PERCEPTIONS MATTER: FACTORS CONTRIBUTING TO SUCCESSFUL STEM EDUCATION IN A TITLE I SCHOOL DISTRICT

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Dedication

To my Heavenly Father, without you, there is no dedication. I am grateful for the opportunity bestowed upon me! Amen! This dissertation is dedicated to my parents, Robert and Rosalind Perry! My dad placed a strong emphasis on education as early as grade school. Dad, the words you said to me after my sister, Dr. Lateefah Perry, graduated with a Doctorate in Pharmacy were, “I will call you Dr. Perry, too.” Dad, you were correct! To my mom, you are the strongest person I know. I get my tenacity and determination from you. Thank you! I would, also, like to dedicate this research to my husband, Gordon Allen, who has supported and prayed for me throughout this journey. Gordon, I love you to the end of time! Additionally, I would like to dedicate this research to my grandparents: Lee and Dorothy Truscott; and the Late TL and Bertha Green. I am standing on the shoulders of giants. To my bonus children, sisters, nephews, family, and friends, thanks for your patience as I went through this process. I hope you see me as the example for “The sky is the limit”. Go!

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To my cohort, may you never stop dreaming. To Marva Rasberry, we started this together - Mama, we made it! To the world, on July 9, 1972, a baby girl was born to change the world - her name is LaKenya Machee Perry.

ABSTRACT

PERCEPTIONS MATTER: FACTORS CONTRIBUTING TO SUCCESSFUL STEM EDUCATION IN A TITLE I SCHOOL DISTRICT

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The purpose of this research study was to examine the perceptions of STEM teachers on the factors contributing to successful STEM education in a Title I school district. A sample of educators who earned their degree in STEM fields and teach STEM related coursework in their district were interviewed and observed. The educators were interviewed to provide a more in-depth understanding of teachers' perceptions regarding effective implementation of STEM education, teachers' perceptions regarding key components influencing effective implementation of a STEM education program, and how teachers' perceptions affect equity in STEM education. Teachers' perceptions regarding effective implementation of STEM education in a Title I school district are affected by early implementation of STEM education, knowledge of the Engineering Design Process (EDP), STEM integration through application, and STEM program support staff. The EDP was a common theme which emerged from the teachers' perceptions concerning the implementation of STEM. All participants perceived self-monitoring and reflections as key components for implementing STEM education. This study revealed an equitable learning environment is key for equity in STEM education.

Finally, most participants agreed access to resources promotes equity in the STEM program environment and access to resources needed within STEM education levels the playing field in STEM.

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CHAPTER I:

INTRODUCTION

Students in the United States (U.S.) are ranked below their counterparts in mathematics and science. Furthermore, the U.S. is ranked 39^{th} in mathematics and 25^{th} in science literacy out of 70 countries (Craig & Marshall, 2018). STEM is an interdisciplinary approach among the four disciplines: Science, Technology, Engineering, and Mathematics (Holmund et al., 2018). STEM jobs are projected to grow rapidly; therefore, the issue is beyond the numbers. For example, between 2017 and 2029, the number of STEM jobs will grow eight percent, a higher rate than non-STEM jobs (Alan et al., 2019). Additionally, positions in computing, engineering, and advanced manufacturing will lead the way in career fields projections (Knowles et al., 2018).

According to Tickner at al. (2017), the lack of mathematics and science skills among individuals will result in jobs being unfilled in the U.S. by its native citizens. On the contrary, the economy will flourish if U.S. school systems produce talented individuals who can enhance STEM fields (Margot et al., 2019). The researchers identified the lack of qualified STEM graduates as aiding the decision for the U.S. to fund adequate resources with the hope to increase the number of STEM teachers. Although many studies have been conducted in effort to understand the impact of STEM education regarding achievement (Jungert et al., 2020; Margot et al., 2019; & Matsuura et al., 2021), there is much less research on educator perception of STEM education integration as a factor contributing to a successful STEM education program in a Title I school district. The present study provides a contribution to further the understanding of the growing need for STEM graduates and the perceptions of STEM educators at a Title I school district.

Research Problem

Student performance in STEM subjects has negatively impacted the achievement gap in subject areas like Mathematics. In fact, recent data from NCES (National Center for Education Statistics) and Trends in International Mathematics and Science Study (TIMSS, 2015) indicated eighth grade mathematics students performed 31% below achievement level on NAEP (National Assessment of Educational Progress) and TEL (Technology and Engineering Literacy assessments). This particular data included 19 high-income countries and economies. Importantly, earning a bachelor's degree conferred in the fields of STEM has been limited. According to NCES (2020), of the two million bachelor's degrees awarded in 2018-19, only 413,425 (20.5%) of them were in STEM degree fields.

Teachers play an important role with closing the STEM achievement gap in the U.S.; however, teachers' perception of STEM integration and education can affect the implementation of a STEM education in a Title I school district (Margot et al., 2019). One variable related to teachers' perception of STEM integration is number of years of experience. For example, teachers with many years of experience understand the importance of STEM education compared to new teachers (Park et al. 2016). Additionally, teachers believe students are empowered and motivated when they work on STEM challenges (Margot et al., 2019). Teacher perceptions, regarding key components of an effective STEM education, can influence the positive implementation of a STEM program in a Title I school district. Key components within STEM education include, but are not limited to, education backgrounds, STEM competencies, content area of instruction, STEM education experiences, and national views (Khuyen, 2020).

There is a need to close the achievement gap existing among students identified as low socioeconomic, particularly in the subjects included within STEM education. The demands of a high-quality STEM education affect low socioeconomic students differently than high socioeconomic students. According to Dietrichson et al. (2017), the socioeconomic status of a student is directly linked to educational achievement. In fact, PISA (Programme for International Student Assessment), concluded there is minimal student achievement among low socioeconomic students, so greater attention to targeted STEM education is essential if achievement is to be improved (National Research Council, 2011). Exposure to STEM education can increase critical thinking and social skills for students from a low socioeconomic background.

To increase the integration of a STEM curriculum used in efforts to improve learning for all students, factors need to be identified regarding the key components influencing effective implementation of a STEM education. Moreover, a discussion about teacher perceptions in what constitutes a quality STEM education needs to be conducted. According to The Buck Institute for Education (2018), STEM education should include key components such as authentic work, collaboration, inquiry, and student voice. However, the perception of a quality STEM education differs among educators.

Teachers' perceptions affect equity in STEM education (Al Muraie et al., 2021); moreover, this particular argument is of grave importance when narrowing the achievement gap between low socioeconomic students and upper socioeconomic students in public schools. According to Deshapande and Harper (2020), the intersection of STEM project-based learning and social justice can increase mathematics achievement in minority and economic disadvantaged students. Furthermore, the researchers believe a challenge exists as some students from marginalized backgrounds have limited exposure and opportunities to see themselves as STEM scholars. This results in low academic performance results in mathematics or related STEM fields and the perception has an effect on students' attitudes towards STEM education.

The perception of teachers regarding implementation of STEM education in their school communities varies among their cognitive understanding of STEM education, as well as their support system. Moreover, the implementation of STEM education can be affected by teachers' competences, the direction and leadership style of administrators, and appropriate training documentation provided in professional development settings (Thang, 2021). Techer perception of STEM education plays an important role on the impact of student achievement in STEM. Contributing to the research on STEM perceptions, this case study aims to support past studies pursuing perceptions of STEM education. The research from this study analyzes the perceptions of STEM educators (educators teaching in a STEM education program) on implementation of STEM education in a Title I district.

In conclusion, examining how teacher perceptions influence STEM education implementation in a Title I school district may contribute to addressing the need of student achievement and the promotion of more students entering STEM fields. When teachers understand the importance of the integration of STEM curriculum and how their perception can influence students, the number of college graduates entering STEM fields will increase (Ngyuen, 2020). As a result, understanding the key components and evaluating the direct link to equity in STEM education could help provide insight to the lack of students matriculating within STEM education. Finally, examining teachers' perceptions regarding effective implementation of a STEM curriculum in a Title I school district is necessary.

Significance of the Study

Teachers perceive the integration of STEM as the inclusion of teaching unit topics from various subjects to enhance problem solving skills (Gunawan et al., 2020). Examining STEM education more closely, it is essential for educators to acknowledge

STEM education, specifically, is the integration of subjects such as science, technology, engineering, and mathematics in addition to the development of thinking skills (Selcen Guzey et al., 2016). In fact, as society continues to experience the demands of an everchanging technology-based world, there continues to be an increased need for college graduates with STEM field expertise (U.S. Bureau of Labor Statistics, 2014). The current population of low socioeconomic K-12 graduates are not choosing STEM fields (Rozek, 2019); therefore, there is importance in understanding how teacher perception influences STEM curriculum implementation particularly in a Title I school district.

Research Purpose and Questions

The purpose of this study is to examine how teacher perceptions influence the implementation of STEM education in a Title I school district.

1. What are teachers' perceptions regarding effective implementation of STEM education in a Title I school district?
2. What are teachers' perceptions regarding key components influencing effective implementation of STEM education in a Title I school district?
3. How do teachers' perceptions affect equity in STEM education?

Definition of Key Terms

Equity in Education: is accomplished when every student gets to learn what they need and want without the outcome determined by race, economic status, or any other demographic indicator (Hadad et. al., 2021).

Intrinsic Motivation: affects teacher professional learning and competencies; determines why a teacher chose to be an educator and the subject he or she selected (Tang et. al., 2020).

Socioeconomic: is defined by the number of students' percentage considered economically disadvantaged; it is associated with the characteristics of the school climate and quality of school (Berkowitz et. al., 2016).

STEM: The International Technology and Engineering Educators Association (ITEEA) defines STEM as a new transdisciplinary subject in schools integrating the disciplines of science, technology, engineering, and mathematics into a single course of study (Dugger, 2010).

STEM Education: is the study of discipline under the four headings; Science, Technology, Engineering, and Mathematics *(*Martín-Páez, et. al, 2019).

STEM Curriculum: an educational framework which defines a system which provides tools for understanding and the testing of ideas applicable throughout subject areas, such as science and engineering (National Research Council, 2011a, p. 84).

Teacher Perception: benefits and barriers to technology and STEM skills integration by either teachers or students in K-12 instruction (Carver, 2016).

Title I School District: Title I was established with the passage of the Elementary and Secondary Education Act in 1965; it is a promising school-level serving high-poverty urban neighborhoods where funding is allocated to support these schools (Christie, 2008).

Conclusion

This chapter provided the need for the study, the significance of the problem, the research purpose and questions, and key definitions pertaining to this study. The present study contributes to a further understanding of the growing need for STEM graduates and aimed to answer the question: Is perception a factor contributing to successful implementation of STEM education in a Title I school district?

CHAPTER II:

REVIEW OF THE LITERATURE

The United States (U.S.) is unable to compete globally in the science and mathematics fields (Wong-Ratcliff et al., 2019). There is a vast amount of literature regarding how integrating STEM education into curriculum can increase the interest of students and teachers (Margot et al., 2019; Holmund et al., 2018). Moreover, there is a need to address gaps regarding preparing for STEM careers in the 21st Century (Widya et al., 2019). Qualitative data regarding the perceptions of teachers in Title I school districts might be limited. The purpose of this study was to examine how teacher perceptions influence the implementation of science, technology, engineering, and mathematics (STEM) education in a Title I school district. To address these areas, the literature review focused on: (a) STEM Education, (b) key components of a STEM curriculum, (c) STEM education in a Title I school district (d) equity in STEM education (e) perceptions of STEM teachers.

STEM Education

History of STEM

According to Lyons (2020), it is important to understand the nature of STEM is more than its four-letter words of the acronym. Moreover, the research suggests there is importance in understanding the origin of STEM and why it has multiple identities. First, the Nation Science Foundation (NSF) embraced the acronym SMET which represented science, mathematics, engineering, and technology (NSF, 1995). The term SMET was used throughout various publication including official documents representing the 107th US Congress (National Science Board [NSB], 2005). The evolution of the term STEM is owned by a variety of sources. According to several sources, (Hallinen, 2015; Mohr-Schroeder et al., 2015), the acronym STEM is credit to Judith Ramaley the former director at NSF. Another source suggests others including advocates for equity in STEM for minorities and women were credited for the use of the acronym (Muller & Collier, 1995). Nevertheless, in 2004, Ramaley along with the work of NSF were able to disseminate the acronym STEM to be recorded in the highest congressional level, the House Science and Math STEM Education Caucus, 108th Congress.

Today, there is critical importance in understanding the power of an acronym of STEM. Across the world including the U.S., the perception of STEM has become a phenomenon. According to Lyons (2020), there was perception of STEM as a combination of resources and disciplines. This gained big attention from lobbyists, universities, public schools, and the media resulting in changing the dynamics of the curriculum. However, the researcher pointed out in order to understand the meaning of STEM, one must be able to comprehend the relationship between the four disciplines the acronym represents. For example, various researchers identified STEM as an interdisciplinary approach where the disciplines are integrated to address real world situations and solve everyday life problems (Lyons, 2020; Nadelson & Siefert, 2017). Additionally, the power of adding Engineering and Technology caused a shift in the professional development of educators to become versed in the area of STEM as an integrated curriculum. Engineering combines the disciplines while promoting critical thinking, creativity, problem solving, brainstorming, and related skills (Kubat & Guray, 2018). Considering there are serval definitions for STEM, defining STEM education is necessary. The following section will define STEM education from various perspectives.

Defining STEM Education

In the U.S., members of professional organizations have urged educators in science, technology, engineering, and mathematics to research and conduct investigation in areas of STEM to improve the quality of STEM education in K-12 programs (National

Science Foundation [NSF], 2015). According to the Southwest Regional STEM Network, STEM is an integration of concepts within the four disciplines (2009). Holmlund et al. (2018) conducted a qualitative study assessing the common ideologies and various views regarding the understanding of STEM education. The researchers attempted to understand how communication empowers people through having the participants create concept maps. The study analyzed the perspective of 34 STEM educators from various roles. These educators were from two traditional middle schools, a STEM-focused school, and a state-wide STEM professional development team. The study addressed the overarching concern on the understanding of STEM educators after implementing or supporting STEM activities. The findings concluded 70% of the 34 reviewed concept maps which had three common themes: interdisciplinary connections, instructional practices, and real-world problems. Moreover, the study revealed educators working in the same systems, with a common vision, have a similar understanding of STEM education.

There is a common theme in STEM education providing an overarching definition of STEM education. Hasanah (2020) conducted a study aimed at identifying the scope of STEM education as a discipline, instruction, field of study, and career. The study revealed STEM can be defined by suggesting four definitions or scopes. According to the researcher, STEM can be defined as a: career, field, discipline, and/or instruction (Hasanah, 2020). STEM as a discipline is a collective approach teaching the four disciplines as a unit (Kubat & Guray, 2018). On the other hand, it is perceived STEM should be taught by five various models which are either taught separately or combine a few of the disciplines (Hobbs et al., 2018). Secondly, 47.0% of studies defined STEM as an instructional model incorporated with 21st century knowledge. This information builds upon prior knowledge while considering critical aspects, such as the validity of materials and integration of STEM (Pawilen & Yuzon, 2019). Third, STEM is seen as a field consisting of areas such as mathematics, engineering, computer sciences, and natural sciences. In fact, five of the 17 studies define STEM as a field (Hasanah, 2020). Contrarily, STEM as a career, was defined by four out of the 17 studies. These studies suggested the selection of STEM as a career is aligned with courses of study selected by students in a post-secondary or graduate program. The definitions were derived from 17 selected literature reviews from 2010-2019.

Hasanah (2020) selected the method for the research to include a search of databases regarding the education, implementation, and definition of STEM.

National Science Teaching Association (NSTA) reported STEM education is the integration of cognitive thinking among disciplines through a project-based focus (NSTA, 2017). This includes learning 21st century skills such as critical thinking, making inferences, drawing conclusions, synthesizing, and conducting research. Next Generation Science Standards (NGSS) describes STEM as an experience connected through the Engineering Design Process (EDP) in mathematics, science, and other related subjects (NGSS, 2017). The experience of participating in EPD challenges provides ample opportunities for student relevancy and real-world experiences.

Trying to find the relationship between paradigm and revolution concerning the direction of STEM education, McComas and Burgin (2020) provided a critique of STEM education from a science perspective. The evaluation suggested there are opposing views regarding STEM education. One view is STEM education is comprised of areas of study under the four disciplines: science, technology, engineering, and mathematics (National Research Council, 2014). The research develops a solid argument these disciplines are strong enough to stand alone as an area of study holistically. In contrast, the study provided opposing views arguing STEM should be integrated into the curriculum or programs (National Science Teaching America [NSTA], 2020). These integrations should include disciplines such as engineering and technology. Moreover, the researcher developed a term, ISTEM (Integration Science Technology Engineering Mathematics), for integration (McComas and Burgin, 2020). This study addresses the need for further investigation regarding the perspective of STEM educators. The results of the study determined there is not enough research to support the effectiveness of STEM integration as a philosophical pedagogy to address science curriculum solely. In fact, the results suggested an integration in a subject area like engineering would eliminate some areas of science including physical and earth science. The following section will identify the key components of a STEM education.

Key Components of a STEM Education

One critical key component regarding STEM education is the ability of educators to acquire innovative ways to integrate STEM curriculum into a framework of study. To understand how a groundbreaking STEM curriculum with a framework can be a key component of a STEM education, a descriptive study was conducted. Moreover, the study identified and described the impact of an innovative framework (Gale et al., 2020). University of Chicago’s Center for Elementary Mathematics and Science Education (CEMSE), the innovative implementation framework provided a description to measure science and mathematics across multiple programs (Century et al., 2014). Additionally, this study was conducted at a newly acquired STEM middle school. The study was based on teacher interviews of a two-year curriculum implementation. Findings concluded there are two key components in the identified STEM curriculum: structural components and interactional components. These results suggested structural components are conceptualize components such as procedural aspects related to problem-based challenges. On the other hand, the interactional key components were notes as the

Engineering Design Process (EDP), mathematics/science integration, advanced manufacturing technology, and collaborative group work.

In a similar study which analyzed the key components of a STEM education, a conceptual framework for the STEM curriculum design, Hu et al. (2021) conducted a case study identifying the construction of the STEM curricula system from four aspects: STEM competencies, elaboration of STEM competencies, design principles of STEM curricula content with the implementation strategies of STEM teaching, and the evaluation of the STEM curriculum. Moreover, the components were determined by presenting a case study from the lens of Think-Based Instruction Theory (TBIT). The study was based on an international STEM educator experienced in the fields of STEM. Moreover, the study concluded the key components designated to guide STEM Education include inspire motivation, cognitive conflict, self-construction, self-monitoring, and reflection and transfer.

Trying to find the key components of a STEM education, Smith et al. (2021) conducted a mixed-study on how a group of ten teachers enrolled in a technology graduate level STEM course at an institution in the Southwestern region discovered the Engineering Design Process (EDP). These teachers were instructed to integrate the EDP in various educational settings. The researchers collected data using the Engineering Design Self-Efficacy (EDSE) survey instrument (Carberry et al., 2010) and weekly reflective journal entries. The Carberry survey instrument was utilized to evaluate engineering design self-efficacy through four lenses: confidence, motivation, expectation of success, and anxiety. Findings concluded, through a quantitative analysis of a pre and posttest, teachers who participated in this study were able to increase confidence and decrease anxiety when they experienced ongoing interdisciplinary interactions.

Eight teachers participated in a profound mixed methods study evaluating an Inclusive STEM High Schools (ISHS) curriculum in order to analyze whether obtaining 21st Century skills influenced an effective STEM education (Stehle at el., 2021). Moreover, the study analyzed teacher lesson plans and student samples of work from seven schools. The study reviewed lesson regarding instruction addressing 21st century skills. The total number of lesson plans reviewed was 67; moreover, out of the 67 reviewed lesson plans, 50 included lessons on 21st century skills. These lessons provided instruction on a more basic level considering the sophistication of 21st century skills. The data indicated there were no significant differences between grade levels, but lesson plans spanning over three days or more, had a higher cognitive level of 21st century skills. The findings of the study established the need for 21st century skills serving ISHSs underrepresented students in STEM deemed as necessary. These skills include content knowledge, problem solving, technology, communication, and self-regulation.

In another study examining key components in a STEM education, Meritt et al., (2019) examined the impact of Problem-Based Learning (PBL) on STEM education. Moreover, the impact of the research was studied from the lens from the STEM School Reform Model (SSRM). The paper examined the outcomes from implementing PBL in a low performing school district, the role of PBL in school improvement, and the challenges to implementing PBL with high fidelity. The researcher used a logic model of the T-STEM Blueprint Rubric, created by the Texas Education Agency (Avery et al., 2010). Findings suggested PBL as a key component for the implementation of STEM education when teachers implement PBL with fidelity. The results indicated there was an increase in the district's test scores, student engagement, and autonomy when students experienced the PBL Model. The following section will explore the explicit components of STEM education in a Title I school district.

STEM Education in a Title I School District

In a study evaluating the socioeconomics influences of black students in grades K-12 public schools, Ramsay-Jordon (2020) suggested funding has decreased the strive of black students in STEM education. The study indicated the quality of education and equity for these students have been subpar (U.S. Department of Education Office for Civil Rights [OCR], 2014). Moreover, the National Science and Technology (NST, 2019) noted the education community should promote awareness regarding an increase in the STEM achievement gap. The findings of the article argued black children bring a different perspective to STEM; however, the major challenge was the effects of the funding system on careers and academic readiness. Moreover, the study reviewed how low-income districts have inadequate resources than their white counterparts.

One challenge affecting low socioeconomic students is the lack of access to advanced coursework which results in decreased STEM engagement and STEM interest for all students. According to Ihrig et al. (2018), the access issue creates an environment which needs a leadership program in order to increase the level of achievement in STEM education. The study conducted a triangulation mixed-methods research design which reviewed 78 high performing students and their 32 teachers. As a part of the study, all 78 students participated in a STEM Excellence and Leadership Program. The program enhanced the abilities of the teachers and students by providing expanding the curriculum and training for teachers. The findings of study obtained from a focus group and opened-ended survey concluded the educators' perspectives configurated into three categories: increased understanding, increased recognition, and enhanced awareness. Students gained knowledge of STEM disciplines and social programs after being participants in STEM Excellence and Leadership program (Ihrig et al., 2018). Secondly, the educators were able to increase the recognition of students while gaining a deeper cognitive understanding of the STEM disciplines. Finally, the program enhanced awareness and solicited students to ask the appropriate questions and reflect on the opportunities related to STEM in their school.

Retaining Title I STEM Teachers

Across the U.S., instructors have been creating summer internship programs to increase the interest and cognitive understanding of STEM fields. According to the American Association for the Advancement of Science (AAAS, 2019), the goals of summer internship programs are to encourage teachers and equip students with STEM skills while responding to the growing shortage of STEM teachers. Wong-Ratcliff and Mundy (2019) argued agendas such as the ones created by National Science Foundation (NSF) and Robert Noyce Teacher Scholarship Program (RNTSP) have shown to identify essential elements in recruiting and retaining STEM teachers.

Additionally, RNTSP has increased the awareness and encouragement in STEM among educators (Wong-Ratcliff & Mundy, 2019). The findings from the AAAS (2019), concluded thousands of students enter the STEM profession and are supported by the Noyce program. Through funding, the RNTSP provides stipends for new teachers when they enter STEM fields. A study conducted by Schuster (2013) set out to determine the impact of two cohort's determination of entering in STEM fields after participating in the RNTSP internship. A goal of this study was to establish which factors had the greatest gains in recruiting and preparing future STEM teachers to the profession. This study conducted a two-part survey questionnaire over three months prior, during, and after entering the internship. Schuster (2013) concluded students' interest in STEM either remained the same or decreases once entering the internship. Nevertheless, the researcher concluded the RNTSP was a good recruitment mechanism but did not affect teacher retention (Wong-Ratcliff & Mundy, 2019).

The qualitative study conducted by Borgerding (2013) explored how a summer internship influenced five students' decisions regarding pursuing teaching and learning, especially in STEM. The researcher conducted pre-internship selection interviews, application documents, daily reflections, author's feedback on reflections, and post-internship interviews for data collection from the five RNTSP Interns. The analysis of the information gathered revealed some increased the interest in STEM and other remained the same (Borgerding, 2013). Research findings concluded early exposure to STEM programs influenced career decisions. Finally, both studies previously mentioned concluded summer internships can increase interest in the field of STEM and recruitment.

According to Dikeman and Benson-Greenwald (2018), the shortages in STEM careers and STEM teachers were due to the lack of opportunities for potential STEM students and/or workers to pursue their goals. Diekeman and Benson-Greenwald (2018) analyzed two pathways directly affecting goal congruity: communal and agentic goal opportunities. Communal goal opportunities are oriented goals and agentic goals are self-oriented goals (Diekeman & Benson-Greenwald, 2018). The researchers conducted a study on how goal congruity affected retention and recruitment rates for teachers in STEM careers in addition to primary and secondary schools' STEM educators.

Data cited by National Science Board (2016) indicated gender gaps are larger in STEM recruitment than in retention. Dikeman and Benson-Greenwald (2018) conducted a longitudinal analysis cohort of students entering college in 2003-2004 to understand the patterns of attrition for STEM. Moreover, 14% of men enrolled in STEM courses and 9% completed the program. On the other hand, 3% of women enrolled and 2% finished the curriculum. In summation, the conclusion from the cited data found the shortage of teachers is greater in science and mathematics. The findings were analyzed by reviewing the two pathways which posed different goal congruity challenges. Future related literature reviews could conduct a study of the development of resilient STEM teachers to add to this research.

There are different complex reasons why teachers leave the profession. Wright, Balgopal, McMeeking, and Weinberg (2019) conducted a case study on how the adaptive model influences teachers' professional resilience. Additionally, the authors argued when teachers develop professional resilience, they are more likely to remain in the professional even when the environment has some adversity (Wright et al., 2019). The data was gathered when an elementary school experienced a decline in student enrollment causing the school to lose funding. Moreover, the leaders of the school community decided to adopt a STEM focused environment.

Wright et al. (2019) analyzed the group of teachers who remained at elementary school. The researchers concluded teachers who adapted to their environment and obtained resources from local experts such as engineers, scientists, and STEM support educators were successful and resilient. Furthermore, 100% of teachers adapted their curriculum practices to improve the overall STEM applications at the elementary school. The case study concluded the teachers at the elementary school demonstrated professional resilience because they adopted new STEM pedagogy and administrative approaches into their school culture. Additionally, the successes of the school were a direct correlation to the teachers accepting the journey and the paradigm shift. Kincheloe, Slattery, and Steinberg (2000) pointed out curriculum is more than a predetermined lesson plan and educators must be prepared for a dynamic structure. The following section will explore and describe equity in STEM education.

Equity in STEM Education

When analyzing equity in STEM education, it may be critical to consider how developing culturally and structurally responsive approaches to STEM education to advance educational equity. In a study designed to address equity in STEM education, Corneille et al. (2020) identified two theoretical frameworks to distinguish strategies in order to increase representation of students of color in STEM. These frameworks were identified as: Critical Race Theory (CRT) and Phenomenological Variant of Ecological Systems Theory (PVEST) (Bell, 1993; Ladson-Billings and Tate, 2006; McGee and Pearman, 2014). These approaches allowed the researchers to understand biases, polices, and practices contributing to inadequacies among students on color in STEM. The findings in this study were categorized by culturally and structurally responsive education practices. Moreover, the outcomes of the findings concluded access to STEM resources, facilities, application of STEM learning, and training to eliminate biases will increase the Black/African students' participation in STEM fields.

There is strong evidence on how certain pathways lead to redefining how individuals access and think about diversity, equity, and inclusion in STEM education. Weisssmann et al. (2019) pointed out a shift in academic approaches and ways of thinking is greatly needed to advance underrepresented minorities. The researchers conducted a study through the lens of multi-context theory and context diversity concepts with the hopes of broaden the ethnic and gender diversity in STEM academic fields, such as geosciences (American Geosciences Institute, 2017). Multi-context provides understanding of the conflict between academic understanding and how one's culture hinders the cognitive growth (Ibarra, 1999a). The multi-context theory revealed when students are exposed to cultural experiences, an individual can be better equipped to set aside biases subpar conscious thinking. Ultimately, the findings from the study revealed actions aligned with the multi-context theory can lead to an increase to a broad understanding on a multicultural and diversity in the STEM environment.

To improve STEM education in the classroom, research should be reviewed in order to determine how does equity in access to STEM education affect curriculum decision and policies. English (2017) argued a viable STEM curriculum should be accessible for all students regardless of the economic disparities between the various schools. This points out equity among socioeconomic status is essential to closing the achievement gap in STEM. The findings concluded STEM-based activities can increase learning for students at their current cognitive level and extend thinking, as well.

In order to research the necessary actions, leaders should bestow upon their historical marginalized students, ethos, and strategies necessary to increase equity. Kahili and Kier (2021) presented a case analyzing how can leaders used design thinking to ensure equal access. The case is based on a large Title I school with almost 600 students in the mid-Atlantic region of United States. Moreover, the school had numerous principals and haven't met the annual progress report measuring academic success. Considering equity-centered design thinking as an approach, the researcher came up with recommendations for the school leader (Kahili and Kier, 2021). The recommendations for increasing equity in STEM education are: possessing empathy for the marginalized students, connecting people to the product and to the process, collaborating about an idea and working together to try to fix the problem, and testing the solution while trying to fix the problem. In another study, CRT was used with the combination of designed thinking theory to create collaborative learning space to denounced segregated practices and to create equitable learning opportunities (Corneille et al., 2020).

To analyze instructional practices in STEM fields providing an inclusive learning environment, Salehi et al. (2020) found cognitive psychology, social psychology, and a discipline-based education should be an integral part of implementing a STEM comprehensive education. This includes providing comprehensive STEM education for historically deprived groups of society occupying school in impoverished areas. Additionally, the researcher's goal was to provide investigated suggestions to increase an inclusive practice across the globe in STEM education. The researchers summarized over 100 literature reviews and concluded the consideration of a culturally sensitive educational program for underrepresented student may impact the disproportionate achievement gap between these students (Salehi et al., 2020). The conclusion was to design disciplines based on three aspects of STEM courses: design, implementation, and classroom discourse. The guidelines for the course design include ensuring students understand the outcomes of their learning (Salehi et al., 2020. Also, the researchers pointed out effective implementation must provide a roadmap to ensure goals are aligned and the educator should avoid language providing implications for demographic groups within the classroom discourse. The following section will identify the perception of STEM teachers.

Perception of STEM Teachers

When examining teachers' perceptions regarding key components influencing effective implementation of STEM education, considering quality in-service instruction, effective pedagogical techniques, and district support for collaboration may be critical. Throughout a vast review of recent research and literature, Margot et al., (2019) found teachers value STEM education, but found pedagogical, curriculum, and structural challenges were barriers. Additionally, by analyzing 25 articles, the researcher concluded teacher support would improve the implementation of STEM education by connecting district support and collaboration with peers to the daily work of the teacher. Furthermore, the researchers conducted the study by utilizing the Preferred Reporting Items for Systematic Reviews and Meta-Analyses PRISIMA guidelines which included 27-item check list and a four -phase flow diagram (Liberati et al. 2009). This systematic review included peer-reviewed journals addressing one of the research questions topics: perception of utilizing STEM pedagogy, challenges and barriers to using STEM pedagogy in their classrooms, and support for teachers in their efforts to improve STEM pedagogy in their classrooms. The findings from the study are teachers value STEM education and believe STEM education is essential for 21st Century learning; moreover, the appropriate support from instructional staff is essential, as well. The research concluded teacher confidence and student achievement should be linked together for the overall success of strong STEM education.

To understand the measurement of teachers' perceptions to sustain STEM education development, a quantitative analysis was conducted to indicate teachers have positive views on STEM education (Kyuyen et al., 2020). The study collected data from survey data from 186 teachers in STEM and Non-STEM fields to examine differences among individual teachers based on experience, background, and assigned subjects. The one-way ANOVA was used to determine if there are any significant differences between the three groups (Kim, 2017). The findings of this study established the higher the educational background both teachers possessed, the statistically significant scores in areas such as STEM education, STEM competencies, and difficulties in STEM education increased. Moreover, novice teachers are believed to have better understanding of STEM competencies and appreciation for the implementation of the pedagogy. In terms of the perception between teaching experience, the study concluded there were no statistically significant differences in teachers' difficulties among this group.

To evaluate STEM education in the 21st century, Bell et al. (2017) analyzed learning at work by exploring the design and technology of teacher perceptions and practices. These teachers worked in fields such as graphic design, engineering, food design, and product design at their schools. Considering the methodological approach and constructivist ground theory (Charmaz, 2017), the study pointed out how teachers working with design and technology can obtain new knowledge in STEM education. Additionally, the researcher indicated teacher's knowledge and perceptions of STEM is related to their method of instruction within their practices and level of support (Bell et al., 2017). The analysis and presentation of findings through semi-structured interviews and groups concluded learning happens formally, informally, and independently.

Looking to analyze the awareness on STEM in-service teachers, preservice teachers, informal educators, and administrators, Navy et al., (2020) surveyed 164 educators regarding their perception on STEM support, STEM careers, and STEM understandings. A mixed methods study surveyed various educators in the Midwest U.S. was conducted. These individuals represented the participant groups. The findings of the study showed preservice teachers had an emerging understanding of STEM than the in-service teacher, informal educators, and the administrators who participated in the study (Navy et al., 2020). The research found informal educators have higher perceptions on the importance of STEM than their comparison K-12 educator groups. Additionally, the informal group, which consists of workers in STEM related fields, findings concluded these individuals have higher perception of understanding STEM than K-12 educators. Administrators and informal educators perceived STEM related activities and initiatives provided greater support. Qualitative data revealed there was some contrast between barriers for entering STEM careers and the demand of STEM fields.

In a similar study, Firat (2020) implemented the case study approach to determine teachers' perception and belief regarding implementing STEM education into their science curriculum. By implementing the case study, the researcher was able to get a current and relevant firsthand account regarding three categories: STEM concept knowledge, curriculum knowledge, and STEM implementation knowledge (Firat, 2020).

Also, semi-structured interviews were performed on ten Science teachers asking questions related to the topics: STEM meaning, STEM integration effect on science curriculum, and qualification for integrating Science curriculum. The overall findings for this study include: teachers perceived STEM as a process for producing a product using engineering skills, many of the participants of the study considered themselves inadequate to ingrate STEM into their Science curriculum, and the participants indicated the potential problem for integrating STEM derives from themselves. Finally, the teacher perceived with the appropriate support, the implementation of STEM education is possible.

Summary of Findings

Several researchers have identified many perceptions regarding the key components, definition, and history of STEM (Lyons, 2020; Muller & Collier, 1995; Holmlund et al.; English, 2017). Research was conducted to indicate when teachers have positive views and confidence regarding STEM education, student's performance increased in all STEM related areas (Kyuyen et al., 2020). The higher the educational background the teachers possessed, the statistically significant scores in areas such as STEM education and STEM competencies increased. On the other hand, low socioeconomic students struggle with engagement in advance coursework due to lack of access for all students (Ramsay-Jordon,2020).

The achievement gap in STEM should be addressed in order to prepare students for STEM careers in the 21st Century (Widya et al., 2019). Across the world including the U.S., STEM has evolved into more than a four-letter word. According to Lyons (2020), it was perceived STEM was a combination of resources and disciplines gaining attention from lobbyists, universities, public schools, and the media to change the dynamics of the curriculum. Additionally, the researcher pointed out understanding the relationship between disciplines will promote a deeper understanding of STEM as a holistic approach. Other researchers have argued adding the engineering component as a discipline increased critical thinking and other skills to help bridge the understanding among the disciplines (Kubat & Guray, 2018).

The understanding and learning of STEM concepts have not been addressed for all students (Ramsay-Jordon, 2020). Current research shows school districts with an inclusive and equitable program will have a deeper understanding of STEM education (Weisssmann et al., 2019). The level of inclusiveness provides an equitable program for all students who have been historically performing below the minimum expectations (U.S. Department of Education Office for Civil Rights [OCR], 2014). Therefore, there is a critical need for the evaluation of how the perception of STEM educators contributes to effective STEM education and a successful STEM education program.

Evaluating the perception of STEM educators in a Title I school may decrease the gap in historical underrepresented students in STEM achievement (NST, 2019; Ihrig et al., 2018; Dikeman and Benson-Greenwald, 2018). After reviewing the perceptions of STEM educators, when examining teachers' perceptions of STEM education, the theoretical framework provides a lens to analyze this research study and other related research studies.

Theoretical Framework

The perception of STEM education is defined through the lens of Grounded theory (GT). Developed by Glaser and Strauss in 1967, the grounded theory, provides an inductive approach to the learning (Walsh et. al, 2015). Historically, the GT approach has become the main technique for qualitive research (Bryant et. al, 2007). Additionally, GT theory is an inductive approach generated based on data collected to form a philosophy from the participants experiences. Moreover, the collection of qualitative data to determine inductive reasoning regarding the study is based on three factors: experience, problem present, and how individuals solve these problems. During this process, the researcher should not form an opinion or have any predispositions regarding the subject matter (Simon, 2006). Moreover, the researchers should adopt a neutral feeling regarding the subject matter.

The impact of educators' perceptions of STEM can be identified through the discovery of patterns. According to Glaser et al., (2017) the discovery of patterns in data will enhance the outcome of research when the human behavioral process is studied. Simply, the researcher must identify patterns of behavior explaining the identified main concern. In other words, the researcher's goal is to discover the unknown variables in order to make effective change. The procedural model aligned with this research study includes open coding, selective coding, and theoretical sampling (Walsh et. al, 2010). Theoretical sampling is a pivotal strategy implemented in a grounded method or theory (Strauss, 1987). This strategy is based on a process of collecting data based on a theory and not any predisposed notions. On the other hand, selective sampling is a method identifying the population and the participants prior to the research (Schatzman et al., 1973). Selective sampling allows the researcher to gain maximum information from their participants.

Conclusion

This chapter presented a review of relevant literature relating to the purpose of the study, which was to examine how teachers' perceptions influence effective implementation of STEM education in a Title I school district. In Chapter III, the methodological aspects of this dissertation are included. The methodological aspects are the research purpose and questions, the research design, population of the study and sampling selection, data collection procedures, data analysis techniques, privacy and ethical considerations, and the research design limitations for this particular study**.**

CHAPTER III:

METHODOLOGY

The purpose of this study is to examine how teachers' perceptions influence the implementation of STEM education in a Title I school district. A purposeful sample of kindergarten through eighth grade (K-8) STEM teachers from a small suburban school district located in Southeast Texas were solicited to participate in interviews. Responses from the interview scripts were analyzed using an inductive thematic coding process. This chapter presents an overview of the research problem, operationalization of theoretical constructs, research purpose and questions, research design, population and sampling selection, instrumentation to be used, data collection procedures, data analysis, privacy and ethical considerations, and the research design limitations of the study.

Overview of the Research Problem

Students' performances in STEM areas have impacted the achievement gap in in areas such as mathematics and science. In the U.S., teachers play an important role with closing the STEM achievement gap. Moreover, teacher perceptions, regarding key components, can influence an effective implementation of a STEM program in a Title I school district (Margot et al., 2019). These key components include, but are not limited to, education backgrounds, STEM competencies, teaching subject, STEM education experiences, and national views (Khuyen, 2020). In order to increase the integration of a STEM into more than one curriculum, factors need to be identified regarding key components influencing an effective implementation of a STEM education. Additionally, teachers perceive, students are empowered and motivated when they work on STEM challenges integrated into the STEM curricular regularly (Margot et al., 2019).

According to Dietrichson et al. (2017), the socioeconomic status of a student is directly linked to educational achievement. In fact, Programme for International Student

Assessment (PISA), concluded there is minimal student achievement among low socioeconomic students, so a greater attention to STEM education is essential (National Research Council, 2011). Furthermore, equity in STEM education needs to be reviewed to close the growing achievement gap between U.S. and other growing nations. According to The Buck Institute for Education (2018), STEM curriculum fostering successful STEM education should include key components such as authentic work, collaboration, inquiry, and student voice.

Research Purpose, and Questions

The purpose of this study is to examine how teacher perceptions influence the implementation of STEM education in a Title I school district. The study will address the following research questions:

1. What are teachers' perceptions regarding effective implementation of STEM education in a Title I school district?
2. What are teachers' perceptions regarding key components influencing effective implementation of STEM education in a Title I school district?
3. How do teachers' perceptions affect equity in STEM education?

Research Design

For this study, a qualitative case study design was used to examine how teacher perceptions influence the implementation of STEM education in a Title I school district (Creswell, 2007; Lichtman, 2010). A case study approach consists of an in-depth inquiry into a specific and complex phenomenon (the case), set within the context of the real-world (Yin, 2013). Creswell and Poth (2016) provided an in-depth investigation of a bounded system (e.g., an activity, event, process, or individuals) based on extensive data collection and recommended this method if the purpose of the research is to understand an event, activity, process, or individuals. Additionally, during this process, the researcher gained a deeper understanding of the STEM educators' perception by analyzing collected qualitative data related to several variables (Heale, 2018). A purposeful sample of K-8 STEM teachers from a small suburban school district located in Southeast Texas were solicited to participate in interviews. Responses from the interview scripts were analyzed using an inductive thematic coding process

Population and Sample

The population of this study consists of a small suburban school district in Southeast Texas. This school district composed of six standard and one alternative campus (high school, middle school, early childhood center, elementary, STEM magnet academy, and alternative education center), employs 222 teachers, and has a student population of 3,586 students (TEA, 2020). The district was chosen because of the relatively diverse teacher population. The district was chosen because of the relatively diverse teacher population: African American 39.3% (n = 87); Asian 10.1%; (n = 23); Hispanic 21.2% (n = 47); American Indian 0.9% (n = 2); Pacific Islander 0% (n = 0); Two or More Races 2.7% (n = 6); and White 25.7% (n = 57). Table 3.1 provides the teacher district data obtained from 2019-2020 Texas Academic Performance Report.

On the elementary campus, there is a total of 60 teachers whereas 61% of these teachers are on record as new teachers. Table 3.2 presents the entire district and the four campuses. These 46 new teachers have between 0 to 5 years of experience. Also, on the elementary campus, 36.9 % (n = 17) of the teaching staff have 1-5 years of teaching experience. The number of teachers at the middle school is 37, with 8.1% (n = 3) listed as beginning teachers. Moreover, 43.2% (n = 6) teachers at the middle school have 1-5 years of teaching experience. Likewise, 33.3% (n = 26) of the teachers at the high school are identified as new teachers and 24.3% (n = 19) of these teachers have 1-5 years of teaching experience.

Table 3.1:

District Teacher Demographic Data

All Teachers	Frequency (n)	Percentage (%)
Female	159	72.0
Male	63	28.0
African American	87	39.0
Hispanic	47	21.0
White	57	26.0
American Indian	2	0.9
Asian	23	10.0
Pacific Islander	0	0.0
Two or More Races	6	3.1

Table 3.2:

District and Campuses Years of Experience

All Teachers	District	Elementary	Intermediate	Middle	High
Beginning Teachers (0 Years)	12.1 (n = 27)	23.9 (n = 11)	17.8 (n = 5)	8.1 (n = 3)	8.9 (n = 7)
1-5 Years' Experience	36.9 (n = 82)	36.9 (n = 17)	50 (n = 14)	43.2 (n = 16)	24.3 (n = 19)
6-10 Years' Experience	14.8 (n = 33)	10.8 (n = 5)	10.7 (n = 3)	13.5 (n = 5)	23.0 (n = 18)
11-20 Years' Experience	25.2 (n = 56)	26.0 (n = 12)	21.4 (n = 6)	27.0 (n = 10)	37.1 (n = 29)
Over 20 Years' Experience	10.8 (n = 24)	2.1 (n = 1)	----	8.1 (n = 3)	19.2 (n = 15)
Teacher Total (n)	222	46	28	37	78

Note. None of the intermediate teachers had over 20 years of experience.

Table 3.3:

District and Campuses Years of Experience

STEM Teachers	District	Elementary	Middle	Intermediate	High
Beginning Teachers (0 Years)	12.9 (n = 17)	23.3 (n = 7)	12.0 (n = 3)	13.6 (n = 3)	7.4 (n = 4)
1-5 Years' Experience	35.8 (n = 47)	33.3 (n = 10)	48 (n =12)	54.5 (n = 12)	24.0 (n = 13)
6-10 Years' Experience	2.2 (n = 3)	10.0 (n = 3)	20 (n = 5)	4.5 (n = 1)	25.9 (n = 14)
11-20 Years' Experience	24.4 (n = 32)	30.0 (n = 9)	16 (n = 4)	27.2 (n = 6)	24.0 (n = 13)
Over 20 Years	9.1 (n = 12)	3.3 (n = 1)	40 (n =1 0)	----	18.5 (n = 10)
Teacher Total (n)	131	30	25	22	54

Note. None of the intermediate teachers had over 20 years of experience.

Participant Selection

The district has a STEM Magnet Academy and established a district-wide STEM focus for all students. Many teachers are certified in the areas of Mathematics, Science, Technology, and Engineering. STEM teachers and STEM leaders from the Elementary and Middle School were invited by e-mail to participate in a Zoom interview. The participants were selected if they are currently working in related STEM areas in the district. The aim of the selection was to have a representation from each area of STEM at all campuses. Moreover, these teachers were observed by the school leadership based on the implementation of STEM education into their classrooms. The guidelines and expectations for the observations were to include identifying classroom teachers who implemented 21st Century skills into their STEM curricular. In addition, these participants were required to attend at least two STEM related professional developments.

Data Collection Procedures

Prior to data collection, the researcher gained approval from the University of Houston-Clear Lake's (UHCL's) Committee for the Protection of Human Subjects (CPHS) and the school district in which the study took place. Next, the participants were contacted via email with a memo regarding a formal introduction, the purpose of the study, and the process for collecting conducting interviews.

Interview

Interviews are often used in qualitative research to prove a firsthand descriptive account of the participants' perception (Bloomberg et. al., 2016). The process of interviewing allows the facilitators to ask thought provoking and follow-up questions for clarification (Cresswell, 2016). Additionally, the researcher can use probing questions to support the data in an interview. One strategy ensuring the accuracy of information consists of using audio recording to capture the information from the interview in its entirety.

Gill et al. (2018) acknowledged it is important for the conductor of the interview to receive consent forms all parties involved. Additionally, the participants should receive the information before the actual interview and be able to withdraw from the process if deemed necessary. There are two approaches for an interview to gain insight or additional data on the research topic: face to face and digital methods. A semi-structured interview can be used to guide the interview based on research questions and literature reviews (Gill et al., 2018). The semi-structured interview allows the researcher to live the participant's experience and guide them to their variables along with the area of interest.

Qualitative data were collected through individual interviews conducted via Zoom. The researcher conducted one 60-minutes semi-structured interview with each participating teacher. The interview protocol consisted of 24 open ended questions; questions 1-21 were adapted from a study conducted by Waters (2018). Interview data from the one-on-one interview protocol was recorded with permission, transcribed by the researcher, scripted, color coded, and analyzed to determine three themes within participant responses. Moreover, during the scripting process, Google Voice was used to assist with capturing the participants exact words. The researcher conducted interviews with participants one at a time based on their availabilities. Additionally, the researcher repeated questions and ensured the participants were comfortable during the process.

Data Analysis

Interview data was collected for the researcher to determine the perceptions of STEM teachers regarding key factors in STEM education. First, the participant was selected based on the years of service and participation in STEM related professional development. Once the participants agreed to be a part of the interview, all selected STEM teachers were given various times to conduct 60 minutes interviews via Zoom. Moreover, participants were communicated all interviews would be recorded and scripted for research. Also, participants were reminded all notes and recordings would be kept confidential and secured.

During the interviews, the researcher asked questions regarding teachers' perceptions regarding effective implementation of STEM education, key components influencing effective implementation of STEM education, and perceptions affecting equity in STEM education in a Title I school district (Waters, 2018). Additionally, participants ended the interviews with additional information they wanted to be added to the collected information.

The data were transcribed using Google Voice, color coded, and analyzed to determine major and sub themes. The research charted the information by all 14 participants and colored coded similar responses. After similar responses were identified, the researcher summarized and paraphrased the collected data. Quotes from the interviews were used to support the data analysis. Next, data were given to participants to check for accuracy and peer debriefing will occur to enhance the qualitative research.

Qualitative Validity

The examination of trustworthiness is crucial in order to ensure reliability in a qualitative study (Scale, 1999). During the collection of qualitative data, the research identified the importance of the reliability and validity of the study. First, to increase the accuracy, the researcher used the triangulation method by identifying various perspectives on the participants by themes. Next, questions were presented in a coherent and logical order to increase the natural flow of the interview. The interview questions were created to build a story about the participants' perception of the key components and implementation of STEM education in a Title I school district (Waters, 2018). The questions were created to build a story about the participants perception of the key components and implementation of STEM education in a Title I school district. Third, transcriptions were carefully done by the researcher to increase accuracy and maintain the participants’ meaning. As a precautionary method, the researcher listened to the recording more than once to ensure words were not eliminated or added to change the meaning.

Additionally, to increase the rigor in the qualitative research three evaluation methods for qualitative data analysis were included: member checking procedures, triangulation, and peer debriefing (Anderson, 2017). First, the results of the data were returned to participants to check for accuracy and quality based on their experiences.

Second, the researcher triangulated the data by the multiple perspectives and theories to develop a comprehensive understanding of phenomena. Third, a qualified unbiased peer researcher reviewed and accessed the final transcripts and themes for accuracy.

Researchers argued ensuring reliability was one of the most important factors in establishing trustworthiness (Golafshani, 2003; Joppe, 2000). Reliability will depict when the study has an accurate representation of the total population, and the results are consistent over a period. For the purposes of this study, reliability was assured through the charting of common themes based on the participants responses. Structured interviews were the researcher's source of data collection. All interviews were recorded and transcribed. The researcher observed the number the number of times a phenomenon occurred in the collected data. Moreover, all questions were presented in the same manner and participants had the same opportunities to answer each question. This provided the researcher access to various types of data creating an understanding of the phenomena.

Privacy and Ethical Considerations

Prior to data collection, the researcher gained approval from the University of Houston-Clear Lake's (UHCL) Committee for the Protection of Human Subjects (CPHS) and the school district in which the study took place. Prior to conducting the interviews, all participants were provided with an informed consent form detailing the purpose of the study, acknowledging their voluntary participation, and ensuring complete confidentiality (see Appendix A). The purpose of the study, ethical considerations, process for collecting data, and timelines would be communicated to teachers through a memo.

The timeline gave the specific dates for the one-to-one interview. Teachers received letters through email prior to the administration of the interviews including the timeline. The letters stated the information regarding the timeline, the estimated timeline to complete the interviews, and ensured the pertinent information would remain confidential. Once the participants agreed, interviews were administered. Teachers were provided a Zoom link with along with a cover letter.

All data was secured in a password-protected folder. Moreover, the information was secured on the hard drive memory and saved on an external hard drive. At the culmination of the study, the data will be maintained by the researcher for five years, which is the time required by CPHS and district guidelines. The researcher will destroy the contents of the file once the deadline expires.

Research Design Limitations

The research design consists of several limitations. First, the participants of the interviews may feel the information may not be confidential since it is being recorded. Second, due to current school climate, some participants may not answer the questions based on their actual perceptions. The researcher ensured the confidentiality of the study and data material security. Third, considering the district is a small suburban school district, the generalizations of the findings were limited to the small number of teachers meeting the sample size qualification for this study. Finally, the potential bias in answers from interviewees can limit this research, so the researcher needed to select participants without being bias, and aligned the research questions to the purpose of this study.

Conclusion

The purpose of the study was to examine how teachers' perceptions influence the implementation of STEM education in a Title I school district. This chapter identified the need to further examine the relationship amongst the constructs. In order to understand the perception between implementation of STEM education, key components of STEM education, and equity in STEM education qualitative findings were essential to the study. In Chapter IV, interviews were analyzed and discussed in further detail.

CHAPTER IV:

RESULTS

The purpose of this qualitative case study was to examine how teacher perceptions influence the implementation of STEM education in a Title I school district. The qualitative data obtained from teacher interviews were analyzed using an inductive coding process. Many studies have confirmed in order to understand the impact of STEM education teacher perceptions need to be examined (Firat, 2020; Kyuyen et al., 2020; Navy et al., 2020). This chapter presents a detailed description of the participants' demographics and the findings for each of the three research questions:

1. What are teachers' perceptions regarding effective implementation of STEM education in a Title I school district?
2. What are teachers' perceptions regarding key components influencing effective implementation of STEM education in a Title I school district?
3. How do teachers' perceptions affect equity in STEM education?

Participant Demographics

A purposeful sample of 14 teachers, identified as STEM educators, were chosen for participation in this study. The pseudonyms for the 14 teachers selected for the study are: Anthony, August, Bess, Felecia, Gayle, Gray, Heather, John, Lisa, Paul, Sally, Sandra, Theresa, and Tonya. These teachers were selected based upon years of experience, associated STEM subject areas, attendance to STEM related professional developments, demographics, and gender. Table 4.1 provides the breakdown for all the participating teachers by the explicit demographic categories. The percentage of female teachers interviewed were calculated to be 79.0% (n = 11). Alternatively, the percentage of male teachers questioned were determined to be 21.0% (n = 3). The teachers' years of service ranges from 0 to 28, with the percentage of teachers with over 20 years reported as 28.5% (n = 4). Additionally, 14.2% (n = 2) of the selected teachers have taught between the ranges of 0 to 5 and 16 to 20 years of service. To ensure reliability and validity, teachers were chosen from a variety of STEM related areas (five from Mathematics, one from Technology, three from Science, one from Robotics, and four from STEM) and were interviewed for their perceptions on implementation of STEM education. As seen in Table 4.1 below, most of the teachers identified as African American 57.1% (n = 8) with 21.4 (n=3) identifying as White. Additionally, the participations identified as Hispanic 7.1% (n = 1); Asian 7.1% (n = 1); and Two or more races 7.1% (n = 1).

Table 4.1:

Participants' Demographic Data

Categories	Frequency (n)	Percentage (%)
1. Gender		
Female	11	79.0
Male	3	21.0
2. Race/Ethnicity		
African American	8	57.1
Hispanic	1	7.1
White	3	21.4
Asian	1	7.1
Two or more races	1	7.1
3. Specialized Subject Area		
Mathematics	5	35.7
Technology	1	7.1
Science	3	21.4
Robotics	1	7.1
STEM	4	28.5
4. Years In-Service		
0-5	2	14.2
6-10	3	21.4
11-15	3	21.4
16-20	2	14.2
More Than 20	4	28.5

Research Question One

Research question one, *What are teachers' perceptions regarding effective implementation of STEM education in a Title I school district?* was answered using a qualitative inductive coding process. The data were closely examined to identify common ideas, topics, and patterns among the response of the participants (Broom, 2021). Fourteen participants responded to this question and other related interview questions. The inductive coding analysis revealed four distinct themes or categories of responses concerning teachers' perception and its effect on the implementation of STEM education: (a) early implementation of STEM, (b) conceptual Framework of STEM, (b) STEM integration, and (c) STEM support staff.

Early Implementation of STEM

Engineering design process (EDP). All teachers perceived early implementation of STEM education would impact the integration of STEM. When asked, "How do you think an early implementation of STEM education will impact your students as compared to other students in a traditional school environment?" all teachers responded an early exposure to STEM will have a great impact on STEM achievement in their district. Tanya, a teacher at the Early Childhood Center (ECC), agreed early implementation of STEM education is needed. Tanya commented, "I think just like with anything else, an early exposure to STEM is the key for success. We are teaching our students the engineering design process as early as Pre-K." Moreover, Felecia corroborated, "Teaching the engineering design process at an early age will allow our young learners to embrace a mindset of learning from their mistakes. I love when the young learners are brainstorming and creating STEM ideas." Many of the participants 95.2% (n=13), agreed the EDP was the best start for implementing STEM Education at early age. Paul stated his thoughts of early implementation of the EDP:

> I think that everyone always underestimates the capabilities of 4 years old. These kids are a part of the technology generation. They love computers and technology devices. I think that starting our younger students with the EDP that promotes thinking and creativity will create a STEM culture in our district. Also, when they get to the elementary school, they will already understand how to think outside of the box and problem solve at an early age. I think that we wouldn't have to worry about basic test like the STAAR if we teach students how to think. Wow! What happened to teaching students how to think? We should create young thinkers that think outside the box. The EDP should start at the ECC.

The statement is evidence early implementation and exposure to STEM education may increase STEM education for young learners; moreover, these actions will start a STEM culture in the district.

STEM career exposure. Some teachers 28.5 % (n=4) thought early exposure to careers in STEM provides awareness and appreciation for STEM education. Bess believed early exposure to STEM education will spark curiosity. She stated, "Monthly STEM career activities at the ECC better equip students with foundational skills while they decide what STEM careers they inspire to love. This will be strengthening their critical thinking and problem-solving skills." Similarly, Anthony believes the early career awareness monthly activities are great for the implementation of STEM education with young learners. Anthony commented:

> The career pathways at the ECC will STEM up our students. One month at our school, the students were little scientist, and they loved the experiments that were done with the STEM specialist. The students wrote narrative papers about their experiences. These papers displayed their appreciation for STEM. We just started the STEM monthly activities this year and students are asking what's next

> already. They love the monthly activities. Another positive note for the monthly STEM activities is that our parents and staff are more involved in our school activities.

The STEM activities mentioned by the participant are evidence of career exposure through students’ real-life experiences to see themselves in STEM fields. Imagine the possibilities students had without leaving the school buildings.

Sandra believed the discrepancy between the number of students entering STEM careers after high school is because of the lack of early exposure of STEM education. Also, she felt students lose confidence in fields such as mathematics and science when they are not exposed to STEM education at an early age. Sandra stated her beliefs regarding this discrepancy:

> The reason why there's such a discrepancy between the amount of people in STEM careers is because by an early age, kids lose their confidence in math and science. Many kids by time they get to 6th grade or 8th grade, they will tell you I hate science, or I hate math. This isn’t because they can't do it. It is because at some point along their education career, they lost confidence and interest. Students need to learn at a very young age how to problem solve and how to have a growth mindset. Especially with our minority students, and female students who don't necessarily see people like them in STEM careers. A lot of them don’t even know certain careers exist in STEM. They don’t know the full scope of STEM careers. I just know that offering a setting with exposure at an early age can help dreams in STEM come alive.

Sandra highlighted exposure to STEM careers could possibly close the gap on minority students entering STEM fields.

Spark curiosity and interest. Sparking curiosity and interest in STEM is instrumental during early implementation. Four participants (28.5%) mentioned inciting an interest and creating important moments for young learners were crucial in STEM education. The consensus was children are naturally curious at a young age, so they are naturally drawn to STEM activities. This notion was supported by Paul's response,

> Children at young age naturally want to explore, we just need the adults to understand this notion. I remember how I loved to explore and loved school when I was in the kindergarten, but somewhere by middle school I hated everything.

A similar response was confirmed by Heather regarding curiosity and interest, "An early exposure prepares students for foundation, so curiosity has to be piqued immediately. I think this will strengthening their critical thinking and problem-solving skills because they are learning things that they love." Per this participant, curiosity and interest is directly linked to pathway for developing critical thinking skills.

Both John and Tonya agreed appreciation for learning STEM education needs to start an early age, as well. A common denominator among these two teachers' responses are students getting to experience the opportunity of "STEM at an early age. Examples of John's comments were: "Proving the opportunity and access to STEM will create a certain amount of curiosity in younger students" and "I think that the impact of STEM education at early age will give students opportunities for discovery compared to traditional places." Likewise, Gray believed the "Opportunity must exist at the ECC for students to spark curiosity and interest," and "Sparking curiosity through interdisciplinary centers will build a passion for STEM." All participants believed the opportunity for STEM starts with encouraging students' interest and curiosity.

Conceptual Framework of STEM

Engineering design process. When the teachers were asked the question, "How do your students engage in the engineering design process to study core content through a variety of challenges?" responses varied across among the participants. Four teachers (28.5%) responded they have limited prior knowledge on how the Engineering Design process could engage students in STEM. John commented, "Right now, honestly, I don't know a lot about the Engineering Design Process, so I can't answer that question. I am not sure how it can engage students in STEM." Likewise, Sally stated, "I am not familiar with Engineering Design Process. I have heard about it, but I need a refresher. This one is hard for me to answer but only because I haven't used the Engineering Design Process in my classroom." Paul commented regarding EDP, "I have been to one training on the Engineering Design Process, but I can't respond on how it engages students in STEM. Finally, all three participants are unaware how to use a the EDP which is noted as a key component for implementing STEM education in the classroom.

On the other hand, most of the teachers 71.4% (n=10) agreed the EDP was a way to study core content through a variety of STEM challenges. When Theresa was asked about the EDP, first she explained how she implements it in her classroom:

> The engineering design process sometimes even follows our lesson planning process. In science, we start by introducing the topic that we're studying. For example, we're studying conservation right now. The students are asked to generate concepts regarding the topic. This allowed students to solicit their background knowledge about their topic.

Additionally, Sandra expounded upon on how the EDP has helped implement STEM. She said, "STEM is about building the 21st century skills. Students can brainstorm, create while they are doing the EDP; this is crucial for implementing STEM. This is STEM."

Sandra ensured the connection was made: STEM builds crucial skills through the implementation of the EDP.

Tonya's response is very similar to Sandra because she agreed the engineering design process enhanced STEM implementation by encouraging students to use their soft skills or 21st century skills such problem solving skills. Tonya expressed:

> I believe the Engineering Design Process should be a part of the curriculum to implement STEM education throughout the district. We use the engineering design process to really do a systematic way to solve a problem. We want students to be innovative, but at the same time we want them to go through problem solving in a systematic way. The EDP help our students organize their thoughts. The engineering design process allows them to narrow their focus because sometimes you can approach one problem five different ways. When this happen, you have a higher risk of not completing your problem. The success rate increases when you go through a systematic process. The brainstorming and elaboration are like the scientific method. These proficiencies are life-long 21st century skills that our students will be able to use in college.

Tonya and Sandra believed the EDP would encourage higher level thinking skills. However, Tonya pointed out the EDP provides an efficient and organize way for students to think.

Both Lisa and Heather explained how the EDP is geared towards giving students choice and voice which is key for the implementation of STEM education. Lisa agreed, "I think it (the EDP) is about giving students choices for their final products. I use it even in math class with choice boards, as well." Equally, Heather responded, "The EDP provides students the opportunity to share their exploration and projects with others. Students have a choice on their assignments which will promote ownership in the STEM projects."

Examples of the responses proved the participants are advocates and believe the district needs to execute the EDP in effort to implement STEM education.

21st century skills. During the interview sessions, all of the participants centralized focus was around the relationship between STEM education and 21st century skills. Participants talked about skills associated with 21st Century skills such as: brainstorming, communicating, analyzing, and critical thinking. Additionally, 78.5 % (n=11) perceived when teachers address 21st century skills, students can develop college and career skills, along with their STEM identities. Sally stated,

> Teachers must address 21st century skills in their lessons and STEM challenges. The question is how teachers develop these skills. Developing these STEM skills prepare students for rigorous college work and STEM careers. Additionally, this will give students more opportunities for brainstorming and taking risk. We have learning profiles that have been adapted into our curriculum. These learning profiles are aligned to 21st century skills.

STEM integration. Ninety percent (n = 13) of the teachers mentioned the use of technology was a priority to increase STEM integration in the small district. The responses and perspectives on how to integrate technology varied among the teachers, such as technology with the use iPads, robotics equipment, and STEM education with our learning management systems. Lisa responded, “I would increase the use of iPads in all class periods, so students can use the various applications aligned to STEM”. Also, Heather believed, “We have some items from LEGO and Maker Maven which are key for integrating STEM in our classrooms.” Another participant agreed technology is a communication mechanism. Paul commented,“ One big component of STEM is communication, so we use our learning management system for projects.” All participants noted technology was a key component for STEM integration.

iPad and STEM. Fifty percent (n = 7) of the teachers responded the integration of the iPad was key for implementing STEM education in the district. Additionally, the teachers added 100% of students have iPads since the district labeled as Title I. Lisa stated, “Students use their iPads in their math classrooms to capture their data and analyze results. Students have use coding applications in their math classroom along with calculators and related strategies to solve real-world problems.” Another teacher, John, acknowledged, “I feel the use iPads and other technological devices have been a game changer in the classroom. Students become miniature scientist when they can reflect, research, and ask questions. They can do this because of the iPad.” John provided evidence technology is a gateway for students to research and ask questions in the classroom.

Other teachers echoed with the following comments regarding iPads:

> iPads are a great way to code. We love to code with Swift on iPad. I like how students capture the moments with their iPads. The videos always show the integration of STEM. The number of apps on the iPads have allowed my students to engage in STEM education.

Overall, the teachers agreed the implementation of iPads has encouraged and supported many of the STEM associated activities, such as coding. Also, students can use many features which capture historical data.

Equipment and resources. Thirty percent (n = 4) of STEM teachers perceived for a successful STEM education to be implemented, students need certain STEM Equipment in the classroom. Gayle responded, “I feel like there should be some explicit look-fors in a STEM classroom. I think we need robotics equipment for makerspaces. This would increase a lot of STEM hands-on activities.” Felecia, added that “Resources the kids love like LEGO kits help teacher implement STEM education in the classroom.”

Both teachers agreed some equipment are costly and require professional development, so teachers always have to implement an alternative plan.

On the other hand, some teachers 28.5% (n = 4) argued STEM implementation can be done without spending thousands of dollars. Bess suggested, “I feel there are so many STEM challenges that can be used from household recycle items that there is no need for purchasing expensive items.” Bess suggested additional resources for implementing STEM education:

> Start a recycle system at your school for STEM resources and materials.
> Join a network with fellow STEM educators for cheap ideas. I follow so many people on Social Media for ideas. Create STEM Makerspaces so that students can brainstorm on ways to integrate STEM. I had Students to do this activity and they came up with activities with little or no materials. Search for free applications for the students iPads and other electronic devices.

STEM with our learning management systems. Twenty percent (n = 3) of STEM teachers identified for a successful STEM education to be implemented, teachers need to utilize the learning management system to enhance communication in STEM. Gray mentioned, “Students are using TEAMS to communicate digital material as well brainstorm within their small groups.” August stated, “TEAMS has allowed our students to have a platform for communication and collaboration of their STEM projects. Also, teachers can collaborate and video chat regarding STEM ideas.” All teachers agreed the learning management system was a great hub for housing STEM projects including lesson ideas and resources. Tonya added, “My STEM specialist places all documents and resources in TEAMS, which makes it easy for me to implement the STEM challenges.” The participants agreed the TEAMS system had managed materials and made obtaining STEM resources more efficient for the educators.

STEM Support Staff

All teachers agreed the STEM support staff, such as the STEM or technology specialist, are essential for implementing STEM education. Sandra pointed out, "Our STEM specialist consults with us during lesson planning processes to generate new ideas for applying the engineering design process into problem solving situations." Also, Sandra mentioned, "In our planning meeting, the specialists help make sure we have the materials that we need and develop the teachers on how to integrate STEM through the different subject areas of our schools." Sally agreed and believed the STEM specialist's support was key for the implementation of STEM education. Sally responded, "I feel like the specialist is an encyclopedia for STEM strategies and ideas. When I am lost, she brainstorms with me regarding a specific lesson using the EDP. It really helps me implement STEM." Additionally, Heather pointed out how the STEM specialist and other district support influence the implementation of STEM education. Heather comments:

> The STEM specialist is over here every week in addition to the STEM director to provide directions to our staff. The directions involve creating lesson plan with the EDP. The teachers like the way the specialist is there to provide insight, suggestions, and help generate ideas. She goes into the classroom and model the STEM lesson.

Another teacher echoed, "The STEM support staff on our campus have definitely help our focus on the integration of STEM design challenges. I think the main two ways that the specialist helped us are modeling the lessons and selecting the resources." The support from the specialist is beneficial especially when teacher can observe the lesson and is provided with ample resources for implementation.

Support motivates teachers. Fifty percent (n = 7) of the STEM educators believed support from STEM specialists and administrators motivated them to provide an engaging STEM education in the classroom. These participants all agreed adults need motivation similar to students when implementing challenging new programs such as one associated with an innovative STEM curriculum**.** Heather described how support has motivated her, "Factors such as motivation, coaching, and modeling foster and provide opportunities for teachers to spark interest and grow in STEM education." On the other hand, Tonya discussed how support specialists provide information to enhance their craft in STEM as a motivating factor. Tonya stated:

> The biggest motivation our STEM specialist provided is when she partnered with Apple. This allowed us to join a cohort with Lamar University. When we partnered with Lamar University, we all had the opportunity to obtain a master's degree in STEM related fields. Also, I was able to obtain my Apple certification which allows me to learn coding with Scratch. Being a part of this cohort was very motivating to me and my colleagues.

Tonya provided an explicit example on the benefits of partnership with universities and STEM industry officials.

Another participant agreed the specialists provide motivating proven units as resources for STEM educators. Sally eagerly stated, "These proven units motivate teachers to optimize the learning environment by engaging students with STEM products which are aligned to critical thinking skills." Moreover, the participant further described these units as a quick way to provide interactive lessons while decreasing and motivating teachers.

In summation, teachers' perceptions regarding an effective implementation of STEM education in a Title I school district are affected by early implementation of STEM education, EDP, STEM integration, and STEM support staff. The perceptions of the participants varied regarding the specific factors which impacted a high-quality

STEM education. Some participants agreed incorporating 21st century skills into the curriculum will prepare students for a demanding STEM education. Additionally, some participants agreed support from trained STEM and/or technology specialists was supportive and motivating for teachers.

Research Question Two

Research question two, What are teachers' perceptions regarding key components influencing effective implementation of STEM education in a Title I school district? was answered using a qualitative inductive coding process. The data was closely examined to identify common ideas, topics, and patterns among the responses of the participants. Fourteen participants responded to the question and other related interview questions. The inductive coding analysis revealed four distinct themes or categories of responses concerning teachers' perception and its effect on the implementation of STEM education: (a) structural components of STEM, (b) highly qualified STEM teachers, (c) STEM implementation of tools and resources, and (d) strategies of STEM teaching.

Structural Components of STEM

STEM identity. Teachers' beliefs regarding students developing their STEM identities varied among stakeholders. The STEM identity is developed when students experience real-world authentic learning in an inclusive environment. When asked, "What is your students STEM identity?" Theresa stated, "In order to implement STEM education, one key component is to bring practical experiences to my classroom and district." Also, she described an event her students experienced:

> At the beginning of the year, students got to participate in our white coat ceremony. They had their white lab coats which made them feel like they were doctors or scientists. One of the tracks at our school is geared towards health sciences careers and pathways. Also, students are getting ahead with courses from

> Baylor College of Medicine such as Neurology, Biotechnology, and Biosciences. These courses develop medical terminology and provide students opportunities to learn about the different professions within science, technology, engineering, and math. Ultimately, students develop their pathways and interest regarding what they want to be when they grow up. There are numerous opportunities like this where students can discover themselves in STEM.

Theresa's comments provided an example of how students can develop the language of STEM and their identities through the courses Baylor College of Medicine designates.

Career STEM pathways. Although there are some differences on the beliefs on what constitutes a STEM identity, 75.8% (n = 11) of the teachers agreed creating STEM pathways for students helps them recognize their STEM identities. Examples of such STEM pathways were specific to engineering, gaming, and cyber security. Bess responded, "Pathways for stem like Engineering which encompass mathematics and critical thinking, can assist students with developing abstract and brainstorming skills." Gray agreed gaming also promoted critical skills. Gray stated, "I would like to see Gaming implemented in our curriculum because it a booming industry that help with problem solving and risk-taking skills." Likewise, Anthony mentioned other programs that provided opportunities for student to develop uniqueness. Anthony acknowledged, "Cyber security can help our students develop skills with management which is key for STEM identification." The teachers' comments show a clear alignment of teachers' perceptions regarding developing a STEM identify as a key component for implementing STEM education.

On the other hand, the other teachers 21. 4%, (n = 3) believed implementing pedagogy and strategies such as the Engineering Design Process will increase 21st century skills aligned to the expectation of a STEM curriculum. Here Sally comments:

> A lot of exposure to the engineering design process will help students with STEM. Also, this exposure will help students with research skills that should be implementing in the Engineering Design Skills. Also, this will help students with their STEM identifications.

Simultaneously, Sandra agreed Sally regarding the benefits of the challenges. Sandra replied, “STEM challenges will help students brainstorm, create, and evaluate. These challenges are done with the Engineering Design Process.” Finally, according to the participants, the EDP is important for students when developing their STEM identity, critical thinking skills, and for organizing thoughts.

Highly Qualified STEM Teachers

When analyzing teachers’ perceptions regarding key components of STEM education, 100% of the teachers agreed developing highly qualified STEM teachers’ plays an important role in the influence of STEM education implementation. Tonya was asked, “What professional development/planning helps teachers identify and make explicit decisions regarding their students’ connections among disciplines?” Tonya stated:

> When teachers are provided with proven units for STEM education during professional development sessions, we get what we need to do the job. I am talking about data proven units that guarantees success for my students. Professional development, with how to use these units, would be a great dynamic for teacher training and development.

Additionally, Heather responded, “Apple coding and industry related certifications will help teachers build STEM academic vocabulary which will trickled down to our students.” Additionally, 100% of teachers stated training on the EDP would make them better equipped to implement STEM education at their respective schools.

Paul mentioned using the program called Defined Learning would ensure all teachers are able to implement STEM education, even if they are not particular skilled in STEM related fields. Paul stated:

> I think that the program, Defined Learning, was instrumental for teacher development. I've seen teachers use it and they really liked that the program because it already has built in lessons that cross subject areas. I would like to see us to start doing different components like planning vertical and horizontal within the master schedule.

Paul pointed out programs such as Defined Learning can help teachers become more qualified to teach STEM because the program provides cross curricular lessons.

STEM related professional development. All participants suggested a variety of professional development and trainings which can assist teachers with developing skills ensuring teachers are highly qualified in STEM education. Additionally, all participants agreed ongoing interaction and professional development throughout the school year would help to develop STEM strategies for all stakeholders. Table 4.2 provides a breakdown of each teacher with the suggested additional professional development for implementing STEM education.

Table 4.2:

Suggested Highly Qualified Professional Development

Teachers	Professional Development	STEM Teachers
Anthony	Time Management	1
August	Lesson Planning	3
Bess	Cross Curriculum	1
Felecia	Planning Vertical and	3
Gray	Horizontal	3
Gayle	Lesson Planning	3
Heather	Technology Integration	2
John	Technology Integration	2
Lisa	Vertical and Horizontal	3
Paul	Project Based Learning	3
Sally	Vertical and Horizontal	3
Sandra	Computer Science	1
Thresa	Project Based Learning	3
Tonya	Project Based Learning	3

The data displayed in Table 4.2 indicated 21.4% (n = 3) of the participants selected vertical and horizontal, and project-based learning as highly qualified professional developments needed for implementing STEM education. On the other hand, 7.1 % (n=1) participants selected computer science; 14.2 % (n=2) participants selected technology integration; and 21.4% (n=3) selected lesson planning as staff developments which are key components for implementing STEM education. Conversely, 7.1% (n = 1) of the participants selected time management and cross curriculum planning as suggested professional development. Finally, the participants mentioned the essential importance of staff developments geared to promote collaboration, critical thinking, and other related skills to implement STEM education.

Internship and summer programs. Most teachers, 57.1% (n = 8) felt an internship or summer program would be greatly beneficial to grow them as STEM educators. The perceptions were based on the notion for STEM educators to be equipped with knowledge in their field, one needs direct contact with STEM industry personnel. Lisa shared Baylor College of Medicine with Biosciences majors have provided her with deeply connected skills in the field of STEM. Lisa shared her belief about how the programs has provided insight on the implementing of STEM education:

> The Biosciences program at Baylor College of Medicine has ensured that I am highly qualified to teach my assigned courses. We learned models on how to improve human health and medical related terminology. I have gone to several trainings in my district regarding teaching strategies, but very few in my direct content area. I think this internship was great for teachers that are in health-related fields. I think this training is a key component for implementing STEM education for non-traditional courses such as Biosciences and Biotechnology.

Paul noted the Rice AP summer program prepared him to be more qualified within his job assignment. Paul stated, “I am having to incorporate Computer Science in my coding class. The Rice AP summer program encompassed key strategies with how to incorporate advanced coding in Computer Science.” In summation, it is evident teachers need industry and career related experiences especially when they are assigned to non-traditional subject areas.

Managing time. When analyzing factors of implementing STEM education, all teachers agreed more time was a crucial key component for implementing STEM education. Additionally, they agreed managing time was crucial for implementing STEM challenges and other related activities. Theresa, an experienced science teacher, stated her beliefs regarding more time:

> I wish there was a little more time for more hands-on activities within the science program and curriculum. Many times, we must rush through the science curriculum, to teach the STAAR test subjects. I really feel frustrated when we are forced to eliminate the science and STEM projects to teach the STAAR test. I wish we had more minutes to do experiments and apply the learning within the class period. These kids are different than previous generation and love technology, hands on activities, and group work. So, we must adapt the curriculum in order to do STEM.

The teacher implemented a science experiment project without being able to establish goals with students' groups because of the limitations and constraints with the pacing guides. Theresa stated, "We are going to skip the goal setting and reflection part of the lab, we have to get to Unit 7 by Monday." Likewise, Bess stated, "STEM projects are wonderful, but we just don't have enough time. Plus, the students are so behind with reading due to COVID-19." This statement by Bess provided evidence some STEM educators perceived time as a factor for implementing STEM activities.

Another teacher, Paul, felt managing time is a skill most teachers need. Additionally, he boldly stated, "Teachers prefer to teach STEM in isolation, so this is why they don't have enough time." Paul expressed a growing concern another teacher, Sandra, communicated:

> I don't understand why educators feel like STEM is a chore or something that should be taught like an elective. STEM education should be naturally in our curriculum as a program of study, but all teachers should teach STEM skills daily. Our children should think like an Engineer.

The participants agreed in order to be a highly qualified STEM educator, additional training preparation and training is needed. All the participants agreed about a program model and proven units were essential for implementing STEM education. Additionally, all participants suggested professional development such as Project Based Learning (PBL), vertical and horizontal planning, and lesson planning training was needed to support an effective STEM education. Similarly, more than half agreed attending internships and summer programs would provide high quality training within STEM industry field. Finally, all participants thought time management, organizing resources, and developing lessons were key components for effective implementation of STEM education.

STEM Implementation of Tools and Resources

When asked, "What key components of a STEM school do you wish were in place at your school?" many teachers (64.2%) believed the implementation of tools and resources are key components for STEM implementation. Sally's belief system centered around her theory where tools and resources must be included in learning plans for executing effective STEM education. Sally explained how obtaining health science and STEM lab equipment and resources would expand STEM education in the district. She said:

> I strongly believe that a health science or STEM lab at all campuses should be explored in this district. Students would be able to explore different things like in the medical field including Biotechnology. I believe that we need more STEM

> labs to address robotics and coding. Students could learn how to code and use programs such as Swift in the coding lab. Also, we need to recycle consumable items and resources for STEM challenges. I have attended workshops where I have observed students, building extensive projects out of construction paper and cardboard. Teachers need to have access to resources that have projects and challenges already designed. I think all of this is going to contribute to the success of this school district.

According to Sally, the implementation of STEM would increase if teachers had additional resources and access to STEM related labs. Also, Sally believes programs with inquiry designed lessons would contribute to the implementation as well.

Heather was asked, “What key components of a STEM school do you wish were in place at your school?” and her perception differed from Sally because she felt additional resources without a plan for current tools are not needed. However, she felt the district needed to align current curricula and resources to STEM education. Heather stated, “We have a lot of technology already. All students have iPads, but there isn’t a true model for integration of these tools. Also, we have STEMScopes and other resources, but the curriculum planning guide doesn’t include STEM challenges.” This belief indicates the planning guides need to be aligned to the current STEM resources.

Paul’s perspective regarding key components for implementing a STEM education included obtaining new tools and resources while expounding on current tools in the district. Similarly, to Sally, he believed the district needs to obtain some of the latest tools for a successful STEM education. Paul stated:

> We need to get more innovative tools like the 3D printers that I recently obtained and augmentative reality kits. Students are using all this software plus gaming tools at home, so the district needs to keep up with the trend.

Alternatively, Paul's beliefs regarding appropriate resources and curriculum alignment are very similar to Heather. Paul added to his comments:

> We just need more opportunities to lesson plan vertically and horizontally through the district. We are a small district, so we should be able to share resources and ideas. We currently have STEMScopes, many technology devices, and much more. We have a lot stuff already, but don't have clear guidance from the district and campus levels. I think that we may need to start with analyzing our current resources before investing in new ones.

Paul's beliefs are STEM education classrooms or labs need certain new materials such 3D printers, but educators need to ensure they are utilizing are current resources, as well. Additionally, the data revealed 85.7% (n = 12) teachers agreed with Paul the district needs a plan to implement their current resources. In contrast, these teachers do believe there are some advance STEM gadgets the district needs to purchase, so all students can be exposed to cutting-edge technological devices.

STEM competencies and standards. Most of the teachers identified the lack of knowledge regarding STEM competencies and standards as the reason for a gap in the implementation of STEM education. In fact, 85.7% (n = 12), agreed they are not familiar with the STEM competences or learning standards beyond their content area aligned with the Texas Knowledge and Skills (TEKS). Theresa pointed out, "I have been teaching for a while now and I don't think that I have seen STEM standards." Likewise, Tonya mentioned, "I have attended professional development sessions at the region office that provide the STEM standards, but honestly I haven't used them in my classroom." Alternatively, 14.3% (n = 2), were very familiar with the STEM competencies and standards. These participants believed the STEM standards are the framework set up by the Texas Ecosystem program. Additionally, the participants felt teachers may want to review the Next Generation Science Standards (NGSS) as guidelines for implementing STEM education in the classroom and beyond because these standards are aligned with 21st century skills and PBL.

To provide triangulation, a qualitive analysis on Heather, Paul, and Sally's theories regarding the key components needed in their school district was conducted. The data revealed Sally believed educators need additional resources to implement STEM education. However, Heather believed teachers need a precise plan to implement STEM education with the resources the district already possesses. Paul believed teachers need additional resources along with a plan to implement, but with current and new resources. Finally, most of the teachers were unaware Texas has STEM standards intended to guide teachers with the implementation of STEM education.

Strategies of STEM Teaching

When analyzing the best approach for implementing STEM education, 100% (n=14) teachers agreed soliciting student engagement and interest are key for a successful STEM education. The consensus focused on student engagement increasing an appreciation and love for STEM education. This method was supported by Felecia when she stated:

> African American and female students could benefit from strategies that engaging them and support learning in their school communities. This could be done with implementing afterschool programs like the ones at the STEM Magnet. This school have coding, robotics, and math clubs for student's afterschool. I absolutely believe that this is a game changer.

Felecia echoed the beliefs of the other participants as she provided strategies to support underserved students in STEM education. The strategy provided an example on how to solicit student engagement and interest.

Bess felt passionately knowing the students' interest can help educators develop lessons connected to real world exploration. She believed there are many more effective ways to spark interest in STEM. However, there needs to be some exploration regarding strategies to increase interest in subjects like Mathematics and Science. Bess explained ways to increase engagement and interest:

> We need to increase real-world explorations in our classrooms. In math class, we need some real-world components with STEM creating coding and doing calculations. This could help integration of our standards and STEM. Also, we should cross curricular where there is a science fair class during the day. For example, science class where students are working on their projects as a class. In English classes, have students work on the writing components and research, so they can think like little scientist. Teaming approach for all classes. Working on the data tables and the calculations in science. In social studies, it could be studying the history behind the inventor and invention. Just working with all the subject areas to complete the STEM challenges.

Bess's perception on STEM strategies indicated students need to collectively work on projects in all STEM classes.

Equipment and technology. Gayle asked, "What key components of a STEM school do you wish were in place at your school?" Gayle agreed with the other participants about engaging students and developing student interest as key components. She added, "Teaching students how to be creative innovative thinkers will help them engage in math. I believe that allowing students to mess up and ask questions will increase their love for math." The researcher did observe the use of hands on activities and creative projects in the teacher's classroom. The activity included building a roller coaster as a project and calculating the speed of the cart. Likewise, Lisa agreed engaging students in activities based on the interest is significant for the implementation of effective STEM education. Lisa shared her ideas regarding the use of technology to explore interests:

> Integrating technology within each lesson is a must. It will give students to address the problem while embracing tools that they frequently use…students are on devices all the time. Also, we can students a chance to problem solve and use the internet to explore options. We need to give them more giving opportunities to do problem solving skills, but then also to reflect on it to analyze what they did and to create a component. Once again, student should get numerous opportunities and options of presenting it in a way that's interesting to them so engaging lessons aligning with student interests but also while incorporating technology.

The participants comments are aligned with the importance of students building 21st century skills while using technology for STEM Challenges. Also, the process is a way to solicit student engagement and interest. August noted:

> Relevancy is important for student interest. Teachers must make lessons relevant for students. I feel we could have of all the best greatest most expensive equipment and technology in the world has to offer but having staff that have the passion and interest and love for their subject will trickled down to students. This will motivate students.

Felecia felt students need to be assessed early on to ensure their learning style. She revealed, "I like to collect information on my students at the beginning of the school year by using a color assessment personality test. It tells me what kind of thinkers my students are-critical thinkers and so on. Then, I can design lessons." Felecia and August understood the use of technology as an effective strategy for assessing students' interest in STEM education.

Self-monitoring and reflection. All STEM educators credited self-monitoring and reflection as key components for implementing STEM education. In fact, the participants mentioned this is a component of the Engineering Design Process or Project-Based Learning. August mentioned, "Self-monitoring ensures that our students have better cognitive understanding of the objectives." Likewise, Bess pointed out, "Students after each project reflect in their journals regarding what they have learned. Also, these students write questions regarding their reflections." Similarly, Felecia stated, "Allowing students to reflect about their recent projects as they prepare for the upcoming challenges." Equally, Gayle gave explicit details on how she ensures self-monitoring and reflection daily in her STEM classroom:

> At the beginning of my classroom, I start off with a question. I always ask my students what they want to learn. Also, I ask my students what the objectives means to them in their own words. After the end of the lessons, I always ask my students about reflecting if they have met their learning objectives. This ensures that they reflect every day on what they should have learned and what they have learned in their STEM classroom.

The findings regarding teaching STEM strategies are teachers' perceptions of interest and engagement, equipment and technology, and self-monitoring/reflection as essential components to implement effective STEM education. The data revealed 100% (n = 14) concluded when students are interested and engaged in their STEM challenges, they are more likely to be successful in STEM courses. Some participants believed the use of technology can spark interest in STEM. On the other hand, one participant believed connecting relevancy to the STEM activity can spark interest among students. Finally, all participants agreed self-monitoring and reflection were equally important for implementing in effective STEM education in a Title I school district.

Research Question Three

Research question three, *How do teachers' perceptions affect equity in STEM education?* was answered using a qualitative inductive coding process. The data was closely examined to identify common ideas, topics, and patterns among the responses of the participants. Fourteen participants responded to this question and other related interview questions. The inductive coding analysis revealed four distinct themes or categories of responses concerning teachers' perception and its effect on the implementation of STEM education: (a) defining equity, (b) access to STEM, (c) empathy towards students, and (d) equitable learning environment.

Defining Equity

When examining teachers' perceptions of equity on STEM education, there was a focus on understanding how the participants define equity and the personal definitions needed to be uncovered to foster the understanding. In this study, equity was defined as leveling the opportunities while providing the necessary and individualized tools for all students; however, 50.0% (n = 7) of the participants defined equity as leveling the playing field. "When asked, how do you define equity?" Theresa responded equity means providing a level playing field for all students to participate in their learning while helping them to get what they need to succeed. Likewise, Sally stated,

> Equity is leveling the playing field to make sure all students regardless of their gender, race, socioeconomic status has an equal opportunity to learn. These students should all have access to the same materials and resources which is not always the case.

“When John was asked, how do you define equity?” John proclaimed, “Equity is giving each individual student what he or she needs to be successful. However, equity does not equate to equality.” John acknowledged, “Most people intertwined equity and equality which means that everyone gets the same thing.” The participant added most people have a misconception about equity when they think it means everybody gets the same opportunities.

Fifty percent (n=7) of the participants defined equity as access to the program of study. Lisa was asked, “How do you define equity?” she stated, “You know that you have equity when every student has the same access to the learning. All students have equal access to education and everything that comes along with the process.” Similarly, other participants defined equity as access. Heather stated, “Equity in the education arena is defined as providing all students equal opportunities for learning.” Likewise, Gray defined equity as, “Having the same opportunity as the person next to me. It is not something that is based on judgement or opinion.” In contrast, Paul stated, “Equity is given whomever; whatever they need in order to be successful. Equity is making sure that all students have equal access to an education.” Overall all 100% (n=14) participants defined equity as an indicator of a high-quality instruction or school. Moreover, STEM instruction and education should be offered for all students. Additionally, teachers perceived access to STEM education as a positive for implementation of STEM education.

Title I school district. Defining equity in a Title I school district is based on experiences. The participants all agreed the perception of educators working in a Title I school district regarding equity is different than non-Title I school district employees. John stated, “I have worked in a Title I district my entire career, so it is clear to me the definition of equity. I think my experiences have equipped with the definition.” Likewise, Lisa stated, “I have seen children go without basic needs in this district, so equity is access to what you need.” Similarly, Sally has worked in both low socioeconomic and affluent districts. She explained the differences:

> Working in a Title I school district , you will have a firsthand account of the inadequacies and the lack of materials. You will see students coming to school without clean clothes or food. On the other hand, I have worked in affluent school where the students talk about their plans to go to Europe for a summer vacation. These major differences affect how you see equity.

Prior knowledge and experiences are linked to how the teachers define equity in the district. Some teachers defined equity as leveling the playing field; while others defined it as access to STEM education. Nevertheless, the teachers’ definition of equity is because they are working at a Title I school district. Working in low socioeconomic school districts allows the teachers to have a firsthand account or perspective on equity.

Access to STEM Education

Bess, Heather, and Lisa perceived all students must have equal access to ensure a quality STEM education is established in their schools. When Bess was asked, “How does teachers’ perceptions affect equity in STEM education?” Bess stated:

> I think that you must look at what the student needs are individually. This means that equal does not mean the same for everyone. In my classroom, I design activities that are open-ended and lends to more than one point of view. Lessons are designed based on students’ interest.

As evidenced by Bess’s response, providing students a choice will lend itself to promoting engagement and interests in STEM education. This will provide access to STEM education. Heather proclaimed teachers’ perceptions affect equity in STEM education. She stated:

> I believe that equity is allowing access to STEM education for all students. Since this is my belief, at my campus all students participate in STEM activities, and nobody is excluded. I believe that all students deserve access and it is not just for the smart kids. Some teachers believe that only the GT students should participate in STEM activities. This is not equal access. I try to make sure there is a variety of activities such as monthly STEM career awareness. This is an ongoing activity on campus. We're not just talking about technology career. We're talking about engineering careers. I introduced careers other than fields only associated with mathematics. My belief is that some students are not good with numbers, but like taking computers apart. This will give them access to a variety of opportunities. My students are so young that this early exposure will help them realized their talents and skills at an early age. I make sure that everyone is involved and that our activities are varied. I am more intentional in my planning processes to ensure our activities are for all genders and learning styles.

The participant believes access for all is essential, despite learning styles, and gender identification of students. Also, the participant believes barriers such as students' performance should be eliminated.

Heather and Lisa believed their personal perceptions toward STEM education affected equity in STEM education. Lisa believed a true STEM education integration is giving each student what he or she needs at their level. She shared her thoughts regrading equity in STEM education:

> The best way in my opinion to ensure equity is to know what the outcome is for each student. I don't force my personal beliefs and goals on my students. I know what the outcome is supposed to be, and I allow all my students to discover their individualized outcomes while ensuring equity. My personal belief on the best

> way to ensure equity in STEM education is to give them access to all materials and resources while allowing them to discover their individual talents.

Bess, Heather, and Lisa equally believed access is key for equity in STEM education. Additionally, the teachers believed an optimistic outlook on implementing STEM education can have a greater positive impact on achievement. Moreover, Heather pointed out early exposure to STEM education is the gateway to a successful STEM education in K-12 programs. Another point made by Heather was STEM education is not just for students labeled as gifted and talented. In other words, the teacher believed STEM education is for all students; therefore, she provides equal access.

Pathways for all STEM students. Some participants mentioned the pathways for all STEM students as needed to be identified in order to ensure an equitable STEM education for all students. Tonya states, “Cultural understanding and sensitivity need to be considered when implementing STEM education.” Moreover, the participant communicated access is not equal for all students. Gayle noted, “I know some students have never had intimate conversation with key people in STEM such as doctors and engineers. We have careers days and various presentation to expose students to these individuals.” Alternatively, one participant mentioned creating pathways through individual mentorship is key for equity in STEM education. Paul stated:

> The biggest thing providing the greatest gain in STEM education is when we started the mentorship program for students to create pathways for all STEM students. All students received individual coaching and mentoring to create their pathways according to their STEM interests. Student create pathways into fields such as health sciences, computer science, and engineering. These are individual plans based on interest and desires. All students have access to this opportunity.

Congruently, creating an access to pathways in STEM education is key regarding equity in STEM education. The participants believed to ensure students are successful in STEM education, all students need access to resources and materials based on their interests. Additionally, when low socioeconomics students are provided pathways to STEM, they are more likely to have equitable opportunities to enter STEM fields just as students at school districts which are not Title I**.**

Empathy Towards Students

Gayle, an experienced African-American mathematics teacher, has taught for more than 10 years, expressed empathy towards her students as she implements STEM education in her classroom. She believed all students will perform when giving the right tools and when they are in an environment providing motivation and coaching techniques. Both Tanya and Heather agreed, “ providing motivational and coaching techniques would demonstrate empathy and compassion while students are working on new STEM challenges.” The following results share Gayle’s perceptions, attitudes, and beliefs regarding equity in STEM education:

> Teachers need to understand “why” we're teaching to have empathy towards students that may struggle with the implementation of STEM education. STEM can be considered rigorous and something that goes beyond students’ daily curriculum. It's not a one size fits all. We must ensure that are classrooms are equitable for everyone that means African Americans, girls, boys, and Hispanic students. I integrate STEM everywhere it can be integrated. On Fridays, I do STEM based project, games, hand-on building activities. Also, I expose the kids to things that they wouldn’t normally see because some of my students come from challenging backgrounds. Also, I bring in games because this a generation that requires a fast pace and gaming channels that experience.

Gayle felt successful teachers should be aware of the background of their students. Also, these teachers should model kindness and have positive outlook when implementing something new such as STEM education. Gayle stated,

> I recently created a wall for new ideas for my students. All students can give feedback to their classmate's new idea; nevertheless, the feedback must be positive. This is how we are taking risk to implement our STEM initiatives and new ideas.

Gayle's wall for new ideas for her students showed the teacher believes in an open communication system for STEM ideas. This is intended to provide access for all students in STEM education.

Paul's belief system hinged on empathy and compassion. He believed he has duty to implement curriculum to enhance STEM education. His goal is closing the achievement gap for students in Title I school district. He felt schools in the inner city don't have enough resources on its campus. Paul passionately stated, "When I plan my lesson, I have my students in mind when I think about my results. I always create my lessons from my students' perspectives." Paul conceptualized the importance of having empathy as he implements daily activities and instructional strategies. Paul shared his beliefs, "I sometime survey my students when I implement my STEM challenges regarding their previous knowledge on the concept or idea. I can't take for granted considering their backgrounds, that all students have prior knowledge on a particular challenge."

Paul's comments provided insight on his perception regarding the importance of empathy and compassion for students as they encounter STEM education in their curriculum.

Sandra conveyed her belief about having empathy regarding students with special needs and from different economic backgrounds in STEM education:

> I have a diverse group of students with different backgrounds. Some of my students are from wealthy and underprivileged families that go without basic needs. When you think of these two groups, their needs are totally different. My wealthier families may have private tutors at home, and time to dedicate extra time from homework and STEM challenges. Also, these students might have their own personal computer and space at home to concentrate on their work. But my low-income students are the ones with deeply rooted needs. I sympathize with the needs of these students. I understand that I may need to provide time at school to complete projects, so they may have all the adequate supplies. Recently, I signed up with some organizations including Girls Who Code to give my students more exposure. This include students with learning disabilities. It's my responsibilities to know the struggles and other hardships at home, learning disabilities or the other things that distract them from succeeding. Providing equity is just kind of leveling the playing field for these groups.

Sandra pointed out leveling the playing field includes having background knowledge on students' learning disabilities; furthermore, it includes knowing students access regarding available resources at home and exposure to clubs.

Cultural inclusion. The participant shared STEM education must be inclusive to all students in order to ensure equity in STEM education. August explained, "We have developed inclusive curricula and promote cultural representation at our STEM academy and hiring staff." August loved the idea of STEM and international festivals to promote cultural inclusion. Another participant revealed, "We must recruit staff that represent the global STEM community." Felecia pointed out, "We are responsible for ensuring that we have a diverse staff that represent STEM fields. It shouldn't just be male math teachers and female reading teachers. This is not equal representation." Conversely, one participant mentioned she believes the one campus violates cultural inclusion. John stated:

> We have a campus that is taking application and assessment to determine entrance to the school. Is this equity and access for all? Also, there is a certain demographic that attends the school more than others. This demographic has historically performed well in mathematics. I just feel like this is not access for all students. This is not an inclusive environment. The school is great, but the demographics need to be diversified, so that all have equal access to this opportunity.

Empathy towards students and cultural inclusions are equally important according to the participants regarding a pursuit to equity in STEM education. All students regardless of their race and socioeconomic status deserve access to STEM education. In fact, the participants shared providing an inclusive environment for STEM is an important factor. Finally, one participant pointed out all campuses should have guidelines focused on not eliminating students from STEM programs.

Equitable Learning Environment

In order to have an equitable learning environment, funding needs to be equally distributed among districts, classrooms, and schools**.** Given 100% (n=100) of the participants felt access was a key factor for equity in STEM education, all participants thought it was justifiable for classrooms to have adequate resources. Being an experienced STEM teacher of fifteen years, Sally had an opportunity to observe other STEM classrooms in the district. During her observation, she noticed all STEM materials weren’t distributed equally among STEM classrooms. As a teacher, she felt she could see inadequacies among the learning environment. Sally’s perception regarding all STEM classrooms was stated:

I really think just providing resources is not just enough. As a district, we need to evaluate through observations and reflections to ensure equity among STEM classrooms. Shouldn’t all campuses have tables set up for collaboration and consumable items for STEM challenges? On the other hand, in some classrooms, the teachers had nothing in the STEM storage bins and lacked materials in order to address the Robotics TEKS. I think we need to start there by making sure that everybody has access to the same materials and resources because that's not the case for all. An equitable learning environment is essential for implementation of STEM education.

Similarly, both Lisa and Sandra perceptions on an equitable learning environment were aligned with Sally’s observation. Lisa pointed out, “access to iPads were a must in her classroom. This doesn’t mean just ensuring all students have a one to one device but the devices need to be fully charged and exposed to an environment that promotes a culture of integration of technology.” She, also, conveyed her belief about all the different approaches and resources for a STEM learning environment. Lisa stated:

A STEM classroom must have apps and give students the knowledge on different platforms that promotes 21st century skills. l encourages all students to break through any barriers that they may have if they need more than others. Also, I have an inclusive classroom, I'm always walking around and making sure everybody can do the activities and provide any extra help if needed.

Both Sandra and Lisa believed it is the responsibility of the teachers to create an inclusive learning environment. She stated, “The learning environment must be properly funded to sustain current trends and promote 21st century skills.”

Promote awareness. Forty percent of the STEM educators think promoting awareness in STEM is crucial for equity in STEM education. Lisa mentioned, “We have to meet students where they are to give them exposure to the opportunities STEM careers can offer." Another echoed the following comments:

> Teachers and students would benefit from activities and program that promote awareness in STEM. My principal recently posted careers in STEM along with their salaries in student social areas in the building. Most of the STEM careers are new to students.

Another participant discussed the training he attended from a well-known STEM advocate. Paul mentioned:

> Before the holiday break, we attended a training by Cindy Ross. She provided statistics and opportunities in STEM that I had never heard before the training. This training was an eye-opening workshop that was geared to promote awareness and get the leadership team motivated to implement STEM education.

Most of the participants (90%) believed community involvement, including the distribution of newsletters, social media posts, and other communication tool were great means to promote awareness in STEM education. Sally stated, "The best way to promote awareness in STEM is to get an interaction between the teachers, students, and the community."

All participants agreed an equitable learning environment is key for equity in STEM education. However, some participants agreed resources will promote equity in their STEM environment. In contrast, some of the participants felt addressing 21st century skills were a way to level the playing field. Finally, most participants felt community involvement will promote STEM awareness and the implementation of STEM education for all students.

Summary of Findings

The findings are based on perceptions regarding effective implementation of a STEM education; key components influencing effective implementation of STEM education; and the effects of equity in STEM education within a Title I school district. The purpose of this qualitative study was to examine how teacher perceptions influence the implementation of STEM education in a Title I school district through utilizing a case study methodology.

Considering teachers' perceptions regarding effective implementation of STEM education on a Title I school district, 100% (n=14) of the teachers mentioned early exposure to STEM would have a great impact on student achievement across the district. Additionally, the data revealed the exposure should be detailed with specific structures including the implementation of the EDP. The EDP was a common theme which emerged from the teachers' perceptions concerning the implementation of STEM. Regarding the EDP, 95.2% (n = 13) of the participants agreed the EDP was essential for effective implementation of STEM education. Early STEM career exposure was another theme which emerged as a factor ensuring effective implementation of STEM education. It is important to mention 28.5% (n = 4) of the teachers believed early career exposure would establish a growth mindset among the students. On the other hand, 90.0% (n = 13) of the teachers agreed the integration of technology was critical for the implementation of effective STEM education. Additionally, 78.5 % (n = 11) of the teachers addressed 21st century skills as way to build STEM identities along with college and career talents. Nevertheless, 50.0% (n = 7) believed support from STEM specialists and administrators motivates STEM educators to provide engaging lessons for all students. Other topics which emerged from the study included: STEM equipment and resources; and the use of support staff as factors to implement a successful STEM education.

When examining key components influencing effective implementation of STEM education, five emerging themes developed. These themes are: maintaining STEM identity, creating STEM pathways, developing highly qualified teachers, providing professional development, creating vertical and horizontal pathways, and managing time. The researcher concluded 75.8% (n = 11) of the participants agreed a key component for the implementation of STEM is when teachers foster and maintain a STEM identity. The participants provided ways for teachers to maintain identification by allowing students opportunities to select pathways for STEM in fields, such as gaming and cybersecurity.

All participants agreed developing highly qualified teachers through modeling STEM lessons and providing STEM related professional developments were key components regarding the implementation of STEM education. On the other hand, 21.4% (n = 3) of the participants commented vertical and horizontal planning opportunities were key for the implementation of STEM education. Nevertheless, 57.1% (n = 8) felt internship opportunities and summer programs would be greatly beneficial for STEM academic growth among educators. This would provide educators ample amount of opportunities to directly work with STEM industry officials. Regarding the STEM standards and competencies, 85.7% (n = 12), were not familiar with the standards. Contrarily, 14.3% of the participants were familiar with the STEM standards and believed them to be beneficial for providing guidance in STEM. Nevertheless, all participants thought self-monitoring and reflections are key components for implementing STEM education. Also, it is important to mention participants unanimously agreed time to engage in STEM resources and solicit student interest was an essential component for the implementation of STEM education.

There was importance for the researcher to understand how the participants defined equity prior to answering the research question. Fifty percent of the participants (n=7) defined equity as leveling the playing field. One participant perceived equity as "Allowing everyone to get what they need, but not the same thing." On the other hand, 50.0% (n=7) of the participants defined equity as having equal access to the curriculum and learning. Nevertheless, 100% (n=14) of the participants agreed equity as indicator of a high-quality STEM education. However, 100% (n=14) of the participants mentioned defining equity from the lens of Title I educator is biased because of the real-life work experiences in low-socioeconomic work environments.

When teachers were asked, "How do teachers' perceptions affect equity in STEM education?" four broad themes emerged from the study. First, teachers believed access is equity, so students must have essential resources in the STEM classrooms. One participant believed equity is "Allowing access to STEM education for all students. Since this is my belief, at my campus all students participate in STEM activities, and nobody is excluded." The second theme which emerged was 50.0% (n = 7) of the teachers believed empathy towards students can affect the implementation of STEM education. On participant stated, "I survey my students prior to implementing STEM challenges, so I can understand their backgrounds." The fourth theme which was developed from the participants' responses centered around the notion of creating an equitable learning environment. Since 100% of the participants felt access was a key factor for equity in STEM education, all thought it was justifiable for classrooms to have adequate resources. Some participants believed mentorship programs and exposure to career pathways increased opportunities for all students in STEM education. Finally, the researcher triangulated three participants theories regarding access to the STEM. Bess, Heather, and Lisa equally believed access is key for equity in STEM education.

Conclusion

This chapter presented a qualitative analysis of teachers' perception regarding the implementation of STEM education in a Title I school district. Overall, all teacher believed their perceptions affect the strategies, resources, and access of STEM education. Chapter V will include a discussion of the findings detailed in this chapter in comparison to the findings listed in Chapter II, along with the implication of the findings concluded for this study and recommendations for future research studies

CHAPTER V:

SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS

Students in the United States (U.S.) are ranking below their counterparts in mathematics and science (Craig & Marshall, 2018). Moreover, the current population of low socioeconomic K-12 graduates are not choosing STEM fields (Rozek, 2019). Although many studies have been conducted to understand the impact of STEM education regarding student achievement (Jungert et al., 2020; Margot et al., 2019; and Matsuura et al., 2021), there is much less research on perceptions as a factor contributing to successful STEM education in a Title I school district. To examine how teacher perceptions and beliefs influenced the implementation of STEM education in a Title I school district school, a qualitive case study was implemented. This study investigated interview transcripts for 14 STEM educators. This chapter presents a detailed discussion of the summary of the findings, implications and recommendations for future research, and conclusion.

Summary

The belief and experience of STEM educators in a Title I school regarding the implementation of STEM education is influenced by the level of support he or she receives from a trained support staff or specialist. These beliefs were determined based on the patterns of responses of STEM educators, which enforced this study's theoretical framework of Grounded Theory (Glaser et al., 2017). The findings of the case study concluded perceptions matter regarding the implementation of STEM education in a Title I school district. This is, also, congruent with findings and conclusions from several researchers who identified many perceptions regarding the key components, definition, and history of STEM (Lyons, 2020; Muller & Collier, 1995; Holmlund et al.; English, 2017).

Consistently, the review of the literature showed teacher perceptions regarding the implementation of STEM education are affected by the level of assistance from STEM support staff (Margot et al., 2019). Similarly, Bell et al., (2017) indicated teacher's knowledge and perceptions of STEM are related to their method of instruction within their practices and level of support. In agreement, overall findings from another researcher indicated teachers perceived themselves as inadequate to integrate STEM into their curriculum; however, their potential for integration increased with the support from trained staff (Firat, 2020). This premise is compatible with findings from this research study where 100% (n=14) of the teachers agreed support staff such as the STEM, technology, or content specialists are essential for implementing STEM education. In parallel, participants mentioned STEM specialists and other district support personnel influence the implementation of STEM education by modeling and providing STEM integration strategies.

Additionally, 100% (n=14) of the STEM educators indicated consultation and sessions which included planning and modeling provided the skills for teachers to implement STEM education. This is parallel to the literature which concluded teachers who adapted to their environment and obtained resources from local experts, such as engineers, scientists and STEM support educators, were successful and resilient (Wright et al. 2019). The research identified teachers were able to integrate STEM through the different subject areas of the schools when they participated in planning sessions. In support of this findings, all the STEM educators in this research study agreed perception played a role in the implementation of STEM education.

Several common themes emerged from the teacher perceptions concerning the key components influencing an effective implementation of a STEM education in a Title I school district. The research revealed the following themes regarding key components and implementation of STEM education: obtaining highly qualified STEM teachers, providing STEM related professional development, and implementing effective STEM tools and resources. When analyzing teachers' perceptions regarding key components of STEM education, 100% (n=14) of the teachers agreed developing highly qualified STEM teachers played an important role in the influence of STEM education implementation. Congruently, these themes are aligned with studies and literature which concluded professional development is a key component (Avery et al., 2010). In general, all participants (n=14) agreed ongoing interaction and professional development throughout the school year will help to develop STEM strategies for all stakeholders and influence effective implementation of STEM education in a Title I school district.

All STEM educators who were interviewed felt project-based learning to be a professional development opportunity which provides explicit strategies regarding their students' connections among disciplines. This study indicated 21.4 % (n=3) of the participants selected vertical and horizontal planning and project-based learning as highly qualified professional developments needed for implementing STEM education. The interview responses affirmed the literature regarding the usefulness as project-based learning as a key component in STEM education (Meritt et al., 2019). Additionally, the literature revealed students' district test scores, student engagement, and autonomy increased when students experienced the project-based learning model or the Engineering Design Process (Kubat & Guray, 2018). This research is aligned to the views on some of the participants the Engineering Design Process provides students the opportunity to share their exploration ideas and projects with others. One participant believed students should have a choice on their assignments because this promotes ownership in STEM projects. In summation, the study concluded project-based learning is geared towards giving students choice and voice, which is key for the implementation of STEM education.

Interview data indicated STEM educators believed teachers' perceptions have an effect on equity in STEM education. The data examined common ideas, topics, and patterns among the responses of the participant. In this study, equity was defined as leveling the opportunities while providing the necessary and individualized tools for all students. In fact, 50% (N=7) of the participant defines equity as leveling the playing field. Based on the qualitative findings, the STEM educators believed through their students; regardless of their race or gender, as being capable of succeeding within the STEM education realm. This suggested the teachers will distinguish strategies soliciting and encouraging all students in STEM education. One explanation of this theory is identified in the literature review as indicated by two theoretical frameworks to distinguish strategies intended to increase representation of students of color in STEM (Corneille et al., 2020). These approaches allowed the researchers to understand biases, polices, and practices which may contribute to inadequacies among students of color in STEM. However, 50% (n=14) of the participants defined equity as access to learning. This is consistent with the findings from Kahili and Kier (2021) where historical marginalized students, ethos, and strategies necessary to increase equity presented a case which analyzed how leaders used design thinking to ensure equal access.

Overall all 100% (n=14) participants defined equity as an indicator of a high-quality instruction or school. Moreover, STEM instruction and education should be offered for all students. Additionally, teachers perceived access to STEM education as a positive for implementation of STEM education. Congruently, the STEM educators' theory illuminated in order to improve STEM education in the classroom, a viable STEM curriculum should be accessible for all students regardless of the economic disparities between the various schools (English, 2017). One educator discussed the best way to ensure equity in STEM education is to give them access to all materials and resources while allowing them to discover their individual talents. There is strong evidence on how certain pathways leads to redefining how individuals access and think about diversity, equity, and inclusion in STEM education. Weisssmann et al. (2019) pointed out a shift in academic approaches and way of thinking is needed to advance underrepresented minorities. In summation, the study concluded teachers' perceptions greatly affect equity in STEM education.

Implications

Based on the summary of the findings discussed in the previous section, implications are warranted. The study concluded teacher perceptions and beliefs influenced the implementation of STEM education. Using the Grounded Theory Method, the research highlighted the lived experiences of STEM educators in their Title I school district. In doing so, this is pointed toward implications for potential implicit biases regarding normally underrepresented marginalized students in STEM education. Implicit bias is documented as one of the reasons for discrimination and injustice, despite most people explicitly believing in the importance of equality and justice for all people (Gullo et al., 2018). The participants prior to study could possibly already have a negative attitude toward low-socioeconomic students in STEM. As this study showed, teachers believed equity is allowing access to STEM education for all students. However, the implementation for STEM education for all students is debatable. Based on the results from the study, one may imply most students may not be receiving equitable STEM education.

Teachers may need professional development to implement STEM education for students who are undeserved in STEM education. Regarding teachers' beliefs on how their perceptions affect equity in STEM education, the district may want to consider including programs and trainings on culture sensitivity and promoting STEM awareness. Additionally, focus groups should be held to ensure ongoing conservations are maintained regarding how to close the opportunity gap in STEM for this group of students. The district should consider developing and implementing policies regarding pedagogical strategies for teaching in underprivileged STEM environment. These policies would provide clear expectation and vision for all stakeholders, while increasing the implementation of STEM education for all students.

The paradigm shifts of teachers learning and employing the Engineering Design Process or Project Based Learning has been an issue nationally (Owens & Hite, 2020). The implications of implementing these strategies are related to the lack of training and time management. Additionally, project-based learning is considered to be a non-traditional strategy (Chen & Yang, 2019). According to this study, 100% (n=14) of teachers stated training on the Engineering Design Process would make them better equipped to implement STEM education at their respective schools. The curriculum department should support this initiative by allocating planning time among the horizonal and vertical teams to implement these strategies. Additionally, the shift in thinking for the educators must be allowed to happen naturally among the educators. This will happen by modeling and providing successful classrooms follow the engineering and project-based learning models.

STEM educators and district leaders should consider school funding when discovering and executing ways to implement STEM education in a Title I school district. Under No Child Left Behind (NCLB), the federal government worked with states to develop requirements were linked to Title I funds (Borman, 1996). The goal was to focus on increasing academic results for undeserved communities and students. Nevertheless, these funds have historically been utilized to support human capital and other associated district costs. In order to ensure STEM for all, the local governing body need to allocate the appropriate funding source. Increasing funding for STEM programs, will increase the probability of STEM for all students. This includes funding for additional equipment and technological programs for STEM leaders, parents, and community members to increase STEM awareness for all stakeholders.

The federal government plays a strong role with providing funding for academic including in the area of STEM (NSCT, 2018). The study was conducted at a Title I campus which means there are additional funding sources allocated for addressing all students' needs. Title I, as modified by Every Student Succeeds Act (ESEA), allocates funds to school with high number of low socioeconomic families to ensure the academic playing field is leveled (Dhaliwal & Bruno, 2021). There is a formula these federal funds are calculated through which provides local education agency's grant funds. The grants are identified as: basic, concentration, targeted, and educational finance grants. Basically, the grants are based on the number of low-income families and the percent these students exceeded the total population of the school. A significant amount of the funds some be allocated directly to students' resources and materials. The district has allocated some funds for closing the STEM opportunity gap; however, additional funds are needed. Moreover, the amount of funds a district has allocated to STEM education or STEM programs may need to be increased.

Future Recommendations

Teacher perceptions can influence the implementation of STEM education in a Title I school district. Given only STEM educators participated in this student, future research should survey the perceptions of non-STEM teachers for a comparative analysis of theories. Additionally, future research could also conduct a longitudinal study on direct impact of the perceptions of non-STEM teachers and STEM teacher students' achievement on state assessments results. This type of research could provide more insight regarding the impact and effectiveness of career and college readiness programs on graduating high school students. Considering there could be potential biases regarding the district's label of Title I, additional research could be conducted on perception of STEM education from schools without Title I labels. Finally, data should be collected to study the specifics regarding the funding, capital resources, and human resources when employing a STEM education. This type of research could provide more insight regarding the resources needed for implementing a STEM education.

Conclusion

STEM is an interdisciplinary approach among the four disciplines: Science, Technology, Engineering, and Mathematics (Holmund et al., 2018). STEM jobs are projected to grow rapidly, so the issue is beyond the numbers. For example, between 2017 and 2029, the number of STEM jobs will grow eight percent, a higher rate than non-STEM jobs (Alan et al., 2019). Additionally, there is a growing number of students in certain economic and minority groups are falling below the standards of STEM. For example, the current population of low socioeconomic K-12 graduates are not choosing STEM fields (Rozek, 2019); therefore, there is importance in understanding how teacher perception influences STEM education in a Title I school district. Considering the major implication perceptions matter, this study could potentially provide a major contribution to closing the opportunity gap in STEM among all groups including students from low socioeconomic backgrounds.

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APPENDIX A:

INFORMED CONSENT

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: Perceptions Matter: Factors Contributing to A Successful STEM Education in a Title I School District
Student Investigator(s): LaKenya Perry
Faculty Sponsor: Dr. Antonio Corrales

PURPOSE OF THE STUDY
The purpose of this research is to examine how teacher perceptions influence the implementation of STEM education in a Title I school district.

PROCEDURES
Teachers were selected to participate in this study based on their experiences in areas of math, science, technology, and/or engineering. Interview data will be collected for this study to determine your perceptions regarding key factors in STEM education. This data will include your perception regarding equity in STEM education in your current district. Also, your instructional STEM labs will be observed regarding instructional resources and practices impacting key factors in STEM education.

EXPECTED DURATION
The total anticipated time commitment will be approximately 60 minutes per participants.

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 teacher perception in STEM Education in Title I school district.

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 Principal Investigator for a minimum of three years after completion of the study. After that time, the participant's documentation may be destroyed.

FINANCIAL COMPENSATION

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

INVESTIGATOR'S RIGHT TO WITHDRAW PARTICIPANT

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

CONTACT INFORMATION FOR QUESTIONS OR PROBLEMS

If you have additional questions during the course of this study about the research or any related problem, you may contact the Student Researcher, LaKenya Perry, by email at lperry-wilson@staffordmsd.org. The Faculty Sponsor, Dr. Antonio Corrales, may be contacted at phone number by email at acorrales@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 which 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 B:

INTERVIEW GUIDE

Participants will be provided the interview protocol and questions prior to participating in the interviews. Consent forms will be completed at the teacher interview and collected by the researcher. The interviews will be audio recorded and the participants will state their name and last four digits of their phone number during the introduction. Prior to answering a question, participants will state their name. Participating in this study is completely voluntary and will provide invaluable data to the researcher.

1. What is your name and last four digits of your phone number?
2. What does the acronym STEM stand for?
3. What is STEM education?
4. What is your role in STEM education?
5. As a teacher/educator, how do you build STEM literacy?
6. How do you boost interest and engagement in STEM education with your students?
7. What are key components you feel makes your STEM school or department successful? Please elaborate.
8. What key components of a STEM school do you wish were in place at your school?
9. What are types of STEM education professional development training you have received?
10. What was the specific focus for the professional development you attended on

STEM education? Please be as descriptive as possible.

Nature of integration

11. How do your students engage in the engineering design process to study core content through a variety of challenges?

Implementation

12. How does the STEM specialist help integrate STEM into classrooms and the engineering lab? Are activities modeled in the classroom?

13. How are teachers provided with "proven units" for STEM education during professional development sessions?

14. Do all teachers participate in developing research questions for design challenges? What are the norms for that process?

15. What professional development/planning helps teachers identify and make explicit decisions regarding their students' connections among disciplines?

16. How would providing teachers more time to plan impact students' ability to make connections within STEM content areas and STEM integrated projects?

Outcomes

17. How is STEM integration made explicit at your school/grade level? (student supports, technology, software, etc.)

18. How is the students' knowledge in individual disciplines supported and STEM connections made within individual disciplines?

19. How do you feel your professional practice has developed as a result of teaching/faculty at a school with STEM integration?

20. How do you think early implementation of STEM education will impact your students as compared to other students in a traditional school environment?

21. How do students develop their STEM identity at your school?

22. What is equity?

23. How do you ensure equity in STEM education for all students?

24. Is there anything else that you would like to add to the interview?