TEACHER AWARENESS OF STEM EDUCATION: INDUSTRY, RESOURCES AND STUDENT PREPARATION FOR SUCCESS IN COLLEGE AND CAREER

Andrew M. Lowry, MS

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TEACHER AWARENESS OF STEM EDUCATION: INDUSTRY, RESOURCES AND STUDENT PREPARATION FOR SUCCESS IN COLLEGE AND CAREER

by

Andrew M. Lowry

APPROVED BY

____
Brenda Weiser, Ed.D., Chair

____
Michelle Peters, Ed.D., Committee Member

____
Kent Divoll, Ed.D., Committee Member

____
Antonio Corrales, Ed.D., Committee Member

RECEIVED/APPROVED BY THE COLLEGE OF EDUCATION:

____
Lillian Benavente McEnery, Ed.D., Interim Associate Dean

____
Joan Y. Pedro, Ph.D., Interim Associate Dean

Dedication

This study is dedicated to my wife Kyle and my two incredible children, Lincoln and Lawson. The countless hours and days I missed with you is something I can never replace. Thank you for letting me chase my dream; it is now time for you to do the same.

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First and foremost, I want to thank my parents, Genna and Mick Lowry. You taught me never to quit and to work smarter, not harder. Thank you for always setting high standards and holding me accountable. Growing up, your expectations were tough, and they taught me perseverance. You are the reason I love learning and continue to exceed. Thank you!

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ABSTRACT

TEACHER AWARENESS OF STEM EDUCATION: INDUSTRY, RESOURCES AND STUDENT PREPARATION FOR SUCCESS IN COLLEGE AND CAREER

Andrew M. Lowry
University of Houston-Clear Lake, 2019

Dissertation Chair: Brenda Weiser, Ed.D.

This study examined science teachers' perceptions and determined their level of STEM awareness and support. Survey, interview, and demographic data were collected from a purposeful sample of 124 high school science teachers across eight high schools in a large suburban school district in southeast Texas. For purposes of this study, the school district was divided into three regions based on the school's percentage of students identified as economically disadvantaged (ED). The *STEM Awareness Community Survey* (SACS), developed by Sondergeld and Johnson, was used to assess teachers STEM awareness and support. Quantitative data were analyzed using frequencies, percentages, and a one-way analysis of variance (ANOVA), while an inductive coding process was used to analyze the collected qualitative data. Quantitative analysis showed there was not a significant mean difference between school district regions and two of the subscales measured, Industry Engagement in STEM Education and STEM Awareness and Resources.

However, results did indicate a significant mean difference between school district regions for the subscale, Preparation of Students for Success in College and Career. The largest mean difference was between Region one (less than 20% ED) and Region three (greater than 40% ED). Overall, the qualitative analysis illustrated the importance of outside business and industry partnerships to engage students in real-world STEM experiences. Qualitative analysis also supported the need for all stakeholders to value STEM education.

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CHAPTER I:

INTRODUCTION

High school teachers have significant influence on students' interest and pursuit of science, technology, engineering, and mathematics (STEM) postsecondary opportunities after high school. Teacher awareness and beliefs for teaching has specific elements, including: knowledge, attitudes, and interests that are critical components. According to current research, these elements directly contribute to the effectiveness of creating and implementing teaching methods (Park, Dimitrov, Patterson, & Park, 2017). Measuring and analyzing teacher beliefs can provide a guide to better understanding their behaviors and decisions in the classroom. Overtime, research has shown how teachers' beliefs influence several areas including: instructional decision making and practices, their interpretation and classroom practices, and their efforts and resistance towards new practices or reforms (Park et al., 2017).

Despite the huge investment in STEM education recently, little attention has been given to teachers' beliefs and awareness of STEM education. More research is needed to determine how teacher awareness of STEM education impacts STEM education reform. This investigation of teacher awareness in STEM education is the first step to better understand how teacher awareness relates to the development of effective STEM programs. The purpose of this study was to examine science teachers' perceptions and determine their level of STEM awareness and support.

Research Problem

In the United States (U.S.), there is a growing need to improve STEM education. The improvement of STEM education has been identified as a critical element for our nation's future economic prosperity and global competitiveness (Park et al., 2017). Concern for improvement in STEM education has resulted in the need to influence more students to pursue future STEM careers. Recent projections show that STEM occupations will increase 17% from 2008 to 2019 and are expected to play a significant role in the stability and future success of the U.S. (U.S. Department of Commerce, Economics and Statistics Administration, 2011). It is vital to create and sustain effective STEM programs that encompass components of collaborative partnerships, stakeholder awareness, and educational development of preparedness for STEM opportunities. The need to increase the number of STEM professionals is a global held concern for industry and education.

Evidence suggests that teacher engagement in educational reform is crucial in sustaining efforts, achieving goals, and maintaining support for desired change (Sondergeld, Johnson, & Walten, 2016). Furthermore, teacher awareness of STEM careers impacts students as they consider career choices (Knowles, Kelley, & Holland, 2018). Although many researchers claim that teachers' beliefs are difficult to change, they also argue that teachers' beliefs are associated with teaching experience (Kagan, 1992). This connection suggests the need for administrative efforts to improve teaching practices, support, and experiences in order to enhance teachers' beliefs about their teaching in areas of subject matter knowledge and general teaching practices (Hughes, 2005; Kim, Kim, Lee, Spector, & DeMeester, 2013).

Science, Technology, Engineering, and Math (STEM) education has a positive impact on students' achievement (Austin, Hirstein, & Walen, 1997), their attitudes and interest in school (Tseng, Chang, Lou, & Chen, 2013) and their motivation to learn (Guthrie, Wigfield, & VonSecker, 2000). Moreover, integrated STEM education has been reported to improve students' higher order thinking skills and technological literacy, making them better problem solvers, innovators, and inventors (Roehrig & Kruse, 2005). As stated previously, STEM education does benefit students and developing teacher awareness for STEM education is a major factor that can escalate student growth and success in STEM.

Significance of the Study

Teachers are the key element for successful STEM education (Bakirci & Karisan, 2018). There is a need to continue expanding the field of STEM research to obtain additional insight about teachers' perceptions for STEM. Furthermore, increasing the level of teacher STEM awareness can impact the number of students choosing STEM postsecondary opportunities (Egarievwe, 2015; Falco, 2017; Knowles et al., 2018). It is also important for teachers to form partnerships with STEM business and industry. These partnerships can create opportunities for students outside of the classroom. Students who participate in these outside-of-the-classroom opportunities gain a more in-depth understanding of STEM content when there is an opportunity to participate in real-world STEM activities (Burns, Chopra, Shelley, & Mosher, 2018; Vennix, den Brok, & Taconis, 2018). Measuring teachers' perceptions for STEM awareness and support provide direction for what factors need to be improved and supported. Teachers who have an awareness for the importance of STEM education and have connections to outside resources for students can escalate overall student growth and increase the total number of students pursuing STEM degrees and careers.

Research Purpose and Questions

The purpose of this study was to examine science teachers' perceptions and determine their level of STEM awareness and support. The study assessed STEM awareness and support among high school science teachers in one large suburban school district across eight high schools. This study addressed the following research questions.

1. To what extent do high school science teachers perceive their school to have an industry engagement in STEM education?

2. To what extent do high school science teachers perceive their school to have an awareness of needed STEM resources?
3. To what extent do high school science teachers perceive their school prepares students for success in postsecondary STEM degrees and careers?
4. What factors do high school science teachers report will improve STEM awareness and engage more students to pursue postsecondary STEM degrees and careers?

Definitions of Key Terms

For this study, it is appropriate to define the following terms.

Awareness and Resources: Awareness and resources is defined as stakeholders understanding of the importance for STEM education and the readily accessible access to information related to STEM opportunities (Burns et al., 2018).

Industry Engagement: Industry engagement is defined as a collaborative partnership between school, community, and businesses that provide educational opportunities that bridge the gap between classroom education and real-world experience in STEM education (Burns et al., 2018).

STEM: An acronym for the subjects of science, technology, engineering, and mathematics (U.S. Department of Commerce, Economics and Statistics Administration, 2011).

STEM Awareness Community Survey (SACS): A quantitative instrumentation comprised of 39 items on a 4-point Likert scale that was developed and tested to assess STEM awareness and support (Sondergeld & Johnson, 2014).

Success in College and Career: Success in college and career is defined as a school's ability to successfully prepare students to think critically, problem solve, and pursue postsecondary studies for future STEM careers (Burns et al., 2018).

Conclusion

In summary, chapter one outlined the purpose of the study and emphasized that the goal of this study was to measure high school science teachers' perceptions for STEM awareness and support. These perceptions can impact the number of students pursuing STEM degrees and careers. This chapter emphasized that teachers have significant influence on students' interest and understanding of STEM education. This influence can be increased when teachers receive encouragement and support from school administration, parents, and outside STEM businesses and industry. Overall, teachers who have a better understanding for the importance of STEM, can positively impact students' perceptions of STEM. Students who have a positive perception for STEM, are more likely to pursue STEM degrees and careers. The next chapter is a literature review of the major topics involved in this study.

CHAPTER II:

LITERATURE REVIEW

The purpose of this study was to examine science teachers' perceptions and determine their level of STEM awareness and support. This chapter examines current literature in the areas of STEM as it relates to industry engagement, awareness and resources, and success in college and career. Furthermore, this chapter will discuss current research in the areas of teacher perception and student socioeconomic status.

School partnerships with industry and businesses have shown positive outcomes to increase student motivation and desire to pursue STEM careers (Vennix et al., 2018). Teachers with high levels of STEM awareness integrate rigorous instruction and seek out STEM related professional development (Knowles et al., 2018). The need for teachers to grow the pipeline of students pursuing STEM careers continues to grow greater. Teacher perception and student socioeconomic status are common barriers that can inhibit the success of STEM education. A teacher's perception can influence their instructional practice which can have both positive and negative effects on students. The expectations teachers set can directly influence students' performance in class and what they plan to pursue postsecondary (McKown & Weinstein, 2008). Socioeconomic status is a factor that can influence a student's success in STEM (Gregory & Huang, 2013). In addition, this chapter examines and discusses current research associated with the relationship of student socioeconomic status and academic success. At the conclusion of this literature review, the summary of findings and theoretical framework are presented.

Industry Engagement

Industry engagement is defined as a collaborative partnership between school, community, and businesses that provide educational opportunities that bridge the gap between classroom education and real-world experiences in STEM education. Burns, Chopra, Shelley, and Mosher (2018), completed a comprehensive research study entitled, Utilizing Multivariate Analysis for Assessing Student Learning Through Effective College-Industry Partnerships. The study's purpose was to assess the impact of industry engagement on student learning. The research question asked was: Do students perceive differences in the impact of various industry engagement activities including: case studies, guest speakers, internships, professional organization involvement, project tours, and videos? The population of this study included undergraduate students at Iowa State University and the sample was composed of 75 students who were enrolled in a senior level technology class for lean manufacturing. The criteria for selecting these students was whether they had or not participated in industry engagement activities during their coursework. Data were collected using a questionnaire-based survey, which was comprised of survey questions obtained from various validated questionnaire items. Survey items were framed using a seven-point Likert-type scale ranging from 1 (Strongly Disagree) to 7 (Strongly Agree) and 0 being neutral. Analysis was done using multivariate analysis of variance to compare student perception scores across the evaluated activities.

Findings showed that there is a significant difference in students' learning for skills used or applied among the activities. There is also a statistically significant difference between the means score for tours from the mean scores of videos. Additionally, there is a mean difference between projects and videos. These results suggested that students attain greater learning through internships, tours, and speakers when learning what skills can be used from the classroom and applied to the real world. Furthermore, students perceive internships, projects, and tours as having the most impact on their learning about the workplace culture. This study suggests that students gain a more in-depth understanding of the classroom material when they do internships. Taking the time identifying and implementing industry engagement activities such as, company tours, guest speakers, and projects helped students better understand the work environment they expect to experience after school.

Vennix, den Brok, and Taconis (2018), also concluded that outreach learning environments created opportunities to increase student motivation and attitude. The purpose of their study was to investigate what extent attitudes toward STEM and motivation during outreach activities are determined by need satisfaction and the learning environment. The population of this study included high school students from the United States and the Netherlands. The sample selected was comprised of 696 students who came from 35 different high schools. Data showed that the student sample included, 56.6% males, 43.2% females and 0.1% unknown. For students to be a part of this study, they had to participate in an outreach activity. There was a wide variety of activities in terms of teaching method and location. These activities ranged from traditional lectures to workshops and lasted from either one day to several days.

Participants in this study completed a questionnaire. This questionnaire contained questions about the following four major elements: learning environment perceptions, need fulfilment, motivation, and attitudes. All items included in the questionnaire used a five-point Likert scale ranging from (1) Strongly Disagree to (5) Strongly Agree. Several types of analysis were used to address the research questions including, means and standard deviations, ANOVA, and multilevel analysis of variance. Results indicated mostly positive attitudes towards STEM careers. Type of motivation was also evaluated. The results suggest that controlled motivation will increase when students perceive more autonomy support and will decrease when student perceive more personal relevance. As for autonomous motivation, it was positively related to perceived personal relevance and perceived needs fulfilment. The research concluded that adding outreach activities to curriculum would add value for students' intrinsic motivation to get more involved in STEM activities. Participation in outreach activities also led to increase autonomous motivation from students. Furthermore, this type of motivation could be enhanced when the outreach learning environment is personally relevant for the student. Findings from this research recommended that teachers and schools should give more attention to adding outreach activities to the curriculum. Specifically, schools should add more out-of-school activities that are personally relevant to students in order to achieve the best results.

Ramey, Lawford, Rose-Krasnor, Freeman, and Lanctot (2018) carried out research were they investigated program quality of community programs as it related to positive youth development. The purpose of their study was to examine community programs and their impact on youth who were involved in them. The population of this study was youth in Ontario, Canada and the sample of participants included 321 youth with an age range from 10 to 24 years of age. Participants identified as Black (25%), White (16%), Indigenous (12%) or South Asian (12%). The assortment of programs focused on many different areas. For example, some programs focused on physical fitness, leadership, or healthy relationships. In the study, several factors were measured including demographics, program quality-positive program features, program quality-youth adult partnerships, and community engagement. Analysis of the data collected was tested with multiple and multilevel regression.

In general, findings indicated, that positive features and youth-adult partnerships was linked to community engagements. The researchers stated, their results aligned well to other studies investigating effects on youth engaged in community activities. Overall, the research supported the importance of program quality and the need for communities to be engaged in their youth.

Another study emphasized; field-based experiences are essential when creating effective STEM teachers. Thiry, Laursen, and Hunter (2011) determined there are benefits for STEM students' learning and development when they engage in a variety of out-of-class experiences such as, internships, professional jobs, and undergraduate research. Their research included a sample of 62 graduating STEM majors from four liberal art colleges. Eighty-five percent of the students included, engaged in at least one out-of-class experience. Methods for the collection of data is qualitative. The data were based on detailed, semi-structured interviews with participants. Questions were designed to be open ended in order to understand complex behaviors, interactions and social processes. Interview protocols were established to identify gains that students reported making both in and out of the classroom. A coding framework was developed based on the research questions. These codes were classified as domains associated with benefits of their undergraduate experiences.

Thiry, Laursen, and Hunter's findings showed that participation in out-of-class experiences resulted in positive comments along with descriptive responses outlining the gain made. As for coursework and general college experiences, these experiences reported a larger percentage of mixed or negative statements. This study emphasized that students who engaged in out-of-class experiences, reported better critical thinking skills, individualization, and greater preparedness for future careers. In summary, there is consistency throughout research that outside-the-classroom experiences and industry support show positive effects and increase student motivation to pursue STEM related studies.

Awareness and Resources

Awareness and resources is defined as stakeholders understanding of the importance for STEM education and the readily accessible access to information related to STEM opportunities (Burns et al., 2018). Knowles, Kelley, and Holland (2018), completed a comprehensive research study entitled, *Increasing Teacher Awareness of STEM Careers.* In their study, they examined the effects of teacher professional development and lesson implementation in integrated STEM on teacher awareness of STEM careers. The purpose of this study was to investigate the effect of teacher awareness of STEM careers in several arenas including: (a) incorporating STEM professionals in a community of practice, (b) developing integrated STEM instruction, and (c) teacher professional development. Participants of this study included high school science and engineering teachers who participated in the project named, *Teachers and Researchers Advancing Integrated Lessons in STEM* (TRAILS). Teachers who participated in this project attended 70 hours of summer professional development that focused on integrating the STEM education model with lessons.

The researchers used an experimental treatment group and compared findings to an untreated control group of non-randomized participants. The study took place over three years and included three cohorts of teachers; one cohort of teachers was used each academic year. The T-STEM survey was utilized as the instrument and it measured STEM career awareness using Likert-type scale questions. Participants were assessed with the survey as a pretest and posttest which occurred after the lesson was delivered during the school year. The researchers used ordinal regression with a cumulative link model to detect difference in Likert scores. Results suggested that the TRAILS professional development had a greater impact on STEM career awareness for science teachers versus engineering teachers. Furthermore, this study revealed evidence that professional development can impact teacher STEM career awareness. Overall, this study found that increasing teacher awareness for STEM can result in more influence for students to choose and pursue STEM postsecondary opportunities.

A study by Park, Dimitrov, Patterson, and Park (2017), examined teachers beliefs about their readiness for teaching STEM. Their study's purpose was to examine beliefs of early childhood teachers' readiness for teaching STEM. The research focused on the following areas: (a) heterogeneity among teachers regarding their beliefs, (b) the relationship between such beliefs and teacher experience, and (c) the perceptions of teachers regarding issues and problems related to their beliefs about readiness for teaching STEM. Participants for this study included 830 early childhood teachers who worked in elementary schools located in rural Western Kentucky. The teacher breakdown of this preschool was pre-kindergarten (12.7%), kindergarten (29.3%), first grade (20.4%), second grade (18.8%), and third grade (18.8%). Gender demographics was male (3.2%) and female (96.8%), and teaching experience was 0–5 years (18.0%), 6–10 years (24.9%), 11–16 years (22.9%), and more than 17 years (34.2%). Data were collected through an online survey that included items on a 4-point Likert scale (1 = Strongly Disagree, 2 = Disagree, 3 = Agree, and 4 = Strongly Agree).

Data analysis for research questions one and two were addressed through a statistical method called, latent class analysis. Research question three was qualitative and was address through data analysis ground in the constant comparative method. Research findings concluded that the early childhood teachers fell into two classes. These two classes differed in means scores on all survey items. Results showed that the chances of higher beliefs in readiness for teaching STEM increased with an increase in teaching experience for participants who were aware of the importance for early childhood STEM education. Open-ended survey responses revealed several themes. One theme was teachers tend to believe that early childhood STEM education is critical and developmentally appropriated. Additional themes were related to the positive role of STEM in jobs and global competitiveness. Overall, this study revealed that attention should be paid to factors that foster positive beliefs for teachers about STEM education. These positive beliefs from teachers leads to positive effects on instructional decisions that directly benefit students.

In a study completed by Bakirci and Karisan (2018), it was reported that teachers are the key elements for successful STEM education. The study's purpose was to investigate preservice science, mathematics and primary school teachers' STEM awareness. Data were collected from preservice teachers at Yuzuncu Yil University during the fall semester of 2017. The study's sample included 558 preservice teachers. Of this sample, 371 were female and 187 were male. Participants ranged in age from 18 to 26 years old. Quantitative data were collected using a survey entitled *STEM Awareness Scale*. The survey consisted of 17 questions and two subscales (positive and negative). Items utilized a five-point Likert scale. Two-way analysis of variance was utilized when examining the department and gender differences in students' STEM awareness. No significant differences were observed for gender; however, there were significant differences among different departments' STEM awareness. Furthermore, differences amongst preservice teachers' STEM awareness with respect to grade level was not significant. Conclusions of the study indicated that in order to develop effective strategies in STEM education, it is necessary to raise teachers' STEM awareness. In summary, the researchers found for teachers to develop their skills in STEM teaching, they must first be aware of STEM. Teachers with a strong awareness of STEM have an opportunity to positively influence students' interest in STEM career fields.

Postsecondary STEM Degrees and Careers

Another component of teacher STEM awareness is students pursuing college and career STEM related fields. Success in college and career is defined as a school's ability to successfully prepare students to think critically, problem solve, and pursue postsecondary studies for future STEM careers (Burns et al., 2018). In a study done by Bozick, Srinivasan, and Gottfried (2017), entitled, *Do High School STEM Courses Prepare Non-College Bound Youth for Jobs in the STEM Economy*, researchers analyzed the impacts of STEM courses on students seeking jobs immediately out of high school. Their study's purpose was to determine if high school STEM courses provided non-college bound youth with the skills and training necessary to successfully transition from high school into the STEM economy.

To analyze their research questions, they examined data from the Educational Longitudinal Study conducted by the National Center for Education Statistics. Their study utilized a two-stage sampling procedure. The first stage, a sample of 752 high schools, both public and private, were selected with probabilities proportional to their size. The second stage, approximately 26 students were randomly sampled from each high school. Students who were eligible for the study had to be in the 10^{th} grade in the spring term of 2002. In this study, 17,591 students were eligible and 15,362 completed the survey about their experiences. In addition, cognitive assessments in mathematics and reading were administered to participants, their parents, teachers, principals and school librarians. In 2004, the participants were re-interviewed, and their transcripts were collected for additional data analysis. Of the 14,159 who fully participated, 3,473 reported not attending college and answered questions about their first and current job. These students who were identified as non-college bound were the sample group for this study.

Study analysis utilized two dependent variables, employment status and wages. Employment status was a nominal variable: 0 (not employed), 1 (employed in a STEM job), and 2 (employed in a non-STEM job). Wages is a continuous variable and was defined as the standardized hourly rate of pay in nominal dollars. Transcripts were broken down and courses were categorized as applied STEM or academic STEM. Applied STEM courses associated with Career and Technology (CTE) pathways. Whereas, academic STEM courses were not classified as CTE. Empirical strategies (multinomial logistic regression) and combining two processes to predict an outcome were the models used to reach conclusions.

Results from this study indicated that taking academic STEM courses or applied STEM courses in high school does not improve the likelihood that non-college bound youth will secure jobs in the STEM economy. Furthermore, taking these courses in high school does not significantly improve wages and students earned as much to their peers who don't work in STEM related jobs. In conclusion, the researchers stated that current high school STEM courses do a better job propelling a student to continue on in higher education than it does for helping non-college bound youth to be more successful. Therefore, schools need to develop better connections between high schools and employers, to meet the needs of the sub-baccalaureate STEM economy.

Egarievwe (2015) was a researcher who demonstrated a procedure that resulted in 80% of graduates pursuing jobs in STEM fields after graduation. His study showcased implementing a model called, Vertical Education Enhancement (VEE). This model was developed specifically to enhance STEM education and research to meet new challenges in a dynamic global environment. The model required the implementation of several components including: curriculum, mentoring, continuous improvement, research, labs, industry, government, and community partnerships. For this research, Egarievwe implemented this model with a multidisciplinary program at Alabama A&M University for nuclear and related STEM fields.

The project was entitled, *Nuclear Education and Research Vertical Enhancement* (NERVE). Project NERVE was a multifaceted program that created new curriculum, recruited students, and retained students by assessing continuously to improve culture. The implementation of the VEE model in the NERVE program resulted in enhancing STEM education and research. Over a three-year period, the NERVE program, enabled technology programs to get full accreditation, infused strong curriculum into existing STEM courses, developed additional degree programs, established additional nuclear labs, strengthen faculty, and prepared more students to successfully pursue STEM careers. Overall, Egarievwe's research showcased how the VEE model could enhance STEM education and motivate more students to pursue STEM careers.

Research has also shown that understanding the factors that influence students' academic and career choices early on is necessary to provide effective interventions and services that will have a positive impact on students' future career outcomes (Falco, 2017). This research synthesized pertinent research on student STEM engagement to better inform school counselors on how to better support STEM career development amongst students. Falco emphasized the importance of school counselors fostering STEM career self-efficacy. His research highlighted that counselors must support math and science achievement. Furthermore, the research stated how important it was for counselors to promote positive attitudes and strong self-efficacy in STEM subject disciplines to ensure student interest and ability to overcome obstacles. Additionally, Falco stated that counselors must address systemic barriers associated with STEM. For example, counselors must make authentic efforts to support females and underrepresented minority students who are least likely to pursue STEM careers. Counselors and teachers need to have more awareness of STEM occupations to have the ability to expose, inform, and motivate students to pursue STEM careers. Career development is a lifelong process, and this research emphasized how STEM awareness and motivation needs to start in K-12 schooling to grow the pipeline of students pursuing

STEM degrees and careers. In conclusion, this research summarized that counselors and teachers are important messengers of information and their attitudes can have powerful effects on students' disposition in the area of STEM career development.

Teacher Perceptions

Teacher perceptions can be defined as a teacher's thoughts about a topic, activity or person. These thoughts are often influenced by one's prior knowledge and experiences. A teacher's perceptions can have both positive and negative effects on students' expectations, and these expectations can directly influence students' performance in class (McKown & Weinstein, 2008). Researchers, Bozkurt and Ercan (2016), examined teachers' perception and competencies as they relate to STEM education. Their study investigated the effects of a professional development on participating science teachers' perceptions. The study was carried out using qualitative research practices. The group studied in this research was composed of 24 science teachers. These teachers were recruited online. Those who were interested in being a part of the study had to complete an application. The researchers used information from the application to construct a heterogeneous sample in terms of teaching location and years of experience. Data were collected through *Teachers' Perceptions on STEM Education Questionnaire*. This questionnaire was developed by the researchers and was given to participants before and after the professional development program. Comparisons were made and themes were constructed.

Results indicated that teachers with positive perceptions for STEM education had better awareness for the importance of STEM education. Furthermore, teachers with positive perceptions were more successful at planning, implementing, and evaluating activities suitable for STEM education. Overall, the research supported the importance of teachers having a positive perception for STEM education.

Asghar, Ellington, Rice, Johnson, and Prime (2012), also studied teachers' perceptions. In their study, they wanted to determine what types of professional development experiences could help teachers' understanding of the interdisciplinary approach to STEM teaching and learning. The purpose of the study was to examine teachers' initial conceptions of Project Based Learning (PBL), their response to an interdisciplinary STEM PBL professional development (PD) experience, and their perceptions of what facilitates or hinders implementation of interdisciplinary STEM PBL in their schools. The research questions asked were: (a) How did teachers' perceptions and conceptions of PBL in STEM education evolve as a result of their participation in this PD?, (b) What were some of the challenges they anticipated in implementing STEM PBL in their classrooms?, and (c) What direction for future PD in STEM can be derived from the responses from these teachers? The population for this study included public school teachers in the State of Maryland. The sample selected included 41 teachers who came from 20 of the 25 public school systems invited. Within this group, there were seven biology teachers, five engineering teachers, 13 math teachers, 10 teachers of a science other than biology, and six technology education teachers. A total of 25 teachers actually completed all five days of the PD series.

Data were collected through several avenues including: (a) pre-workshop survey, (b) participant observation notes of the activities and discussions during the PD, (c) focus group discussions, (d) individual interviews, and (e) workshop feedback and evaluation forms. Descriptive statistical techniques were employed to analyze survey data, while an inductive coding approach was utilized to analyze interviews, focus groups, and observational data. Quantitative results showed that 88% of the teachers surveyed felt that the STEM PD helped them learn new ideas. In addition, 77% felt the experience was unique and 86% expressed that the experience was a good change from typical PD they attended. Qualitative data results indicated that a majority of teachers felt that there was not enough clarity in the program and that hands-on experiences were lacking. Additionally, many teachers had a difficult time envisioning how this STEM curriculum is going to mesh with current school curriculum and content assessment standards. Overall, teachers exhibited resistance to the implementation of the STEM model.

The researchers in this study highlighted how negative teacher perceptions create barriers for the success of STEM education. Recommending that educational leaders must recognize the internal and external barriers that teachers face when trying to implement such an innovative approach, like STEM. To overcome these barriers, the researchers explained that teachers must receive encouragement, support, and additional professional development. Teachers must also have time to collaborate with colleagues to develop and implement innovative STEM curriculum.

In addition, this study revealed how teachers' perceptions are hindered by accountability and assessment systems. The research stated that teachers were apprehensive implementing an integrated STEM curriculum due to an underlying fear that students would perform poorly on content specific state-mandated tests in algebra and biology. Researchers attempted to alleviate these concerns by providing teachers with a strong case for how STEM education could improve students' conceptual understandings and critical thinking skills. However, the teachers reiterated that the only way to ensure student success on these assessments, would be to teach the specific skills and content being tested. Teachers believed teaching interdisciplinary content was insufficient and their instruction had to be tailored specifically to the content for which they were being held accountable.

Impacts of Socioeconomic Status on STEM Education

Student socioeconomic status and the impacts it has on student academic success is one of the most research topics in education. A study by Bolshakova, Johnson, and Czerniak (2011), indicated that all students, regardless of culture, gender, race, or socioeconomic status, if given the opportunity, can learn and do science. Their study's purpose was to explore how science teachers' effectiveness in the classroom impacts the self-efficacy of students. This qualitative study identified three teachers and 14 Hispanic students. Hispanics were the study's focus due to the history of underperformance throughout the school district. All 14 students attended an urban middle school in the southwest. The school had a diverse population of approximately 650 students. The ethnic breakdown was White-non-Hispanic (35%), Hispanic (58%), and the remaining seven percent representing Black-non-Hispanic, Asian and Pacific Islander, and Native American. Most students (76%) were identified coming from economically disadvantaged families.

The three science teachers participated in eight monthly full-day professional development sessions with other science teachers. They all received two inquiry-based modules to use with their students. During the PD, the teachers participated in doing the lessons, conducting peer observations, and planning new modules for instruction. Data were collected through classroom observations and interviews with students and teachers. The classroom observations were analyzed using a LSC protocol. All interviews were coded and analyzed to find emergent themes. Findings indicated a relationship between teacher effectiveness and student outcomes. A student's desire to learn and participate in science diminished the more a teacher uses less effective instructional strategies. Teachers who are more effective foster interactive and positive classroom dynamics between teacher-student and student-student relationships. Additionally, teachers with stronger self-efficacy can have a positive impact on student's self-efficacy regardless if they are identified being at-risk. In conclusion, heightening teachers' awareness of the impact of their self-efficacy can have significant positive effects on students. Thus, increasing the chances that students go on to pursue STEM degrees and careers.

Researchers Gregory and Huang (2013) completed a study that examined the link between varying sources of expectations and student outcomes. The research questions asked were: (a) Beyond performance on standardized exams, track level, gender, socioeconomic status and race/ethnicity, do college-going expectations held by the student, parent, and two teachers in 10^{th} grade predict postsecondary education 4-years later?, and (b) In relation to postsecondary education, do student, parent, and teacher expectations in the 10^{th} grade have greater predictive power for low income students and for traditionally underrepresent ethnic minorities? Data for this study came from the 2002-2006 Educational Longitudinal Study conducted by the National Center for Educational Statistics at the U.S. Department of Education. Approximately, 15,000 students were included in the study's sample. In the spring of 2002, students were given self-report questionnaires and achievement tests in reading and mathematics. The student's parents and 10^{th} grade teachers (English and mathematics) were given a survey to complete for each student. A total of 4,094 students completed the data requirements to remain in the study. The study's participants had a range of socioeconomic backgrounds including: (a) 31% of students came from families with incomes below $35,000, (b) 42% of students came from families with incomes between $35,001 and $75,000, and (c) 27% of students came from families with incomes greater than $75,000.

Statistical analysis software was used to analyze the data. Several cross-classified random effects models were used to tests the hypotheses. Results indicated that student, parent, and teacher expectations in 10^{th} grade each uniquely predicted college-going 4-

years later. Additionally, the research revealed that no matter the characteristics of the student in the 10^{th} grade, multiple sources of positive expectations for a student can help them stay on the college-going trajectory. Interestingly, the study also concluded that when compared to student and parent positive expectations, a teacher's positive expectations have the greatest predictive power to postsecondary education. Furthermore, this link between teacher positive perceptions and student progress in postsecondary opportunities was stronger for lower income students. Thus, highlighting a teacher's unique ability to help socially and economical elevate typically underrepresented students.

Summary of Findings

As explained in this chapter, STEM teacher awareness is influenced by a variety of factors. The following factors were examined: industry engagement, awareness and resources, and success in college and career. Current research indicated that students gain a more in-depth understanding of STEM content when they have the opportunity to participate in real-world STEM activities (Burns et al., 2018; Vennix et al., 2018). Knowles, Kelley, and Holland (2018) found that increasing teacher STEM awareness has the potential to directly impact the number of students choosing STEM postsecondary opportunities. Teachers positive beliefs often lead to positive effects on instructional decisions that directly benefit students (Park et al., 2017). Bakirci and Karisan (2018) stated in their research that teachers are the key elements for successful STEM education.

As for the relationship between STEM and postsecondary options, Bozick, Srinivasan, and Gottfried (2017), indicated that taking academic STEM courses or applied STEM courses in high school does not improve the likelihood that non-college bound youth will secure jobs in the STEM economy. Whereas, another study showed that implementing a STEM based curriculum could produce up to 80% of graduates pursuing jobs in STEM fields after graduation (Egarievwe, 2015). Research has also shown that understanding the factors that influence students' academic and career choices early will have a positive impact on students' future career outcomes (Falco, 2017). Overall, having a better understanding for teachers' STEM awareness and the resources available can directly impact students pursuing postsecondary STEM degrees and careers.

Common barriers inhibiting the improvement of STEM education were also discussed. A teacher is a powerful influencer and their perceptions can have both positive and negative effects on students' expectations. These expectations can directly influence students in the following manners: (a) academic performance, (b) awareness of STEM, and (c) potential for pursuing STEM degrees and careers (Bolshakova et al., 2011; McKown & Weinstein, 2008). Another barrier for STEM education examined was students' socioeconomic status. A study by Bolshakova, Johnson, and Czerniak (2011), indicated that all students, regardless of culture, gender, race, or socioeconomic status, if given the opportunity, can learn and do science. Gregory and Huang (2013) concluded that when compared to student and parent positive expectations, a teacher's positive expectations have the greatest predictive power to postsecondary education. This link between teacher positive perceptions and student progress in postsecondary opportunities was stronger for lower income students. Overall, the research shows that teacher perceptions can overcome barriers that inhibit the improvement of STEM education.

Theoretical Framework

Fullan's (2006) work was used for this research. His change theory is based on the idea that change cannot occur without motivation. This notion is supported by seven core ideas: (a) motivation; (b) capacity building focused on results; (c) learning in context for those enacting reform; (d) capacity to change the larger context; (e) reflective action; (f) tri-level engagement; and (g) persistence and flexibility. Fullan reports that no matter how excellent any instructional program is, learning will be no greater than the student's level of motivation. Teachers must apply pressure to achieve results, and teachers must buy-in to the program and remained open minded to promote strong collaboration. Most importantly, Fullan's theory expects teachers to maintain persistence and flexibility in order to achieve action. This theoretical framework establishes the main framework of this study.

Conclusion

This chapter presented current research about teacher STEM awareness as it relates to industry engagement, awareness and resources, and success in college and career. The research provided insight of how each of these key constructs can impact a teacher's awareness of STEM. Furthermore, several studies discussed indicated that increasing STEM teacher awareness can influence more students to pursue STEM postsecondary opportunities. Lastly, STEM research that included connections to teacher perceptions and student socioeconomic status were reviewed. Chapter III will report the methodology for this study.

CHAPTER III:

METHODOLOGY

The purpose of this study was to examine science teachers' perceptions and determine their level of STEM awareness and support. The study assessed STEM awareness and support among high school science teachers in a large suburban school district in southeast Texas. At the time this study was conducted, there were eight high schools in the school district. Survey data were collected from a purposeful sample of high school science teachers. The exclusive selection to use only science teachers for this study was done intentionally. In this school district, the most suitable option to implement STEM education is to incorporate the other disciplines into one of the STEM disciplines. This school district implements STEM education by integrating mathematics, engineering, and technology into the science program. STEM education is done exclusively in science classrooms.

Quantitative data were collected using the *STEM Awareness and Community Support Survey* (SACS). Qualitative data were collected through semi-structured interviews and it were analyzed using an inductive coding process. This chapter presents an overview of the research problem, operational definitions of theoretical constructs, the purpose of the research and the corresponding research questions, the research design, the population and sampling of the participants, the demographic characteristics of the research participants, instrumentation, instrument reliability, how the data were collected and analyzed, ethical considerations, and the limitations of the study.

Overview of the Research Problem

According to a report and book by the National Academy of Sciences (Sciences, 2007), STEM education is essential for the United States (U.S.) to remain globally competitive. The need to increase the number of students pursuing STEM careers in the

U.S. is an increasing concern for those in leadership, industry, and education. Despite large financial investments in STEM, there has been little attention devoted to generating a better understanding for STEM (Breiner, Harkness, Johnson, & Koehler, 2012). According to Carla Johnson (2012), development of this awareness to help community members understand the importance of STEM regarding the future prosperity of the U.S., and preparedness of children for future careers, has been nonexistent. Current literature reports community engagement is essential for implementing and sustaining reform programs (Zmuda, Kuklis, & Kline, 2004). If the U.S. educational system is to make a dramatic shift in how students are prepared for future careers, a collaborative effort must be made amongst multiple stakeholders to accomplish (Shirley, 2009). Measuring current high school science teachers STEM awareness is a critical first step to identify and address potential gaps in our educational system's overall understanding of STEM.

Operationalization of Theoretical Constructs

This study consists of three constructs: (a) industry engagement, (b) awareness and resources, and (c) success in college and career. Industry engagement is defined as a collaborative partnership between school, community, and businesses that provide educational opportunities that bridge the gap between classroom education and real-world experience in STEM education (Burns et al., 2018). Awareness and resources is defined as stakeholders understanding of the importance for STEM education and the readily accessible access to information related to STEM opportunities. Success in college and career is defined as a school's ability to successfully prepare students to think critically, problem solve, and pursue postsecondary studies for future STEM careers. These three constructs were measured using the *K-12 STEM Awareness and Community Support Survey* (Sondergeld & Johnson, 2014).

Research Purpose and Questions

The purpose of this study was to examine science teachers' perceptions and determine their level of STEM awareness and support. The study assessed STEM awareness and support among high school science teachers in one large suburban school district across eight high schools. This study addressed the following research questions.

1. To what extent do high school science teachers perceive their school to have an industry engagement in STEM education?
2. To what extent do high school science teachers perceive their school to have an awareness of needed STEM resources?
3. To what extent do high school science teachers perceive their school prepares students for success in postsecondary STEM degrees and careers?
4. What factors do high school science teachers report will improve STEM awareness and engage more students to pursue postsecondary STEM degrees and careers?

Research Design

This study used a mixed-methods research design to examine the attitudes and beliefs of high school science teachers in terms of their STEM awareness and perceptions of district and community support. Using a mixed-methods approach provided the researcher with a more in-depth understanding of high school science teachers STEM awareness and helped the researcher identify potential strategies for improving STEM awareness. A purposeful sample of high school science teachers employed in a large suburban school district in southeast Texas were solicited to provide responses to the *STEM Awareness and Community Support Survey* (SACS). Quantitative data were collected through the use of a survey. Qualitative data were collected through semi-structured interviews. Quantitative data were analyzed using frequencies, percentages, and a one-way analysis of variance (ANOVA), while the qualitative data were analyzed using an inductive coding process.

Population and Sample

The population of this study consisted of 9^{th} through 12^{th} grade high school science teachers in a large suburban school district in southeast Texas. In the 2016-2017 school year, this district served approximately 75,000 students. Table 3.1 displays the student population of the school district and provides the demographic information for the 2016-2017 school year. Most students in this school district identified themselves as White (36.9%) or Hispanic (34.6%). Followed by Asian (14.9%) and African American (10.3%). In addition to student demographic information, represented staff demographics for these high schools are displayed in Table 3.2. There are 1,366 high school teachers in this district and 182 are science teachers (13.3%). Most high school science teachers identify themselves as White (75.4%). Followed by Hispanic (14.0%) and African American (6.4%). A purposeful sample of high school (9^{th}-12^{th} grade) science teachers were solicited to participate in this study.

Table 3.1

Participating School District's Student Population and Demographics

	Student (n)	Percentage (%)
Total Students	75,231	100.0
African American	7,771	10.3
Hispanic	26,007	34.6
White	27,725	36.9
American Indian	275	0.4
Asian	11,202	14.9
Pacific Islander	93	0.1
Two or More Races	2,158	6.6
Economically Disadvantage	21,290	28.3
English Language Learner (ELL)	12,262	16.3
Special Education (SPED)	6,620	8.8

Table 3.2

Participating School District's High School Teacher Population and Demographics

	Teachers (n)	Percentage (%)
Total Teachers	1,366	100.0
African American	87	6.4
Hispanic	191	14.0
White	1,030	75.4
American Indian	7	0.5
Asian	34	2.5
Pacific Islander	1	0.1
Two or More Races	15	1.1
High School Science Teachers (Grades 9-12)	182	13.3

Participant Schools

There are eight high school campuses in this school district. Table 3.3 displays the student demographic breakdown per high school. The percentage of students identified as White were the majority at five high school campuses: A (47.8%), B (48.4%), E (41.0%), F (48.2%), and G (45.1%). The percentage of students identified as Hispanic were the majority at three high school campuses: C (56.2%), D (52.9%), and H (49.0%). The percentage of students identified as economically disadvantage (ED) varied greatly between high schools. High schools, F (11.3%) and G (6.4%), was composed of less than 20% ED; high schools, A (33.0%), B (28.4%), and E (21.5%), consisted of between 20%

and 40% ED; and high schools C (58.4%), D (57.9%), and H (48.6%) had greater than 40% ED students.

Table 3.3

Student Demographics of the Eight High Schools

	A (%)	B (%)	C (%)	D (%)	E (%)	F (%)	G (%)	H (%)
African American	7.5	8.6	17.2	19.6	6.8	8.1	8.5	22.5
Hispanic	24.4	36.1	56.2	52.9	23.5	24.0	24.3	49.0
White	47.8	48.4	17.7	18.8	41.0	48.2	45.1	21.2
American Indian	0.2	0.5	0.5	0.2	0.4	0.5	0.3	0.1
Asian	16.3	3.7	6.9	5.8	25.5	15.8	18.5	5.8
Pacific Islander	0.2	0.1	0.1	0.2	0.1	0.2	0.3	0.1
Two or More Races	3.7	2.7	1.4	2.4	2.6	3.2	3.0	1.2
Economically Disadvantaged	33.0	28.4	58.4	57.9	21.5	11.3	6.4	48.6
ELL	5.2	3.7	6.9	7.2	3.4	4.8	2.0	5.2
SPED	4.9	9.5	9.8	8.5	5.2	6.4	5.0	8.2

Instrumentation

The *STEM Awareness Community Survey* (SACS) was developed and tested to assess STEM awareness and support (Sondergeld & Johnson, 2014). The scale was piloted using Rasch measurement methods and results showed highly reliable items (Rasch reliability = 1.00). Rasch models are mathematical models that require unidimensionality and result in additivity. Using Rasch measurement methods revealed that the construct of STEM awareness and support is a unidimensional variable that fits the Rasch model after numerous iterations within two pilot tests. Three parallel versions of the SACS were created to assess K-12 teachers, higher education faculty, and members from the business community in their attitudes and beliefs about regional STEM awareness and support.

The surveys were each composed of 63 items with the majority of items being on a traditional 1–5-point Likert-scale (Strongly Disagree to Strongly Agree), but also having some select all appropriate items, and open-ended questions. Seven sections were developed for the survey: demographic information (six items), employment/employer information (four items), industry engagement in STEM education (12 Likert-scale items), STEM awareness and resources (14 Likert-scale items), preparation of students for success in college and career (six Likert-scale items and two select appropriate options item), and regional STEM careers and workforce (13 Likert-scale items). The instrument also measured a wide range of attitudes (separation = 15.89), indicating a meaningful construct was established.

The SACS is comprised of 39 items on a 4-point Likert scale (1 = Strongly Disagree, 2 = Disagree, 3 = Agree, 4 = Strongly Agree) with four subscales: Industry Engagement in STEM Education (IE: eight items), STEM Awareness and Resources (AR: 13 items), Preparation of Students for Success in College and Career (PR: six items), and Regional STEM Careers and Workforce (CW: 12 items). Rasch reliability is similar to traditional reliability in that it is the statistical reproducibility of a set of values. Traditional reliability is computed for raw scores, whereas, Rasch reliability is computed for person abilities and item difficulties. Separation and reliability of 1.50 and 0.70, respectively, are considered acceptable; 2.00 and 0.80, respectively, are good; 3.00 and 0.90, respectively, represent excellent levels. Upon reducing the survey items and limiting the Likert-scale to four options, person reliability and item reliability reported in the excellent level.

To interpret data, a total score is calculated, and this score is converted using a provided table that identifies the corresponding logit measure. This measure is utilized to look up on the SACS ruler and determine a percentage of STEM awareness. If this instrument is used correctly, the SACS has the potential to create a road map for systematically planning and implementing STEM reform efforts in schools and communities. For purposes of this research, only three of the four subscales were measured: (a) Industry Engagement in STEM Education, (b) STEM Awareness and Resources, and (c) Preparation of Students for Success in College and Career.

Data Collection Procedures

Prior to any data collection, the researcher obtain permission to conduct the study from the University of Houston-Clear Lake (UHCL) Committee for the Protection of Human Subjects (CPHS). Once permission was granted, the researcher contacted each high school campus principal through email to discuss the purpose of the student and the process for collecting teacher survey responses. After communicating with the principal, the researcher emailed all high school science teachers in the district. The email included, the study’s purpose, SurveyMonkey link, directions for completing the survey and timeline for completion. The email emphasized that survey participation is voluntary and that all responses will remain confidential. Participants who clicked on the SurveyMonkey link, were directed to a webpage that assured confidentiality, and prompted them to complete an electronic consent form.

Quantitative

Once consent was obtained, the participant was navigated to a SurveyMonkey survey that explained the survey directions and timeline for completion. Appendix A contains a copy of the survey information letter and Appendix B includes a copy of the *STEM Awareness Community Survey* (SACS). At the end of the survey, participants had to select if they wanted to be interviewed by the researcher to provide additional clarity about STEM awareness and support.

Qualitative

For the qualitative data, the researcher contacted participants who volunteer to be interviewed and conducted a 30-minute semi-structure interview. All participants were required to provide verbal consent and a semi-structured interview script was followed (See Appendix C – Interview Questions). All interviews were recorded, with participant permission. The researcher transcribed the interviews, coded and analyzed to find emergent themes within the participant’s responses. Data is stored electronically on the researcher’s personal encrypted cloud server. Access to this data is password protected and will remain there for five years before being destroyed.

Data Analysis

Quantitative

All quantitative data were analyzed using IBM SPSS. Research questions one, two, and three were addressed by calculating frequencies and percentages to determine science teachers’ perceptions of industry engagement in STEM education, STEM awareness and resources, and preparation of students for success in postsecondary STEM degrees and careers. For each of the three subscales, a composite score was calculated. A one-way analysis of variance (ANOVA) was then conducted for each subscale to determine if the region of the school district had an influence on the science teachers' perceptions of industry engagement in STEM education, STEM awareness and resources, and preparation of students for success in postsecondary STEM degrees and careers. An effect size was calculated using partial eta squared and statistical significance value of .05 was used for this study.

Qualitative

To examine research question four, an inductive coding process was utilized to address responses obtained during semi-structured interviews with participants. Themes were constructed based on identified code patterns in the transcribed interviews (Lichtman, 2013). Transcripts were then uploaded into *NVivo*, a qualitative analysis coding software. Using this software, the interview data were combined and organized by interview questions. Recurring concepts became codes and these codes help to form categories. These categories emerged into themes for the research question. The development of these themes allowed the researcher to draw conclusions and determine what factors do high school science teachers report will improve STEM awareness and engage more students to pursue postsecondary STEM degrees and careers. Furthermore, these emergent themes assisted the researcher with additional information and clarification for the quantitative findings.

Validity

Conclusions drawn from the quantitative research process were supported by the qualitative research. Researcher bias was minimized by asking interview participants open-ended questions and follow-up questions for clarity, as well as maintaining a neutral stance and being supportive. All interviews were personally conducted by the researcher to ensure reliability and triangulation were employed as a validity check. Triangulation was achieved by having multiple participants, from different high schools, and through the use of multiple data collection methods (Yin, 2016). Additionally, the researcher previously piloted the semi-structured interviews and questions with research colleagues and teachers in positions similar to those being solicited for the study. Precautions were taken by the researcher and accuracy of qualitative data were ensured through several methods including: summarizing perspective through member checking, all interviews were recorded digitally and transcribed, and accuracy checks completed after analysis.

Privacy and Ethical Considerations

The researcher gained approval from UHCL and the CPHS of the participating school district prior to collecting data. After approval was granted, the researcher sent an email with the survey link to all participants with a notice stating that by participating in the survey, you are giving consent to participate in the study. The survey letter also included the purpose of the study, a statement that participation is voluntary, and how participants' identities and their campus information will remain confidential. Electronic consent was obtained.

In addition, to the collection of the quantitative data, the researcher planned to utilize methods to protect confidentiality of the study's qualitative component. In an effort to receive honest feedback from interviewees, participants were told their identity will be kept confidential. Participants who are interviewed were given false identities chosen by the researcher. In addition, the school names were removed. All data collected from the study is stored electronically on the researcher's personal encrypted cloud server. Access to the data is password protected and will remain there for five years before being destroyed.

Research Design Limitations

The research design consisted of several limitations. First, the study's sample size and geographical location was limited due to the use of eight high schools belonging to one school district. Others must use caution when generalizing this research to other schools with different populations or geographical settings. Second, the *STEM Awareness Community Survey* (SACS) is a self-reporting instrument and participants could have reported inaccurate or dishonest information. Therefore, the researcher was unable to ensure the absolute accuracy of teacher responses. Third, even though the study's response rate was around 70%, this rate varied from high school to high school. There were a few high schools with high rates of response, while others had lower rates. The varied range of response rates across all high schools could impact the justifications of results and limit study conclusions. Lastly, the researcher is currently an administrator at one of the high schools in this district. The researcher has also worked in different professional capacities at three of the other high school campuses throughout the past 10 years. During this study, the researcher's employment information was not revealed to participants; however, some participants could have prior knowledge and personal experiences working with the researcher. For this reason, some individuals could have felt uncomfortable and provided responses that were not completely honest. This respondent bias had potential to skew the studies' results.

Conclusion

The purpose of this study was to examine science teachers' perceptions and determine their level of STEM awareness and support. This chapter provided an overview of the research problem, operationalization of theoretical constructs, research purpose, 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. Chapter IV will report results of the study.

CHAPTER IV:

RESULTS

The purpose of this study was to examine science teachers' perceptions and determine their level of STEM awareness and support. The study was completed in the spring of 2019 at eight high school campuses in a large suburban school district in southeast Texas. This chapter presents the data analysis and findings from both quantitative and qualitative data. Survey results were analyzed using frequencies, percentages, and a one-way analysis of variance (ANOVA), while interview data were analyzed using an inductive coding process. This chapter begins with an explanation of the participant's demographic characteristics, followed by the results for each of the four research questions. The chapter concludes with a summary of findings.

Participant Demographics

Data were collected across eight high schools in a large suburban school district in southeast Texas. The participating school district was broken down into three regions based on the percentage of students identified as economically disadvantaged (ED). Region one was composed of high schools with less than 20% ED; Region two consisted of between 20% and 40% ED; and Region three had greater than 40% ED students. During the spring of 2019, an email was sent to all 182 high school science teachers soliciting participation in a survey exploring STEM teachers' awareness and perceptions. A total of 124 high school science teachers completed the survey (68% response rate). Furthermore, ten of the 124 teachers volunteered and participated in interviews to provide qualitative data for this study. Table 4.1 displays participant demographics per region of the school district. The majority of the participants were female (69.4%, n = 86), while male participants represented 30.6% (n = 38). Eighty two percent (n = 101) of the participants self-identified as Caucasian/White, while Hispanic/Latino followed with

11.3% (n = 14). Tables 4.2 provides participant experience of years teaching STEM per school district region. Region one and three had the highest percentage of teachers with experience between 0-5 years range. Whereas, Region two had the highest percentage of teachers with experience between the 11-20 years range. Overall, the majority of teachers in this study had less than 10 years of experience teaching STEM courses.

Table 4.1

Number of Participants per School District and Region (%)

	All Schools	Region 1	Region 2	Region 3
Total Participants	100 (n = 124)	29.0 (n = 36)	39.5 (n = 49)	31.5 (n = 39)
Male	30.6 (n = 38)	36.1 (n = 13)	24.5 (n = 12)	33.3 (n = 13)
Female	69.4 (n = 86)	63.9 (n = 23)	75.5 (n = 37)	66.7 (n = 26)
American Indian or Alaska Native	0.8 (n = 1)	0.0 (n = 0)	0.0 (n = 0)	2.6 (n = 1)
Asian or Asian American	6.5 (n = 8)	8.3 (n = 3)	4.1 (n = 2)	7.7 (n = 3)
Black or African American	2.4 (n = 3)	0.0 (n = 0)	0.0 (n = 0)	7.7 (n = 3)
Caucasian or White	81.5 (n = 101)	83.3 (n = 30)	83.7 (n = 41)	76.9 (n = 30)
Hispanic or Latino	11.3 (n = 14)	11.1 (n = 4)	14.3 (n = 7)	7.7 (n = 3)
Native Hawaiian or Pacific Islander	0.0 (n = 0)	0.0 (n = 0)	0.0 (n = 0)	0.0 (n = 0)
Two or More Races	3.2 (n = 4)	2.8 (n = 1)	4.1 (n = 2)	2.6 (n = 1)

Table 4.2

Number of Years Teaching STEM per School District and Region (%)

Years	All Schools	Region 1	Region 2	Region 3
0-5	29.8 (n = 37)	36.1 (n = 13)	24.4 (n = 11)	33.3 (n = 13)
6-10	29.8 (n = 37)	33.3 (n = 12)	30.6 (n = 15)	25.6 (n = 10)
11-20	30.7 (n = 38)	27.8 (n = 10)	32.7 (n = 16)	30.8 (n = 12)
21-30	8.1 (n = 10)	2.8 (n = 1)	14.3 (n = 7)	5.1 (n = 2)
30+	1.6 (n = 2)	0.0 (n = 0)	0.0 (n = 0)	5.1 (n = 2)

Research Question One

Research question one, To what extent do high school science teachers perceive their school to have an industry engagement in STEM education? was answered by calculating frequencies and percentages of the participants' responses to the STEM Awareness Community Survey (SACS). Research question one was further addressed by calculating a composite score for this subscale and conducting a one-way analysis of variance (ANOVA) to determine if there was a statistically significant mean difference among the three regions of the school district in terms of industry engagement in STEM education (see Table 4.3). The results of the one-way ANOVA indicated that the region of the school district did not influence the science teachers' perception of industry engagement in STEM education, $F(2, 121) = .423$, $p = .656$. All three regions had teachers that mutually agreed on the support they received from outside industry and business. Predominantly, most teachers reported only receiving support by guest speakers. The responses related to the subscale of Industry Engagement in STEM Education per socioeconomic region are provided below.

Table 4.3

School District Region and Industry Engagement in STEM Education

Region	N	M	SD	F-value	df	*p*-value
1	36	19.1	3.39	.423	(2, 121)	.656
2	49	19.1	3.49			
3	39	18.5	3.83			

Region One

Region one had less than 20.0% economically disadvantage students. Most teachers (97.2%) *Agreed/Strongly Agreed* it is important for area businesses to be in STEM partnerships with their school, there are organizations interested in providing STEM education opportunities to students (80.6%), and STEM education opportunities for students have increased (66.7%). Only (58.3%) of teachers *Agreed/Strongly Agreed* they had community/business guest speakers at school and only (61.1%) of teachers *Agreed/Strongly Agreed* there are opportunities for students to complete STEM internships. Overall, there is agreement that opportunities are available; however, most teachers (75.0%) *Disagreed/Strongly Disagreed* that they worked closely with community/business organization members and 52.7% *Disagreed/Strongly Disagreed* having businesses/community fund STEM education programs or events at their school.

Region Two

Region two had between 20.0% and 40.0% economically disadvantage students. Most teachers (98.0%) *Agreed/Strongly Agreed* it is important for area businesses to be in STEM partnerships with their school, there are organizations interested in providing STEM education opportunities to students (85.7%), and opportunities for students have increased (66.7%). Furthermore, 67.3% of teachers *Agreed/Strongly Agreed* there are opportunities for students to complete STEM internships. Most teachers (75.5%) *Disagreed/Strongly Disagreed* that they worked closely with community/business organization members, had community/business guest speakers at school (59.2%), and had business/community fund STEM education programs or events at their school (55.1%).

Region Three

Region three had greater than 40.0% economically disadvantage students. All teachers (100.0%) *Agreed/Strongly Agreed* it is important for area businesses to be in STEM partnerships with their school. A majority of teachers (64.1%) *Agreed/Strongly* there are organizations interested in providing STEM education opportunities to students and opportunities for students to complete STEM internships (53.8%). Only 51.3% *Agreed/Strongly Agreed* they had community/business guest speakers at school. Additionally, only 51.3% *Agreed/Strongly Agreed* there has been an increase in STEM education opportunities for students in the last year. Most teachers (79.5%) *Disagreed/Strongly Disagreed* that they worked closely with community/business organization members and 51.3% *Disagreed/Strongly Disagreed* having businesses/community fund STEM education programs or events at their school.

Region Comparison

All high school science teachers of the district consistently *Agreed/Strongly Agreed* there were STEM education opportunities available to students and that these opportunities have increased in the last year. Furthermore, most Region one (80.6%) and two (85.7%) teachers *Agreed/Strongly Agreed* there are organizations interested in providing STEM education opportunities to students. Whereas, only 64.1% of Region three teachers *Agreed/Strongly Agreed* there are organizations interested in providing

STEM education opportunities to students. There were variations of agreement as it pertained to teachers having community/business guest speakers at school. Teachers from Regions one and three *Agreed/Strongly Agreed* having community/business guest speakers and Region two teachers *Disagreed/Strongly Disagreed*. Lastly, all teachers where consistent indicating they had not worked closely with community/business organizations. Tables 4.4 and 4.5 display the percentages and frequencies of teachers in Regions 1-3 on responses in expanded and collapsed form respectively on perceptions related to survey items associated with industry engagement in STEM education.

Table 4.4

Participant Responses to Industry Engagement in STEM Education per Socioeconomic Region (%)

		Strongly Disagree	Disagree	Agree	Strongly Agree
1. I believe it is important for area businesses to be involved in STEM partnership(s) with my school.	Region 1	0.0 (n = 0)	2.8 (n = 1)	58.3 (n = 21)	38.9 (n = 14)
	Region 2	2.0 (n = 1)	0.0 (n = 0)	55.1 (n = 27)	42.9 (n = 21)
	Region 3	0.0 (n = 0)	0.0 (n = 0)	38.5 (n = 15)	61.5 (n = 24)
	All	0.8 (n = 1)	0.8 (n = 1)	50.8 (n = 63)	47.6 (n = 59)
2. I have had business/community funded STEM education programs or events in my school.	Region 1	8.3 (n = 3)	44.4 (n = 16)	36.1 (n = 13)	11.1 (n = 4)
	Region 2	8.2 (n = 4)	46.9 (n = 23)	28.6 (n = 14)	16.3 (n = 8)
	Region 3	5.1 (n = 2)	46.2 (n = 18)	30.8 (n = 12)	17.9 (n = 7)
	All	7.3 (n = 9)	46.0 (n = 57)	31.5 (n = 39)	15.3 (n = 19)

3. I have had community/business guest speakers in my school.	Region 1	5.6 (n = 2)	36.1 (n = 13)	36.1 (n = 13)	22.2 (n = 8)
	Region 2	10.2 (n = 5)	49.0 (n = 24)	24.5 (n = 12)	16.3 (n = 8)
	Region 3	10.3 (n = 4)	38.5 (n = 15)	35.9 (n = 14)	15.4 (n = 6)
	All	8.9 (n = 11)	41.9 (n = 52)	31.5 (n = 39)	17.7 (n = 22)
4. There are opportunities for students at my school to complete STEM internships.	Region 1	2.8 (n = 1)	36.1 (n = 13)	52.8 (n = 19)	8.3 (n = 3)
	Region 2	4.1 (n = 2)	28.6 (n = 14)	55.1 (n = 27)	12.2 (n = 6)
	Region 3	12.8 (n = 5)	33.3 (n = 13)	48.7 (n = 19)	5.1 (n = 2)
	All	6.5 (n = 8)	32.3 (n = 40)	52.4 (n = 65)	8.9 (n = 11)
5. There are organizations interested in providing STEM education opportunities for students in my school.	Region 1	2.8 (n = 1)	16.7 (n = 6)	63.9 (n = 23)	16.7 (n = 6)
	Region 2	0.0 (n = 0)	14.3 (n = 7)	61.2 (n = 30)	24.5 (n = 12)
	Region 3	5.1 (n = 2)	30.8 (n = 12)	51.3 (n = 20)	12.8 (n = 5)
	All	2.4 (n = 3)	20.2 (n = 25)	58.9 (n = 73)	18.5 (n = 23)

6. Overall, there has been an increase in STEM education opportunities for students in the school in the last year.	Region 1	2.8 (n = 1)	30.6 (n = 11)	52.8 (n = 19)	13.9 (n = 5)
	Region 2	2.0 (n = 1)	34.7 (n = 17)	53.1 (n = 26)	10.2 (n = 5)
	Region 3	10.3 (n = 4)	38.5 (n = 15)	38.5 (n = 15)	12.8 (n = 5)
	All	4.8 (n = 6)	34.7 (n = 43)	48.4 (n = 60)	12.1 (n = 15)
7. I have worked closely with community/business organization members in my role as an educator.	Region 1	30.6 (n = 11)	44.4 (n = 16)	13.9 (n = 5)	11.1 (n = 4)
	Region 2	18.4 (n = 9)	57.1 (n = 28)	14.3 (n = 7)	10.2 (n = 5)
	Region 3	33.3 (n = 13)	46.2 (n = 18)	12.8 (n = 5)	7.7 (n = 3)
	All	26.6 (n = 33)	50.0 (n = 62)	13.7 (n = 17)	9.7 (n = 12)

Table 4.5

Collapsed Participant Responses to Industry Engagement in STEM Education per Socioeconomic Region (%)

		Strongly Disagree/ Disagree	Agree/ Strongly Agree
1. I believe it is important for area businesses to be involved in STEM partnership(s) with my school.	Region 1	2.8 (n = 1)	97.2 (n = 35)
	Region 2	2.0 (n = 1)	98.0 (n = 48)
	Region 3	0.0 (n = 0)	100.0 (n = 39)
	All	1.6 (n = 2)	98.4 (n = 122)
2. I have had business/community funded STEM education programs or events in my school.	Region 1	52.8 (n = 19)	47.2 (n = 17)
	Region 2	55.1 (n = 27)	44.9 (n = 22)
	Region 3	51.3 (n = 20)	48.7 (n = 19)
	All	53.2 (n = 66)	46.8 (n = 58)

3. I have had community/business guest speakers in my school.	Region 1	41.7 (n = 15)	58.3 (n = 21)
	Region 2	59.2 (n = 29)	40.8 (n = 20)
	Region 3	48.7 (n = 19)	51.3 (n = 20)
	All	50.8 (n = 63)	49.2 (n = 61)
4. There are opportunities for students at my school to complete STEM internships.	Region 1	38.9 (n = 14)	61.1 (n = 22)
	Region 2	32.7 (n = 16)	67.3 (n = 33)
	Region 3	46.2 (n = 18)	53.8 (n = 21)
	All	38.7 (n = 48)	61.3 (n = 76)
5. There are organizations interested in providing STEM education opportunities for students in my school.	Region 1	19.4 (n = 7)	80.6 (n = 29)
	Region 2	14.3 (n = 7)	85.7 (n = 42)
	Region 3	35.9 (n = 14)	64.1 (n = 25)
	All	22.6 (n = 28)	77.4 (n = 96)

6. Overall, there has been an increase in STEM education opportunities for students in the school in the last year.	Region 1	33.3 (n = 12)	66.7 (n = 24)
	Region 2	36.7 (n = 18)	63.3 (n = 31)
	Region 3	48.7 (n = 19)	51.3 (n = 20)
	All	39.5 (n = 49)	60.5 (n = 75)
7. I have worked closely with community/business organization members in my role as an educator.	Region 1	75.0 (n = 27)	25.0 (n = 9)
	Region 2	75.5 (n = 37)	24.5 (n = 12)
	Region 3	79.5 (n = 31)	20.5 (n = 8)
	All	76.6 (n = 95)	23.4 (n = 29)

Research Question Two

Research question two, To what extent do high school science teachers perceive their school to have an awareness of needed STEM resources? was measured by calculating frequencies and percentages of the participants' responses to the STEM Awareness Community Survey (SACS). Research question two was further addressed by calculating a composite score for this subscale and conducting a one-way analysis of variance (ANOVA) to determine if there was a statistically significant mean difference among the three regions of the school district in terms of STEM awareness and resources (see Table 4.6). The results of the one-way ANOVA indicated that the region of the school district did not influence science teachers' perception for STEM awareness and resources, $F(2, 121) = .660$, $p = .518$. All three regions had teachers that mutually agreed they understood the importance of STEM education and felt supported by the school district. The responses related to the subscale of STEM Awareness and Resources per socioeconomic region are provided below.

Table 4.6

School District Region and STEM Awareness and Resources

Region	N	M	SD	F-value	df	*p*-value
1	36	32.2	3.67	.660	(2, 121)	.518
2	49	31.8	3.23			
3	39	31.2	3.96			

Region One

Teachers in Region one *Agreed/Strongly Agreed* their school understands the importance of STEM education (80.6%), parents understand the importance of STEM education (83.3%), and more work needs to be completed to spread awareness of STEM education (94.4%). Overall, less than 20.0% of all high school science teachers disagreed about the importance of STEM education. Additionally, teachers *Agreed/Strongly Agreed* students with postsecondary education are more likely to secure a career in a STEM field (97.2%) and there are postsecondary academic institutions (college, university, community college) that offer scholarships for students to pursue STEM degrees (80.6%). All teachers in Region one *Agreed/Strongly Agreed* STEM skills are integral to student success today (100.0%) and increasing the STEM talent pool is necessary for economic vitality (100.0%). In regard to STEM online resources, teachers *Agreed/Strongly Agreed* information on regional STEM career opportunities is available online (86.1%), local organizations recruit STEM talent online (72.2%), and information related to STEM opportunities in my school is available online (55.6%).

Region Two

Teachers in Region two *Agreed/Strongly Agreed* their school understands the importance of STEM education (93.9%), parents understand the importance of STEM education (65.3%), and more work needs to be completed to spread awareness of STEM education (93.9%). Most teachers also *Agreed/Strongly Agreed* STEM skills are integral to student success today (98.0%), increasing the STEM talent pool is necessary for economic vitality (95.9%), students with postsecondary education are more likely to secure a career in a STEM field (98.0%) and there are postsecondary academic institutions (college, university, community college) that offer scholarships for students to pursue STEM degrees (85.7%). Furthermore, a majority of teachers *Agreed/Strongly*

Agreed information on regional STEM career opportunities is available online (91.8%), local organizations recruit STEM talent online (69.4%), and information related to STEM opportunities in my school is available online (71.4%).

Region Three

Region three teachers *Agreed/Strongly Agreed* with all, but one item associated with STEM Awareness and Resources. All teachers (100.0%) *Agreed/Strongly Agreed* STEM skills are integral to student success today. A majority of teachers *Agreed/Strongly Agreed* more work needs to be completed to spread awareness of STEM education (97.4%), increasing the STEM talent pool is necessary for economic vitality (97.4%), and students with postsecondary education are more likely to secure a career in a STEM field (94.9%). Most teachers *Agreed/Strongly Agreed* information on regional STEM career opportunities is available online (87.2%) and there are postsecondary academic institutions (college, university, community college) that offer scholarships for students to pursue STEM degrees (84.6%). Less teachers in Region three *Agreed/Strongly Agreed* their school understands the importance of STEM education (79.5%), local organizations recruit STEM talent online (59.0%), and information related to STEM opportunities in my school is available online (66.7%). The one item teachers in Region three *Strongly Disagreed/Disagreed* was parents in my school understand the importance of STEM education (59.0%).

Region Comparison

Overall, teachers from all regions in the school district *Agreed/Strongly Agreed* with all survey items. The only exception was teachers in Region three who *Strongly Disagreed/Disagreed* that parents understand the importance of STEM education. Investigating this variation in perception revealed a pattern between socioeconomic status percentage and the number of teachers who *Agreed/Strongly Agreed.* Region one had the smallest socioeconomic status percentage (less than 20.0%) and the highest percentage of *Agreed/Strongly Agreed* (83.3%). Whereas, Region three had the highest socioeconomic status percentage (greater than 40.0%) and the lowest percentage of *Agreed/Strongly Agreed* (41.0%). This pattern of teacher perception was also revealed on the survey item inquiring if local organizations recruit STEM talent online. Tables 4.7 and 4.8 display the percentages and frequencies of teachers in Regions 1-3 on responses related to the subscale of STEM Awareness and Resources per School District Region.

Table 4.7

Participant Responses to STEM Awareness and Resources per Socioeconomic Region (%)

		Strongly Disagree	Disagree	Agree	Strongly Agree
8. My school understands the importance of STEM education.	Region 1	2.8 (n = 1)	16.7 (n = 6)	47.2 (n = 17)	33.3 (n = 12)
	Region 2	2.0 (n = 1)	4.1 (n = 2)	57.1 (n = 28)	36.7 (n = 18)
	Region 3	2.6 (n = 1)	17.9 (n = 7)	56.4 (n = 22)	23.1 (n = 9)
	All	2.4 (n = 3)	12.1 (n = 15)	54.0 (n = 67)	31.5 (n = 39)
9. Parents in my school understand the importance of STEM education.	Region 1	5.6 (n = 2)	11.1 (n = 4)	47.2 (n = 17)	36.1 (n = 13)
	Region 2	4.1 (n = 2)	30.6 (n = 15)	46.9 (n = 23)	18.4 (n = 9)
	Region 3	17.9 (n = 7)	41.0 (n = 16)	38.5 (n = 15)	2.6 (n = 1)
	All	8.9 (n = 11)	28.2 (n = 35)	44.4 (n = 55)	18.5 (n = 23)

10. More work needs to be completed to spread awareness of STEM education.	Region 1	0.0 (n = 0)	5.6 (n = 2)	52.8 (n = 19)	41.7 (n = 15)
	Region 2	0.0 (n = 0)	6.1 (n = 3)	40.8 (n = 20)	53.1 (n = 26)
	Region 3	0.0 (n = 0)	2.6 (n = 1)	33.3 (n = 13)	64.1 (n = 25)
	All	0.0 (n = 0)	4.8 (n = 6)	41.9 (n = 52)	53.2 (n = 66)
11. STEM skills are integral to student success today.	Region 1	0.0 (n = 0)	0.0 (n = 0)	33.3 (n = 12)	66.7 (n = 24)
	Region 2	0.0 (n = 0)	2.0 (n = 1)	36.7 (n = 18)	61.2 (n = 30)
	Region 3	0.0 (n = 0)	0.0 (n = 0)	23.1 (n = 9)	76.9 (n = 30)
	All	0.0 (n = 0)	0.8 (n = 1)	31.5 (n = 39)	67.7 (n = 84)
12. Increasing the STEM talent pool is necessary for economic vitality.	Region 1	0.0 (n = 0)	0.0 (n = 0)	36.1 (n = 13)	63.9 (n = 23)
	Region 2	0.0 (n = 0)	4.1 (n = 2)	34.7 (n = 17)	61.2 (n = 30)
	Region 3	0.0 (n = 0)	2.6 (n = 1)	28.2 (n = 11)	69.2 (n = 27)
	All	0.0 (n = 0)	2.4 (n = 3)	33.1 (n = 41)	64.5 (n = 80)

13. Students with postsecondary education are more likely to secure a career in a STEM field.	Region 1	0.0 (n = 0)	2.8 (n = 1)	44.4 (n = 16)	52.8 (n = 19)
	Region 2	0.0 (n = 0)	2.0 (n = 1)	44.9 (n = 22)	53.1 (n = 26)
	Region 3	0.0 (n = 0)	5.1 (n = 2)	51.3 (n = 20)	43.6 (n = 17)
	All	0.0 (n = 0)	3.2 (n = 4)	46.8 (n = 58)	50.0 (n = 62)
14. There are colleges and/or universities and/or community colleges that offer scholarships for students to pursue STEM degrees in my school.	Region 1	0.0 (n = 0)	19.4 (n = 7)	44.4 (n = 16)	36.1 (n = 13)
	Region 2	2.0 (n = 1)	12.2 (n = 6)	65.3 (n = 32)	20.4 (n = 10)
	Region 3	2.6 (n = 1)	12.8 (n = 5)	51.3 (n = 20)	33.3 (n = 13)
	All	1.6 (n = 2)	14.5 (n = 18)	54.8 (n = 68)	29.0 (n = 36)
15. Information on regional STEM career opportunities is available online.	Region 1	0.0 (n = 0)	13.9 (n = 5)	61.1 (n = 22)	25.0 (n = 9)
	Region 2	2.0 (n = 1)	6.1 (n = 3)	75.5 (n = 37)	16.3 (n = 8)
	Region 3	0.0 (n = 0)	12.8 (n = 5)	59.0 (n = 23)	28.2 (n = 11)
	All	0.8 (n = 1)	10.5 (n = 13)	66.1 (n = 82)	22.6 (n = 28)

16. Local organizations recruit STEM talent online.	Region 1	0.0 (n = 0)	27.8 (n = 10)	61.1 (n = 22)	11.1 (n = 4)
	Region 2	4.1 (n = 2)	26.5 (n = 13)	61.2 (n = 30)	8.2 (n = 4)
	Region 3	7.7 (n = 3)	33.3 (n = 13)	52.8 (n = 21)	5.1 (n = 2)
	All	4.0 (n = 5)	29.0 (n = 36)	58.9 (n = 73)	8.1 (n = 10)
17. Information related to STEM opportunities in my school is available online.	Region 1	2.8 (n = 1)	41.7 (n = 15)	44.4 (n = 16)	11.1 (n = 4)
	Region 2	0.0 (n = 0)	28.6 (n = 14)	65.3 (n = 32)	6.1 (n = 3)
	Region 3	2.6 (n = 1)	30.8 (n = 12)	64.1 (n = 25)	2.6 (n = 1)
	All	1.6 (n = 2)	33.1 (n = 41)	58.9 (n = 73)	6.5 (n = 8)

Table 4.8

Collapsed Participant Responses to STEM Awareness and Resources per Socioeconomic Region (%)

		Strongly Disagree/ Disagree	Agree/ Strongly Agree
8. My school understands the importance of STEM education.	Region 1	19.4 (n = 7)	80.6 (n = 29)
	Region 2	6.1 (n = 3)	93.9 (n = 46)
	Region 3	20.5 (n = 8)	79.5 (n = 0)
	All	14.5 (n = 18)	85.6 (n = 106)
9. Parents in my school understand the importance of STEM education.	Region 1	16.7 (n = 6)	83.3 (n = 30)
	Region 2	34.7 (n = 17)	65.3 (n = 32)
	Region 3	59.0 (n = 23)	41.0 (n = 16)
	All	37.1 (n = 46)	62.9 (n = 78)

10. More work needs to be completed to spread awareness of STEM education.	Region 1	5.6 (n = 2)	94.4 (n = 34)
	Region 2	6.1 (n = 3)	93.9 (n = 46)
	Region 3	2.6 (n = 1)	97.4 (n = 38)
	All	4.8 (n = 6)	95.2 (n = 118)
11. STEM skills are integral to student success today.	Region 1	0.0 (n = 0)	100.0 (n = 36)
	Region 2	2.0 (n = 1)	98.0 (n = 48)
	Region 3	0.0 (n = 0)	100.0 (n = 39)
	All	0.8 (n = 1)	99.2 (n = 123)
12. Increasing the STEM talent pool is necessary for economic vitality.	Region 1	0.0 (n = 0)	100.0 (n = 36)
	Region 2	4.1 (n = 2)	95.9 (n = 47)
	Region 3	2.6 (n = 1)	97.4 (n = 38)
	All	2.4 (n = 3)	97.6 (n = 121)

13. Students with postsecondary education are more likely to secure a career in a STEM field.	Region 1	2.8 (n = 1)	97.2 (n = 35)
	Region 2	2.0 (n = 1)	98.0 (n = 48)
	Region 3	5.1 (n = 2)	94.9 (n = 37)
	All	3.2 (n = 4)	96.8 (n = 120)
14. There are colleges and/or universities and/or community colleges that offer scholarships for students to pursue STEM degrees in my school.	Region 1	19.4 (n = 7)	80.6 (n = 29)
	Region 2	14.3 (n = 7)	85.7 (n = 42)
	Region 3	15.4 (n = 6)	84.6 (n = 33)
	All	16.1 (n = 20)	83.9 (n = 104)
15. Information on regional STEM career opportunities is available online.	Region 1	13.9 (n = 5)	86.1 (n = 31)
	Region 2	8.2 (n = 4)	91.8 (n = 45)
	Region 3	12.8 (n = 5)	87.2 (n = 34)
	All	11.3 (n = 14)	88.7 (n = 110)

16. Local organizations recruit STEM talent online.	Region 1	27.8 (n = 10)	72.2 (n = 26)
	Region 2	30.6 (n = 15)	69.4 (n = 34)
	Region 3	41.0 (n = 16)	59.0 (n = 23)
	All	33.1 (n = 41)	66.9 (n = 83)
17. Information related to STEM opportunities in my school is available online.	Region 1	44.4 (n = 16)	55.6 (n = 20)
	Region 2	28.6 (n = 14)	71.4 (n = 35)
	Region 3	33.3 (n = 13)	66.7 (n = 26)
	All	34.7 (n = 43)	65.3 (n = 81)

Research Question Three

Research question three, To what extent do high school science teachers perceive their school prepares students for success in postsecondary STEM degrees and careers? was measured by calculating frequencies and percentages of the participants' responses to STEM Awareness Community Survey (SACS). Research question three was further addressed by calculating a composite score for the subscale and conducting a one-way analysis of variance (ANOVA) to determine if there was a statistically significant mean difference among the three regions of the school district in terms of schools preparing students for success in postsecondary STEM degrees and careers (see Table 4.9).

The results of the one-way ANOVA indicated that the school regions did influence science teachers' perception of the preparation of students for success in postsecondary STEM degrees and careers, $F(2, 121) = 4.357$, $p = .015$, $\eta^2 = .067$. The proportion of variance explained in this subscale (Preparation of Students for Success in College and Career) by school district region was 6.7%. The Tukey post-hoc test revealed there was a statistically significant mean difference ($M_d = 2.066$) between Region one (less than 20% ED) and Region three (greater than 40% ED) in terms of schools preparing students for success in postsecondary STEM degrees and careers. Thus, indicating that the percentage of economically disadvantaged students significantly impacts teachers' perceptions for student success postsecondary. The Tukey post-hoc test did not reveal any statistically significant difference between Regions one and two and Regions two and three. The responses related to the subscale of Preparation of Students for Success in College and Career per socioeconomic region are provided below.

Table 4.9

School District Region and Preparation of Students for Success in Postsecondary STEM Degrees and Careers

Region	N	M	SD	F-value	df	*p*-value	η^2
1	36	17.2	3.45	4.357	(2, 121)	.015*	.067
2	49	16.8	3.52				
3	39	15.1	2.69				

*Statistically Significant (p < .05)

Region One

Most teachers agreed their students were prepared to be successful in postsecondary STEM degrees and careers. Teachers in Region one *Agreed/Strongly Agreed* students in their school are prepared to be successful in postsecondary studies (94.4%) and *Agreed/Strongly Agreed* their school effectively teaches students STEM knowledge and skills (86.1%). Most teachers *Agreed/Strongly Agreed* their school prepares students who are critical thinkers and problems solvers (77.8%). Furthermore, most teachers *Agreed/Strongly Agreed* students in their school are knowledgeable about the STEM careers that will be in high demand when they graduate (69.4%). Teacher perceptions were split as (50.0%) *Agreed/Strongly Agreed* about community partners (business and higher education) are engaged in making STEM education more relevant through providing real-world connections, while (50.0%) *Strongly Disagreed/Disagreed*. Teachers (76.9%) *Strongly Disagreed/Disagreed* that the state standardized tests used in school adequately assess STEM knowledge and skills.

Region Two

Teachers in Region two *Agreed/Strongly Agreed* students in their school are prepared to be successful in postsecondary studies (83.7%), students are knowledgeable about the STEM careers that will be in high demand when they graduate (67.3%). Most teachers *Agreed/Strongly Agreed* their school effectively teaches students STEM knowledge and skills (79.6%) and their school prepares students who are critical thinkers and problems solvers (75.5%). *Agreed/Strongly Agreed* perceptions were also expressed about community partners (business and higher education) are engaged in making STEM education more relevant through providing real-world connections (61.2%). Teachers (71.4%) *Strongly Disagreed/Disagreed* that the state standardized tests used in school adequately assess STEM knowledge and skills.

Region Three

Teachers in Region three *Agreed/Strongly Agreed* their school effectively teaches students STEM knowledge and skills (66.7%), students in their school are prepared to be successful in postsecondary studies (74.4%), and their school prepares students who are critical thinkers and problems solvers (64.1%). Only 56.4% *Agreed/Strongly Agreed* students are knowledgeable about the STEM careers that will be in high demand when they graduate. Additionally, only 51.3% *Agreed/Strongly Agreed* community partners (business and higher education) are engaged in making STEM education more relevant through providing real-world connections. Most teachers (76.9%) *Strongly Disagreed/Disagreed* that the state standardized tests used in school adequately assess STEM knowledge and skills.

Region Comparison

Teachers in all regions were consistent in agreement that students are prepared for postsecondary success, are knowledgeable of STEM careers, and are able to think critically and problem solve. All teachers *Agreed/Strongly Agreed* their school effectively teaches students STEM knowledge and skills, while all *Strongly Disagreed/Disagreed* the state standardized tests used adequately assess STEM knowledge and skills. Furthermore, five of the six survey items showed a consistent pattern between socioeconomic status percentage and teacher perception. The data revealed, as socioeconomic status percentage decreases, teachers' perceptions for agreement increases. This pattern occurred across all regions of the school district. Shown below, tables 4.10 and 4.11 illustrate the percentages and frequencies of teachers in Regions 1-3 on responses related to the subscale of Preparation of Students for Success in College and Career.

Table 4.10

Participant Responses to Success in Postsecondary STEM Degrees and Careers per Socioeconomic Region (%)

		Strongly Disagree	Disagree	Agree	Strongly Agree
18. Students in my school are prepared to be successful in postsecondary study (2- or 4-year colleges or universities and technical programs).	Region 1	0.0 (n = 0)	5.6 (n = 2)	33.3 (n = 12)	61.1 (n = 22)
	Region 2	0.0 (n = 0)	16.3 (n = 8)	44.9 (n = 22)	38.8 (n = 19)
	Region 3	0.0 (n = 0)	25.6 (n = 10)	69.2 (n = 27)	5.1 (n = 2)
	All	0.0 (n = 0)	16.1 (n = 20)	49.2 (n = 61)	34.7 (n = 43)
19. Students in my school are knowledgeable about the STEM careers that will be in high demand when they graduate.	Region 1	2.8 (n = 1)	27.8 (n = 10)	52.8 (n = 19)	16.7 (n = 6)
	Region 2	2.0 (n = 1)	30.6 (n = 15)	55.1 (n = 27)	12.2 (n = 6)
	Region 3	5.1 (n = 2)	38.5 (n = 15)	56.4 (n = 22)	0.0 (n = 0)
	All	3.2 (n = 4)	32.3 (n = 40)	54.8 (n = 68)	9.7 (n = 12)

20. My school effectively teaches students STEM knowledge and skills.	Region 1	2.8 (n = 1)	11.1 (n = 4)	58.3 (n = 21)	27.8 (n = 10)
	Region 2	2.0 (n = 1)	18.4 (n = 9)	49.0 (n = 24)	30.6 (n = 15)
	Region 3	0.0 (n = 0)	33.3 (n = 13)	56.4 (n = 22)	10.3 (n = 4)
	All	1.6 (n = 2)	21.0 (n = 26)	54.0 (n = 67)	23.4 (n = 0)
21. The state standardized tests used in my school adequately assess STEM knowledge and skills.	Region 1	16.7 (n = 6)	52.8 (n = 19)	25.0 (n = 9)	5.6 (n = 2)
	Region 2	24.5 (n = 12)	46.9 (n = 23)	24.5 (n = 12)	4.1 (n = 2)
	Region 3	30.8 (n = 12)	46.2 (n = 18)	23.1 (n = 9)	0.0 (n = 0)
	All	24.2 (n = 30)	48.4 (n = 60)	24.2 (n = 30)	3.2 (n = 4)
22. My school prepares students who are critical thinkers and problem solvers.	Region 1	2.8 (n = 1)	19.4 (n = 7)	58.3 (n = 21)	19.4 (n = 7)
	Region 2	4.1 (n = 2)	20.4 (n = 10)	55.1 (n = 27)	20.4 (n = 10)
	Region 3	5.1 (n = 2)	30.8 (n = 12)	56.4 (n = 22)	7.7 (n = 3)
	All	4.0 (n = 5)	23.4 (n = 29)	56.5 (n = 70)	16.1 (n = 20)

23. Community partners (e.g., business and higher education) are engaged in making STEM education more relevant through providing real-world connections in your school district.	Region 1	8.3 (n = 3)	41.7 (n = 15)	36.1 (n = 13)	13.9 (n = 5)
	Region 2	4.1 (n = 2)	34.7 (n = 17)	49.0 (n = 24)	12.2 (n = 6)
	Region 3	7.7 (n = 3)	41.0 (n = 16)	48.7 (n = 19)	2.6 (n = 1)
	All	6.5 (n = 8)	38.7 (n = 48)	45.2 (n = 56)	9.7 (n = 12)

Table 4.11

Collapsed Participant Responses to Success in Postsecondary STEM Degrees and Careers per Socioeconomic Region (%)

		Strongly Disagree/ Disagree	Agree/ Strongly Agree
18. Students in my school are prepared to be successful in postsecondary study (2- or 4-year colleges or universities and technical programs).	Region 1	5.6 (n = 2)	94.4 (n = 34)
	Region 2	16.3 (n = 8)	83.7 (n = 41)
	Region 3	25.6 (n = 10)	74.4 (n = 29)
	All	16.1 (n = 20)	83.9 (n = 104)
19. Students in my school are knowledgeable about the STEM careers that will be in high demand when they graduate.	Region 1	30.6 (n = 11)	69.4 (n = 25)
	Region 2	32.7 (n = 16)	67.3 (n = 33)
	Region 3	43.6 (n = 17)	56.4 (n = 22)
	All	35.5 (n = 44)	64.5 (n = 80)

20. My school effectively teaches students STEM knowledge and skills.	Region 1	13.9 (n = 5)	86.1 (n = 31)
	Region 2	20.4 (n = 10)	79.6 (n = 39)
	Region 3	33.3 (n = 13)	66.7 (n = 26)
	All	22.6 (n = 28)	77.4 (n = 96)
21. The state standardized tests used in my school adequately assess STEM knowledge and skills.	Region 1	69.4 (n = 25)	30.6 (n = 11)
	Region 2	71.4 (n = 35)	28.6 (n = 14)
	Region 3	76.9 (n = 30)	23.1 (n = 9)
	All	72.6 (n = 90)	27.4 (n = 34)
22. My school prepares students who are critical thinkers and problem solvers.	Region 1	22.2 (n = 8)	77.8 (n = 28)
	Region 2	24.5 (n = 12)	75.5 (n = 37)
	Region 3	35.9 (n = 14)	64.1 (n = 25)
	All	27.4 (n = 34)	72.6 (n = 90)

23. Community partners (e.g., business and higher education) are engaged in making STEM education more relevant through providing real-world connections in your school district.	Region 1	50.0 (n = 18)	50.0 (n = 18)
	Region 2	38.8 (n = 19)	61.2 (n = 30)
	Region 3	48.7 (n = 19)	51.3 (n = 20)
	All	45.2 (n = 56)	54.8 (n = 68)

Research Question Four

Research question four, What factors do high school science teachers report will improve STEM awareness and engage more students to pursue postsecondary STEM degrees and careers? was answered using a qualitative inductive coding process. Ten high school science teachers within the school district were interviewed to provide additional information for improving STEM education in their school and to clarify how outside entities (businesses, industry, and community, school district) support STEM education. Themes were constructed based on an inductive coding analysis of the transcribed interviews. The statements included in the study were from interviewee responses. The qualitative analysis identified four major themes: (a) Building Partnerships Outside of School, (b) STEM Opportunities Outside the Classroom, (c) Real-world Experiences, and (d) Valuing STEM Education. Subthemes emerged from these major themes identified. The major themes and subthemes obtained from interviewee responses have been provided below followed by sample comments.

Building Partnerships Outside of School

Building partnerships outside of school refers to creating a relationship between schools and STEM businesses and industries. Six of the ten teachers interviewed explained how businesses and industry partners work with schools to support STEM education. According to teachers' responses developing and fostering these relationships can create opportunities for students to learn directly from outside professionals and to raise funds for the school. The teachers' views on building partnerships outside of school can be broken down into two subthemes: (a) guest speaker experiences for students, and (b) raising funds.

Four teachers expressed how guest speakers can help motivate and give students an authentic understanding of STEM careers. Heather, an integrated physics and chemistry teacher, explained that guest speakers provide different experiences, “Rather than the teacher providing the information, getting some people that are professionals in STEM industries to come in and talk with students is beneficial.” Matthew, a physics teacher, shared how a former student volunteered his time to be a guest speaker to his current students and during his presentation he explain the path he took through technical school and into the STEM workforce:

> Instead of going to college, he (guest speaker) went to a technical school. He explained that he had about a year of training and is now making over $100,000 a year working in the field with high voltage for an electricity company. This former student is using all these things he learned in physics and it certainly is a lucrative opportunity for him.

Anthony, an intergraded chemistry and physics teacher, discussed how guest speakers could teach students about STEM career paths:

> It would be useful to have more industry professionals come in and describe their career path and their process, what their education was, what they did to get to where they are, and exactly what their job is because I think many students are not aware of exactly what it means to work in STEM.

Kimberly, a biology teacher, elaborated on how guest speakers can influence students to pursue STEM careers:

> We have community visitors that come in and talk about their area of expertise, and how the students in high school right now can lead to that job. I think this has been one of the biggest influences because students are in a small group and can talk, ask questions, and get a lot out of it.

These comments indicate that some teachers believe guest speakers sharing their authentic STEM career and educational experiences can help motivate and influence students to pursue STEM careers.

Furthermore, two teachers explained that fostering partnerships with businesses and industries could result in raising funds or donations. Stacey, a biology teacher, shared her awareness of schools receiving donations, “I know other schools have business partners that will either donate funds or equipment needed for a lab.” Vicki, a chemistry teacher, disclosed how a company she partnered with provided additional funding to the school, “In the past we’ve had a great relationship with a hedge fund company. They would match funds we raised to get big ticket items, and this helped tremendously.” These comments shared by teachers illustrate examples of how businesses and industry partners support STEM education in high school.

Teachers stated on several occasions that industry professionals would make good guest speakers because they have first-hand knowledge of their job in the industry. A few teachers explained that students in high school are motivated by money, and business/industry guest speakers can elaborate on high dollar salaries found in STEM industry. Two participants mentioned how business and industry partners could help by donating funds.

STEM Opportunities Outside the Classroom

During interviews, teachers were asked to describe what outside factors influence STEM education in your school? These STEM opportunities for students would occur outside of the typical classroom instructional time. A total of 80% (n = 8) of the interview participants reported how outside opportunities influenced STEM education. The teachers’ views of outside opportunities that influence STEM education were separated into three subthemes: (a) clubs, (b) STEM center, and (c) field trips.

Five of the ten teachers explained clubs associated with STEM disciplines give students a sense of belonging and allow them to experience STEM activities outside of the classroom environment. Kimberly shared how clubs raise awareness for STEM, "I would say the robotics team and the competitions they do. The individual clubs, like science club, and the things they do to promote awareness and give opportunity to actually engage in doing something with them." Michelle, a physics teacher, explained how clubs give students a shared platform to have STEM experiences:

> I think clubs are one of the best extracurricular activities that our students have whether some of the clubs are hosted by teachers themselves. These clubs give students a way to participate and sort of further their understanding about the STEM career. I think it gives kids a way to- I don't know a PC term but- nerd out- they're able to collectively get with other students that have the same passion.

Matthew described that clubs offer more exposure to STEM, "There are extracurricular clubs, like robotics, Science National Honor Society, and Science UIL. I think between the extracurricular and the course selections, students have about as much exposure as you can with something like this (STEM)." Susan, a chemistry teacher, added that starting a STEM club gets students who have a shared interest involved in something outside of the classroom, " I think we are doing a pretty decent job with that, we have started a science club, our National Science Honors Society, and a STEM club got a lot of kids involved." Tori, a biology teacher, elaborated on what types of experiences STEM clubs can provide students:

> Our school does help organize these club events. I know a lot of the clubs go to the STEM center. We also- it's kind of funny there's a theatre company that come and do funny plays like a calculus play to get kids excited. It is kind of a priority of all the classes that they go so they can sing about the formulas.

These comments showcase how clubs associated with STEM disciplines can have a positive impact on students and provide them with a sense of belonging.

In addition, two teachers explained how the school district's STEM center was another opportunity for students to engage in STEM outside of the classroom. Stacey shared information about the STEM center, "We have the STEM center and this entire facility is for STEM education, STEM field trips, and robotics." Vicki, discussed additional benefits of the STEM center, "We have a STEM center which is good for some of the like computer-based stuff, robotics, and forensics." These comments indicate that a couple teachers see the district's STEM center as a place for students to experience STEM outside of the classroom.

One teacher said that field trips were students only opportunity to engage in STEM experiences outside of the classroom. Heather shared, "At my school it's just the field trip opportunities. I can only think of the field trip to an oil and gas company." This comment shows that one teacher sees a field trip as an example of an opportunity to engage students in STEM experiences outside of the classroom.

Overall, these comments indicate that most teachers see clubs that are associated with STEM as a valuable setting for students to experience and engage in STEM activities outside of the classroom. Followed by, two participants who discussed the STEM center and one teacher who shared that a field trip can be an opportunity for students to engage in STEM.

Real-world Experiences

Three teachers communicated that students need more real-world experiences with STEM education. These teachers shared how their past experiences helped them to motivate and engage students in STEM. Their comments can be separated into two subthemes: (a) content knowledge of the teacher, and (b) teacher's prior STEM experiences.

One teacher shared that her extensive content knowledge and advanced degrees in the content allowed her to provide students with more authentic real-world experiences. Stacey explained how her academic knowledge and research experience impacted her students' engagement:

> I think providing more relevant real-world experiences in STEM, more inquiry, and more experience actually doing science instead of just, textbook reading. Also, a lot of teachers just have a basic certification and they don't have any research experience or masters level education in their field, which can impact student's achievement and engagement in the field.

This comment indicates a teacher's perspective suggesting teachers with stronger subject area content backgrounds or educational experiences are able to provide more engaging real-world STEM experiences for students.

Furthermore, two additional teachers shared information about prior real-world experiences and the impacts on student engagement. Michelle shared an experience where students lost motivation when the school administration prevented her students from experiencing the solar eclipse first-hand:

> Case and point, the solar eclipse a year or two ago, we had the whole school ready to go outside and view it with pinhole projectors. Spanish classes had solar eclipse related vocabulary that they were studying, and our Special Education Department, was training their students on how to use the pinhole projector. But when it came to the day, administration shut the event down in fear that students would have permanent damage to their eyes by viewing it. Preventing students from experiencing this put a damper on students' motivation and willingness to be

> excited about future events. I think allowing students to have more real-world experiences with science, would drastically improve their motivation and their participation in STEM activities.

Tori explained a prior experience she had engaging in real-world STEM experiences and the impact it had on her future:

> I grew up in New York and so I feel like we had a little bit more of an opportunity. When I was a freshman in high school I was able to be an intern in a hospital and shadow someone around. This happened during the school year. After school some days I would go to an actual hospital and find doctors that I can work with and kind of see and have a feel if I wanted to pursue this career. I also had friends that were part of an engineering group where they could talk to actual engineers and get an idea of what it is like in the field. I feel that this is something that would make more interest and a lot of kids would pursue the career. Having early exposure or an early start within a STEM career is important for students.

These comments indicate that teachers feel strongly about students having opportunities to receive real-world experiences in STEM. Although each teachers' justification differed, they all agreed that real-world experiences highly motivated their students and engaged them in the potential to pursue STEM degrees and careers after high school.

Valuing STEM Education

The final theme that presented itself was named, valuing STEM education. A majority of teachers (80%) expressed a high volume of responses indicating that STEM education needed to be seen as an important topic and concern. This theme ran consistent throughout participants' responses when asked, what strategies do you feel could improve STEM education in your school? The teachers' views on valuing STEM education can be broken down into three subthemes: (a) parental support, (b) school promotion, and (c) development of a strong STEM culture.

Eight of the ten teachers shared that parental support was a vital factor that was necessary for students to pursue STEM degrees and careers after high school. Furthermore, these teachers reported that parents value STEM education but have a limited understanding of STEM education. Stacey explained that parents support STEM because there are good job opportunities stating, “Parents are familiar with STEM mostly because they are concerned about their child getting a good paying job after they come out of college.” Heather shared that parents often focus on the amount of money one can make in the profession:

> I think that some parents realize that some of the money-making professions are in STEM education. And so, I think parents highlight that importance of being a doctor or being an engineer, but I don’t know that parents would say they are highlighting the importance of STEM education.

Susan expressed that parents are involved and support STEM education:

> Of the students I have, their parents are pretty involved and want their students to take STEM based studies, at least most of them. I would say 50% of them value STEM education in terms of engineering and math-based curriculum.

Tori also explained that parents are very involved, “Parents are very dedicated; they want their kids to succeed and they do push their kids to pursue STEM.” Michelle also contributed that students who have parents working in STEM related fields tend to value STEM education more:

> I think a lot of the population of our school, have a parent who is involved in a STEM career. Many parents work in the oil and gas industry as engineers or project managers. I believe these parents have seen the fruits of their labor and

> they know that investing in STEM education and STEM careers in the long run, will have a bigger pay off. These students see this in their parents and they automatically value STEM education.

Kimberly shared that only some parents understand the importance of STEM, stating, “Only certain groups of parents really understand the importance of STEM because their kids are on the robotics team or they work in STEM.” Matthew clarified what parents don’t understand:

> I think the message parents get is STEM is not important. I don’t think parents fully understand why STEM literacy is important. They are familiar with the word STEM because of media but I don’t know they really understand the underlying importance of STEM. It is just a label that gets thrown around a lot.

Vicki reiterated that parents have a limited understanding of STEM education:

> I don’t think we’ve done a great job of promoting it. We say STEM but we don’t really define it to a lot of parents. Especially, those parents that do not have a college background. I think it’s still a big mystery about how it works. The study habits and the study skills are needed. The cash value it is work in the long run over other degrees. I think we need to do a much better job in promoting it. Sometimes kids do a good job but the parents don’t see a value in it.

These comments shared by teachers indicate that most parents value STEM education but lack a full understanding why it is important. Only parents who were actively involved in a STEM career or had personal knowledge of STEM understood the importance. Most parents know you can make money in STEM careers but don’t understand why else it is important.

Additionally, three teachers including some from parent support theme discussed how educational institutions can better support STEM education. Kimberly explained that STEM awareness is necessary for all parties,

> I think the awareness is important for school district administration, the campus administration, the teacher, the parents, and the students. I believe if everyone understood what STEM is and what STEM has to offer then I don't think there's an argument that it is not a good thing.

Michelle shared the importance for hiring teachers with STEM industry experience:

> I think school districts need to hire quality teachers that have actual backgrounds in STEM careers. I believe that one of the highest displays of valuing STEM education is hiring people who have that experience.

Vicki expressed that schools need to value and celebrate success in STEM:

> My school has a former student who is a cancer researcher. He has made huge advancements in his field, but we don't celebrate him. We need to celebrate those quiet nerds that are getting lots of good things done and I think we need to let kids know what a paycheck looks like for STEM careers. Publicity! They need to do a better job of celebrating the great achievements STEM kids do and showing what interesting and creative things are being done in classes.

These comments indicate how schools can promote and show value for STEM education.

Furthermore, two teachers including some from parent support theme discussed the development of a STEM culture and the outside influencers who can alter it over time. Susan explained that social media has an influence on students:

> I feel like you have to educate students and give them the opportunity to look beyond what they have in their community. Influence naturally what they see on

> social media. There is so much out there on social media that I am sure influences a student’s decision.

Tori discussed that STEM education can be impacted by a community’s culture:

> I actually have a group of girls this year that are a part of robotics and engineering. In class, whenever they get a really hard question correct, they say, #WomenInSTEM. So there is a culture where girls are very proud to belong to this community.

Overall, these comments shared by teachers indicate that parents, schools, and the community can impact the success of STEM education. Findings of this study suggest that the continual support from these areas have the power to influence a student’s decision to pursue a STEM degree or career after high school. Thus, all stakeholders play a significant role for improving and supporting STEM education.

Conclusion

This chapter presented the analysis of qualitative and quantitative data collected from surveys and interviews, participant demographics, and processes of answering each research question. In the next chapter, findings are presented to compare what was found through this study with existing literature. Implications of this study in education and future research is discussed.

CHAPTER V:

SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS

The purpose of this study was to examine science teachers' perceptions and determine their level of STEM awareness and support. Four questions were explored for this study. The first question asked: To what extent do high school science teachers perceive their school to have an industry engagement in STEM education? The second question asked: To what extent do high school science teachers perceive their school to have an awareness of needed STEM resources? The third question asked: To what extent do high school science teachers perceive their school prepares students for success in postsecondary STEM degrees and careers? The fourth question asked: What factors do high school science teachers report will improve STEM awareness and engage more students to pursue postsecondary STEM degrees and careers?

Independently, both teacher perception and STEM education have been well documented. However, there is minimal research associated with STEM awareness and perceptions of STEM teachers. To quantify STEM awareness and perceptions of STEM teachers, 124 high school science teachers from eight different high schools in a large urban school district completed the *STEM Awareness Community Survey* (SACS). Additionally, ten teachers from this group were interviewed to provide additional information for improving STEM education in their school and to clarify how outside entities (businesses, industry, community, parents, and school district) support STEM education. This chapter presents a summary of findings, implications, and recommendations for practice and future research.

Summary

The research questions for this study addressed how high school science teachers perceive their awareness and support of STEM education. Research Question One focused on how high school science teachers perceive their school to have engagement and active partnership with STEM business and industry. Quantitative analysis indicated that there was not a significant difference in teachers' perceptions for industry engagement in STEM education between regions. The frequencies and percentages analysis revealed variations of agreement between regions on whether there were partnerships with STEM business and industry. Survey data indicated there were opportunities for students to work with STEM businesses and industries; however, this result was contradicted by survey data showing that a majority of teachers reported they did not work closely with community/business organizations this past year. As these variations and inconsistencies across the data indicate that the partnerships between schools and STEM business/industry was minimal. Survey data illustrated that the majority of teachers agreed these partnerships are important but provided little authentic evidence these partnerships existed. As research has shown before, relying solely on teacher self-reported data can lead to inaccurate and inflated results (Feldman & O¨zalp, 2019). Therefore, the quantitative findings of this study will be compared with the qualitative findings to ensure accuracy.

In this study, teachers' feedback supported the idea that schools need to have partnerships with STEM business and industry. Data revealed that teachers perceived hosting industry guest speakers as the preferred method for fostering these partnerships. Teachers explained that guest speaker opportunities increased student motivation and preparedness to pursue a STEM degree or career after high school. The teachers' responses revealed that these partnerships were limited and did not provide students with a variety of opportunities to engage in STEM activities outside of the classroom. Providing students with a variety of opportunities to participate in outreach STEM activities will increase students' autonomous motivation and greater preparedness for future careers (Thiry et al., 2011; Vennix et al., 2018). These experiences are what help students deepen critical thinking skills and gain a more in-depth understanding of classroom materials (Burns et al., 2018).

Therefore, based on these findings, this school district needs additional guidance on developing authentic partnerships with businesses and industries that allow students more access to unique out-of-classroom STEM experiences. Doing this successfully means going beyond a teacher's ability to establish and foster these partnerships. These findings suggest that teachers alone do not have the ability to effectively implement business/industry partnerships beyond hosting a guest speaker. It will take collaboration between the school district and industry stakeholders to create more opportunities such as STEM internships for students or business funded STEM educational programs.

Research Question Two asked how high school science teachers perceive their awareness and support of STEM education. Quantitative analysis indicated that there was not a significant difference in teachers' perceptions for STEM awareness and resources between regions. The frequencies and percentages analysis revealed that teachers perceived their school to understand the importance of STEM education. Additionally, the data indicated teachers feel that increasing their awareness of STEM will benefit students and help them pursue careers in a STEM field. These results supported previous research that shows in order to develop students STEM awareness, teachers must first be aware of STEM (Bakirci & Karisan, 2018).

Quantitative data provided evidence that there was a relationship between the teachers' perception of the parents' understanding of STEM and the school's overall socioeconomic status percentage. This relationship showed that as the school's percentage of socioeconomic status decreased, the more teachers are likely to agree their students' parents understand the importance of STEM education. Qualitative findings help to clarify this relationship. Teachers who reported parents valuing STEM education more, did this because they worked or had close connections with STEM professionals. Parents in these situations often have a higher income than most. Thus explaining, one reason why you see this trend between socioeconomic status and teachers' perceptions for parents' understanding of STEM. Overall, these results are consistent with findings from researchers Gregory and Huang (2013) and Bolshakova, Johnson, and Czerniak (2011) who found that a teacher's positive expectations and effectiveness in the classroom have more predictive power of student success, regardless of a parent's perceptions and a student's socioeconomic status.

Research Question Three asked how science teachers perceive their school district prepares students for postsecondary STEM degrees and careers. Quantitative analysis indicated that there was not a significant difference in teachers' perceptions for preparation of students for success in college and career. Results showed that the school district region does influence teachers' perception for preparation of students for success in college and career. The frequencies and percentages analysis revealed that all regions of the school district were consistent in agreement that students are prepared for postsecondary success. Furthermore, the data indicated that the majority of teachers feel that students are knowledgeable of STEM careers that will be of high demand when they graduate. These results agree with previous research that explains students who have more awareness of STEM occupations are more likely to pursue STEM careers (Falco, 2017).

Another trend that was identified in five of the six survey items in this subscale was as the region's socioeconomic status percentage decreased, teachers' perceptions of agreement for student STEM preparedness increased. Illustrating the trend that teachers' in high poverty areas tend to have lower perceptions for students pursuing STEM degrees and careers. One reason for this inverse relationship is both students and parents tend to have less awareness of STEM in high socioeconomic percentage regions. The lack of awareness both students and parents have for the importance of STEM education can impact the number of students pursuing STEM degrees and careers. Qualitative findings elaborated that teachers perceived STEM awareness to be lower for students and parents because they don't have extensive knowledge for why STEM education is important. Teachers shared in this study that students and parents are mainly aware of the financial gains associated with STEM careers but lack the deeper understanding for the importance of STEM education. These results were consistent with findings from Bozkurt and Ercan (2016) and Asghar et al. (2012) which indicated teachers are the most powerful influencers and have the potential to elevate typically underrepresented students.

Data in this study revealed that teachers' perceptions for their students being prepared for postsecondary degrees and careers in STEM differed across regions. Findings showed teachers in a region with a low percentage of socioeconomic disadvantage students perceive more of their students to be prepared to pursue STEM degrees and careers versus teachers who taught in a region with a high percentage of socioeconomic disadvantage students. Prior research has indicated that all students can be successful, regardless of socioeconomic status (Bolshakova et al., 2011; Gregory & Huang, 2013). Furthermore, McKown and Weinstein (2008) stated that teachers are powerful influencers and can directly impact students' academic performance, STEM awareness, and potential for pursuing STEM degrees and careers. It is imperative that teachers realize the magnitude of influence their expectations have on their students and their perceptions can significantly impact students' postsecondary success.

Research Question Four asked high school science teachers' perceptions on what they thought would improve STEM awareness and engage more students to pursue postsecondary STEM degrees and careers. The ten teachers who participated in the interview responded to the questions with suggestions on what could be done outside of the classroom to improve STEM awareness and engage more students in STEM postsecondary opportunities. There was consistent emphasis across several interviews that parents, students, school administrators and the community have a limited understanding for the importance of STEM education. The responses were categorized into four major themes: (a) Building Partnerships Outside of School, (b) STEM Opportunities Outside the Classroom, (c) Real-world Experiences, and (d) Valuing STEM Education. These teacher interviews provided additional information for improving STEM education within these high schools and offered clarity about how outside entities (businesses, industry, and community, school district) could better support STEM education.

Teacher responses to the interview questions pertaining to building partnerships outside of school were consistent across all participants. Feedback from participants indicated the importance of partnering with STEM business and industry partners. For example, several teachers shared that industry professionals make excellent guest speakers because they have first-hand knowledge of their job in the industry. This aligns with research that shows these partnerships can create opportunities that positively impact student motivation (Thiry et al., 2011; Vennix et al., 2018). It was evident from the interviews that industry partnerships were informal and teachers utilized connections they had or created on their own. These industry connections need to be further developed to create stronger partnerships that are collaborative, consistent, and can provide the variety of opportunities for students to engage in STEM opportunities outside of the classroom.

Burns et al. (2018) findings suggest that students attain greater learning through internships, tours, and speakers. In this study, there were shared responses amongst teachers for the theme, STEM opportunities outside the classroom. Participants reported how clubs associated with STEM disciplines influence STEM education and are beneficial for students. Teachers also expressed that the school district's STEM center was a venue where students could in engage in STEM activities such as, robotics. Overall, most data revealed that activities are available for students to engage in STEM outside of the classroom. However, the scope and total number of activities that teachers reported where minimal. The establishment of more opportunities for STEM education outside of the typical classroom setting can have greater positive impacts on students. Especially, opportunities like, internships, projects, and industry tours which have been shown to have greater impacts on students' critical thinking skills, individualization, and preparedness for future careers (Thiry et al., 2011).

Teachers across the school district's regions shared a common understanding of the real-world experiences theme. Teachers agreed that real-world experiences would motivate and engage more students in STEM. This is consistent with prior research that indicated students gain a more in-depth understanding of STEM content when they have the opportunity to participate in real-world STEM activities (Burns et al., 2018; Vennix et al., 2018). Teachers also reported that students who had more experience in real-world settings were better informed and aware of what to expect in future STEM career settings. One teacher's response suggested that teachers who have industry experience or stronger content backgrounds are able to provide more engaging real-world STEM experiences for students. This response agrees with research that suggests science teachers need more industry experiences or schooling to better prepare students for future STEM degrees and careers (Feldman, Divoll, & Rogan-Klyve, 2009; Feldman, Divoll, &

Rogan-Klyve, 2013). In this study, data reaffirms the importance of teachers having the education and experiences necessary to teach STEM disciplines. Furthermore, both STEM curriculum and instruction needs to be regularly evaluated to ensure students are receiving the positive experiences and in-depth skills necessary to be successful in future STEM degrees and careers. This aligns with research that indicates teachers who foster positive beliefs for STEM education lead to positive effects for instructional decisions which directly benefit students (Park et al., 2017).

In regard to valuing STEM education, all teachers agreed that parents, students, school administrators, and the community need to value STEM education. Overall, this theme ran consistent through all participants' responses. Teachers indicated that most parents value STEM education but lack a full understanding why it is important. Teachers reported that more publicity is needed to raise community awareness of STEM. In summary, teachers explained they understand the importance of STEM and have a strong awareness of STEM. These results are consistent with research done by Bakirci and Karisan (2018) who found teachers with a strong awareness of STEM have an opportunity to positively influence students' interest in pursuing STEM career fields.

Data in this study revealed teachers have strong STEM awareness and the desire to improve STEM education. To do this effectively, teachers will need encouragement, support, and additional learning experiences to strengthen their instruction. Teachers must also have time to collaborate with colleagues to develop and implement innovative STEM curriculum. Based on the information gained from this study, teachers will also need assistance building and sustaining STEM business and industry partnerships. The development of these partnerships can lead to more opportunities for students to engage in STEM education outside of the typical classroom. In conclusion, this study's findings indicate teachers' perceptions can have both positive and negative effects on students.

These perceptions are powerful influencers and can directly impact students' potential for pursuing STEM degrees and careers.

Implications

As a result of this study's examination of science teachers' perceptions to determine their level of STEM awareness and support, several implications for both administrators and teachers emerged. For administrators, this research highlighted that teachers need a supportive environment to learn new approaches to instruction and assessments (Asghar et al., 2012). Administrator support is essential to create an environment that encourages teachers to take risks and try new strategies and techniques. A supportive environment involves providing suitable incentives, rewards, and professional development opportunities to teachers to improve their practice (Asghar et al., 2012). School administrators are the leaders of a school and their vision impacts the school's academic program. Additionally, school administrators are responsible for providing teachers with effective and engaging professional developments. Purposeful trainings that emphasize the importance of STEM can enhance teachers' competencies in planning, implementation, and evaluation of an instructional process for the integration of STEM education.

For teachers, the findings provide guidance on how to increase the number of students pursuing postsecondary STEM degrees and careers. This study revealed that teachers have significant influence for the success of STEM in the classroom and its impacts on students. Teachers are responsible for creating a safe and nurturing learning environment to support the development of STEM talent (Bruce-Davis et al., 2014). Furthermore, teachers need to provide students with opportunities outside the classroom to engage in STEM activities. Research shows that students who engage in out-of-class experiences reported better critical thinking skills, individualization, and greater preparedness for future careers (Thiry et al., 2011). This study displayed the need for teacher professional development that emphasizes how to create positive expectations and maintain a positive classroom culture. Research indicates that a teacher's positive beliefs and expectations for STEM can create positive effects on instruction and elevate the number of students wishing to pursue postsecondary STEM opportunities (Gregory & Huang, 2013; Park et al., 2017).

Lastly, this study highlights the importance of parents' involvement in STEM education awareness. Qualitative interviews revealed that parents do value STEM education but lack a full understanding why it is important. Only parents who were actively involved in a STEM career or had personal knowledge of STEM understood the importance. A study by Bolshakova, Johnson, and Czerniak (2011), concluded that heightening parents' awareness of the impact of their self-efficacy can have significant positive effects on their children. Thus, increasing parents' awareness for the importance of STEM can increase the chances of their child going on to pursue future STEM degrees and careers.

Recommendations for Future Research

Several recommendations are suggested for future research. First, this study needs to be replicated in other school districts. Collecting data from other school districts will provide additional evidence to strengthen the study's results. Another recommendation would be to investigate STEM awareness and supports for different stakeholders in the same community. According to Carla Johnson (2012), development of this awareness to help community members understand the importance of STEM regarding the future prosperity of the U.S., and preparedness of children for future careers, has been nonexistent. Thus, expanding the research to include students, parents, and community members in this area could provide a better understanding about how STEM awareness and supports differs amongst stakeholder groups within the same community. Furthermore, this information could assist identifying what stakeholder groups need to be targeted to improve the overall perception of STEM awareness throughout the community. The final recommendation for future research would be to investigate how race and gender differences of students impact their STEM awareness and desire to pursue postsecondary STEM degrees and careers. In this study, there were five high school campuses that the majority of students identified as White, and there were three campuses that most students identified as Hispanic. Additionally, there is a need in STEM education to motivate more girls to pursue STEM careers. It would be beneficial to investigate these differences and determine how race and gender impact STEM awareness and the number of students pursuing STEM degrees and careers.

Conclusion

The purpose of this study was to examine science teachers' perceptions and determine their level of STEM awareness and support. Teachers' perceptions were investigated in the areas of industry engagement, awareness and resources, and success in college and career. Research for teacher perceptions and student socioeconomic status were investigated further as possible barriers for STEM awareness and support. From this study, school districts will have a better idea about what factors influence STEM education the most. The findings, implications, and recommendations from this study contribute to the ongoing efforts to develop better and more effective methods for promoting STEM education.

As indicated in the literature review, teachers are the key element for successful STEM education (Bakirci & Karisan, 2018). Increasing teacher STEM awareness has the potential to directly impact the number of students choosing STEM postsecondary opportunities (Knowles et al., 2018). Measuring STEM teachers' perceptions provided direction for what factors need to be improved and supported. In summary, teachers who continue to improve their STEM awareness and maintain positive perceptions for STEM are more likely to engage more students to pursue postsecondary STEM degrees and careers.

REFERENCES

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

Austin, J. D., Hirstein, J., & Walen, S. (1997). Integrated mathematics interfaced with science. *School Science and Mathematics, 97*(1), 45-49. doi:doi:10.1111/j.1949-8594.1997.tb17339.x

Bakirci, H., & Karisan, D. (2018). Investigating the preservice primary school, mathematics and science teachers' STEM awareness. *Journal of Education and Training Studies, 6*(1), 32-42.

Bolshakova, V. L. J., Johnson, C. C., & Czerniak, C. M. (2011). "It depends on what science teacher you got": Urban science self-efficacy from teacher and student voices. *Cultural Studies of Science Education, 6*(4), 961-997.

Bozick, R., Srinivasan, S., & Gottfried, M. (2017). Do high school STEM courses prepare non-college bound youth for jobs in the STEM economy? *Education Economics, 25*(3), 234-250. doi:10.1080/09645292.2016.1234585

Bozkurt Altan, E., & Ercan, S. (2016). STEM education program for science teachers: Perceptions and competencies. *Journal of Turkish Science Education (TUSED), 13*, 103-117. doi:10.12973/tused.10174a

Breiner, J. M., Harkness, S. S., Johnson, C. C., & Koehler, C. M. (2012). What is STEM? A discussion about conceptions of STEM in education and partnerships. *School*

Science and Mathematics, 112(1), 3-11. doi:doi:10.1111/j.1949-8594.2011.00109.x

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

Burns, C., Chopra, S., Shelley, M., & Mosher, G. (2018). Utilizing multivariate analysis for assessing student learning through effective college-industry partnerships. *Journal of STEM Education: Innovations & Research, 19*(3), 27-32.

Egarievwe, S. U. (2015). Vertical education enhancement – A model for enhancing STEM education and research. *Procedia - Social and Behavioral Sciences, 177,* 336-344. doi:https://doi.org/10.1016/j.sbspro.2015.02.354

Falco, L. D. (2017). The school counselor and STEM career development. *Journal of Career Development, 44*(4), 359-374. doi:10.1177/0894845316656445

Feldman, A., Divoll, K., & Rogan-Klyve, A. (2009). Research education of new scientists: Implications for science teacher education. *Journal of Research in Science Teaching, 46*(4), 442-459.

Feldman, A., Divoll, K. A., & Rogan-Klyve, A. (2013). Becoming researchers: The participation of undergraduate and graduate students in scientific research groups. *Science Education, 97*(2), 218-243. doi:10.1002/sce.21051

Feldman, A., & O¨zalp, D. (2019). Science teachers' ability to self-calibrate and the trustworthiness of their self-reporting. *Journal of Science Teacher Education, 30*(3), 280-299.

Fullan, M. (2006). *Change theory: A force for school improvement*. Paper presented at the Centre for Strategic Education Seminar Series Paper No. 157. http://michaelfullan.ca/wp-content/uploads/2016/06/13396072630.pdf

Gregory, A., & Huang, F. (2013). It takes a village: the effects of 10th grade college-going expectations of students, parents, and teachers four years later. *American Journal Of Community Psychology*, *52*(1-2), 41-55. doi:10.1007/s10464-013-9575-5

Guthrie, J. T., Wigfield, A., & VonSecker, C. (2000). Effects of integrated instruction on motivation and strategy use in reading. *Journal of Educational Psychology, 92*(2), 331-341. doi:10.1037/0022-0663.92.2.331

Hughes, J. (2005). The role of teacher knowledge and learning experiences in forming technology-integrated pedagogy. *Journal of Technology and Teacher Education, 13*(2), 277-302.

Johnson, C. C. (2012). Implementation of STEM education policy: Challenges, progress, and lessons learned. *School Science & Mathematics*, *112*(1), 45-55. doi:10.1111/j.1949-8594.2011.00110.x

Kagan, D. M. (1992). Implication of research on teacher belief. *Educational Psychologist*, *27*(1), 65-90. doi:10.1207/s15326985ep2701_6

Kim, C., Kim, M. K., Lee, C., Spector, J. M., & DeMeester, K. (2013). Teacher beliefs and technology integration. *Teaching and Teacher Education, 29,* 76-85. doi:https://doi.org/10.1016/j.tate.2012.08.005

Knowles, J. G., Kelley, T. R., & Holland, J. D. (2018). Increasing teacher awareness of STEM careers. *Journal of STEM Education: Innovations & Research, 19*(3), 47-55.

Lichtman, M. (2013). *Qualitative Research in Education* (3rd ed.). Thousand Oaks, CA: SAGE Publications.

McKown, C., & Weinstein, R. (2008). Teacher expectations, classroom context, and the achievement gap. *Journal of School Psychology, 46*(3), 235-261. doi:10.1016/j.jsp.2007.05.001

Park, M.-H., Dimitrov, D. M., Patterson, L. G., & Park, D.-Y. (2017). Early childhood teachers' beliefs about readiness for teaching science, technology, engineering, and mathematics. *Journal of Early Childhood Research, 15*(3), 275-291. doi:10.1177/1476718x15614040

Ramey, H. L., Lawford, H. L., Rose-Krasnor, L., Freeman, J., & Lanctot, J. (2018). Engaging diverse Canadian youth in youth development programs: Program quality and community engagement. *Children and Youth Services Review, 94*, 20-26. doi:https://doi.org/10.1016/j.childyouth.2018.09.023

Roehrig, G. H., & Kruse, R. A. (2005). The role of teachers' beliefs and knowledge in the adoption of a reform-based curriculum. *School Science and Mathematics, 105*(8), 412-422. doi:doi:10.1111/j.1949-8594.2005.tb18061.x

Sciences, N. A. o. (2007). *Rising above the gathering strom*. Retrieved from http://www.nap.edu/catalog/11463.html

Shirley, D. (2009). Community organizing and educational change: a reconnaissance. *Journal of Educational Change, 10*(2/3), 229-237. doi:10.1007/s10833-009-9112-3

Sondergeld, T. A., & Johnson, C. C. (2014). Using rasch measurement for the development and use of affective assessments in science education research. *Science Education, 98*(4), 581-613. doi:10.1002/sce.21118

Sondergeld, T. A., Johnson, C. C., & Walten, J. B. (2016). Assessing the impact of a statewide STEM investment on K-12, higher education, and business/community STEM awareness over time. *School Science & Mathematics, 116*(2), 104-110. doi:10.1111/ssm.12155

Thiry, H., Laursen, S. L., & Hunter, A.-B. (2011). What experiences help students become scientists? A comparative study of research and other sources of personal and professional gains for STEM undergraduates. *Journal of Higher Education, 82*(4), 357-388.

Tseng, K.-H., Chang, C.-C., Lou, S.-J., & Chen, W.-P. (2013). Attitudes towards science, technology, engineering and mathematics (STEM) in a project-based learning (PjBL) environment. *International Journal of Technology & Design Education, 23*(1), 87-102. doi:10.1007/s10798-011-9160-x

Vennix, J., den Brok, P., & Taconis, R. (2018). Do outreach activities in secondary STEM education motivate students and improve their attitudes towards STEM?

International Journal of Science Education, *40*(11), 1263-1283. doi:10.1080/09500693.2018.1473659

Zmuda, A., Kuklis, R., & Kline, E. (2004). *Transforming Schools : Creating a Culture of Continuous Improvement*. Alexandria, VA: Assoc. for Supervision and Curriculum Development.

APPENDIX A:

SURVEY COVER LETTER

University of Houston Clear Lake

March 2019

Dear High School Science Teachers:

Greetings! I am doctoral student at the University of Houston-Clear-Lake conducting a study on STEM Awareness and Community Support. The purpose of this study is to identify and address potential gaps in our educational system's overall understanding of STEM and increase the number of students pursuing STEM degrees and careers.

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 Support survey is not only greatly appreciated, but also invaluable to help further STEM education. If you have any further questions, please feel free to contact me (lowrya9550@uhcl.edu). Thank you!

Sincerely,

Andrew M. Lowry, MS
The University of Houston-Clear Lake
lowrya9550@uhcl.edu

APPENDIX B:

K-12 STEM AWARENESS SURVEY

Teacher Awareness of STEM Education Survey

Science Teachers:

Greetings! I am doctoral student at the University of Houston-Clear-Lake conducting a study on STEM Awareness and Community Support. The purpose of this study is to identify and address potential gaps in our educational system's overall understanding of STEM.

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 Support survey is not only greatly appreciated, but also invaluable to help further STEM education. If you have any further questions, please feel free to contact me (lowrya9550@uhcl.edu). Thank you!

33%

Next

Teacher Awareness of STEM Education Survey

K-12 STEM Awareness and Community Support Survey

Directions: This questionnaire is designed to help the researcher gain a better understanding of the kinds of things that create difficulties for teachers in their school activities. In your opinion, please indicate how much you can do for each of the statements below.

*** *Industry Engagement***

	Strongly Disagree	Disagree	Agree	Strongly Agree
I believe it is important for area businesses to be involved in STEM partnership(s) with my school.	◯	◯	◯	◯
I have had business/community funded STEM education programs or events in my school.	◯	◯	◯	◯
I have had community/business guest speakers in my school.	◯	◯	◯	◯
There are opportunities for students at my school to complete STEM internships.	◯	◯	◯	◯
There are organizations interested in providing STEM education opportunities for students in my school.	◯	◯	◯	◯
Overall, there has been an increase in STEM education opportunities for students in the school in the last year.	◯	◯	◯	◯
I have worked closely with community/business organization members in my role as an educator.	◯	◯	◯	◯

*** *Awareness and Resources***

	Strongly Disagree	Disagree	Agree	Strongly Agree
My school understands the importance of STEM education.	◯	◯	◯	◯
Parents in my school understand the importance of STEM education.	◯	◯	◯	◯
More work needs to be completed to spread awareness of STEM education.	◯	◯	◯	◯
STEM skills are integral to student success today.	◯	◯	◯	◯
Increasing the STEM talent pool is necessary for economic vitality.	◯	◯	◯	◯
Students with postsecondary education are more likely to secure a career in a STEM field.	◯	◯	◯	◯
There are colleges and/or universities and/or community colleges that offer scholarships for students to pursue STEM degrees in my school.	◯	◯	◯	◯
Information on regional STEM career opportunities is available online.	◯	◯	◯	◯
Local organizations recruit STEM talent online.	◯	◯	◯	◯
Information related to STEM opportunities in my school is available online.	◯	◯	◯	◯

*** *Success in College & Careers***

	Strongly Disagree	Disagree	Agree	Strongly Agree
Students in my school are prepared to be successful in postsecondary study (2- or 4-year colleges or universities ad technical programs).	○	○	○	○
Students in my school are knowledgeable about the STEM careers that will be in high demand when they graduate.	○	○	○	○
My school effectively teaches students STEM knowledge and skills.	○	○	○	○
The state standardized tests used in my school adequately assess STEM knowledge and skills.	○	○	○	○
My school prepares students who are critical thinkers and problem solvers.	○	○	○	○
Community partners (e.g., business and higher education) are engaged in making STEM education more relevant through providing real-world connections in your school district.	○	○	○	○

*** Would you be willing to be interviewed for this study? Selected participants would participate in a 15 minute interview to help the researcher explore a greater depth about teacher STEM awareness and perceptions.**

○ Yes

○ No

If yes, please type in your name and email below or you can email Andrew Lowry (lowrya9550@uhcl.edu) directly.

Please note that your name and contact information will remain completely confidential and will not be linked with any of your survey answers.

67%

Prev Next

Teacher Awareness of STEM Education Survey

Directions: This questionnaire is designed to collect basic demographic data to help the researcher gain a better understanding of STEM Awareness and perceptions.

What is your gender?

- ◯ Male
- ◯ Female
- ◯ Other (please specify)

[ ]

Select the ethnic and/or racial background with which you most identify.

- ☐ American Indian or Alaska Native
- ☐ Asian or Asian American
- ☐ Black or African American
- ☐ Caucasian or White
- ☐ Hispanic or Latino
- ☐ Native Hawaiian or other Pacific Islander
- ☐ Two or More Races
- ☐ Other Race (please specify)

[ ]

What grade level(s) do you currently teach? (Check all that apply).

- ☐ 6th Grade
- ☐ 7th Grade
- ☐ 8th Grade
- ☐ 9th Grade
- ☐ 10th Grade
- ☐ 11th Grade
- ☐ 12th Grade

What level of courses do you currently teach? (Check all that apply).

- ☐ Academic
- ☐ PreAP
- ☐ Advanced Placement (AP)

How long have you been teaching STEM courses?

- 1-5 years
- 6-10 years
- 11-20 years
- 21-30 years
- 30 or more years

As a thank you for participating in this survey, I would like to offer you a chance to enter a drawing to win a $20.00 gift card from Amazon. To facilitate this, please provide the following contact information:

Name

Email Address

Please note that your name and contact information will remain completely confidential and will not be linked with any of your survey answers.

100%

Prev Submit

APPENDIX C:

INFORMED CONSENT

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: Teacher Awareness of STEM Education: Industry, Resources and Student Preparation for Success in College and Career

Principal Investigator(s): N/A
Student Investigator(s): Andrew Lowry
Faculty Sponsor: Michelle L. Peters, COE, Associate Professor of Research & Applied Statistics, EdD

PURPOSE OF THE STUDY
The purpose of this study was to examine science teachers' perceptions and determine their level of STEM awareness and support.
PROCEDURES
For the qualitative data, the research will contact participants who volunteer and will conduct one 30-minute semi-structure interview. All participants will be required to provide consent and a structured interview script will be followed. All interviews will be recorded, with participant permission. The researcher will transcribe the interviews, code and analyze to find emergent themes within the participant's responses. Data will be stored electronically on the researcher's personal encrypted cloud server. Access to this data is password protected and will remain there for five years before being destroyed.

EXPECTED DURATION
The total anticipated time commitment will be approximately 30 minutes.

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 potential gaps in our educational system's overall understanding of STEM.

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 Faculty Sponsor 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

The investigator has offered to answer all your questions. If you have additional questions during the course of this study about the research or any related problem, you may contact the Student Researcher, Andrew Lowry, at phone number 281-881-0884 or by email at lowrya9550@uhcl.edu. The Faculty Sponsor Dr. Michelle Peters, Ed.D., may be contacted by email at petersm@uhcl.edu.

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)

APPENDIX D:
INTERVIEW QUESTIONS

Teacher Interview Guide

1. How, if in any way, do businesses and industry partners work with your school district to support STEM education?
2. How, if in any way, do students' parents understand the importance of STEM education in your school?
3. How, if in any way, does your school district support STEM education?
4. Can you describe what outside factors influences STEM education in your school?
5. What, if any, areas do you feel could be addressed to improve more students pursue STEM postsecondary opportunities in college and/or career?
6. What, if any, strategies do you feel could improve STEM education in your school?
7. Do you have any other comments that you would like to make that I did not specifically ask you about?