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ARE ELEMENTARY TEACHERS PREPARED TO TEACH A STEM FOCUSED CURRICULUM: A NEEDS ASSESSMENT OF AN INNER-CITY ELEMENTARY SCHOOL

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A NEEDS ASSESSMENT OF AN INNER-CITY ELEMENTARY SCHOOL: ARE ELEMENTARY TEACHERS PREPARED TO TEACH A STEM FOCUSED CURRICULUM?

A Thesis By:

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ABSTRACT

Are Elementary Teachers Prepared to Teach A STEM Focused Curriculum: A Needs Assessment of An Inner-City Elementary School

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Public school districts across the United States adhere to state standards outlining fundamental knowledge and skills necessary for students' success in core subjects. In Texas, significant changes are underway as science standards are being revamped, set to be implemented in 2024. These updated standards closely align with the Next Generation Science Standards (NGSS), focusing not only on content but also on science and engineering practices and recurring themes within the subject. This shift necessitates teachers to integrate Science, Technology, Engineering, and Mathematics (STEM) content and practices in their classrooms. To gauge the necessary support for these upcoming standards, a quantitative approach was adopted. The T-STEM survey was administered, evaluating educators' perceptions, beliefs, and efficacy regarding STEM education in inner-city schools in Texas. The needs assessment uncovered opportunity for professional development particularly in the areas of science and STEM practices with technology being the leading practice.

DEDICATION

To my heavenly father, my spirit finds its unwavering strength and boundless inspiration. You are the cornerstone of my success, the silent force that has shaped my journey into the accomplished woman I am today. With deep reverence, I dedicate this study to my cherished husband, whose unwavering support has been my rock through every trial and triumph. His presence has turned late nights into moments of solace, transformed tears into pearls of resilience, and replaced worries with unwavering faith. His relentless encouragement has propelled me further in my career and education, bringing me closer to the fulfillment of my life's dreams.

Additionally, this endeavor is a tribute to my beloved parents, Irene Massey and Jeffery Sr. Massey. From the early years of my life, they engraved in my heart the profound values of hard work and the transformative power of a good education. Their wisdom has been my guiding star, illuminating the path toward boundless possibilities. To my dear brother, I extend my heartfelt hopes that my achievements bring pride to your heart.

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CHAPTER ONE: OVERVIEW OF RESEARCH

Introduction

In the United States every state has a set of adopted academic standards. State standards in education ensure consistency and accountability by setting common expectations for what students should learn at each grade level. These standards are usually revised every seven to ten years. Standards help promote equity by ensuring all students have access to a quality education, regardless of location, and serve as a framework for curriculum development and assessment. Each grade level has a different set of standards that vertically build upon each other in a particular discipline. The public-school system is required to use these academic standards that have been adopted by their states. This requires curriculum leaders to take these standards and create or adopt a curriculum to support grade level teachers to meet these standards by the end of the school year. Curriculum leaders will then support grade level teachers by providing professional development on the curriculum they may use to target standard based instruction, dependent upon the grade level.

Evolution of Science Standards

In the 1980's, a group of chemists, biologists, educators, and technologists developed an innovative science curriculum that identified what would be important for the next generations of students to know in order to be considered scientifically literate (American Association for the Advancement of Science (AAAS), 1989). During this same timeframe several government agencies and education reform groups promoted a more universal structure being applied to science education in American schools. These groups produced several publications on the topic, which include: *A Nation at Risk* (1983), "a government publication which called for reconsideration and reform of the U.S. education system" (National

Commission on Excellence in Education, p.14), and the American Association for the Advancement of Science (AAAS) reform group, called *Project 2061*, published *Science for All Americans* (Rutherford, 1990) which has since become a major influence on science education policy. This focus on science education policy would eventually lead to the development of the first national science education standards in 1996. The *National Science Education Standards* (1996) were written in response to the nationally recognized need for goals and standards that could improve the quality of science education for all students (National Academies of Sciences, Engineering, and Medicine, 1997). Today, an updated version of science education literature including the National Research Council's *A Framework for K-12 Science Education* (2012) and *Next Generation Science Standards* (2013) supports policy makers to guide the way for what it means to teach and learn science.

Science Education and STEM

In 1983, the Reagan administration called for a report to determine how the United States compared with other leading nations with respect to educational success. As a result, *A Nation at Risk* was published by The National Commission on Excellence in Education (1983) which suggested America's educational system was failing to educate students well, particularly in the areas of math and science. Among other things, it recommended that schools become more rigorous, that they adopt new standards, and that teacher preparation and pay scales should be evaluated. *A Nation at Risk* was the first time that the fate of the US economy, and the skills of the US workforce, were extensively placed on the shoulders of K-12 education. The report suggested that it was the effective role of the K-12 system to create citizens who were proficient in math, reading, and science at the level needed to immediately enter into the workforce upon graduation from high school. The AAAS released the first set of science standards (1996) in response to *A Nation at Risk*, which would support students in building their science literacy.

In 2006, the Bush administration called for another administrative evaluation of the performance of the K-12 education system in the areas of concern outlined in *A Nation at Risk*. The resulting publication, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* (2007), indicated that our economy and skill of the labor force had continued to decline in the face of other nations and once again the areas of concern were in the areas of STEM. This report included recommendations to create high-quality jobs and focus new science and technology efforts on meeting the nation's needs. As a result of these findings, science standards are now continuously revised about every ten years with the intent of preparing our students to enter the global economy with the knowledge and skills needed to fill the new STEM related jobs that would drive our prosperity.

In 2012, *A Framework for K-12 Science Education* was written by scientists, engineers, medical professionals, and educators to address the critical issues of U.S. competitiveness and to better prepare the workforce of the future. *A Framework for K-12 Science Education* (2012) proposed a new approach to K-12 science education that would simultaneously capture students' interest while providing them with the necessary foundational knowledge in the much needed fields of science and engineering. This framework established the design components for the next set of science standards, which would be called the *Next Generation Science Standards* also known as NGSS (2013). The NGSS created an interdisciplinary approach to science standards incorporating engineering practices and technology applications into science curriculum (Bybee, 2014).

2021 Texas Science TEKS

Texas' newly adopted science standards (2021) were created using the National Research Council's *A Framework for K-12 Science Education* (2012) to align Science Texas Essential Knowledge and Skills (TEKS) with the NGSS (2013). According to the National Research Council (2012):

> The overarching goal of the framework for K-12 science education is to ensure that by the end of 12th grade, all students have some appreciation of the beauty and wonder of science; possess sufficient knowledge of science and engineering to engage in public discussions on related issues; are careful consumers of scientific and technological information related to their everyday lives; are able to continue to learn about science outside school; and have the skills to enter careers of their choice, including (but not limited to) careers in science, engineering, and technology creating the Science and engineering practices are now a part of these standards which may require teachers to be familiar with STEM practices and STEM careers. (p.1)

As it was with the NGSS, implementing the new science TEKS will require Texas teachers to incorporate a three-dimensional learning experience as outlined in *A Framework for K-12 Science Education*. The three-dimensional learning experience includes Science and Engineering Practices, Crosscutting Concepts, and Disciplinary Core Ideas (National Research Council (NRC), 2012). However, Texas labels their "three-dimensional learning" as Science and Engineering Practices (SEPs), Recurring Themes and Concepts (RTCs), and Disciplinary Core Concepts (DCCs). School districts will need to adopt a concept-based curriculum to support grade level teachers with these new practices and teachers will require professional development in how to successfully deploy these new components within their classrooms.

When properly implemented, the three-dimensional framework will actively engage students in scientific and engineering practices in order to deepen their understanding of crosscutting concepts and disciplinary core ideas (NRC, 2012).

Purpose of the Study

Early Childhood through sixth grade generalist teachers enter the elementary world under prepared in science concepts and literacy (Fauth et al., 2019). Teacher education programs are rather general which makes science literacy particularly challenging for elementary school teachers to build up knowledge on how to teach science as well as to actually understand science phenomena (Fauth et al., 2019). Texas, using *A Framework for K-12 Science Education* as a guide to write the new Science TEKS brings three-dimensional learning to the forefront in classrooms, which will not only require elementary teachers to have a robust science knowledge, but will also require an understanding of engineering principles. Starting in the beginning of the 2024-2025 school year, a need has emerged for an evaluation of teachers' confidence and self-efficacy in STEM content and teaching ability. This study aims to identify to what degree elementary teachers in a particular school are prepared to teach a STEM focused curriculum, such as is stated by the new science TEKS.

Statement of the Problem

In the state of Texas, the Texas Education Agency (TEA) has released new science standards that will be implemented beginning in the 2024-2025 school year. The new science standards will include a new framework which will include Science and Engineering Practices (SEP), Recurring Themes and Concepts (RTC), and Disciplinary Core Concepts (DCC) as inspired by the *A Framework for K-12 Science Education* (2012) and in alignment with NGSS (2013). Many Texas fifth grade students are struggling to be successful with the State of Texas

Assessment of Academic Readiness (STAAR) exam covering the current science standards as evidenced by the Spring 2022 STAAR Summation report. There were 34% of students in Texas that did not meet the requirements for passing, which is equivalent to 129,626 students that did not pass the science STAAR exam. The school used for this evaluation only had 29% of students passing the exam in 2022. In order to pass the fifth grade STAAR exam in 2022, students had to score a 58% to pass, which is the equivalent to getting at least 21 questions correct. In many countries, including the United States, elementary school teachers are generalists who often do not have an academic background in a science-related subject (Brobst et al., 2017). With elementary teachers already entering the profession unprepared in science and with the addition of the STEM instructional practices in the new standards, districts are likely to struggle in the preparation of their teachers for the implementation of a new curriculum that will have SEP, RTC, and science concepts.

Research Question

This study seeks to address the following research question: To what degree are elementary teachers prepared to teach a STEM focused curriculum? The process of answering this question represents a needs assessment of the school that is serving as the site for this investigation. Therefore, the results of this study can be used as a tool to identify the needs of the teachers at this particular school as they relate to STEM educator professional development.

CHAPTER TWO: LITERATURE REVIEW

New Science Standards

About every 10 years the state of Texas rewrites their own set of standards that must be used in public schools called Texas Essential Knowledge and Skills (TEKS). Texas has rewritten, and adopted, the latest iteration of the science TEKS (2021) that will be implemented in K-12 classrooms in Fall 2024. These new science TEKS were inspired by *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (2012)* and are similar to the *Next Generation Science Standards* (2013). The Framework was developed by the National Research Council (NRC) and used to inform the production of the Next Generation Science Standards (NGSS). The Next Generation Science Standards were the result of a multi-state effort in the United States to create new education standards that were rich in content and practice, arranged in a coherent manner across disciplines and grades, and provided all students an internationally benchmarked science education (NGSS, 2013). The NGSS paved the way for science standards and as a result the new science TEKS were drafted in the same way as the NGSS are written.

The new science TEKS, just like the NGSS, focus on a smaller number of *Disciplinary Core Ideas* and *Crosscutting Concepts* that can be used to explain phenomena and solve problems through science and engineering practices (Tala, 2021). The NRC refers to this as *Three-Dimensional Learning*. When referring to "three-dimensional learning" in Texas the TEKS (TEC §112.A) include the *Science and Engineering Practices* (SEPs), *Recurring Themes and Concepts* (RTCs), and *Disciplinary Core Concepts* (DCCs) which are closely related to the previously listed components of the NGSS's three-dimensional learning.

It is expected by the creators of the *A Framework for K-12 Science Education:*

Practices, Crosscutting Concepts, and Core Ideas (2012) "that three-dimensional learning can stimulate improvement in student learning outcomes through developing student interest in science" (p.217). Teachers and administrators acknowledge that the NGSS calls for a change away from teaching facts and toward students creating explanations for observations (Reiser, 2013), which is also implied in the new science TEKS. According to the National Research Council (2007):

> Students must engage with content if they are to learn scientific and engineering techniques. If one of the three dimensions is left out of instruction, then students may not be able to gain competency over the disciplinary core ideas. We must have all three dimensions working together, combining practice and content if we want students to use content, solve problems, think critically, and make statements based on evidence. (p.43)

The new science TEKS may allow teachers to design a curriculum and instruction plan to start kids as early as kindergarten with basic skills using three-dimensional learning (National Research Council, 2007).

T-STEM Survey

The Technology- Science, Technology, Engineering, and Mathematics survey (T-STEM) is a research tool designed by the Friday Institute for Educational Innovation to assess various aspects of STEM (Science, Technology, Engineering, and Mathematics) education and educators' perceptions, beliefs, and efficacy within these domains. The William and Ida Friday Institute for Educational Innovation is located at North Carolina State University and exists for the purpose of bringing together researchers, practitioners and policymakers to lead the transition to various next-generation education systems that will prepare students for success in the digital-age world (The William and Ida Friday Institute for Educational Innovation, 2011). The T-STEM survey is particularly valuable for capturing data related to interdisciplinary STEM teaching, which includes science, technology, engineering, and mathematics, and often integrates these subjects to prepare students for the modern workforce (Friday Institute for Educational Innovation, 2012).

The survey is sectioned into seven constructs that include Personal Teaching Efficacy and beliefs, Teaching Outcome Expectancy Beliefs, Student Technology Use, STEM Instruction, 21st Century Learning Attitudes, Teacher Leadership Attitudes, and STEM Career Awareness (Friday Institute for Educational Innovation, 2012). These constructs within the T-STEM survey derive from other existing instruments that measure a variety of constructs related to teaching STEM. These surveys include the Science Teacher Efficacy Belief Instrument (Riggs & Enochs, 1990), the Math Teacher Efficacy Belief Instrument (Enochs et al., 2000), the Student Technology Needs Assessment (SERVE Center, 2005), North Carolina's Race to the Top grant (Corn, et al., 2013), the Friday Institute's Student Learning Conditions Survey (2012) and North Carolina Department of Public Instruction's Professional Standards for Educators (2012). These constructs and instruments collectively provide a comprehensive view of STEM education, allowing researchers and educators to assess the strengths and weaknesses of STEM programs, identify areas for improvement, and tailor interventions to enhance STEM teaching and learning.

Science Teacher Efficacy Belief Instrument (STEBI)

The Personal Science Teaching Efficacy and Beliefs (PSTE) construct and the Science Teaching Outcome Expectancy Beliefs (STOE) constructs as they appear on the T-STEM instrument were derived from a well-known survey of science teachers known as the Science

Teaching Efficacy Belief Instrument, or the STEBI (Riggs & Enochs, 1990). PSTE measures educators' self-efficacy and confidence in their ability to teach STEM subjects effectively and STOE measures the degree to which the respondent believes, in general, student-learning in the specific science subject can be impacted by actions of teachers (Riggs & Enochs, 1990). The STEBI is a widely used self-report instrument designed to assess teachers' beliefs and confidence in their teaching abilities (Rubeck & Enochs, 1991).

Math Teacher Efficacy Belief Instrument (MTEBI)

The Mathematics Teaching Efficacy Belief Instrument (MTEBI) is derived from the STEBI. Like the STEBI, the MTEBI includes the constructs Personal Mathematics Teaching Efficacy (PMTE) and Mathematics Teaching Outcome Expectancy (MTOE) (Enochs et al., 2000). In studies, this tool has been used to survey preservice teachers' self-efficacy beliefs related to teaching mathematics (Byrd & Giles, 2023). The MTEBI is a widely used instrument that provides insight to teachers' efficacy teaching math and their personal belief on their impact on student performance in math.

Student Technology Needs Assessment (STNA)

The Student Technology Use construct on the T-STEM instrument was derived from the Student Technology Needs Assessment tool. The STNA tool was created by the *North Carolina Department of Public Instruction* (NCDPI) to collect data about educators' perceptions regarding a variety of areas of technology implementation in schools, providing data necessary to help school-level leaders make planning and evaluative decisions related to technology projects (Corn, 2009). The School Technology Needs Assessment (STNA) provided "a free, user-friendly online tool that met this need for planning and formative evaluation of technology projects within educational settings" (Corn, p. 353). The assessment can show the positive impact technology may have in the classroom depending on how often students use technology in the respondent's classes. Schools and districts can gain knowledge from the questions used in the STNA to understand various technology projects and how technology is being utilized in the classroom.

North Carolina's Race to the Top Grant (RttT)

The STEM Instruction construct was based on items that were developed by The Friday Institute and used in a statewide evaluation of the professional development activities in alignment with North Carolina's Race to the Top grant (Corn et al., 2013). The construct examines the extent to which educators integrate science, technology, engineering, and mathematics in their teaching practices. It assesses their awareness of the interconnectedness of these disciplines and their efforts to promote interdisciplinary learning.

North Carolina's successful transition to new standards and assessments, as well as the use of data to improve instruction, were ultimately dependent upon the effectiveness of the professional development, technical assistance, and support materials provided to educators across the state. The focus of the professional development evaluation plan was to implement formative and summative evaluations to provide feedback to state leaders on the quality of professional development activities and resources provided at the state level that were funded by the Race to the Top grant (Corn et al., 2013). Over three years, a large portion of North Carolina's RttT funds were used to support professional development efforts for teachers, principals, and other education leaders across the state. The purpose of the grant was to examine the extent to which participation in high-quality professional development activities, provided through RttT funds, would build capacity in the educational workforce to deliver effective instruction, and, ultimately, to increase student performance (Corn, et al., 2013).

Friday Institute's Student Learning Conditions Survey

The 21st century learning attitudes and STEM Careers constructs from the T-STEM Survey were adapted from the Friday Institute's Student Learning Conditions Survey (2011). Educational organizations across the country set out to implement innovative STEM educational programs designed in part to increase student attitudes toward STEM subjects and careers (Faber et al., 2013). The Friday Institute's Student Learning Conditions Survey focuses on educators' attitudes toward STEM education, their perceptions of the value and relevance of STEM subjects in real-world contexts, and their beliefs about the potential impact of STEM on students' future success (2011).

North Carolina Professional Teaching Standards

The Teacher Leadership Attitudes construct in the T-STEM instrument was taken from the North Carolina Department of Public Instruction's Professional Standards for Educators (NC State Board of Education, 2013). The North Carolina Professional Teaching Standards are the basis for teacher preparation, teacher evaluation, and professional development. These standards include the skills and knowledge needed for 21st century teaching and learning. Standard one focuses on how teachers should demonstrate leadership. The Teacher Leadership Attitudes construct focuses on attitudes toward teacher leadership activities such as; "*I think it is important that students have learning opportunities to lead others to… accomplish a goal, encourage others to do their best, or respect the differences of their peers"*.

CHAPTER THREE: RESEARCH METHODOLOGY

Introduction

The question that guided this research was: to what degree are Elementary teachers prepared to teach a STEM focused curriculum? After considering the reviewed literature of Riggs & Enochs (1990), Corn (2009), and Friday Institute of Educational Innovation (2012), there is a justifiable need to measure the gap between teachers implementing STEM focused science standards currently to what it should be as intended in the new standards (Watkins et al., 2022). The findings from this study will constitute a needs assessment which may be considered as an initial step for a wider program evaluation for the site of this study- an elementary school in a large, inner-city school district in Texas. This needs assessment can help to determine the current condition of teachers' confidence and comfortability with STEM concepts (the potential gap in knowledge and/or readiness) and thus may identify problem areas, issues, and/or difficulties that should be resolved (Rosen, 1991). Typically, when needs are assessed and problems are identified, a call for resources would be a necessity for closing the gap and enabling schools or districts to adopt a strong, concept-based curriculum that may further lead teachers to properly implement three-dimensional instruction in classrooms (Watkins & Kaufman, 2022).

After *A Framework for K-12 Science Education* (2012) was written, The *National Research Council* (2012) wrote the *Next Generation Science Standards* (2013) to set the standard for science education K-12. A 2017 study by Harris, Sithole, and Kibirige, conducted a needs and preparedness assessment using online surveys on public K-12 teachers before the implementation phase of NGSS. The study, drawing from 16 schools across the US, found that most of the teachers in the study were not knowledgeable enough, nor equipped to integrate the proposed changes in standards with the current curricula and their teaching plans (Harris et al., 2017). By utilizing a similar needs assessment to inform this investigation, the findings may provide information about the ability of current teachers to implement the new state standards in Texas.

Texas schools, such as the site of this investigation may benefit from a program evaluation just like North Carolina did with the *Race to the Top Grant* (Corn et al., 2013). This investigation may serve as a model that would allow large inner-city districts to identify a professional development plan based on needs assessment data and provide feedback to state leaders on the quality of professional development activities and resources that could be provided at the state level. This could raise the specter of the need for adequate funding to prepare elementary teachers to implement the newly adopted science TEKS thereby preparing Texas students to be proficient in STEM fluency skills that will allow them to fill future jobs that are centered around STEM.

Data Collection

The T-STEM Survey is intended to measure changes in teachers' confidence and self-efficacy in STEM subject content and teaching, use of technology in the classroom, 21st century learning skills, leadership attitudes, and STEM career awareness (Friday Institute for Educational Innovation, 2012). Data were collected through a survey that was created by using an online software survey program called Qualtrics. The survey included the set of questions from the T-STEM survey created by the Friday Institute. Participants were sent an email with the survey linked and were asked to voluntarily fill out the survey.

The Teacher Efficacy and Attitudes Toward STEM (T-STEM) Survey was utilized to collect data on K-5 teachers' confidence and self-efficacy as it relates to their STEM content knowledge and teaching, use of technology in the classroom, 21st century learning skills, leadership attitudes, and STEM career awareness (Friday Institute for Educational Innovation, 2012). The T-STEM survey consists of 83 items. Each section provided a 5-point Likert-scale where respondents were asked to relate to each of the items as either continuous variables like “strongly disagree, disagree, neither agree or disagree, agree, or strongly agree” or ordinal variables such as “never, occasionally, about half the time, usually, every time” (See Appendix). Respondents were also asked to complete ten additional questions for demographic purposes. These items included contact information (email), gender and race (participants may decline), grade level currently teaching, total years of teaching experience, courses taught (math/science), and hours of professional development received in science, math and STEM.

Participants

The research question, "To what degree are elementary teachers prepared to teach a STEM-focused curriculum?" is critical in understanding the capacity of educators to effectively implement STEM education in elementary schools. The answer to this research question has led to professional development solutions to increase the initial capacity of these particular participants to implement the new standards in the upcoming school year. Participants come from a large inner-city district located in Texas. The survey was offered to participants who teach students in grades Kinder through fifth grade who are located at an inner-city school, that is a convenient selection. The participants who filled out the survey took part in the research. The sample method of selection was classified through educators who have taught math and/or science, years of experience, and grade level they currently teach.

Data Analysis

The data collected were organized in an excel spreadsheet. The data were analyzed for fitness for factor analysis and entered into SPSS where a statistical analysis between the constructs in the T-STEM survey and the demographic data collected by participants were run to identify any meaningful relationships that may exist in the data. Bivariant correlations were run in result of the statistical analysis and the means of each statement were found. The results of the data analyzed identified the high leverage areas for determining the professional development needs as they are associated with the constructs from the T-STEM Survey and the demographic data collected.

CHAPTER FOUR: FINDINGS

Descriptive Statistics

The descriptive statistics related to the participants in this study finds that the population is predominantly female (82.4%) and Hispanic (70.6%). The population represents teachers from grade levels kindergarten through fifth grade, with the most teachers, 4 (23.5%), representing second grade. There were three teachers (17.6%) in kindergarten, as well as the fourth and fifth grades. There were two teachers (11.8%) in first and third grades. Relative to the amount of time that they each have taught these grades, 14 (82.4%) have less than 5 years while two (11.8%) have been teaching in their current grade level for more than 10 years. Seven of the teachers (41.2%) have fewer than five years teaching experience in total, five teachers (29.4%) have between 5 and 10 years of experience and another five teachers (29.4%) have more than 10 years of experience.

The descriptive statistics related to the quantity of professional development (measured in hours) for the study population revealed that eight teachers (47.1%) have not had any professional development in STEM. While five teachers (29.4%) have not had any science professional development and three teachers (17.6%) have not had any math professional development. This indicates that the teachers in this study have collectively had more hours of math professional development than either of the other two (science and/or STEM).

Results of the T-STEM Survey

Initially, an exploratory factor analysis was conducted to determine if any of the constructs evaluated on the T-STEM survey could explain each other. However, the KMO-Bartlett measure of sampling adequacy yielded a value of 0.489. A KMO-Bartlett test must yield a value greater than 0.8 for the data to be considered robust enough for a factor analysis that can reliably determine principal components, allowing for a dimension reduction of the data set (Shrestha, 2021). Therefore, the KMO-Bartlett statistical results reveal that the data set is insufficient for dimension reduction. This is not surprising because it is widely acknowledged that 100 cases (n=100) is considered the minimum number of data sources needed to yield trustworthy results.

To better understand the nature of the relationship between the constructs on the T-STEM survey, bivariate correlations were generated. Table 1 contains the significant correlations between the various constructs measured by the T-STEM survey. Many of the constructs were statistically significant and strongly correlated as determined by the resulting correlation coefficients as defined in Cohen (Cohen, 1988). Some of the most notable strong correlations include those between Personal Science Teaching Efficacy (PSTE) and the Personal Math Teaching Efficacy (PMTE), (*r* (15) =.790, p=.01) and between Science Teaching Outcome Expectancy (STOE) and Math Teaching Outcome Expectancy (MTOE), (*r* (15) =.790, p=.01). The

strongest positive correlation between any two T-STEM constructs was between the Student Technology Needs Assessment (STNA) and Elementary STEM Instruction (eSTEM), (*r* (15) =.912, p=.01). The strong positive correlations identified above and in Table 1 potentially indicate that professional development targeted at improvement in one of the correlated constructs are likely to cause improvement in the other as well.

When evaluating the relationship between teacher experience and teacher professional development history, there were no significant correlations discovered. Teacher experience for the purpose of this investigation consisted of the number of years each of the participants have spent teaching in their current grade level and their total number of years teaching, regardless of grade level. Teacher professional development history consists of the number of professional development hours that they have received as related to instruction in Math, Science, and/or STEM. Significant Pearson correlation coefficients were computed between hours of STEM professional development and personal science teaching efficacy (PSTE), (r (15) =.480, p=.05) and between hours of math professional development and personal math teaching efficacy (PMTE), (r (15) =.511, p=.01). These represent moderately strong linear relationships which also indicate that, for the sample population, STEM professional development was associated with personal science teaching efficacy and math professional development was associated with personal math teaching efficacy.

Interestingly, no significant relationships were found between science professional development and personal science teaching beliefs or science teaching outcome expectancy. Also, of interest is that professional development in STEM was not related to teachers' understanding of elementary STEM instruction. Perhaps most importantly to acknowledge from these findings is that the teachers' experience was not significantly related to any of the constructs evaluated on the T-STEM survey, meaning that all of the teachers in this investigation are similar in their perspectives of teaching STEM regardless of level of teaching experience or professional development received.

Table 1

Correlations for T-STEM Survey Constructs

T-STEM constructs	Correlation Coefficient (*r*)
PSTE - PMTE	.790**
STOE - MTOE	.755**
PMTE - MTOE	.563*
STNA - eSTEM	.912**
STNA - TchrLead	.502*
STNA - STEMcareer	.666**
eSTEM - STEMcareer	.685*
Learn21st - TchrLead	.654*

**Correlation significant at the 0.01 level

* Correlation significant at the 0.05 level

CHAPTER FIVE: CONCLUSIONS

Introduction

The findings presented indicate the need for professional development opportunities that could potentially enhance the effectiveness of elementary STEM education. These opportunities are instrumental in equipping teachers with the necessary skills and knowledge to confidently teach the upcoming science standards, set to be introduced in the 2024-2025 school year. Based on the correlations of the T-STEM Survey (Table 1), the construct *Student Technology Use* (STNA) should be the focus of improvement due to the nature of how it correlates with multiple other constructs as well. Developing comprehensive professional development opportunities that focus on Science efficacy and the use of technology in the classroom will be essential for teachers to implement a STEM focused curriculum. By prioritizing this educational approach, we can better equip our students with the necessary skills and knowledge, preparing them for future careers in STEM fields and addressing the growing demand for skilled professionals in these areas (Knowles et al., 2018).

Professional Development Opportunities

The data derived from the 2022 Science STAAR assessment conducted at the inner-city school revealed that only 29% of students were performing at the expected grade level in science. It's important to note that these assessments were specifically administered to fifth grade students. Consequently, this indicates that a significant percentage of fifth graders (71%) did not meet the expected proficiency level in science. Furthermore, upon analyzing the various constructs, specifically the *Science Teaching Efficacy and Beliefs* construct, it was observed, as detailed in Table 2, that teachers lacked confidence in their capacity to effectively teach science.

The robust correlation found between teachers’ self-efficacy in math and teachers’ self-efficacy in science suggests that targeted professional development in science could bolster teachers' confidence in their ability to effectively teach both science and math, thereby positively impacting student performance. Achieving this goal entails designing professional development that concentrates on Science and Engineering Practices aligned with the new science TEKS. These practices could be modeled in hands-on workshops where teachers can deepen their understanding of K- 12 science standards and acknowledge that science content should be introduced to students as phenomena to be explored. In order to understand a phenomenon, scientists use science practices to explore by asking questions, planning and conducting investigations, and explain a phenomenon by using appropriate science tools and models. Once teachers understand what science practices are, then we would implement engineering practices into instruction. By understanding the science, teachers can then build students' problem-solving skills through project-based learning or “STEM Challenges”. These challenges would take students through the Engineering Design Process (EDP) that will require students to use background knowledge in STEM content that they have developed within other disciplines, such as science, and apply this knowledge to real world problem-solving.

Another professional development opportunity would involve mechanisms for integrating technology into the classroom. Based on the correlations data in Table 1, by directing our efforts towards enhancing the Student Technology Use construct (STNA), we inadvertently provide support and improvement for the Elementary STEM Instruction (eSTEM), Teacher Leadership Attitudes (TchrLead), and STEM Career Awareness (STEMcareer) constructs (see Table 1). Upon analyzing the means from targeted STNA items, seen in Table 3, it becomes evident that the teachers at the study site lack the knowledge to incorporate technology effectively into science instruction. For instance, at this elementary school, teachers might struggle with tasks such as guiding students to gather weather data outdoors using scientific tools, and subsequently entering this data into a digital spreadsheet. This spreadsheet could then be utilized to generate graphical representations, demonstrating trends over a specific time.

We can support teachers with implementing technology in the classroom through a professional development opportunity that supports STEM practices in the classroom. The focus of the professional development would equip educators with the knowledge, skills, and strategies to effectively integrate technology into their teaching practices. The professional development initiative commences with an exploration of the pedagogical foundations of technology integration. Blended learning environments will be emphasized, enabling seamless incorporation of technology into instruction. Educators will be introduced to a diverse array of educational apps, software, and online platforms provided by the district for instructional purposes. Through hands-on experiences during the workshop, participants will gain practical insights into the potential of these tools, enriching both teaching and learning. Furthermore, participants will actively engage with these digital platforms, creating interactive lessons, multimedia presentations, and collaborative projects. This hands-on approach will boost their confidence in utilizing these platforms effectively. Educators will also gain insights into utilizing technology for student assessment and delivering timely feedback, thereby reinforcing STEM practices in the classroom.

In these professional development sessions, it is advised to offer opportunities for exploration, group discussions, and making real world connections. The STEM Career

Awareness construct means data indicated that the teachers are not very knowledgeable about the plethora of STEM jobs that can be associated with the content (See table 4). Connecting educators with guest speakers from various STEM career fields can facilitate networking opportunities, enabling teachers to establish connections with companies and professionals. Encouraging group work and collaborative discussions, along with providing time for reflection, will serve as a model for the STEM practices we aim to instill in the classroom. Following the reflective process, educators should be encouraged to formulate a plan outlining their next steps, set specific goals, and devise strategies to achieve these goals.

Incorporating STEM practices within the science curriculum is paramount for shaping the future workforce. The rapid advancement of technology and its integration into various industries underscores the necessity for a workforce well-versed in STEM disciplines. By fostering STEM practices in the classroom, students will have opportunities to learn by engaging in hands-on, problem-solving experiences that mirror real-world challenges. This approach cultivates critical thinking, innovation, and adaptability skills essential for navigating the ever-changing landscape of the modern workforce. Moreover, a strong foundation in STEM education prepares students to tackle complex issues, collaborate effectively, and invent creative solutions, all of which are invaluable in today's competitive job market. As industries continue to evolve and become increasingly reliant on technology, fostering STEM practices ensures that our future workers are not only proficient in their respective fields but also equipped to drive innovation, spur economic growth, and address global challenges in an increasingly interconnected world.

Future Considerations

Conducting a comprehensive needs assessment for the new science TEKS holds immense potential to support elementary schools not only within this school and district but also across the state of Texas. By systematically evaluating the existing resources, teacher expertise, and infrastructure, schools can identify specific areas where they require additional support to effectively implement the new science standards. This assessment process allows schools to pinpoint their strengths and weaknesses, enabling targeted professional development programs and resource allocation for teachers and students. Furthermore, sharing the findings and best practices derived from this assessment with other elementary schools statewide fosters a collaborative learning environment. Schools can learn from each other's experiences, ensuring a more cohesive and standardized approach to implementing the new science standards. This collective knowledge-sharing initiative not only strengthens the educational foundation for students but also promotes a consistent and high-quality STEM curriculum across Texas, ultimately preparing the next generation with the skills and knowledge necessary for success in the ever-evolving scientific landscape.

To ensure the effective implementation of a STEM-focused curriculum, it is recommended to regularly administer the T-STEM survey in conjunction with common district assessments. This ongoing evaluation helps assess teachers' effectiveness and their beliefs in delivering a STEM-focused curriculum. The consistent collection of data enables schools and districts to tailor professional development programs, pinpointing specific areas where teachers might require additional support. By integrating data from common assessments, district level assessments, and state assessments, districts can accurately measure students' progress within the newly established STEM-focused curriculum, aligning with the updated standards. This holistic approach ensures a comprehensive understanding of both teacher efficacy and student growth, enabling targeted interventions and continuous improvement in

STEM education.

Table 2

Means for Targeted Items Related to Science Teaching Efficacy and Beliefs

Science Teaching Efficacy and Beliefs Questions	Means
"I am continually improving my science teaching practice."	3.47
"I wonder if I have the necessary skills to teach science."	3.47
"Students' learning in science is directly related to their teacher's effectiveness in science teaching."	3.35

Table 3

Means for Student Technology Use Items

Student Technology Use Questions	Means
"Use technology to communicate and collaborate with others, beyond the classroom..."	2.53
"Work on technology-enhanced projects that approach real- world applications of technology."	2.18
"Use technology to support higher-order thinking, e.g. analysis, synthesis and evaluation of ideas and information."	2.76
"Use technology to create new ideas and representations of information."	2.53

Table 4

Means STEM Career Awareness

STEM Career Awareness Questions	Means
"I know where to go to learn more about STEM careers."	2.88
"I know where to find resources for teaching students about STEM careers."	2.82
"I know where to direct students or parents to find information about STEM careers."	2.65

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APPEDIX

1. T-STEM Survey

a. ***Science Teaching Efficacy and Beliefs Instructions and Questions***

Directions: Please respond to these questions regarding your feelings about your own teaching.

[ ] Strongly disagree, [ ] Disagree, [ ] Neither Agree nor Disagree, [ ] Agree, [ ] Strongly Agree

11. I am continually improving my science teaching practice.
12. I know the steps necessary to teach science effectively.
13. I am confident that I can explain to students why science experiments work.
14. I am confident that I can teach science effectively.
15. I wonder if I have the necessary skills to teach science.
16. I understand science concepts well enough to be effective in teaching science.
17. Given a choice, I would invite a colleague to evaluate my science teaching.
18. I am confident that I can answer students' science questions.
19. When a student has difficulty understanding a science concept, I am confident that I know how to help the student understand it better.
20. When teaching science, I am confident enough to welcome student questions.
21. I know what to do to increase student interest in science.

b. ***Science Teaching Outcome Expectancy Beliefs Instructions and Questions***

Directions: The following questions ask about your feelings about teaching in general. Please respond accordingly.

[ ] Strongly disagree, [ ] Disagree, [ ] Neither Agree nor Disagree, [ ] Agree, [ ] Strongly Agree

22. When a student does better than usual in science, it is often because the teacher exerted a little extra effort.

23. The inadequacy of a student's science background can be overcome by good teaching.
24. When a student's learning in science is greater than expected, it is most often due to their teacher having found a more effective teaching approach.
25. The teacher is generally responsible for students' learning in science.
26. If students' learning in science is less than expected, it is most likely due to ineffective science teaching.
27. Students' learning in science is directly related to their teacher's effectiveness in science teaching.
28. When a low achieving child progresses more than expected in science, it is usually due to extra attention given by the teacher.
29. If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher.
30. Minimal student learning in science can generally be attributed to their teachers.

c. *Mathematics Teaching Efficacy and Beliefs Instructions and Questions*

Directions: Please respond to these questions regarding your feelings about your own teaching.

[ ] Strongly disagree, [ ] Disagree, [ ] Neither Agree nor Disagree, [ ] Agree, [ ] Strongly Agree

32. I am continually improving my mathematics teaching practice.
33. I know the steps necessary to teach mathematics effectively.
34. I am confident that I can explain to students why mathematics experiments work.
35. I am confident that I can teach mathematics effectively.
36. I wonder if I have the necessary skills to teach mathematics.
37. I understand mathematics concepts well enough to be effective in teaching mathematics.

38. Given a choice, I would invite a colleague to evaluate my mathematics teaching.
39. I am confident that I can answer students' mathematics questions.
40. When a student has difficulty understanding a mathematics concept, I am confident that I know how to help the student understand it better.
41. When teaching mathematics, I am confident enough to welcome student questions.
42. I know what to do to increase student interest in mathematics.

d. ***Mathematics Teaching Outcome Expectancy Beliefs Instructions and Questions***

Directions: The following questions ask about your feelings about teaching in general. Please respond accordingly.

[ ] Strongly disagree, [ ] Disagree, [ ] Neither Agree nor Disagree, [ ] Agree, [ ] Strongly Agree

43. When a student does better than usual in mathematics, it is often because the teacher exerted a little extra effort.
44. The inadequacy of a student's mathematics background can be overcome by good teaching.
45. When a student's learning in mathematics is greater than expected, it is most often due to their teacher having found a more effective teaching approach.
46. The teacher is generally responsible for students' learning in mathematics.
47. If students' learning in mathematics is less than expected, it is most likely due to ineffective mathematics teaching.
48. Students' learning in mathematics is directly related to their teacher's effectiveness in mathematics teaching.
49. When a low achieving child progresses more than expected in mathematics, it is usually due to extra attention given by the teacher.

50. If parents comment that their child is showing more interest in mathematics at school, it is probably due to the performance of the child's teacher.
51. Minimal student learning in mathematics can generally be attributed to their teachers.

e. *Student Technology Use Instructions and Questions*

Directions: Please answer the following questions about how often students use technology in settings where you instruct students. If the question is not applicable to your situation, please select "Not Applicable."

[ ] Never, [ ] Occasionally, [ ] About half the time, [ ] Usually, [ ] Every time

"During elementary STEM instructional meetings (e.g. class periods, after school activities, days of summer camp, etc.), **how often do your students…**"

52. Use a variety of technologies, e.g. productivity, data visualization, research, and communication tools.
53. Use technology to communicate and collaborate with others, beyond the classroom..
54. Use technology to access online resources and information as a part of activities.
55. Use the same kinds of tools that professional researchers use, e.g. simulations, databases, satellite imagery.
56. Work on technology-enhanced projects that approach real- world applications of technology.
57. Use technology to help solve problems.
58. Use technology to support higher-order thinking, e.g. analysis, synthesis and evaluation of ideas and information.
59. Use technology to create new ideas and representations of information.

f. *Elementary STEM Instruction Instructions and Questions*

Directions: Please answer the following questions about how often students engage in the following tasks during your instructional time.

[ ] Never, [ ] Occasionally, [ ] About half the time, [ ] Usually, [ ] Every time

"During elementary STEM instructional meetings (e.g. class periods, after school activities, days of summer camp, etc.), **how often do your students…**"

60. Develop problem-solving skills through investigations (e.g. scientific, design or theoretical investigations).
61. Work in small groups.
62. Make predictions that can be tested.
63. Make careful observations or measurements.
64. Use tools to gather data (e.g. calculators, computers, computer programs, scales, rulers, compasses, etc.).
65. Recognize patterns in data.
66. Create reasonable explanations of results of an experiment or investigation.
67. Choose the most appropriate methods to express results (e.g. drawings, models, charts, graphs, technical language, etc.).
68. Complete activities with a real-world context.
69. Engage in content-driven dialogue.
70. Reason abstractly.
71. Reason quantitatively.
72. Critique the reasoning of others.
73. Learn about careers related to the instructional content.

g. *21st Century Learning Attitudes Instructions and Questions*

Directions: Please respond to the following questions regarding your feelings about learning in general.

[ ] Strongly disagree, [ ] Disagree, [ ] Neither Agree nor Disagree, [ ] Agree, [ ] Strongly Agree

"I think it is important that students have learning opportunities to..."

74. Lead others to accomplish a goal.
75. Encourage others to do their best.
76. Respect the differences of their peers.
77. Help their peers.
78. Include others' perspectives when making decisions.
79. Make changes when things do not go as planned.
80. Set their own learning goals.
81. Manage their time wisely when working on their own.
82. Choose which assignment out of many needs to be done first.
83. Work well with students from different backgrounds.

h. *Teacher Leadership Attitudes Instructions and Questions*

Directions: Please respond to the following questions regarding your feelings about teacher leadership in general.

[ ] Strongly disagree, [ ] Disagree, [ ] Neither Agree nor Disagree, [ ] Agree, [ ] Strongly Agree

"I think it is important that teachers ..."

84. Take responsibility for all students' learning.
85. Communicate vision to students.
86. Use a variety of assessment data throughout the year to evaluate progress.
87. Use a variety of data to organize, plan and set goals.

88. Establish a safe and orderly environment.

89. Empower students.

i. *STEM Career Awareness Instructions and Questions*

Directions: Please respond to the following questions based upon how much you disagree or agree with the statements.

[ ] Strongly disagree, [ ] Disagree, [ ] Neither Agree nor Disagree, [ ] Agree, [ ] Strongly Agree

"I know ..."

90. I know about current STEM careers.

91. I know where to go to learn more about STEM careers.

92. I know where to find resources for teaching students about STEM careers.

93. I know where to direct students or parents to find information about STEM careers.

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