n = 118)
	Alternative	19.7 (n = 14)	80.3 (n = 57)
9. There are STEM education Web sites available for this region that include activities for teachers and students.	University	21.7 (n = 30)	78.2 (n = 108)
	Alternative	22.5 (n = 16)	77.5 (n = 55)

10. Information on regional STEM career opportunities is available online.	University	26.8 (n = 37)	73.2 (n = 101)
	Alternative	23.9 (n = 17)	76.0 (n = 54)
11. Local organizations recruit STEM talent online.	University	48.6 (n = 67)	51.5 (n = 71)
	Alternative	52.1 (n = 37)	47.9 (n = 34)
12. Information related to STEM opportunities in my region is available online.	University	33.3 (n = 46)	66.7 (n = 92)
	Alternative	35.2 (n = 25)	64.7 (n = 46)
13. There are other STEM online tools available to this region.	University	26.8 (n = 37)	73.1 (n = 101)
	Alternative	36.6 (n = 26)	63.3 (n = 45)

The findings of the two-tailed independent t-test revealed teacher educational background does not influence their awareness to STEM resources, $t(206) = .254$, $p = .800$. A teacher's educational background does not necessarily influence his or her responses to subscale to STEM awareness and STEM resource awareness. The mean score of teachers with bachelor's degrees ($M = 2.97$) was practically the same as the mean score of teachers with master's degrees ($M = 2.96$) meaning teachers with graduate degrees did not possess a stronger sense of items regarding to STEM awareness and STEM resource awareness. Table 4.10 shows the results of the two-tailed independent t-test regarding educational background.

Table 4.13

Teacher Educational Background

Degree	N	M	SD	t-value	df	p-value
Bachelors	125	2.97	0.39	.254	206	.800
Masters	83	2.96	0.38			

*Statistically significant ($p < .05$)

Furthermore, the findings of the two-tailed independent t-test revealed teacher certification training does not influence teacher awareness of STEM resources, $t(207) = 1.54$, $p = .125$. A teacher's educational background does not influence his or her awareness of STEM resources. The mean score of teachers with university certification training ($M = 3.00$) was slightly higher than the mean score of teachers with alternative certification training ($M = 2.91$). Table 4.10 and 4.11 shows the results of the two-tailed independent t-test regarding certification training and educational background in relation to STEM awareness and STEM resource awareness.

Table 4.14

Teacher Certification Program

Certification Program	N	M	SD	t-value	df	p-value
University	138	3.00	0.37	1.54	207	.125
Alternative	71	2.91	0.41			

*Statistically significant ($p < .05$)

Research Question Two

Research question two, *To what extent are secondary art educators aware of student success in college and careers related to STEM?*, was answered by using descriptive statistics and a two-tailed independent t-test. Descriptive statistics (frequencies and percentages) measured secondary art teachers STEM awareness. The survey section relating to *preparation of students for success in college and careers related to STEM* included 6-items using a 4-point Likert scale (1 = *Strongly Disagree,* 2 = *Disagree,* 3 = *Agree,* 4 = *Strongly Agree*). Table 4.12 shows the frequencies and percentages for teachers' responses to the *preparation of students for success in college and careers related to STEM* portion of the survey. Table 4.13 shows the collapsed results of the reparation of *preparation of students for success in college and careers related to STEM* portion of the survey to examine the frequencies and percentages. The responses related to *preparation of students for success in college and careers related to STEM* are provided below.

Art educators (74.4%) *Agreed/Strongly Agreed* about students in this region are prepared by K-12 schools to be successful in postsecondary study. Art educator's awareness were divided regarding community partners engagement in making K-12 STEM education more relevant through providing real-world connections in this region with 45.0% who *Strongly Disagreed/Disagreed* and 55.0% who *Agreed/Strongly Agreed*. Art educators (62.1%) *Disagreed/Strongly Disagreed* about the state standardized tests used in this region's K-12 schools adequately assess STEM knowledge and skills. Tables 4.8 and 4.9 displays the percentages and frequencies of art educator's responses in expanded form and collapsed form respectively on perceptions related to preparation of students for success in college and careers related to STEM.

Table 4.15

Expanded Responses to Preparation of Students for Success in College & Careers (PR) for All Participants (%)

	Strongly Disagree	Disagree	Agree	Strongly Agree
1. Students in this region are prepared by K-12 schools to be successful in postsecondary study (2- or 4-year colleges or universities and technical programs).	4.3 (n = 9)	21.3 (n = 45)	62.6 (n = 132)	11.8 (n = 25)
2. Students in this region are knowledgeable about the STEM careers that will be in high demand when they graduate.	4.3 (n = 9)	34.6 (n = 73)	50.7 (n = 107)	10.4 (n = 22)
3. The K-12 public schools in this region effectively teach students STEM knowledge and skills.	2.8 (n = 6)	32.2 (n = 68)	56.9 (n = 120)	8.1 (n = 17)
4. The state standardized tests used in this region's K-12 schools adequately assess STEM knowledge and skills.	19.9 (n = 42)	42.2 (n = 89)	32.7 (n = 69)	5.2 (n = 11)

5. The K-12 schools in this region prepare students who are critical thinkers and problem solvers.	8.1 (n = 17)	32.2 (n = 68)	51.2 (n = 108)	8.5 (n = 18)
6. Community partners (e.g., business and higher education) are engaged in making K-12 STEM education more relevant through providing real-world connections in this region.	6.6 (n = 14)	38.4 (n = 81)	47.4 (n = 100)	7.6 (n = 16)

Table 4.16

Collapsed Responses to Preparation of Students for Success in College & Careers (PR) for All Participants (%)

	Strongly Disagree /Disagree	Agree/ Strongly Agree
1. Students in this region are prepared by K-12 schools to be successful in postsecondary study (2- or 4-year colleges or universities and technical programs).	25.6 (n = 54)	74.4 (n = 157)
2. Students in this region are knowledgeable about the STEM careers that will be in high demand when they graduate.	38.9 (n = 82)	61.1 (n = 129)
3. The K-12 public schools in this region effectively teach students STEM knowledge and skills.	35.0 (n = 74)	65.0 (n = 137)
4. The state standardized tests used in this region's K-12 schools adequately assess STEM knowledge and skills.	62.1 (n = 131)	37.9 (n = 80)

5. The K-12 schools in this region prepare students who are critical thinkers and problem solvers.	40.3 (n = 85)	59.7 (n = 126)
6. Community partners (e.g., business and higher education) are engaged in making K-12 STEM education more relevant through providing real-world connections in this region.	45.0 (n = 95)	55.0 (n = 116)

Teachers with Bachelor's Degrees

Art educators with bachelor's degrees (75.3%) *Agreed/Strongly Agreed* about students in this region are prepared by K-12 schools to be successful in postsecondary study. In regards to community partners engagement in making K-12 STEM education more relevant through providing real-world connections in this region, teachers responded 48.0% as *Strongly Disagreed/Disagreed*. *Strongly Disagreed/Disagreed* perceptions (63.2%) were recorded in regards to state standardized tests used in this region's K-12 schools to adequately assess STEM knowledge and skills. Teachers (60%) responded *Agree/Strongly Agree* to K-12 preparing students to be critical thinkers and problem solvers, 64.8% *Agreed/Strongly Agreed* to K-12 effectively teaching STEM knowledge and skills, and 60.8% *Agreed/Strongly Agreed* to student's knowledge for the high demand of STEM careers.

Teachers with Master's Degrees

Art educators with master's degrees (72.2%) *Agreed/Strongly Agreed* about students in this region are prepared by K-12 schools to be successful in postsecondary study. The largest reported *Strongly Disagree/Disagree* (40.9%) was in regards to community partners engagement in making K-12 STEM education more relevant through providing real-world connections in this region. Art educators (60.2%) *Strongly Disagreed/Disagreed* about the state standardized tests used in this region's K-12 schools adequately assess STEM knowledge and skills. Teachers (42.1%) responded *Agree/Strongly Agree* to K-12 preparing students to be critical thinkers and problem solvers, 36.1% *Agreed/Strongly Agreed* to K-12 effectively teaching STEM knowledge and skills, and 39.7% *Agreed/Strongly Agreed* to student's knowledge for the high demand of STEM careers.

Comparison of Teachers' Educational Backgrounds

Overall, the majority of art teachers *Agreed/Strongly Agreed* with the items on the survey. The only exception was teachers selecting *Strongly Disagree/Disagree* in regards to the adequacy of state standardized tests assessment STEM knowledge and skills in K-12. The largest difference between groups showed teacher's with master's degrees (40.9%) reporting *Strongly Disagree/Disagree* in regards to community partners engagement in making K-12 STEM education more relevant through providing real-world connections in this region compared to teacher's with bachelor's degrees (48.0%). Tables 4.14 and 4.15 present the percentages and frequencies of teacher's responses related to the subscale of preparation of students for success in college and careers per teacher educational background.

Table 4.17

Responses to Preparation of Students for Success in College & Careers (PR) per Teacher Educational Background (%)

		Strongly Disagree	Disagree	Agree	Strongly Agree
1. Students in this region are prepared by K-12 schools to be successful in postsecondary study (2 - or 4-year colleges or universities and technical programs).	Bachelor	4.0 (n = 5)	20.8 (n = 26)	63.2 (n = 79)	12.0 (n = 15)
	Master	4.8 (n = 4)	22.9 (n = 19)	61.4 (n = 51)	10.8 (n = 9)
2. Students in this region are knowledgeable about the STEM careers that will be in high demand when they graduate.	Bachelor	3.2 (n = 4)	36.0 (n = 45)	52.0 (n = 65)	8.8 (n = 11)
	Master	6.0 (n = 5)	33.7 (n = 28)	48.2 (n = 40)	12.0 (n = 10)
3. The K-12 public schools in this region effectively teach students STEM knowledge and skills.	Bachelor	3.2 (n =4)	32.0 (n = 40)	56.8 (n = 71)	8.0 (n = 10)
	Master	2.4 (n = 2)	33.7 (n = 28)	55.4 (n = 46)	8.4 (n = 7)
4. The state standardized tests used in this region's K-12 schools adequately assess STEM knowledge and skills.	Bachelor	16.8 (n = 21)	46.4 (n = 58)	32.0 (n = 40)	4.8 (n = 6)
	Master	25.3 (n = 21)	34.9 (n = 29)	33.7 (n = 28)	6.0 (n = 5)

5. The K-12 schools in this region prepare students who are critical thinkers and problem solvers.	Bachelor	6.4 (n =8)	33.6 (n = 42)	52.0 (n = 65)	8.0 (n = 10)
	Master	10.8 (n = 9)	31.3 (n = 26)	50.6 (n = 42)	7.2 (n = 6)
6. Community partners (e.g., business and higher education) are engaged in making K-12 STEM education more relevant through providing real-world connections in this region.	Bachelor	8.0 (n = 10)	40.0 (n = 50)	43.2 (n = 54)	8.8 (n = 11)
	Master	4.8 (n = 4)	36.1 (n = 30)	54.2 (n = 45)	4.8 (n = 4)

Table 4.18

Collapsed Responses to Students for Success in College & Careers (PR) per Teacher Educational Background (%)

		Strongly Disagree / Disagree	Agree / Strongly Agree
1. Students in this region are prepared by K-12 schools to be successful in postsecondary study (2- or 4-year colleges or universities and technical programs).	Bachelor	24.8 (n = 31)	75.3 (n = 94)
	Master	27.7 (n = 23)	72.2 (n = 60)
2. Students in this region are knowledgeable about the STEM careers that will be in high demand when they graduate.	Bachelor	39.2 (n = 49)	60.8 (n = 76)
	Master	39.7 (n = 33)	60.2 (n = 50)
3. The K-12 public schools in this region effectively teach students STEM knowledge and skills.	Bachelor	35.3 (n = 44)	64.8 (n = 81)
	Master	36.1 (n = 30)	63.8 (n = 53)
4. The state standardized tests used in this region's K-12 schools adequately assess STEM knowledge and skills.	Bachelor	63.2 (n = 79)	36.8 (n = 46)
	Master	60.2 (n = 50)	39.7 (n = 33)

5. The K-12 schools in this region prepare students who are critical thinkers and problem solvers.	Bachelor	40.0 (n = 50)	60.0 (n = 75)
	Master	42.1 (n = 35)	57.8 (n = 48)
6. Community partners (e.g., business and higher education) are engaged in making K-12 STEM education more relevant through providing real-world connections in this region.	Bachelor	48.0 (n = 60)	52.0 (n = 65)
	Master	40.9 (n = 34)	59.0 (n = 49)

Teachers with University Certification

Art educators with university certification (77.6%) *Agreed/Strongly Agreed* about students in this region are prepared by K-12 schools to be successful in postsecondary study. *Strongly Disagreed/Disagreed* perceptions (39.2%) were reported in regards to community partners engagement in making K-12 STEM education more relevant through providing real-world connections in this region. Art educators (58.7%) *Disagreed/Strongly Disagreed* about the state standardized tests used in this region's K-12 schools to adequately assess STEM knowledge and skills. Teachers (65.9%) responded *Agree/Strongly Agree* to K-12 preparing students to be critical thinkers and problem solvers, 69.6% *Agreed/Strongly Agreed* to K-12 effectively teaching STEM knowledge and skills, and 68.1% *Agreed/Strongly Agreed* to student's knowledge for the high demand of STEM careers.

Teachers with Alternative Certification

Art educators with alternative certification (67.6%) *Agreed/Strongly Agreed* about students in this region are prepared by K-12 schools to be successful in postsecondary study. In regards to community partners engagement in making K-12 STEM education more relevant through providing real-world connections in this region, teachers responded 57.8% as *Strongly Disagreed/Disagreed*. Art educators (69.1%) *Strongly Disagreed/Disagreed* about the state standardized tests used in this region's K-12 schools adequately assess STEM knowledge and skills. Teachers (46.5%) responded *Agree/Strongly Agree* to K-12 preparing students to be critical thinkers and problem solvers, 54.9% *Agreed/Strongly Agreed* to K-12 effectively teaching STEM knowledge and skills, and 46.4% *Agreed/Strongly Agreed* to student's knowledge for the high demand of STEM careers.

Comparison of Teachers' Certification Training

Overall, the majority of art teachers *Agreed/Strongly Agreed* with the items on the survey. The only exception was teachers selecting *Strongly Disagree/Disagree* in regards to the adequacy of state standardized tests assessment STEM knowledge and skills in K-12. The largest difference between groups showed university certified teacher's (31.9%) reporting *Strongly Disagree/Disagree* to student's knowledge regarding STEM careers that will be in high demand when they graduate compared to alternatively certified teachers (53.5%). Tables 4.16 and 4.17 present the percentages and frequencies of teacher's responses related to the subscale of preparation of students for success in college and careers per teacher educational background.

Table 4.19

Participant Responses to Preparation of Students for Success in College & Careers (PR) per Teacher Certification (%)

		Strongly Disagree	Disagree	Agree	Strongly Agree
1. Students in this region are prepared by K-12 schools to be successful in postsecondary study (2- or 4-year colleges or universities and technical programs).	University	2.2 (n = 3)	20.3 (n = 28)	63.8 (n = 88)	13.8 (n = 19)
	Alternative	8.5 (n = 6)	23.9 (n = 17)	60.6 (n = 43)	7.0 (n = 5)
2. Students in this region are knowledgeable about the STEM careers that will be in high demand when they graduate.	University	2.9 (n = 4)	29.0 (n = 40)	55.8 (n = 77)	12.3 (n = 17)
	Alternative	7.0 (n = 5)	46.5 (n = 33)	40.8 (n = 29)	5.6 (n = 4)
3. The K-12 public schools in this region effectively teach students STEM knowledge and skills.	University	2.2 (n = 3)	28.3 (n = 39)	60.9 (n = 84)	8.7 (n = 12)
	Alternative	4.2 (n = 3)	40.8 (n = 29)	47.9 (n = 34)	7.0 (n = 5)
4. The state standardized tests used in this region's K-12 schools adequately assess STEM knowledge and skills.	University	17.4 (n = 24)	41.3 (n = 57)	34.8 (n = 48)	6.5 (n = 9)
	Alternative	25.4 (n = 18)	43.7 (n = 31)	28.2 (n = 20)	2.8 (n = 2)

5. The K-12 schools in this region prepare students who are critical thinkers and problem solvers.	University	5.8 (n = 8)	28.3 (n = 39)	55.8 (n = 77)	10.1 (n = 14)
	Alternative	12.7 (n = 9)	40.8 (n = 29)	42.3 (n = 30)	4.2 (n = 3)
6. Community partners (e.g., business and higher education) are engaged in making K-12 STEM education more relevant through providing real-world connections in this region.	University	5.1 (n = 7)	34.1 (n = 47)	52.9 (n = 73)	8.0 (n = 11)
	Alternative	9.9 (n = 7)	47.9 (n = 34)	36.6 (n = 26)	5.6 (n = 4)

Table 4.20

Collapsed Responses to Preparation of Students for Success in College & Careers (PR) per Teacher Certification (%)

		Strongly Disagree / Disagree	Agree / Strongly Agree
1. Students in this region are prepared by K-12 schools to be successful in postsecondary study (2- or 4-year colleges or universities and technical programs).	University	22.5 (n = 31)	77.6 (n = 107)
	Alternative	32.4 (n = 23)	67.6 (n = 48)
2. Students in this region are knowledgeable about the STEM careers that will be in high demand when they graduate.	University	31.9 (n = 44)	68.1 (n = 94)
	Alternative	53.5 (n = 38)	46.4 (n = 33)
3. The K-12 public schools in this region effectively teach students STEM knowledge and skills.	University	30.5 (n = 42)	69.6 (n = 96)
	Alternative	45.0 (n = 32)	54.9 (n = 39)
4. The state standardized tests used in this region's K-12 schools adequately assess STEM knowledge and skills.	University	58.7 (n = 81)	41.3 (n = 57)
	Alternative	69.1 (n = 49)	31.0 (n = 22)

5. The K-12 schools in this region prepare students who are critical thinkers and problem solvers.	University	36.1 (n = 47)	65.9 (n = 91)
	Alternative	53.5 (n = 38)	46.5 (n = 33)
6. Community partners (e.g., business and higher education) are engaged in making K-12 STEM education more relevant through providing real-world connections in this region.	University	39.2 (n = 54)	60.9 (n = 84)
	Alternative	57.8 (n = 41)	42.2 (n = 30)

The findings of the two-tailed independent t-test revealed teacher educational background does not influence teacher perception of preparation of students for success in college and careers, t(206) = .214, p = .831. A teacher's educational background does not necessarily influence his or her perceptions of student preparedness and success in regards to college and career. The mean score of teachers with bachelor's degrees (M = 2.60) was slightly higher than the mean score of teachers with master's degrees (M = 2.58) meaning teachers with graduate degrees did not possess a stronger perception of student preparedness and success in regards to college and career. Table 4.18 shows the results of the two-tailed independent t-test regarding teacher educational background in relation to subscale preparation of students for success in college and careers.

Table 4.21

Teacher Educational Background

Degree	N	M	SD	t-value	df	p-value
Bachelors	125	2.60	.57	.214	206	.831
Masters	83	2.58	.55			

*Statistically significant (p < .05)

Furthermore, the findings of the two-tailed independent t-test revealed teacher certification training does influence teacher perception of preparation of students for success in college and careers, t(207) = 3.205, p = .002, *d* = .47 (small effect size), r^2 = 0.052. The r^2 value of .052 indicates that 5.2% of the variation in the dependent variable (perceptions of student preparedness and success in regards to college and career) can be explained by the independent variable (teacher certification training). Therefore, a teacher's certification training does influence his or her perceptions of student preparedness and success in regards to college and career. The mean score of teachers with university certification training (M = 2.68) was significantly higher than the mean score of teachers with alternative certification training (M = 2.42) meaning teachers with university certification training maintained a stronger perception of student preparedness and success in regards to college and career. Table 4.19 shows the results of the two-tailed independent t-test regarding teacher certification in relation to subscale preparation of students for success in college and careers.

Table 4.22

Teacher Certification Program

Certification Program	N	M	SD	t-value	df	p-value
University	138	2.68	.54	3.205	207	.002*
Alternative	71	2.42	.57			

*Statistically significant ($p < .05$)

Research Question Three

Research question three, *To what extent are secondary art educators aware of the regional STEM careers and workforce?*, was answered by using descriptive statistics and a two-tailed independent t-test. Descriptive statistics (frequencies and percentages) measured secondary art teachers STEM awareness. The survey questionnaire relating to *regional STEM careers and workforce* included 12-items using a 4-point Likert scale (1 = *Strongly Disagree*, 2 = *Disagree*, 3 = *Agree,* 4 = *Strongly Agree*). Table 4.12 shows the frequencies and percentages for teachers' responses to the *regional STEM careers and workforce* portion of the survey. Table 4.13 shows the collapsed results of the *regional STEM careers and workforce* portion of the survey to examine the frequencies and percentages. The responses related to *regional STEM careers and workforce* are provided below.

When asked whether career-oriented education is for all students, art educators responded with an 85.8% *Agree/Strongly Agree.* Art educators (94.3%) *Agreed/Strongly Agreed* about students receiving information about careers that are expected to be in demand in this region when they graduate from K-12/college. In addition, art educators (80.6%) *Agreed/Strongly Agreed* about stakeholders within community/business organizations having STEM skills and knowledge that could be an asset to K-12 schools in their region. Art educators were divided regarding organizations having experienced an increase in the number of women and minorities in STEM positions in the last year in this region with 44.1% who *Strongly Disagreed/Disagreed* and 56.0% who *Agreed/Strongly Agreed*. In addition, art educators were divided regarding organizations being able to fill STEM-related positions with local STEM talent region with 54.1% who *Strongly Disagreed/Disagreed* and 46.9% who *Agreed/Strongly Agreed*. Tables 4.12 and 4.13 displays the percentages and frequencies of art educator's responses in expanded and collapsed per perceptions related to regional STEM careers and workforce for all participants.

Table 4.23

Expanded Responses to STEM Careers and Workforce (CW) for All Participants (%)

	Strongly Disagree	Disagree	Agree	Strongly Agree
1. There are businesses and industries that provide signing bonuses and/or incentives for workers choosing a STEM career in the region.	5.7 (n = 12)	45.5 (n = 96)	44.5 (n = 94)	4.3 (n = 9)
2. Organizations have experienced an increase in the number of STEM positions available in the last year in this region.	5.2 (n = 11)	34.1 (n = 72)	56.4 (n = 119)	4.3 (n = 9)
3. Organizations have been able to fill all STEM-related positions within the last year in this region.	4.7 (n = 10)	52.1 (n = 110)	40.3 (n = 85)	2.8 (n = 6)
4. Organizations have experienced an increase in the number of women and minorities in STEM positions in the last year in this region.	6.2 (n = 13)	37.9 (n = 80)	49.8 (n = 105)	6.2 (n = 13)

5. Organizations have been able to fill STEM-related positions with local STEM talent.	7.1 (n = 15)	46.0 (n = 97)	43.6 (n = 92)	3.3 (n = 7)
6. It is important for businesses in this region to be able to recruit skilled workers locally.	1.4 (n = 3)	7.6 (n = 16)	54.0 (n = 114)	37.0 (n = 78)
7. All students should receive information about careers that are expected to be in demand in this region when they graduate from K-12/college.	0.9 (n = 2)	4.7 (n = 10)	48.3 (n = 102)	46.0 (n = 97)
8. All K-12 schools in this region teach the STEM skills and knowledge appropriate for jobs that will be available in the region.	6.2 (n = 13)	33.6 (n = 71)	50.7 (n = 107)	9.5 (n = 20)
9. All K-12 students should have access to STEM education.	0.5 (n = 1)	4.7 (n = 10)	50.2 (n = 106)	44.5 (n = 94)
10. Career-oriented education is for all students.	4.3 (n = 9)	10.0 (n = 21)	44.1 (n = 93)	41.7 (n = 88)

11. Preparing students for careers in STEM is a top priority for schools in this region.	5.7 (n = 12)	34.1 (n = 72)	46.9 (n = 99)	13.3 (n = 28)
12. Stakeholders within community/business organizations have STEM skills and knowledge that could be an asset to K-12 schools in this region.	2.8 (n = 6)	16.6 (n = 35)	63.5 (n = 134)	17.1 (n = 36)

Table 4.24

Collapsed Responses to STEM Careers and Workforce (CW) for All Participants (%)

	Strongly Disagree /Disagree	Agree/ Strongly Agree
1. There are businesses and industries that provide signing bonuses and/or incentives for workers choosing a STEM career in the region.	51.2 (n = 108)	48.8 (n = 103)
2. Organizations have experienced an increase in the number of STEM positions available in the last year in this region.	39.3 (n = 83)	60.7 (n = 128)
3. Organizations have been able to fill all STEM-related positions within the last year in this region.	56.8 (n = 120)	43.1 (n = 91)
4. Organizations have experienced an increase in the number of women and minorities in STEM positions in the last year in this region.	44.1 (n = 93)	56.0 (n = 118)

5. Organizations have been able to fill STEM-related positions with local STEM talent.	54.1 (n = 112)	46.9 (n = 99)
6. It is important for businesses in this region to be able to recruit skilled workers locally.	9.0 (n = 19)	91.0 (n = 192)
7. All students should receive information about careers that are expected to be in demand in this region when they graduate from K-12/college.	5.6 (n = 12)	94.3 (n = 199)
8. All K-12 schools in this region teach the STEM skills and knowledge appropriate for jobs that will be available in the region.	39.8 (n = 84)	60.2 (n = 127)
9. All K-12 students should have access to STEM education.	5.2 (n = 11)	94.7 (n = 200)
10. Career-oriented education is for all students.	14.3 (n = 30)	85.8 (n = 181)

11. Preparing students for careers in STEM is a top priority for schools in this region.	39.8 (n = 84)	60.2 (n = 127)
12. Stakeholders within community/business organizations have STEM skills and knowledge that could be an asset to K-12 schools in this region.	19.4 (n = 41)	80.6 (n = 170)

Teachers with Bachelor's Degrees

Art educators with bachelor's degrees (85.6%) responded *Agree/Strongly Agree* for career-oriented education being available for all students. *Agreed/Strongly Agreed* perceptions (94.4%) revealed students receiving information about careers that are expected to be in demand in this region when they graduate from K-12/college. In addition, art educators (80.0%) *Agreed/Strongly Agreed* about stakeholders within community/business organizations having STEM skills and knowledge that could be an asset to K-12 schools in their region. Regarding organizations having experienced an increase in the number of women and minorities in STEM positions in the last year, teachers (48.8%) responded *Strongly Disagreed/Disagreed*. Art educators (54.4%) *Strongly Disagreed/Disagreed* regarding organizations being able to fill STEM-related positions with local STEM talent, 55.2% *Strongly Disagreed/Disagreed* organizations have been able to fill STEM related positions in the past year, and 52.8% *Strongly Disagreed/Disagreed* businesses and industries were providing signing bonuses and/or incentives for workers choosing a STEM career

Teachers with Master's Degrees

In regards to art educators with master's degrees, (85.6%) responded *Agree/Strongly Agree* for career-oriented education being for all students. Art educators (94.0%) *Agreed/Strongly Agreed* about students receiving information about careers that are expected to be in demand in this region when they graduate from K-12/college. In addition, art educators (80.8%) *Agreed/Strongly Agreed* about stakeholders within community/business organizations having STEM skills and knowledge that could be an asset to K-12 schools in their region. Regarding organizations having experienced an increase in the number of women and minorities in STEM positions in the last year, teachers (37.3%) responded *Strongly Disagreed/Disagreed*. Art educators (51.8%)

Strongly Disagreed/Disagreed regarding organizations being able to fill STEM-related positions with local STEM talent, 49.3% *Strongly Disagreed/Disagreed* businesses and industries were providing signing bonuses and/or incentives for workers choosing a STEM career, 59.0% *Strongly Disagreed/Disagreed* organizations have been able to fill STEM related positions in the past year.

Comparison of Teachers' Educational Backgrounds

Overall, the majority of art teachers *Agreed/Strongly Agreed* with the items on the survey, however there were a few exceptions. A majority of teachers with bachelor's degrees selected *Strongly Disagree/Disagree* in regards business providing incentives to choose a STE career, the filling of all STEM positions in the region, and filling STEM careers with STEM talent. In comparison, the majority of teachers with master's degrees selected *Strongly Disagree/Disagree* in the filling of all STEM positions in the region and filling STEM careers with STEM talent. The largest difference between groups showed teacher's with master's degrees (37.3%) reporting *Strongly Disagree/Disagree* in regards to organizations increasing in the number of women and minorities in STEM positions in the last year in this region compared to teacher's with bachelor's degrees (48.8%). Tables 4.22 and 4.23 present the percentages and frequencies of teacher's responses related to the subscale of preparation of students for success in college and careers per teacher educational background.

Table 4.25

Participant Responses to STEM Careers and Workforce per Teacher Educational Background (%)

		Strongly Disagree	Disagree	Agree	Strongly Agree
1. There are businesses and industries that provide signing bonuses and/or incentives for workers choosing a STEM career in the region.	Bachelor	1.6 (n = 2)	51.2 (n = 64)	42.4 (n = 53)	4.8 (n = 6)
	Master	12.0 (n = 10)	37.3 (n = 31)	48.2 (n = 40)	2.4 (n = 2)
2. Organizations have experienced an increase in the number of STEM positions available in the last year in this region.	Bachelor	3.2 (n = 4)	36.0 (n = 45)	55.2 (n = 69)	5.6 (n = 7)
	Master	8.4 (n = 7)	32.5 (n = 27)	56.6 (n = 47)	2.4 (n = 2)
3. Organizations have been able to fill all STEM-related positions within the last year in this region.	Bachelor	4.0 (n =5)	51.2 (n = 64)	40.8 (n = 51)	4.0 (n = 5)
	Master	6.0 (n = 5)	53.0 (n = 44)	39.8 (n = 33)	1.2 (n = 1)
4. Organizations have experienced an increase in the number of women and minorities in STEM positions in the last year in this region.	Bachelor	4.8 (n = 6)	44.0 (n = 55)	45.6 (n = 57)	5.6 (n = 7)
	Master	8.4 (n = 7)	28.9 (n = 24)	56.6 (n = 47)	6.0 (n = 5)

5. Organizations have been able to fill STEM-related positions with local STEM talent.	Bachelor	7.2 (n =9)	47.2 (n = 59)	42.4 (n = 53)	3.2 (n = 4)
	Master	7.2 (n = 6)	44.6 (n = 37)	45.8 (n = 38)	2.4 (n = 2)
6. It is important for businesses in this region to be able to recruit skilled workers locally.	Bachelor	0.0 (n = 0)	8.8 (n = 11)	52.0 (n = 65)	39.2 (n = 49)
	Master	3.6 (n = 3)	6.0 (n = 5)	56.6 (n = 47)	33.7 (n = 28)
7. All students should receive information about careers that are expected to be in demand in this region when they graduate from K-12/college.	Bachelor	0.8 (n = 1)	4.8 (n = 6)	45.6 (n = 57)	48.8 (n = 61)
	Master	1.2 (n = 1)	4.8 (n = 4)	51.8 (n = 43)	48.8 (n = 35)
8. All K-12 schools in this region teach the STEM skills and knowledge appropriate for jobs that will be available in the region.	Bachelor	4.0 (n = 5)	33.6 (n = 42)	52.8 (n = 66)	9.6 (n = 12)
	Master	9.6 (n = 8)	34.9 (n = 29)	47.0 (n = 39)	8.4 (n = 7)
9. All K-12 students should have access to STEM education.	Bachelor	0.8 (n = 1)	3.2 (n = 4)	51.2 (n = 64)	44.8 (n = 56)
	Master	0.0 (n = 0)	7.2 (n = 6)	48.2 (n = 40)	44.6 (n = 37)

10. Career-oriented education is for all students.	Bachelor	4.8 (n = 6)	9.6 (n = 12)	45.6 (n = 57)	40.0 (n = 50)
	Master	3.6 (n = 3)	10.8 (n = 9)	41.0 (n = 34)	44.6 (n = 37)
11. Preparing students for careers in STEM is a top priority for schools in this region.	Bachelor	4.8 (n = 6)	33.6 (n = 42)	48.0 (n = 60)	13.6 (n = 17)
	Master	7.2 (n = 6)	34.9 (n = 29)	45.8 (n = 38)	12.0 (n = 10)
12. Stakeholders within community/business organizations have STEM skills and knowledge that could be an asset to K-12 schools in this region.	Bachelor	1.6 (n = 2)	18.4 (n = 23)	63.2 (n = 79	16.8 (n = 21)
	Master	4.8 (n = 4)	14.5 (n = 12)	63.9 (n = 53)	16.9 (n = 17)

Table 4.26

Collapsed Participant Responses to STEM Careers and Workforce per Teacher Educational Background (%)

		Strongly Disagree / Disagree	Agree / Strongly Agree
1. There are businesses and industries that provide signing bonuses and/or incentives for workers choosing a STEM career in the region.	Bachelor	52.8 (n = 66)	47.2 (n = 59)
	Master	49.3 (n = 41)	50.6 (n = 42)
2. Organizations have experienced an increase in the number of STEM positions available in the last year in this region.	Bachelor	39.2 (n = 49)	60.8 (n = 76)
	Master	40.9 (n = 34)	59.0 (n = 49)
3. Organizations have been able to fill all STEM-related positions within the last year in this region.	Bachelor	55.2 (n = 69)	44.8 (n = 56)
	Master	59.0 (n = 49)	41.0 (n = 34)
4. Organizations have experienced an increase in the number of women and minorities in STEM positions in the last year in this region.	Bachelor	48.8 (n = 61)	51.2 (n = 64)
	Master	37.3 (n = 31)	62.6 (n = 69)

5. Organizations have been able to fill STEM-related positions with local STEM talent.	Bachelor	54.4 (n = 68)	45.6 (n = 57)
	Master	51.8 (n = 43)	48.2 (n = 40)
6. It is important for businesses in this region to be able to recruit skilled workers locally.	Bachelor	8.8 (n = 11)	91.2 (n = 114)
	Master	9.6 (n = 8)	90.3 (n = 75)
7. All students should receive information about careers that are expected to be in demand in this region when they graduate from K-12/college.	Bachelor	5.6 (n = 7)	94.4 (n = 118)
	Master	6.0 (n = 5)	94.0 (n = 78)
8. All K-12 schools in this region teach the STEM skills and knowledge appropriate for jobs that will be available in the region.	Bachelor	37.6 (n = 47)	62.4 (n = 78)
	Master	44.5 (n = 37)	55.4 (n = 46)
9. All K-12 students should have access to STEM education.	Bachelor	4.0 (n = 5)	96.0 (n = 120)
	Master	7.2 (n = 6)	92.8 (n = 77)

10. Career-oriented education is for all students.	Bachelor	15.4 (n = 18)	85.6 (n = 107)
	Master	14.4 (n = 12)	85.6 (n = 71)
11. Preparing students for careers in STEM is a top priority for schools in this region.	Bachelor	38.4 (n = 48)	61.6 (n = 77)
	Master	52.1 (n = 35)	57.8 (n = 48)
12. Stakeholders within community/business organizations have STEM skills and knowledge that could be an asset to K-12 schools in this region.	Bachelor	20.0 (n = 25)	80.0 (n = 100)
	Master	19.3 (n = 16)	80.8 (n = 67)

Teachers with University Certification

Art educators with university certification degrees (84.1%) responded *Agree/Strongly Agree* for career-oriented education being for all students. Art educators (94.9%) *Agreed/Strongly Agreed* about students receiving information about careers that are expected to be in demand in this region when they graduate from K-12/college. In addition, art educators (80.4%) *Agreed/Strongly Agreed* about stakeholders within community/business organizations having STEM skills and knowledge that could be an asset to K-12 schools in their region. Regarding organizations having experienced an increase in the number of women and minorities in STEM positions in the last year, teachers (39.8%) responded *Strongly Disagreed/Disagreed*. Art educators (53.6%) *Strongly Disagreed/Disagreed* regarding organizations being able to fill STEM-related positions with local STEM talent, 50.7% *Strongly Disagreed/Disagreed* businesses and industries were providing signing bonuses and/or incentives for workers choosing a STEM career, 55.8% *Strongly Disagreed/Disagreed* organizations have been able to fill STEM related positions in the past year.

Teachers with Alternative Certification

Art educators with alternative certification degrees (85.6%) responded *Agree/Strongly Agree* for career-oriented education being for all students. *Agreed/Strongly Agreed* perceptions (92.9%) were recorded about students receiving information about careers that are expected to be in demand in this region when they graduate from K-12/college. A majority of art educators (80.3%) *Agreed/Strongly Agreed* about stakeholders within community/business organizations having STEM skills and knowledge that could be an asset to K-12 schools. Regarding organizations having experienced an increase in the number of women and minorities in STEM positions in the last year, teachers (59.1%) responded *Strongly Disagreed/Disagreed*. Furthermore, art educators (53.6%) *Strongly Disagreed/Disagreed* regarding organizations being able to fill STEM-related positions with local STEM talent, 56.3% *Strongly Disagreed/ Disagreed* businesses and industries were providing signing bonuses and/or incentives for workers choosing a STEM career, and 59.1% *Strongly Disagreed/Disagreed* organizations have been able to fill STEM related positions in the past year.

Comparison of Teachers' Certification Training

While the majority of art teachers *Agreed/Strongly Agreed* with the items on the survey, there were several noted areas of disagreement. Teacher's selected *Strongly Disagree/Disagree* in regards to the adequacy of state standardized tests assessment STEM knowledge and skills in K-12, businesses using incentives to choose STEM related careers, the ability of STEM positions to be filled, an increase of minorities and women in the STEM workplace, and the ability to fill STEM positions with local STEM talent. The largest difference between groups showed university certified teacher's (60.1%) reporting A*gree/Strongly Agree* to organizations increasing the number of women and minorities in STEM positions compared to alternatively certified teachers (47.9%). Tables 4.24 and 4.25 present the percentages and frequencies of teacher's responses related to the subscale of preparation of students for success in college and careers per teacher educational background.

Table 4.27

Participant Responses to STEM Careers and Workforce per Teacher Certification (%)

		Strongly Disagree	Disagree	Agree	Strongly Agree
1. There are businesses and industries that provide signing bonuses and/or incentives for workers choosing a STEM career in the region.	University	7.2 (n = 10)	42.0 (n = 58)	47.8 (n = 66)	2.9 (n = 4)
	Alternative	2.8 (n = 2)	53.5 (n = 38)	38.0 (n = 27)	5.6 (n = 4)
2. Organizations have experienced an increase in the number of STEM positions available in the last year in this region.	University	6.5 (n = 9)	30.4 (n = 42)	59.4 (n = 82)	3.6 (n = 5)
	Alternative	2.8 (n = 2)	42.3 (n = 30)	49.3 (n = 35)	5.6 (n = 4)
3. Organizations have been able to fill all STEM-related positions within the last year in this region.	University	5.1 (n = 7)	50.7 (n = 70)	41.3 (n = 57)	2.9 (n = 4)
	Alternative	4.2 (n = 3)	54.9 (n = 39)	38.0 (n = 27)	2.8 (n = 2)
4. Organizations have experienced an increase in the number of women and minorities in STEM positions in the last year in this region.	University	6.5 (n = 9)	33.3 (n = 46)	54.3 (n = 75)	5.8 (n = 8)
	Alternative	5.6 (n = 4)	46.5 (n = 33)	42.3 (n = 30)	5.6 (n = 4)

5. Organizations have been able to fill STEM-related positions with local STEM talent.	University	7.2 (n = 10)	46.4 (n = 64)	43.5 (n = 60)	2.9 (n = 4)
	Alternative	7.0 (n = 5)	46.5 (n = 33)	43.7 (n = 31)	2.8 (n = 2)
6. It is important for businesses in this region to be able to recruit skilled workers locally.	University	1.4 (n = 2)	7.2 (n = 10)	57.2 (n = 79)	34.1 (n = 47)
	Alternative	1.4 (n = 1)	8.5 (n = 6)	46.5 (n = 33)	43.7 (n = 31)
7. All students should receive information about careers that are expected to be in demand in this region when they graduate from K-12/college.	University	0.0 (n = 0)	5.1 (n = 7)	53.6 (n = 74)	41.3 (n = 57)
	Alternative	2.8 (n = 2)	4.2 (n = 3)	36.6 (n = 26)	56.3 (n = 40)
8. All K-12 schools in this region teach the STEM skills and knowledge appropriate for jobs that will be available in the region.	University	4.3 (n =6)	34.8 (n = 48)	50.7 (n = 70)	10.1 (n = 14)
	Alternative	9.9 (n = 7)	32.4 (n = 23)	49.3 (n = 35)	8.5 (n = 6)
9. All K-12 students should have access to STEM education.	University	0.7 (n = 1)	5.1 (n = 7)	54.3 (n = 75)	39.9 (n = 55)
	Alternative	0.0 (n = 0)	4.2 (n = 3)	40.8 (n = 29)	54.9 (n = 39)

10. Career-oriented education is for all students.	University	6.5 (n = 9)	9.4 (n = 13)	46.4 (n = 64)	37.3 (n = 52)
	Alternative	0.0 (n = 0)	11.3 (n = 8)	38.0 (n = 27)	50.7 (n = 36)
11. Preparing students for careers in STEM is a top priority for schools in this region.	University	4.3 (n = 6)	35.5 (n = 49)	47.8 (n = 66)	12.3 (n = 17)
	Alternative	8.5 (n = 6)	32.4 (n = 23)	45.1 (n = 32)	14.1 (n = 10)
12. Stakeholders within community/business organizations have STEM skills and knowledge that could be an asset to K-12 schools in this region.	University	2.9 (n = 4)	16.7 (n = 23)	65.9 (n = 91)	14.5 (n = 20)
	Alternative	2.8 (n = 12)	16.9 (n = 12)	59.2 (n = 42)	21.1 (n = 15)

Table 4.28

Collapsed Participant Responses STEM Careers and Workforce per Teacher Certification (%)

		Strongly Disagree / Disagree	Agree / Strongly Agree
1. There are businesses and industries that provide signing bonuses and/or incentives for workers choosing a STEM career in the region.	University	49.2 (n = 68)	50.7 (n = 70)
	Alternative	56.3 (n = 40)	43.6 (n = 31)
2. Organizations have experienced an increase in the number of STEM positions available in the last year in this region.	University	36.9 (n = 51)	63.0 (n = 87)
	Alternative	45.1 (n = 32)	54.9 (n = 39)
3. Organizations have been able to fill all STEM-related positions within the last year in this region.	University	55.8 (n = 77)	44.2 (n = 61)
	Alternative	59.1 (n = 42)	40.8 (n = 29)
4. Organizations have experienced an increase in the number of women and minorities in STEM positions in the last year in this region.	University	39.8 (n = 55)	60.1 (n = 83)
	Alternative	52.1 (n = 37)	47.9 (n = 34)

5. Organizations have been able to fill STEM-related positions with local STEM talent.	University	53.6 (n = 74)	46.4 (n = 64)
	Alternative	53.6 (n = 38)	46.5 (n = 33)
6. It is important for businesses in this region to be able to recruit skilled workers locally.	University	8.6 (n = 12)	91.3 (n = 126)
	Alternative	9.9 (n = 7)	90.2 (n = 64)
7. All students should receive information about careers that are expected to be in demand in this region when they graduate from K-12/college.	University	5.1 (n = 7)	94.9 (n = 131)
	Alternative	7.0 (n = 5)	92.9 (n = 66)
8. All K-12 schools in this region teach the STEM skills and knowledge appropriate for jobs that will be available in the region.	University	39.1 (n = 54)	60.8 (n = 84)
	Alternative	42.3 (n = 30)	57.8 (n = 41)
9. All K-12 students should have access to STEM education.	University	5.8 (n = 8)	94.2 (n = 130)
	Alternative	4.2 (n = 3)	95.7 (n = 68)

10. Career-oriented education is for all students.	University	15.9 (n = 22)	84.1 (n = 116)
	Alternative	11.3 (n = 8)	88.7 (n = 63)
11. Preparing students for careers in STEM is a top priority for schools in this region.	University	39.8 (n = 55)	60.1 (n = 83)
	Alternative	40.9 (n = 29)	59.2 (n = 42)
12. Stakeholders within community/business organizations have STEM skills and knowledge that could be an asset to K-12 schools in this region.	University	19.6 (n = 27)	80.4 (n = 111)
	Alternative	19.7 (n = 14)	80.3 (n = 57)

The findings of the two-tailed independent t-test revealed teacher educational background does not influence teacher perception of regional STEM career and workforce, $t(206) = .835$, $p = .405$. A teacher's educational background does not necessarily influence his or her perceptions of regional STEM career and workforce. The mean score of teachers with bachelor's degrees ($M = 2.85$) was slightly higher than the mean score of teachers with master's degrees ($M = 2.80$) meaning teachers with graduate degrees did not possess a stronger awareness of regional STEM career and workforce. Table 4.26 shows the results of the two-tailed independent t-test regarding teacher certification in relation to STEM careers and workforce.

Table 4.29

Teacher Educational Background

Degree	N	M	SD	t-value	df	p-value
Bachelors	125	2.85	.38	.835	206	.405
Masters	83	2.80	.43			

*Statistically significant ($p < .05$)

Furthermore, the two-tailed independent t-test revealed teacher certification training does not influence teacher perception of regional STEM career and workforce, $t(207) = -.530$, $p = .596$. The mean score of teachers with university certification training ($M = 2.82$) was slightly lower than the mean score of teachers with master's degrees ($M = 2.85$) meaning teachers with graduate degrees possessed an increased awareness of regional STEM career and workforce. Table 4.27 shows the results of the two-tailed independent t-test regarding teacher certification in relation to STEM careers and workforce.

Table 4.30

Teacher Certification Program

Certification Program	N	M	SD	t-value	df	p-value
University	138	2.82	.38	-.530	207	.596
Alternative	71	2.85	.43			

*Statistically significant (p < .05)

Research Question Four

Research question four, *How do secondary art educators perceive the benefits of art in relation to STEM*, was answered by using a qualitative inductive coding process. In an attempt to capture a variety of educational experiences, ten art educators with diverse backgrounds were interviewed regarding their perceptions on the issue. All ten participants previously completed the SACS survey and were recruited for interviews. Participants were given pseudonyms from famous artists to insure confidentiality. The interview questions were based off the *STEM Awareness and Community Survey* in order to provide insight to the importance of the domain compared to the arts. A deductive coding analysis developed three major themes based on responses concerning STEM awareness and STEM resource awareness, which could be applied to 6 or more participants. The major themes responses are provided below followed by a sample of the teacher's comments.

Art Applies Principles of Creativity

Eight of the 10 participants described some aspect of creativity as a benefit of art in regards to STEM when asked, "In your opinion, how does art connect to STEM?" Kahlo began by sharing an admittedly limit undertaking with STEM, but addressing interest in the possibility of STEAM program, stating "[…] if I had the time to start a program, it would be within the school that I work at, and I would probably collaborate with the robotics team to create a STEAM program that incorporates the arts." Kahlo further elaborates the reasons for incorporating the arts into STEM by unpacking the challenge of creating original content within the art field. Kahlo states:

> Where do you come up with an idea that's original and hasn't been done before, while you're being inspired by something that you're looking at? How do you translate this specific thing you are looking at into something totally different, yet still having some element of that within your new idea? […] I think that's probably a really big thing that STEM and STEAM would help to push students or just individuals who are in that field into doing. Because like I said, it's not a very one-track minded way of thinking. It's like, you have to delve down different avenues and converge and go back and really do lots of research in order to come up with an original idea.

For Kahlo, creativity was an approach to problem solving which allowed students, "a creative way of thinking in order to accomplish [their] goals." Calder makes a similar claim stating, "you need to understand the basics of good design, because art brings in critical thinking, it brings in problem solving, all those things that are important for those kids." However, Calder looked to emphasize the humanized aspect of creativity as it pertains to the job market:

> We are consumers first before we are anything else. We need critical thinkers because if a robot can do your job, it is going to happen. If a computer can do your job, it's gonna happen. So, what you bring to the table is that critical thinking that a computer can't do, and those human interactions.

The domains of STEM have a stigma of being about facts, figures, and formulas, which is why creativity within art appeals extensively to benefiting STEM. In support of Calder's perspective, Picasso notes the importance of creativity as a competitive edge for colleges stating:

> Colleges that are interested in you when you go in for your interview, when you go in and talk to them, they are asking you about the other things. They're gonna teach you the math and science that they need you to know. But they need to know that you can be a creative being as well.

Picasso further states the importance of art because it, "broadens their [families] perspective, especially for students in homes where art is not valued." The lack of creativity associated with art could inhibit desirable holistic learning of STEM students. Moreover, Rothko elaborates on creativity being an enjoyable component that lessens the intimidation factor of STEM, "when it's presented to the students or to an individual in a unique and creative way." Moreover, Rothko addresses the contrast of perceptions of STEM compared to art stating:

> STEM sounds like research, like really rigid cold sterile, but then you add STEAM, and it's a little bit like, oh it's a little bit more fun, why is that? And, when you add the art, it's not as intimidating to somebody else for whatever reason.

Bansky also believed art, "without a doubt [was] able to make connections that are creative […]. [In fact] Being more creative or […] see[ing] their own personal experience and take on things, rather than just regurgitating numbers, facts, figures." Furthermore, Banksy viewed art as a "thread that kind of ties everything together." When combined with STEM, art makes "connections between the different disciplines and again creative solutions to a problem outside of math or engineering or science […]. And being able to explain things, but tell stories in different ways that help people to understand the connections." Rothko turns the notion of formulas around by relating them to artists saying, “as artists we use formulas to create art, elements and principles.” Rothko viewed the visual nature of art as simply another problem the artist must solve stating, “you’re basically both in it to solve some sort of problem. The problem is just presented differently.” Taking a slightly different slant on creativity by focusing on educational learning objectives, Kusama states:

> I think the whole planning process and trying to think critically, critical thinking. Because naturally art you’re high up in Bloom’s Taxonomy, and in science it is a little bit harder to use your assessment words to kind of make it higher thinking. In art you already have analyze, create, design, and those are pretty high up.

The peak of Bloom’s Taxonomy does in fact aim for learners to create new original ideas, which are built on the domains of evaluating and analyzing. In addition, Stella describes how art when used in conjunction with STEM “[…] helps you be innovative. It’s like you find creativity through arts. […] It teaches you to think critically, which can help you and assist you in any way as far as anything regarding STEM.” Bourgeois augments Stella’s response regarding innovation by adding some depth stating:

> I feel like any career that has heightened creativity that you’re having to use multi-facets of your brain can be a STEM career. And, I feel like a lot of those careers that are going to be more sought after, higher paying jobs, will tend to be STEM careers, because you are having to multitask in a way that other people are, not just computing information. Those are not your cubicle jobs in a sense to me. Those are going to be people that are having to manage, invent. They are having to do more things, multitask more.

Bourgeois emphasized the multi-tasking nature of working within multiple disciplines like art and STEM, which generates opportunities to synthesize new ideas. From a more practical perspective, Bourgeois describes facilitating art and STEM projects in the classroom, “they [core subject teachers] don’t make the kids sit down and make an appropriate plan to get a final product at the end anyway, and then they have no revision process to make their product useful.” The design process calls for several iterations and extensive planning in order to complete meaningful creative work, which can often become overlooked if students are striving to generate correct answers.

While the majority of participants touched on creativity connecting art and STEM, their perspectives widely varied. The domain of creativity contained multiple facets making their definitions complex, yet vague. Participants expressed components of creativity as containing problem solving, critical thinking, planning, and motivation. Furthermore, statements regarding the benefits of art toward STEM were not solely discussed in terms of the subject, but related to workforce, college, pedagogy.

Art Allows for Communication Through Aesthetics

Six of the 10 participants mentioned the communication of ideas via aesthetics as a benefit of art in relation to STEM. As students prepare to advance through college and career, the ability to communicate becomes paramount. Picasso remarks on the value of communication through the arts as students prepare for college stating:

> Your science and math get you in the door, but what’s gonna give you scholarships is your art. And so, because they [college admissions] are more concerned with her ability to communicate with others. That it doesn’t matter how great your brain is if it’s trapped inside your head, and you can’t communicate.

The expressive nature of the arts can allow for opportunities for students to develop communication skills. Bourgeois remarks when the, “A [art] that they’ve put in STEAM or whatever in STEM, to make it STEAM, is kind of like the glue that fuses all of it together.” In support of Picasso, Bourgeois further elaborates:

> Because at the end of the day, you can have a great idea, but if you cannot communicate [...] it's the communication behind it. So, if you cannot communicate yourself visually or well enough to get your point across about whatever it is that you're doing […]

The efficiency by which a student can communicate an idea proves vital especially when considering the future workplace. The consumeristic nature of the culture demands the ability to capture an audience. Calder describes, "It's all basically aesthetics. We are consumers first before we are anything else," therefore, a demand is created for students who possess the ability to communicate ideas. Calder states:

> I was always telling kids, these companies are going to need graphic designers to promote their product. You are going to need to be able to do a layout that is visually attractive that attracts customers. And so, I tell them that all the time that you need to have both.

Further connecting communication, but at a personal level, O'Keeffe notes that, "art gives the students the opportunity to express themselves in a way that mere science and math and the more structured more rigid subjects allow them to. That's all knowledge and facts but art is, it's dealing with emotions." According to O'Keeffe, art, "would give them an outlet to de-stress because you're taking your mind off of the things that you're having to deal with on a daily basis," especially in relation to the stress associated with vocation and college.

The challenge of materializing an idea into a tangible product is epitomized in art, but proves beneficial to improve communication skills. Warhol describes the communication characteristic of artists having:

> To be able to have a skill, to be able to produce those images or the photography or whatever it is [in reference to] the actual thing. From designing a building, an

> architect, and I [might not] have it down as to what I need to be able to design that building correctly or to make it beautiful […]. You know, [the] aesthetics.

In addition to bringing the immaterial to life, the artists must present ideas in a manner that shows the value of the ideas communicated. In discussing student experiences of an art competition, Banksy sheds light on the value and practicality needed to communicate artistic ideas. Banksy describes his students as:

> Not only build[ing] something that's beautiful or interesting to look at or functional or whatever it is, but it's gotta be able to withstand the elements. So, again […] there is no sort of cookie cutter kit that you use, they have to figure out what to use, how to put it together, and how it's going to work. And, I think it's a pretty incredible experience.

The participants highlighting the significance of communication as a benefit of art in regards to STEM appeared to focus on taking immaterial ideas and using visual media to either tell a story, advertise an idea, or express oneself. Depending on the context, the significance of communication varied. In a personal context, art communicates the self as a means to destress. From a professional aspect, the communication of ideas requires the skill necessary for success in noted fields like marketing or graphic design. In regards to preparing for college, the experiences of communication through art can give students a competitive edge. While challenging, the arts can be used to package ideas in meaningful ways in order to communicate designs, concepts, and thoughts.

Art Assists the Visualization of Concepts

Five out of 10 participants expressed visual arts as assisting students in their visualization of STEM concepts. Warhol related the career of an artist who might be required to create scientific illustrations stating, "artists are illustrators and illustrate the anatomy or in books and artistic things. Because that kind of interested me a while back,

[…] to me art is everywhere." Even at a pedological level Warhol relates the usefulness of visuals to understand concepts stating:

> I could talk to someone that's a scientist, and I can understand some of what they are saying, but visuals help me. I do the same with my students, [whether] I will explain something verbally or not, […] I show examples. So, I think […] the two work well together.

When discussing how they implement art and STEM in the classroom, Calder makes a similar connection as Warhol, noting:

> You think of medical illustrations. You think of mathematical illustrations for problems. You think of just the technology aspect trying to explain something to someone and break it down into steps. Same with art reflecting on what you've done, breaking it down into steps. That way if somebody could do it later on you could repeat it back to them.

The visualization aspect of art not only benefits the user in conveying ideas, but also the viewer in understanding concepts, which is commonly associated with the visual learning aspect of multiple intelligences. Similarly, Stella also makes the connection of using anatomy as a visual concept for art stating, "studying anatomy or learning different parts of anatomy right, and learning how to actually depict them. I think it would help them maybe visualize it or understand anatomy in a different way, maybe more fully comprehend it." Bourgeois remarks on the visualization of art as, "a building block for human anatomy." However, Bourgeois elaborates on more advanced skills developed in students and describes student experiences as:

> [having] to go from moquette drawings to larger drawings, so we're hitting on scale, proportion, the process of that. And so, we're more concerned with them

> making something that is visually stimulating, and it's making sure it's hitting all of those elements and principles of design.

When appropriate, STEM skills and art principles can connect to create rigorous learning opportunities for students, however, this may not always be the case.

While discussing teaching experiences of connecting art and STEM, Picasso states, "that anytime we can tie in the science and the math into art that we need to." Picasso continues to describe the need to incorporate more STEM with art because, "one of the biggest struggles that I have and it seems like it's so weird, but it is, is that kids don't know how to use rulers anymore." However, Picasso takes note of art allowing students the opportunity to use STEM skills as the cost of art instruction, stating:

> They don't have some of the basic skills that I consider to be math, science skills. I don't think that as an art teacher I should be teaching the concepts of the compass and the protractor. I don't know where they're being taught. But those are not skills that they have. So, even just matting their artwork, being able to change proportion. We use proportion constantly, gridding things, adding. I think STEM is a great idea, but my issue is they don't have the basic math skills. So, I'm teaching basic art but they don't have basic math.

While art can assist in the visualization of concepts, unless students have working math and science fundamentals challenges in connecting art could persist in accomplishing lesson goals and objectives.

The majority of participants related anatomy and scientific illustrations to show the significance of how art can help with the visualization of concepts. Other participants emphasized the relationship between STEM skills and the visual nature of art to complete lesson objectives. Overall, the visualization of concepts was exclusively related to work conducted in the classroom setting.

Summary of Findings

The study contained three constructs (industry engagement in STEM education, STEM awareness and STEM resource awareness, and preparation of students for success in college and careers) as outlined by the SACS. Survey data were analyzed using descriptive statistics (frequencies and percentages), as well as independent t-tests. Teacher perception was addressed using interview questions based on the SACS. The researcher examined the relationship in each respected question. For research question 1, participants reported *Agree/Strongly Agree* for the majority of items relating to STEM awareness and STEM resource awareness. However, there was no significance in regards to teacher educational background or teacher certification training. For research question 2, participants also reported *Agree/Strongly Agree* for the majority of items relating to preparation of students for success in college and careers. In addition, teacher certification training impacted participants perceptions of preparation of students for success in college and careers. For research question 3, participants reported *Agree/Strongly Agree* for the majority of items relating to STEM careers and workforce. However, there was no significance in regards to teacher educational background or teacher certification training.

Research question four, was answered using an inductive thematic coding process based on semi-structured interviews with secondary art educators in Region 4 of the state of Texas. Responses were organized into three major themes. The major themes were arts application of principles of creativity, art allowing for communication through aesthetics, and art assisting in the visualization of concepts. When comparing survey data to interview responses, art educator responses pertaining to STEM awareness and teacher perception of the importance of art were consistent across all ten participants.

In regards to the major themes, educators shared their thoughts of the benefits of art in relation to STEM. Educators described how creativity developed well-rounded students preparing for STEM college and careers. In addition, art provided students the opportunity to communicate ideas, concepts, and self-expressions. Finally, the participants expressed the advantage of art in assisting students to visualize concepts in STEM or otherwise.

Conclusion

This chapter offered an analysis of quantitative and qualitative data collected from the SACS survey and interviews. In the next chapter, a summary of the findings will be presented and compared to the literature discussed in chapter two. The implications of this study in STEAM education and recommendations for future research will be addressed.

CHAPTER V:

SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS

The purpose of this study is to identify STEM awareness of secondary art educators. The benefits of STEM education have been well documented in research literature, but connecting the benefits of arts education and STEM continues to require further exploration. This mixed methods study collected survey and interview data from a purposeful sample of 211secondary art educators in the state of Texas. In order to quantify secondary educators STEM awareness, quantitative data was collected using the *STEM Awareness and Community Survey* (SACS) and reported using descriptive statistics. To quantify perspectives of arts connection to STEM, 10 secondary art educators participated in semi-structured interviews. The interview responses aided in understanding the reported levels of STEM awareness with art educator's perceptions of arts benefit in relation to STEM. An inductive coding process was used to look for emerging themes from the participants' interview data.

This chapter contextualizes the findings in relationship to research literature regarding STEM and art. Implications are provided for secondary art teachers, district art supervisors, alternative certification programs, and higher education. Recommendations for future research are also included to promote further scholarship.

Summary

The research questions presented aimed to determine levels of STEM awareness among secondary art educators. The following research questions guided this study: To what extent are secondary art educators aware of STEM and STEM resources?

1. To what extent are secondary art educators aware of student success in college and careers related to STEM?

2. To what extent are secondary art educators aware of the STEM careers and workforce?
3. How do secondary art educators perceive the benefits of art in relation to STEM?

STEM awareness has three factors (STEM resources, student success in college and career, and STEM careers and workforce). Secondary art educator's perceptions of art and STEM were captured based on interview question data. The data was examined by the researcher to establish relationships.

Research Question 1

The current study provided insight of the various levels of STEM awareness in secondary art educators. Survey data indicated teachers possessed heightened levels of STEM awareness. However, the extent of awareness with STEM resources was comparatively lower. This suggests teachers and administrators should consider developing awareness in regards to STEM-based professional development opportunities, web-based resources, and additional local/regional resources.

Awareness of STEM and STEM resource. Based on the quantitative findings, art teachers overwhelmingly agreed STEM education was important at the district and regional level. One explanation is the systemic advocacy for STEM, which places the framework on the forefront of programs across Texas. In contrast, teachers felt less convinced of parents support of STEM education, which could be an indication of school climate and culture. Educators were particularly disagreeable on the availability of STEM resources at the local and regional level; however, professional development opportunities could potentially stimulate awareness (Knowles, Kelley, & Holland, 2018).

Research Question 2

In contrast to research question 1, responses from educators regarding student preparedness for college and career were the most notably even. Areas like student awareness of STEM careers, standardized testing ability to assess STEM skills, the development of critical thinkers in K-12 schools, and the participation of community partners to make STEM more relevant through real-world applications were the most evenly split. This suggests continued efforts from K-12 schools and community partners are required to further develop prepare students for college and increase involvement in advocacy for STEM careers.

Student success in college and career. Based on the quantitative findings, the only significance was in regards to teacher certification training and its influence on participants' perceptions of student preparedness and success in regards to college and career. When considering the type of culture that exists within university compared to the lack of culture associated with an alternative certification program, the results appear highly feasible. The notion that one's environment, visual or otherwise, can have a significant influence on his or her and their beliefs, is outlined by this studies' theoretical framework (Chapman, 1978; Lanier, 1983; Stein, 1953).

Art educators were most evenly split on community partners engagement with K-12 STEM education. In regards to success in college and career, the current literature is scarce on the involvement of STEM businesses with K-12 schools, especially in regards to real-world applications. Stronger connections between K-12 schools and institutions of higher education (IHE) could explain the contrast in the lack of STEM business involvement, as STEM businesses might not possess the same vested interest as higher education. Higher education and business involvement are not the only limitation, but matters of curricula development and authentic real-world connections are called to question. While business sponsorships and university professional development might be common, the contextualization and creation of real-world connections might be lacking.

The perspective of teachers' awareness regarding state standardized tests inability to adequately assess STEM knowledge and skills comes as little surprise because teachers are typically vocal about issues regarding standardized testing (Angle et al., 2016). Survey data from this study indicated teachers' did not agree in the ability of standardized testing to assess STEM knowledge and skills. The disagreement could be due to commonly held negative views regarding standardized testing.

An area deserves further exploration pertains to the development of critical thinkers and problem solvers among K-12 students. While overall these findings suggested little difference, there was a small indication educators' agreed that schools in their region did well in developing critical thinkers and problem solvers. However, improvement in this area proves necessary in order to promote holistic learners as defined by the tenets of 21st century skills and studio thinking (Hetland et al., 2007; Logsdon, 2013; Partnership for 21st Century Skills, 2009).

Research Question 3

Initially, responses for question 3 appeared the most skewed in agreement with items involving regional STEM careers and workforce. However, a closer analysis proved educators showed more agreement with responses that were broader toward education and not exclusively applicable to STEM. Regardless, the findings suggest the need for continual support for K-12 schools and further advocacy from community partners in bringing awareness of STEM careers and workforce to those employed at the regional level.

STEM career and workforce. Based on the quantitative findings, art educators were most evenly split regarding items covering a STEM emphasis in workforce. Teacher demographics regarding living location could provide insight, as areas with higher STEM career and workforce opportunities could bring increased awareness. Furthermore, art educators believed the demand on STEM-related positions are not being met, which coincides with current literature regarding the need to occupy STEM workforce (Daugherty, 2013). There might be a lack of involvement or interest from STEM business members, which could explain the mid-levels of awareness regarding STEM career and workforce. However, the literature shows STEM community and business stakeholders' involvement with secondary programs show a mutually beneficial relationship, which enhances teacher expertise and promotes student success in STEM (Watters & Diezmann, 2013).

The SACS contained items that seemed applicable to general notions of educational equity. Art educators' responses to items which promoted student access to STEM education, the importance of recruiting skilled workers, and student access to information regarding STEM careers were in overwhelming agreement. Such items might need revision in order to capture a stronger depth of awareness in STEM careers and workforce.

Research Question 4

Research question 4 was answered using survey data generating three major themes. The major themes were: a) arts application of principles of creativity, b) art allowing for communication through aesthetics, and c) art assisting in the visualization of concepts. The findings suggest art educators are not only aware of various aspects of STEM education, particularly 21st century skills, but many are attempting to make connections in the classroom.

Benefit of arts in relation to STEM. The notion of creativity was emphasized among art educators as a benefit to STEM. One explanation could be the holistic aspects of 21st century skills currently being associated with STEM, which include creativity, collaboration, communication, and critical thinking (Partnership for 21st Century Skills, 2009). The open-ended nature of visual arts allows for divergent thinking processes to be experienced by students, which is best facilitated at the secondary level by a studio thinking framework (Hetland et al., 2007). The majority of participants affirmed creativity often works in conjunction with critical thinking within the sciences as a way of opening up pathways to understanding the physical world (Braund & Reiss, 2019).

Interview responses affirmed current literature in regards to the usefulness of visuals as a means to assist retention and comprehension of students (McBride & Dosher, 2002; Rinne et al., 2011). The visual nature of art lends to not only communicating ideas but also understanding concepts, which enforces this study's theoretical framework of visual-spatial learning. Art teachers believed art and STEM can serve one another, however, challenges integrating the two will continue to persist.

Implications

Implications for secondary art educators, STEAM programs, STEM business and community stakeholders, and higher education administrators emerged as a result of this study. For secondary art educators, this research revealed a need for improved STEM awareness to promote stronger integration of arts in STEM. For district art supervisors, the research provided deeper insight about the necessity of professional development opportunities to develop means of better integrating 21st century skills. For alternative certification programs, the findings revealed the importance of creating and maintaining a community culture that promotes awareness in STEM careers and college readiness. For higher education administrators, this study suggests they should strive to improve partnerships with K-12 in order to promote real-world connections and STEM resources.

The connection of STEM businesses and community stakeholders to K-12 schools provides access of STEM resources, which may not otherwise be available.

Implications for Secondary Art Educators

While STEAM education should not be the emphasis for every art program, art educators who are interested would greatly benefit by developing a stronger sense of STEM awareness. Art educator participants indicated minimal to no professional development participation in regards to STEM education. Art educators who claimed to integrate art into STEM held a range of experiences too wide to generalize. Art educators undoubtably hold a rich depth of knowledge in their field, however, if the arts are to be truly integrated into STEM more professional development is required (Reider, Knestis, & Malyn-Smith, 2016; Watters & Diezmann, 2013). Art educators should seek to be an active voice as to how art ought to be integrated into STEM. The transdisciplinary approach of STEM education allows room for the arts as a useful addition to utilize 21st century skills.

Implications for Arts and STEM programs

Existing STEM programs looking to add the arts would benefit by considering how artistic components are integrated within their curricula. STEAM projects should transition from focusing purely on the aesthetic aspects of art and begin considering integrating art education frameworks like visual culture art education. Understanding how the real-world and visual culture impacts students' beliefs and habits of thinking could spur the creation of innovative learning projects. In addition, art programs looking to capitalize on the current interest in STEM need to further develop their understanding of STEM education in regards to its framework, challenges, and current trends. Any Arts and STEM program that fails to embrace the philosophical underpinnings of the other's discipline will continue to create programs that are strong in one discipline and pander to the other.

Implications for Alternative Certification Programs

Overall, university trained teachers scored higher on the survey items compared to alternatively certified teachers, revealing a gap in STEM awareness among alternatively certified art teachers. Universities typically thrive with a variety of teacher associations, student groups, and professional development opportunities which bring awareness regarding college and career choices. Alternative certification programs interested in creating 21st century skills teachers would benefit by providing their students with supplemental course work or educational opportunities aimed toward developing awareness in terms of college and career readiness.

Recommendations for Future Research

Findings from this study involved obtaining responses (quantitative and qualitative) from secondary art educators. Even though findings for this study provided data and information regarding art educators' perceptions of STEM awareness, future research will assist in the expansion of this particular body of knowledge. The subsequent recommendations are based on the findings of this study.

This study utilized the Texas Art Educators Association members directory to find participants throughout the state of Texas. Therefore, results only applied to current members leaving out a variety of potential participants. If data were collected from specific regions or school districts, then different results could be produced. A recommendation for future research would be to compare specific districts representing rural, suburban, and urban teacher demographics in order to capture differentiation of teachers' experiences based on geographic living areas. Future research could also focus on examining lesson plan materials and student products of art teachers who claim to incorporate STEM components into art-based projects, in order to show the depth and variety of integration. The measurements of this study relied heavily on self-reporting, which lacked the substance lesson exemplars could provide. Finally, data could be collected on professional development experiences provided to art teachers relating to STEM integration. Such research could show the type of exposure teachers receive, which could directly affect their levels of STEM awareness.

Conclusion

While the advancement of STEM continues to permeate through the educational landscape, continued assessment of STEM awareness among stakeholders is critical. This study showed secondary educators are in a unique position to advocate for STEM, or STEAM, but efforts to promote awareness are required. The study revealed certification training plays a role on the teacher's perceptions of how students are preparing for college and career in STEM. Furthermore, researchers suggest that the arts promote visual-spatial learning, creative, and divergent thinking, which are fundamental skills required to succeed in STEM (Braund & Reiss, 2019; Gardner, 2011; Hetland et al. 2007). Secondary art educators are tasked with not only teaching technique and composition, but are positioned to developing learning opportunities which embrace critical, creative, and divergent thinking. This study's contribution is not only limited to teachers and administrators, but to the overall discussion on how the arts fit within STEM education.

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APPENDIX A:

STEM AWARENESS AND COMMUNITY SURVEY (SACS)

STEM AWARENESS AND COMMUNITY SURVEY

All items are on a 1–4 point Likert-scale with 1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree. No items are reverse coded.

Industry Engagement in STEM Education (IE)

1. I believe it is important for area businesses to be involved in STEM partnership(s) with K-12 schools in my region.

2. I have had business/community funded STEM education programs of events in my school or school district.

3. I have had community/business volunteers for STEM education programs or events in my school or district.

4. I have had community/business guest speakers in my school or school district.

5. There are opportunities for K-12 students to complete internships or coops in the region.

6. There are organizations interested in providing STEM education opportunities for K-12 students in this region.

7. Overall, there has been an increase in K-12 STEM education opportunities for students in the region in the last year.

8. I have worked closely with community/business organization members in my role as an educator.

STEM awareness and STEM resource awareness (AR)

1. My school district understands the importance of STEM education.

2. The schools in this region understand the importance of STEM education.

3. Parents in this region understand the importance of STEM education.

4. More work needs to be completed to spread awareness of STEM education.

5. STEM skills are integral to student success today.

6. Increasing the STEM talent pool is necessary for economic vitality.

7. Students with postsecondary education are more likely to secure a career in a STEM field.

8. There are colleges and/or universities and/or community colleges that offer scholarships for students to pursue STEM degrees in my region.

9. There are STEM education Web sites available for this region that include activities for teachers and students.

10. Information on regional STEM career opportunities is available online.

11. Local organizations recruit STEM talent online.

12. Information related to STEM opportunities in my region is available online.

13. There are other STEM online tools available to this region.

Preparation of Students for Success in College & Careers (PR)

1. Students in this region are prepared by K-12 schools to be successful in postsecondary study (2- or 4-year colleges or universities and technical programs).

2. Students in this region are knowledgeable about the STEM careers that will be in high demand when they graduate.

3. The K-12 public schools in this region effectively teach students STEM knowledge and skills.

4. The state standardized tests used in this region's K-12 schools adequately assess STEM knowledge and skills.

5. The K-12 schools in this region prepare students who are critical thinkers and problem solvers.

6. Community partners (e.g., business and higher education) are engaged in making K-12

STEM education more relevant through providing real-world connections in this region.

Regional STEM Careers and Workforce (CW)

1. There are businesses and industries that provide signing bonuses and/or incentives for workers choosing a STEM career in the region.

2. Organizations have experienced an increase in the number of STEM positions available in the last year in this region.

3. Organizations have been able to fill all STEM-related positions within the last year in this region.

4. Organizations have experienced an increase in the number of women and minorities in STEM positions in the last year in this region.

5. Organizations have been able to fill STEM-related positions with local STEM talent.

6. It is important for businesses in this region to be able to recruit skilled workers locally.

7. All students should receive information about careers that are expected to be in demand in this region when they graduate from K-12 schools and postsecondary institutions.

8. All K-12 schools in this region teach the STEM skills and knowledge appropriate for jobs that will be available in the region.

9. All K-12 students should have access to STEM education.

10. Career-oriented education is for all students.

11. Preparing students for careers in STEM is a top priority for schools in this region.

12. Stakeholders within community/business organizations have STEM skills and knowledge that could be an asset to K-12 schools in this region.

APPENDIX B:

SURVEY COVER LETTER

University
of Houston
Clear Lake

August 2019

Dear Art Teacher:

Greetings! You are being solicited to complete the *STEM Awareness and Community* survey. The purpose of this survey is to examine STEM awareness in education and community partners. The data obtained from this study will not only reveal areas of strength and growth in STEM awareness, but provide a means to improve our understanding of STEAM and the policies that drive this framework.

Please try to answer all the questions. Filling out the attached survey is entirely voluntary, but answering each response will make the survey most useful. This survey will take approximately 5-10 minutes to complete and all of your responses will be kept completely confidential. No obvious undue risks will be endured and you may stop your participation at any time. In addition, you will also not benefit directly from your participation in the study.

Your cooperation is greatly appreciated and your willingness to participate in this study is implied if you proceed with completing the survey. Your completion of the *STEM Awareness and Community Survey* is not only greatly appreciated, but invaluable. If you have any further questions, please feel free to contact me at your convenience. Thank you!

Sincerely,
David Moya
UHCL Doctoral candidate
[redacted]

APPENDIX C:

INTERVIEW PROTOCOL

1. Please define STEM education.
2. Please describe any interactions you’ve had with STEM industries.
    a. If no interactions, how might you plan to start one?
3. Please provide an example of a STEM resource available to you.
    a. Did you implement this resource, if so how?
    b. Were you able to connect the resource to art? If so, how?
4. Please provide an example of a STEM resource available to your students.
5. Please describe how art might bring success for students in a STEM related college or career.
6. Please describe what STEM careers and workforce means to you?
    a. Please list examples of STEM careers and workforce.
7. In your opinion, how does art connect to STEM?
8. In your experience, how have you implemented art and STEM in your classroom?

APPENDIX D:

SURVEY PERMISSION

Good day Dr. Sondergeld & Dr. Johnson,

Thank you for your time in replying to my emails. As you know, I am a doctoral student at the University of Houston-Clear Lake completing a dissertation in Curriculum and Instruction. I am writing to formally ask written permission to use the STEM Awareness and Community Survey in my research study. I will be using the survey to directly target art educators in the state of Texas. My research is being supervised by my professor, Dr. Michelle Peters.

I plan to use the entire instrument without modifying or adapting any of the questions. I plan on using Qualtrics to disseminate the survey via email.

I would also appreciate receiving any supplemental material that will help me administer the test and analyze the results; for example, (1) the test questionnaire, (2) the standard instructions for administering the test, and (3) scoring procedures.

In addition to using the instrument, I also ask your permission to reproduce it in my dissertation appendix. The dissertation will be published in the UHCL Institutional Repository at https://uhcl-ir.tdl.org/uhcl-ir/ and deposited in the ProQuest Dissertations & Theses database.

I would like to use [and reproduce] the SACS under the following conditions:
I will use the SACS only for my research study and will not sell or use it for any other purposes.

I will include a statement of attribution and copyright on all copies of the instrument. If you have a specific statement of attribution that you would like for me to include, please provide it in your response.

At your request, I will send a copy of my completed research study to you upon completion of the study and/or provide a hyperlink to the final manuscript.
If you do not control the copyright for these materials, I would appreciate any information you can provide concerning the proper person or organization I should contact.

If these are acceptable terms and conditions, please indicate so by replying to me through e-mail at [redacted].

Sincerely,
David Moya

APPENDIX E:

DEMOGRAPHIC PORTION OF SURVEY

Demographic Information Portion of Survey

1. (requirement) Are you certified in the state of Texas to teach EC-12 art in the public-school system?
    a. Yes
    b. No

2. (requirement) Are you considered a full-time regular classroom teacher in the state of Texas?
    a. Yes
    b. No

3. (ethnicity) Please select ethnicity you identify:
    a. African American
    b. Hispanic
    c. White
    d. Native American
    e. Asian
    f. Pacific Islander
    g. Two or more races
    h. Prefer not to answer

4. (gender) Please fill in the gender you identify with:
    a. Open-ended

5. (age) Please select your age range:
    a. 21 – 24
    b. 25 – 34
    c. 35 – 44
    d. 45 – 54
    e. 55 – 64
    f. 65+

6. (education) Please indicate the highest-level degree held:
    a. No degree
    b. Bachelors
    c. Masters

d. Doctorate

7. (education) Were you certified through a university program or alternatively certified?
    a. University program
    b. Alternatively certified

8. (experience) Please indicate your years of teaching experience:
    a. Beginning teacher
    b. 1-5 years experience
    c. 6-10 years experience
    d. 11-20 years experience
    e. Over 20 years experience

APPENDIX F:

INFORMED CONSENT TO PARTICIPATE IN RESEARCH

You are being asked to participate in the research project described below. Your participation in this study is entirely voluntary and you may refuse to participate, or you may decide to stop your participation at any time. Should you refuse to participate in the study or should you withdraw your consent and stop participation in the study, your decision will involve no penalty or loss of benefits to which you may be otherwise entitled. You are being asked to read the information below carefully, and ask questions about anything you don't understand before deciding whether or not to participate.

Title: Identifying STEM Awareness in Secondary Art Educators

Student Investigator(s): David Moya, M.A.

Faculty Sponsor: Dr. Michelle Peters, Ed.D.

PURPOSE OF THE STUDY

The purpose of this study is to identify STEM awareness of secondary art educators.

PROCEDURES

Prior to study, approval from the Committee for the Protection of Human Subjects (CPHS) at the University of Houston Clear Lake (UHCL) will be obtained. You, the participant, will be emailed a Survey Cover Letter informing your selection regarding the study. You will receive an email with a link to the survey which will be completed via mobile device or computer. The survey consists of a demographics section and the STEM Awareness and Community Survey. The survey portion will take you approximately 10-15 minutes to complete. After the surveys are complete, interviews will be conducted individually. The interview portion of data collection process will be conducted during a time agreed upon and take approximately 30 minutes.

EXPECTED DURATION

The total anticipated time commitment will be approximately 40-55 minutes if you participate in both the survey and interview.

RISKS OF PARTICIPATION

There are no anticipated risks associated with participation in this project.

BENEFITS TO THE SUBJECT

There is no direct benefit received from your participation in this study, but your participation will help the investigator(s) better understand disparities of STEM awareness in secondary art educators.

CONFIDENTIALITY OF RECORDS

Every effort will be made to maintain the confidentiality of your study records. The data collected from the study will be used for educational and publication purposes, however, you will not be identified by name. For federal audit purposes, the participant's documentation for this research project will be maintained and safeguarded by the Student Investigator, David Moya, for a minimum of three years after completion of the study. After that time, the participant's documentation may be destroyed.

FINANCIAL COMPENSATION

There is no financial compensation to be offered for participation in the study.

INVESTIGATOR'S RIGHT TO WITHDRAW PARTICIPANT

The investigator has the right to withdraw you from this study at any time.

CONTACT INFORMATION FOR QUESTIONS OR PROBLEMS

If you have additional questions during the course of this study about the research or any related problem, you may contact the Student Researcher, David Moya, at phone number [redacted] or by email at [redacted]. The Faculty Sponsor Michelle Peters, Ph.D., may be contacted by email at [redacted]

SIGNATURES**:**

Your signature below acknowledges your voluntary participation in this research project. Such participation does not release the investigator(s), institution(s), sponsor(s) or granting agency(ies) from their professional and ethical responsibility to you. By signing the form, you are not waiving any of your legal rights.

The purpose of this study, procedures to be followed, and explanation of risks or benefits have been explained to you. You have been allowed to ask questions and your questions have been answered to your satisfaction. You have been told who to contact if you have additional questions. You have read this consent form and voluntarily agree to participate as a subject in this study. You are free to withdraw your consent at any time by contacting the Principal Investigator or Student Researcher/Faculty Sponsor. You will be given a copy of the consent form you have signed.

Subject's printed name: ______________________________

Signature of Subject: ______________________________

Date: ______________________________

Using language that is understandable and appropriate, I have discussed this project and the items listed above with the subject.

Printed name and title ______________________________

Signature of Person Obtaining

Consent: ______________________________

Date: ______________________________

THE UNIVERSITY OF HOUSTON-CLEAR LAKE (UHCL) COMMITTEE FOR PROTECTION OF HUMAN SUBJECTS HAS REVIEWED AND APPROVED THIS PROJECT. ANY QUESTIONS REGARDING YOUR RIGHTS AS A RESEARCH SUBJECT MAY BE ADDRESSED TO THE UHCL COMMITTEE FOR THE PROTECTION OF HUMAN SUBJECTS (281-283-3015). ALL RESEARCH PROJECTS THAT ARE CARRIED OUT BY INVESTIGATORS AT UHCL ARE GOVERNED BY REQUIREMENTS OF THE UNIVERSITY AND THE FEDERAL GOVERNMENT. (FEDERALWIDE ASSURANCE # FWA00004068)