THE ROLE OF SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) EFFICACY FOR COURSE-TAKING AND HIGH SCHOOL GRADUATION OF ENGLISH LANGUAGE LEARNERS

A dissertation submitted in partial fulfillment
of the requirements for the degree of

DOCTOR OF EDUCATION

to the faculty of the

DEPARTMENT OF ADMINISTRATIVE AND INSTRUCTIONAL LEADERSHIP

of

THE SCHOOL OF EDUCATION

at

ST. JOHN'S UNIVERSITY
New York

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Date Submitted March 28, 2023

Date Approved May 19, 2023

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ABSTRACT

THE ROLE OF SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) EFFICACY FOR COURSE-TAKING AND HIGH SCHOOL GRADUATION OF ENGLISH LANGUAGE LEARNERS

Yazmín Torres

This study examines how Science, Technology, Engineering, and Mathematics (STEM) Education may improve English Language Learners' academic achievement and high school graduation. In particular, it highlights the plight faced by ELLs in high schools regarding quality education that allows them to graduate on time and attend college. The analysis for this study is grounded on the self-efficacy component of Albert Bandura's Social Cognitive Theory (Bandura, 1977), which focuses on the hypothesis that students are motivated by positive experiences that contributes to their academic success (Hsieh & Kang, 2010). Using Albert Bandura's self-efficacy framework and nationally representative data from the High School Longitudinal Study of 2009 (HSLS:09), this study will analyze: (a) To what extent do ELLs differ from non-English learners in STEM course-taking?; (b) To what extent do ELLs differ from non-English learners in high school graduation? ; (c)To what extent do ELLs differ from non-English learners in STEM efficacy?; (d) To what extent is higher STEM efficacy related to STEM course-taking for ELLs?; and (e) To what extent is higher STEM efficacy related to high school graduation for ELLs? The sample for this study consists of a subset of 546 ELLs. Two independent sample t-tests were performed to compare ELLs and non-English learners' STEM participation and STEM efficacy. A chi-square test of independence will be implemented to compare ELLs and non-English learners' high school graduation. A

multivariate linear regression analysis was conducted to explore STEM course-taking predictability related to STEM course-taking efficacy. In addition, a logistic regression analysis will be conducted to investigate the degree to which higher STEM efficacy is related to ELLs' high school graduation. This study is significant because the national graduation rate of ELLs is 69.9 %, compared to 84% for the general student population (U.S. Department of Education, NCES, 2017) (Ku & Brantly, 2020). Ensuring all our students have proper access and equitable opportunities to quality education, including ELLs and ELLs with disabilities, is a matter of social justice. As responsible and ethical leaders, we must be agents of change, ensuring all historically disadvantaged students have equitable opportunities to achieve and access academic excellence.

DEDICATION

I dedicate this dissertation to my children, family, and friends for their encouragement, support, and unconditional love. May they be as proud of me as I am of them. I hope this dissertation inspires them to achieve their dreams and accomplishments. To my children, family, and friends, thank you for your wisdom and for believing in my potential to achieve what seemed unattainable one day. I could not have done it without all of you.

ACKNOWLEDGEMENTS

I want to express my deepest gratitude to my committee chair and mentor, Dr. Stephen Kotok, who provided much assistance and unwavering support. Thank you for your words of wisdom and encouragement. I am grateful for my committee members, Dr. Ceceilia Parnther and Dr. Audrey Figueroa-Murphy, whose assistance and motivation cannot be overestimated. I very much appreciated Dr. Figueroa-Murphy's precise suggestions and advice. I would also like to thank Dr. Ceceilia Parnther for her kindness and challenging inspirational teachings. Each of you made what seemed impossible attainable. Thank you for your guidance.

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CHAPTER 1

Introduction

The United States' school population is becoming increasingly diverse regarding race, ethnic groups, language, and socio-economic status. The under preparation of culturally and ethnically diverse students at the high school level, in addition to the low participation of this population in Science, Technology, Engineering, and Mathematics (STEM) fields, is a matter of concern considering the goal of the United States of America to remain competitive in a global economy (Center for Policy Innovation, 2011). The COVID-19 global pandemic revealed educational inequalities for vulnerable populations, including ELLs (Ku & Brantly, 2020). English Language Learners are the fastest-growing student subgroup in the United States (NEA, 2018). According to National Education Association, by 2025, an estimated 25 percent of public-school students will be ELLs (NEA, 2018). During the 2015-2016 school year, there were more than 4.6 million ELL students in public schools (NCES, 2018), many of whom were immigrant English Language Learners' adolescents who experienced significant challenges adapting to a new culture and educational system.

Previous research has established that immigrant ELLs have a higher dropout rate and score lower on standardized tests than their native English- speaking peers (Lee, 2012). High-quality education for ELLs that allows them to graduate on time continues to be a challenge, as the current national graduation rate of English Language Learners is 69.9 % compared to 84% general student population (U.S. Department of Education, NCES, 2017). Researchers have recognized several factors that influence the ability of

ELLs to succeed academically and graduate on time. Among those factors, implementing effective STEM education, which prepares students with 21st-century skills such as conducting research, creating, synthesizing, analyzing, hypothesizing, and solving real-world problems, plays an important role (Watson, 2016).

In addition, scholars have found that secondary schools English Language Learners are overlooked and underserved (Menken, 2013). Hansen-Thomas & Sourdot (2015) argued that there is a high need for opportunities and special programs to improve ELLs' graduation rates. To this end, Jimerson & Patterson (2016) established that there is a need to provide ongoing training to teachers so that they are well-prepared to meet the linguistic and academic needs of English Language Learners in secondary-level classrooms.

Purpose of the Study

This study investigates how the role of STEM efficacy for STEM course-taking may improve English Language Learners' academic achievement and high school graduation. To better understand the impact of STEM education on ELLs in the COVID-19 academic recovery era, it is of utmost importance to develop the analysis in the context of second language acquisition. The second language acquisition language theory provides information on educating linguistically and culturally diverse students with varied English language proficiency levels while gaining academic skills (Collier, 1995). Steven Krashen's (1982) natural approach to second language acquisition established an input hypothesis as "a necessary (but insufficient) condition to move from stage i to stage i + 1 is that the acquirer understands input that includes i + 1, where the understanding ' significance implies that the acquirer will concentrate on the meaning instead of the message" (p. 21). In other words, language will be acquired if content beyond the learner's level is contained in the message. In addition, Krashen (1982) indicated that the affective filter affects second language acquisition. Thus, the hypothesis explains that a second language is affected by affective factors (e.g., motivation, self-confidence, and anxiety). According to the authors, effective second language acquisition teachers must offer comprehensive input and a culturally responsive classroom environment to encourage low anxiety among students (Krashen, 1982). Research shows that underrepresented students, including ELLs and immigrant students, must overcome both academic and affective barriers to succeed at the secondary level (Moore & Christensen, 2005; Zamel & Spack, 2004).

STEM education assists with developing an environment that reduces anxiety levels as it provides opportunities for ELLs to learn in a non-threatening way in which they can receive comprehensible input. The core principles of successful language acquisition establish that background knowledge makes content-based English as a second language input more comprehensible, assisting language acquisition. STEM education is becoming popular in mainstream classrooms as it reinforces best practices for content-based English as a second language preparing students with much-needed 21st-century skills.

Educational reforms based on STEM education offer exceptional improvement opportunities for ELL instructional best practices. However, the achievement gap between native-speaking peers in STEM subjects and ELLs further highlights ELLs' missed educational opportunities when mainstream teachers are not prepared to meet their unique needs (DelliCarpini & Alonso, 2014). Project-Based Learning (PBL) STEM educational experiences emphasize STEM contextualizing course content to build meaningful understandings for ELLs through critical and analytical thinking, collaboration with peers, self-directed learning, and real-world problem-solving (Capraro, Capraro, & Morgan, 2013).

Therefore, this study aims to investigate how the role of STEM efficacy for STEM course-taking can improve English Language Learners' academic achievement and high school graduation.

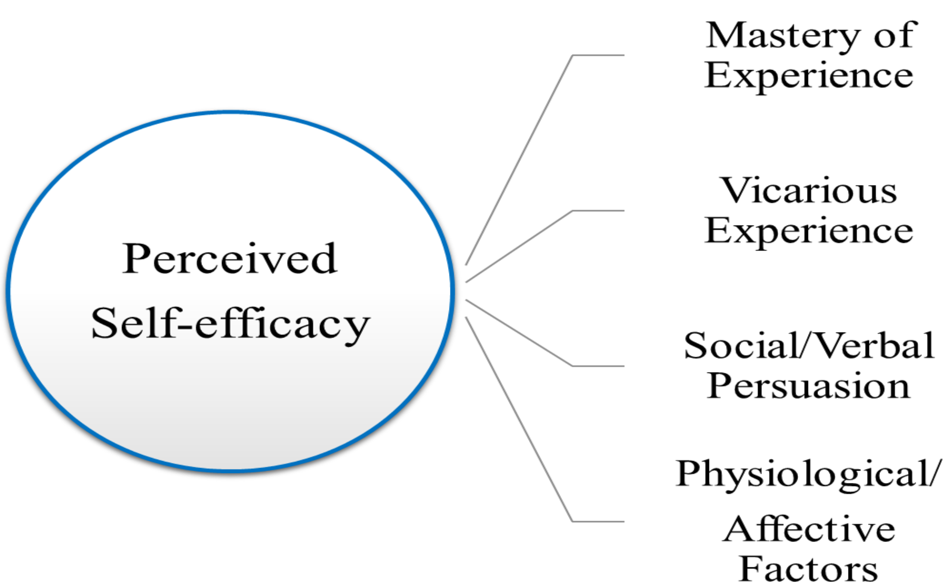
Theoretical Framework

Albert Bandura's Social Cognitive Theory (SCT) self-efficacy component grounds the current study (1986). Albert Bandura’s Social Cognitive Theory (SCT) establishes that cognition, behavior, and environmental interaction influence each other (Bandura, 1986). Self-efficacy is an essential construct of the Social Cognitive Theory as it is considered the basis for human agency and relates to effort, persistence, and choice (Bandura, 2006). The self-efficacy theory is "the belief in one's capabilities to organize and execute the courses of action required to manage prospective situations" (Bandura, 1995, p. 2). In other words, self-efficacy is considered a person's belief in his or her ability to succeed in a particular situation (Bandura, 1977, 1986,1997). Self-efficacy theory (Bandura, 1977) focuses on the hypothesis that students are motivated by positive experiences that contribute to their academic success (Hsieh & Kang, 2010).

An efficacy expectation is a belief that an individual can complete the behavior and actions needed to produce the desired outcomes. Perceived self-efficacy can directly affect activities and actions in which people participate. People tend to avoid threatening situations that generate fear when they believe situations are beyond their coping abilities. In contrast, they are more likely to get involved in situations and behaviors they believe can be managed (Bandura, 1977). In self-efficacy theory, expectations are derived from four experiential sources: performance accomplishments or mastery of experience (content-specific performance accomplishments), vicarious experience (i.e., modeling), verbal persuasion, and physiological states. The more consistent and steadfast the experiential sources are for the individual, the greater the changes in perceived self-efficacy. Coping actions demonstrate students' self-efficacy expectations, effort expended, and how long they can sustain these behaviors when facing obstacles and adverse experiences (Bandura, 1977).

Figure 1

Representation of Albert Bandura's Self-Efficacy Development (1977).



Note: This figure represents the four experiential sources of information that individuals employ to judge their efficacy: mastery of experience (performance accomplishments), vicarious experiences (i.e., modeling), social/verbal persuasion, and physiological/affective factors, which involves feedback (emotional arousal).

Young people also develop their beliefs about their competence relative to their peers. They formulate perceptions of ability and relative standing within their class through social comparisons with others. They also begin to differentiate their perceptions by subject area and to ascertain how smart they are in subjects such as reading and mathematics. Learners also develop theories about agency and control in academic situations. This power to act to obtain desired outcomes is central to social cognitive theory (Bandura, 1997) and constructivist theories (Martin, 2004). Bandura contended that self-efficacy is a crucial influence on an agency, whereas constructivist theories emphasize learners' activities in their physical and sociocultural environments (Martin, 2004). Self-efficacy plays a role in English Language Learners' ability to learn in the context of STEM programs, improve reading skills and develop STEM competencies in two languages. As students' model for and observe each other, they teach skills and experience higher self-efficacy for learning (Schunk, 1995). In combination with an appropriate environment to foster practical content-based English as a second language and literacy skills, self-efficacy can make a difference in a student's ability to succeed.

Significance of the Study

ELLs are considered the fastest-growing student population in U.S. schools (Calderón, Slavin, & Sánchez, 2011). ELLs' growth projections indicate that by 2030, the number of language minority students will comprise 40 percent of the school-age student population (Collier & Collier Thomas, 2001). The rising number of ELLs in the education system has amplified national attention to academic recovery reforms that assist teachers with the academic success of language minority students (Molle, 2013; NCES, 2016). Research shows that underrepresented students, including English

Language Learners and immigrant students, must overcome both academic and affective barriers to success at the secondary level (Moore & Christensen, 2005; Zamel & Spack, 2004).

Scholars believe that cognitive strategies and self-efficacy reduce the achievement gap between high school English Language Learners and their English-speaking peers. In the area of the COVID-19 pandemic, academic recovery plans, and text-based academic content writing, many reports from policy centers and blue-ribbon panels implicate poor understanding of cognitive strategies are the primary reason adolescents struggle with reading and writing (Snow & Biancarosa, 2003; Graham, 2006; Conley, 2008). Cognitive strategies, which include summarizing meaning, repetition, using imagery for memorization, and guessing meaning from context, assist ELLs with understanding content-specific vocabulary/language, leading to STEM course success. Effective use of cognitive strategies, which involve deliberate manipulation of language, helps develop STEM efficacy in ELLs improving the academic achievement of STEM courses.

Research on college course content and instructor expectations conducted during the past 15 years indicates that using cognitive strategies is the key to college and career readiness in high school students (Conley, 2013). The lack of appropriate use of cognitive strategies to promote exposure to higher-level thinking skills has been found by scholars to be the result of assuming that ELLs must demonstrate the ability to learn the "basic levels of knowledge" before they can learn a second language. When ELLs are not immersed in a rich content-based English as a second language that is culturally relevant, valuing native language use are generally not taught higher-level thinking skills until the student has mastered English fully since many teachers assume that students are not able to comprehend until they can speak English well (Garcia & Pearson, 1991).

However, in the context of effective ELL programs that teach English through content (including math and science) emphasizing the value of native language skills, teachers are normally able to use cognitive strategies to capitalize on students' higher-level thinking skills using students' native language because teachers know those skills can be transferred to the second language. Considering ELLs have historically scored significantly below their English-speaking peers in math, English Language Arts (ELA), and science on standardized assessments (National Assessment for Educational Progress, 2020), the topic of the study is highly significant and relevant as research indicates that STEM education can be highly beneficial for the academic achievement of ELLs.

The role of Science, Technology, Engineering, and Mathematics (STEM) efficacy for course-taking and high school graduation of ELLs is a topic that has not been deeply explored. Extensive research can be found about the causes of the high dropout rate and low high school graduation of ELLs (Filindra, Blading & Coll, 2011; Hansen-Thomas & Sourdot, 2015; Jimerson & Patterson, 2016; Lee, 2012; Menken, 2013) and the effectiveness of quality STEM education in increasing graduation rates (Bicer, Lee& Perihan, 2020; LaCosse et al., 2020; McKim, Velez & Sorensen, 2017; Oemig & Baptiste, 2018). However, I found one peer-reviewed article focused on Technology, Engineering, and Mathematics (STEM) efficacy for course-taking and English Language Learners' high school graduation.

Connection with Social Justice and Vincentian Mission in Education

Ensuring all our students have proper access and equitable opportunities to quality education, including ELLs and English Language Learners with Disabilities, is a matter of social justice. Race, religion, gender, cultural background, or financial status should not be the determinant factor in the quality of education our children receive. As responsible and ethical leaders, we must be agents of change, ensuring all historically disadvantaged students, including ELLs, have equitable opportunities to achieve and have access to academic excellence.

This study aligns with St. John's University's mission in addressing an issue of social justice for ELLs' historically underrepresented population, discriminated against and disadvantaged. In addition, the study challenges institutional structures and perceptions that serve as barriers to educational reform. The current study intents to inform future policy and education, focusing on effective STEM education that promotes STEM efficacy for course-taking to improve high school graduation of English Language Learners.

Research Questions

1. To what extent do English Language Learners differ from non-English learners in STEM course-taking?
2. To what extent do English Language Learners differ from non-English learners in and high school graduation?

3. To what extent do English Language Learners differ from non-English learners in STEM efficacy?
4. To what extent is higher STEM efficacy related to STEM course-taking for English Language Learners?
5. To what extent is higher STEM efficacy related to high school graduation for English Language Learners?

Hypotheses

H_0 1: The means of the two populations (ELLs and non-ELLs) are equal.

H_1 1: The means of the two populations (ELLs and non-ELLs) are not equal.

H_0 2: There is no association between high school graduation and student type.

H_1 2: There is an association between high school graduation and student type.

H_0 3: The means of the two populations (ELLs and non-ELLs) are equal.

H_1 3: The means of the two populations (ELLs and non-ELLs) are not equal.

H_0 4: $\beta p\text{-}1 = 0$ There is no statistically significant relationship between higher STEM efficacy and STEM course-taking.

H_1 4: $\beta i \neq 0$ At least one of the independent variables helps explain/predict Y (number of STEM courses).

H_0 5: $\beta = 0$ There is no statistically significant relationship between higher STEM efficacy and high school graduation.

H_1 5: $\beta \neq 0$ There is a statistically significant relationship between higher STEM efficacy and high school graduation.

Definition of Terms

English Language Learners (ELLs) are defined as national-origin-minority students who are limited-English-proficient. This term is often preferred over limited-English-proficient (LEP) as it highlights accomplishments rather than deficits (U.S. Department of Education, 2021). English Language Learners are comprised of six subgroups (NYSED, 2021). However, this study will focus on the current first five. The six ELLs subgroups are as follows: (1) Newcomers (0-3 Years of Service), (2) Developing ELLs (4-6 Years of Service), (3) Long-Term ELLs (7 Years of Service), (4) ELLs with Disabilities, (5) SIFE (Students with Inconsistent/Interrupted Formal Schooling), (6) Former ELLs.

English as a Second Language (ESL) is a program in which research-based methodologies, techniques, and curricula are implemented to teach ELLs English language skills focused on listening, speaking, reading, and writing. In addition, ESL, also known as English as a New Language (ENL), supports learning content-based vocabulary embedded in culturally relevant literature. ESL (or ENL) instruction is usually in English with native language support (U.S. Department of Education, 2021; New York Department of Education, 2021).

Content-Based English as a Second Language is an approach that uses instructional materials, classroom techniques, and classroom learning tasks from academic content areas to develop language, content, cognitive, and study skills. English is the medium of instruction (U.S. Department of Education, 2021).

STEM Education for this study refers to the purposeful integration of science, technology, engineering, and mathematics applications to create a student-centered learning environment that allows children to research and investigate real-world problems. Through STEM education, students develop evidence-based explanations and solutions to world phenomena using an intentional, collaborative approach resulting in socio-emotional awareness of their surroundings (Florida Department of Education, 2021).

Equity Pedagogy in this study is defined as implementing instruction in which the teacher modifies practices to facilitate the academic achievement of students from diverse cultural, racial, gender, and socio-economic class groups. This definition suggests that more than teaching students how to read, write and compute is required. Instead, equity pedagogy implies that teachers must develop critical-thinking skills that allow diverse students to be effective agents of social change (Banks, 1995).

CHAPTER 2

Introduction

This chapter begins with a discussion of Albert Bandura's (1977) self-efficacy theory applied to English Language Learners' academic success and an explanation of the four self-efficacy experiential sources, the theoretical framework that guides the study. We outline how the framework will provide a common language and foundation for developing STEM course-taking self-efficacy in ELLs and its impact on their high school graduation. The theoretical framework will also include research studies that support the application of Bandura's self-efficacy theory to the current study. Each associated study discussed in this section will add to the framework by providing the independent variables against which we can operationalize Albert Bandura's (1977) four experiential sources that conform to self-efficacy. The theoretical framework will then explain how the current study fits within the prior research of various researchers such as Shi, Qi (2017), Oemig and Baptiste (2018), Velez and Sorensen (2018), and LaCosse, Canning, Bowman, Murph, Logel (2020).

The literature review will explain the importance of STEM education in ELLs' academic success and high school graduation. To understand the importance of STEM education in academic success and high school graduation of English Language Learners, I will examine how policy for language minority students' legislation beginning in the 1960s led to federal laws mandating English as a second language (ESL). In addition, an overview of significant legislative actions on STEM education policy will be provided. The extensive benefits of STEM education for English Language Learners are then discussed to provide equitable educational opportunities that allow them to graduate high school. Finally, the research will connect prior research to the present study to establish that STEM education/STEM efficacy for course-taking helps English Language Learners develop interdisciplinary, integrated STEM conceptual understanding that should be considered in the complex reform era of COVID-19.

Theoretical Framework

Many scholars believe Albert Bandura's self-efficacy component of the social-cognitive theory to be a critically crucial theoretical contribution to the study of learning, motivation, and academic achievement (Pajares, 2006; Schunk, 1995). To understand why some ELLs are more successful than others in acquiring a second language, taking into consideration the same aptitude and capabilities, researchers have focused their attention on the learners' perceptions of the task (Williams & Burden, 1997). In addition, researchers have focused on learners' beliefs and their abilities to perform a task (Bandura, 1997), individual differences such as learning strategies (Cohen, 1998; O'Malley & Chamot, 1990), and motivation (Dörnyei, 2001, 2005).

As an essential element of social cognitive theory, self-efficacy is "a person's beliefs of capabilities to organize and execute the courses of action required to produce a given attainment" (Bandura, 1997, p. 3). According to Bandura (1986), students learn self-efficacy at home. However, school is the primary location where students develop their cognitive efficacy and gain problem-solving and other skills necessary to function in society. "Students who develop a strong sense of self-efficacy are well equipped to educate themselves when they have to rely on their initiative" (Bandura, 1986, p. 417). Students' beliefs in their ability to learn a second language impact their performance (Bandura,1997).

Students who experience success develop high self-efficacy, which explains why previous experiences are essential in developing self-efficacy beliefs. In his research, Bandura (1997) explains that mastery experience, vicarious experience, social persuasion, and physiological/affective factors are four sources that can impact self-efficacy. Students who develop high self-efficacy regarding learning, receive encouragement, and are valued for their expertise are more likely to succeed academically and graduate. Students who received native language support in content-based English as a second language are more likely to experience success in their native language (domain-specific) and can transfer those skills to the second language.

Self-efficacy constitutes a motivational variable in the learning process, and it appears almost unfeasible to analyze certain aspects of human functions, such as learning and academic performance, independent of the role of self-efficacy beliefs of the learners (Pajares & Urdan, 2006). Physiological/affective factors in ELLs, such as anxiety and stress, can affect self-efficacy (Bandura, 1997; Krashen, 1982). ELLs who experience low anxiety during the second language acquisition learning process have a pleasant experience strengthening their self-efficacy, which can positively impact their ability to succeed in school.

Four Sources of Self-Efficacy

Albert Bandura (1977) establishes that four experiential sources conform to self-efficacy. These four sources are (a) mastery of experience, (b) vicarious experience, (c) verbal persuasion, and (d) physiological and affective states. Mastery of experience refers to past efficacious or unsuccessful experiences, debatably the most influential and authentic source of self-efficacy (Bandura, 1997). Assessments of an individual's competence are affected by previous past performance experiences. Learners with a high degree of mastery experience are confident to endure adversity and setbacks.

Furthermore, research has established that perceptions of mastery experiences are better predictors of self-efficacy than objective performance results (Usher & Pajares, 2008). Vicarious experiences are acquired by witnessing the mastery experiences of other individuals. Through the success of other individuals, learners evaluate their potential to succeed or construct an ideal of relative mastery. Social comparison or group norms shape how individuals appraise their capabilities (Bandura, 1997). However, vicarious experiences establish the importance of modeling for the learner. Witnessing the success of peers can increase the perceived self-efficacy of an individual. In his research, Bandura (1986) highlights how vicarious information can be most influential when students are uncertain about their abilities to succeed.

Social or verbal persuasions are persuasive messages from others and can deteriorate or fortify a learner's self-efficacy beliefs (Bandura, 1986; Hattie &Timperley, 2007). According to Bandura (1997), evaluative, effective feedback involves a credible and knowledgeable basis and an evaluation that is modestly beyond what learners can do and should include authenticity and appropriateness of verbal persuasion for the learner. When students receive positive feedback that is perceived to be authentic and realistic, the response is usually to try harder. In contrast, the students may perceive effusive praise as inconsequential and in alignment with low expectations. Nevertheless, harsh criticism can hurt students, hindering their sense of self-efficacy (Vallerand & Reid, 1984). The student can also interpret harsh criticism as unrealistic expectations from the critic.

The physiological and affective source of self-efficacy relates to the individual emotional perceptions and tendencies influenced by stress levels and physical status. Self-efficacy beliefs can be altered by an individual physiological and affective state. Usher and Pajares (2006) explained that students could perceive anxiety caused by a challenging course as incompetency. In contrast, when students are excited and energized by learning experiences, they will execute instructional tasks more confidently. The physiological and affective source of self-efficacy is considered the cognitive interpretation of the bodily, emotional, and physical states that eventually regulate self-efficacy. Nevertheless, the physiological and affective source solely is not considered the root cause of an individual sense of self-efficacy. Bandura (1997) explains that the four sources of self-efficacy integrated form an intelligible and operative sense of self-efficacy.

Fong and Asera (2010) established that "when students successfully construct a sense of personal self-efficacy, their beliefs can contribute to the quality of human functioning in diverse ways" (p.5). Developing a strong sense of self-efficacy in ELLs by providing enriched learning experiences in which learners actively process information efficaciously, vicariously, socially, and emotionally can positively impact academic achievement and high school graduation.

Review of Related Literature

The literature review will begin with the history of educational policy and court cases that impacted the education of ELLs to understand why they are entitled to receive specialized instruction to learn English as a Second Language (also known as English as a New Language in some states). Then, I will provide an overview of STEM legislation to contextualize the need for continued improvement of STEM education. In addition, I will discuss the benefits of STEM education for ELLs explaining what previous studies have found regarding ELLs' education and their ability to improve self-efficacy and STEM efficacy. Finally, the importance of the STEM efficacy related to the STEM course-taking relationship and its effect on high school graduation will be explored.

History of Policy and Supreme Court Cases Related to English Language Learners' Education

Between the 1920s and the 1960s, educational policies in the United States of America promoted English immersion or "sink-or-swim" as a methodology to instruct language minority students. School districts provided minimal instructional support or remedial instruction to ELLs. English Language Learners were usually held at the same grade level until they learned sufficient English to master core subject areas (Ruiz, Bybee, Henderson, Hinojosa, 2014).

In 1963, the Ford Foundation Coral Way Elementary in Miami-Dade County, Florida, inspired the implementation of bilingual programs in the country due to the successful implementation of a two-way bilingual program for Cuban refugees (Logan, 1967). The Coral Way Elementary planning and steering committee established that the school should follow the Miami Dade County school's scope and sequence curriculum. However, students needed to receive instruction for part of the day in their native language (Spanish) with a native speaker teacher. Similarly, a native English speaker teacher imparted English instruction. In addition, second language materials were purchased or developed to reinforce or supplement native language instruction.

The Coral Way Elementary planning and steering committee provided summer workshops to train school personnel in implementing an effective two-way Dual Language program (Logan, 1967).

In 1964, Title VI of the Civil Rights Act prohibited discrimination based on race, color, or national origin in all federally funded assisted programs (U.S. Government National Archives, 1964). The Civil Rights Act influenced education because schools/districts are forbidden to discriminate based on race, color, or national origin. Therefore, schools/districts must measure the progress of ELLs students and ensure they demonstrate that ELLs have equal rights to participate in federally funded school programs and services. The Civil Rights Act was used to sue districts for discriminatory practices with non-English speakers.

The 1968 Bilingual Education Act under Title VII of the Elementary and Secondary Education Act outlines bilingual education federal policy for language minority students. The Bilingual Education Act authorized the use of federal funds for innovative programs acknowledging the unique educational disadvantages faced by non-English speaking students (Bilingual Education Act, 1968).

In 1974, the Lau Vs. Nichols Supreme Court case establishes that the Office for Civil Rights, under the former Department of Health, Education, and Welfare, has the authority to impose regulations for Title VI enforcement. In this case, a Chinese family sued the San Francisco Board of Education under the 1964 Title VI Civil Rights Act (U.S. Department of Education, 1980). The case resulted in what educators consider the birth of ESL, now also known as English as a New Language (ENL), because the ruling stated that identical education (referring to education provided to non-English speakers in comparison to English speakers) does not constitute equality; as a result, Chinese-speaking students were provided language support to access English curriculum. This ruling determined that school districts needed to take affirmative action in eliminating education barriers for non-English speakers.

During the same year, a group of Puerto Rican parents represented by ASPIRA of New York and supported by ASPIRA of America won the lawsuit against the New York City Board of Education established in 1972. The ruling led to the ASPIRA consent decree, which established that Limited English Proficient (LEP) students had the right to receive bilingual education. For New York educators, this historical event is considered the birth of bilingual education in New York City (ASPIRA of New York, 2021).

Title VII of the Elementary and Secondary Education Act was amended in 1978 to emphasize the strictly transitional nature of native language instruction, expanding eligibility to Limited English Proficient (LEP) students and allowing the enrollment of English-speaking students in bilingual programs (U.S. Department of Education, 2021). This guideline provided a three-year participation limit in most Title VII programs allowing for fellowship programs for the professional development of educators focused on language acquisition (U.S. Department of Education, 1988). In 1988, Title VII was amended again for provisions of increased funding to state education agencies, amplifying funds for "special alternative" programs where only English was used. In 1994, Title VII was reconfigured as a result of robust educational reforms that aim to provide new provisions and funding for language acquisition professional development, special consideration to foreign language instruction, language maintenance, and improvement of research and evaluation at the state and local level. In addition, these educational reforms provided immigrant education funds (U.S. Department of Education, 1988).

In 2001, the reauthorization of the 1965 Elementary and Secondary Education Act established the No Child Left Behind Act (NCLB), which provided state funding for the academic improvement of Limited English Proficient (LEP) students (currently known as ELLs) to assist them with meeting the state academic standards. NCLB increased the federal government's involvement in public education, emphasizing annual testing, annual academic progress, schools' report cards, and teacher qualifications (U.S. Department of Education, 2001). Furthermore, Title III of the No Child Left Behind (NCLB) Act required that all ELLs receive quality instruction for learning both English and grade-level academic content. The No Child Left Behind Title III LEP provisions outlined the guidelines for supplemental programs funding (Before School, After School, and Saturday Academy) specifically designed to assist ELLs with English language acquisition and the challenges of the academic content. Title III also allocated additional funding for immigrant students, whether ELLs or not, and translation and interpretation funds for parents and students. NCLB allowed local flexibility for choosing instruction programs while demanding greater accountability for ELLs' English language proficiency and academic progress.

Under Title III, states were required to develop English language proficiency standards and link those standards to the state's academic content standards. NCLB established the state's accountability system in which ELLs' academic progress was followed over time. NCLB required the following from states: (1) ELLs English proficiency must be tested at least once a year, (2) ELLs must be tested in English language arts and mathematics,(3) ELLs with less than a year in the U.S. are exempt from ELA assessment, (4) ELLs are allowed to take the content assessments in their native language, (5) teachers servicing ELLs must be certified as English language proficient and certified in other native languages for bilingual programs, (6) school districts were held accountable for ensuring that ELLs meet adequate yearly progress (AYP), (7) language instruction curricula used to teach ELLs must be scientifically based research and demonstrated to be effective, (8) flexibility for districts to choose the ELL instructional methodology, (9) states must establish standards and benchmarks for raising the level of English proficiency, (10) the district is legally accountable for notifying parents language acquisition progress, (11)and parents exercised their right to choose their preferred program -ESL or bilingual-(U.S. Department of Education, 2002).

According to researchers, despite the benefits NCLB intended for ELLs, the increased national testing and accountability mandates of the law resulted in several negative consequences, which included low high school graduation rates and high dropout rates (Gandara & Baca, 2008; Fry, 2008; Menken, 2010).

In December 2015, Every Student Succeeds Act (ESSA) was signed into law. Every Student Succeeds Act (U.S. Department of Education, 2016) reauthorizes the 1965 Elementary and Secondary Act to implement the overall goal of ensuring equal access to high-quality education for all students in the United States of America. The national implementation of specific guidelines for educational standards, assessment/ accountability measures, teacher quality, program innovation, and other vital educational areas is how our government expects every school district to achieve this goal. To that end, ESSA integrated ELLs for the first time in history in a system that holds all schools and districts accountable (American Federation of Teachers, 2016).

ESSA amplified Title III funding authorization levels recognizing that the percentage of ELLs is growing nationally. In addition, the law provisions ensure states and school districts implement and sustain high-quality education for English Language Learners, immigrant children, and youth, to attain content and language proficiency, specifically in English Language Arts and mathematics, as measured by academic standards. ESSA (2015) establishes fair accountability for ELLs by providing two options for delaying ELLs inclusion in the accountability systems while they are learning English: (1) One-time exemption for English Language Learners from the ELA state assessment (one year) not including the results of the ELA or both ELA and Math state assessments scores for accountability purposes or ; (2) Reporting the students' scores in the first year of student enrollment in the United States but excluding them from the accountability system on test reporting; for the second year of enrollment, include a measure of student growth on both state assessments; and for the third year of enrollment include proficiency on both state assessments in the accountability system (U.S. Department of Education, 2016). According to ESSA, states must establish clear identification/entrance and exit criteria to ensure ELLs receive the necessary support while learning English, even when they move between schools or districts. Furthermore, ESSA requires reporting the percentage of ELLs with disabilities and percentages of Long-Term ELLs considering students who have maintained the classification for five or more years (U.S. Department of Education, 2016).

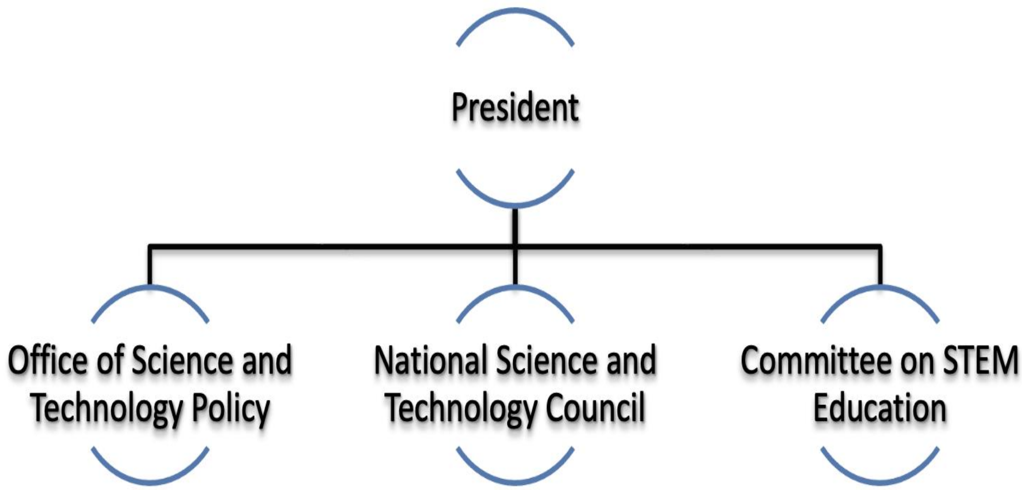
Overview of Legislation on STEM Education

There is a growing concern about our nation's scientific and technological proficiency; therefore, our government pays great attention to the relationship between STEM education and national prosperity. The PCAST (2012) policy report stated that the United States needed to produce one million more STEM specialists to maintain competitiveness over the next decade considering current projections. In addition, scholars have found that approximately 40 percent of college students majoring in STEM fields, especially underrepresented minorities, and women (Kassaee & Rowell, 2016), change their majors or do not finish their degrees (e.g., Chen & Soldner, 2013; Peterson et al., 2011).

Policymakers have recognized that our educational system is one of the significant sources of STEM knowledge and skills. For this reason, there is a sense of urgency to continue federal STEM education efforts to increase the nation's competitiveness worldwide. STEM components contribute to a well-rounded education that prepares English Language Learners with much-needed 21st-century skills to meet our country's labor demands. STEM education provides a forum for ELLs to improve their STEM efficacy laying the foundation for understanding real-world challenges and encouraging knowledge application which can increase employability in support of our country's labor demands. As shown below, the United States has a federal STEM policy administration structure to ensure STEM initiatives are accomplished.

Figure 2

Structure of Federal STEM Policy Administration (Washington DC, 2018).



Note: This figure represents how the STEM federal administration functions. The Office of Science and Technology Policy (OSTP) counsels on scientific matters and foreign policy (OSTP). The National Science and Technology Council (NSTC) manages science and policy at the federal government level (Science and Technology Act, 1997). However, educational initiatives and programs at the federal level are the obligation of NSTC's Committee on STEM Education (CoSTEM) (America COMPETES Reauthorization Act, 2010).

In 1950, the National Science Foundation Authorization Act established scientific research and education policy development and encouragement. NSF was recognized for providing the first fellowship for pre-and post-doctoral STEM students in 1952. In 1953, NSF began providing teacher institutes to improve STEM education in lower grades (Praeger, 1969). Although the president and congress changed the NSF, STEM education remained the agency's focus (Praeger, 1969).

In 1959, the National Defense Education Act was passed due to the Soviet Union's launch of Sputnik. The NDEA was created to deal with prevailing imbalances in the U.S. educational programs, which led to disproportions in educational opportunities in science, mathematics, modern foreign languages, and technology amongst our student population. (Jolly, 2019). The NDEA authorized the first federal state loan program focused on science, mathematics, and foreign language instruction. In addition, NDEA approved state grants to identify gifted and talented students of science and mathematics (Jolly, 2019).

In 1965, the Elementary and Secondary Education Act was established. The Elementary and Secondary Education Act had been the primary source of federal funding for education. In its inception, STEM education was not the act's primary focus. However, its recent amendments and reauthorizations, such as Every Student Succeeds Act of 2015, provide STEM-specific provisions to improve STEM education to close the STEM gap among minority populations (U.S. Department of Education, 2015).

Similarly, The Higher Education Act was passed in 1965. This act provided federal funding to higher education programs, assisting families with the high cost of postsecondary education. The HEA, reauthorized in 2008 by the Higher Education Opportunity Act, offered direct aid to students pursuing postsecondary degrees in STEM and other fields. Nevertheless, the Higher Education Reconciliation Act of 2005 provided a significant STEM-focused postsecondary program administered by the Department of Education. These amendments included the provision of a four-thousand-dollar grant to students majoring in STEM fields. The U.S. Department of Education awarded $1.4 billion in grants between 2006 and 2010. Congress provided a program sunset at the end of the 2010-2011 academic year (U.S. Department of Education, 2012).

In 1979, the Department of Education Organization Act was established as an independent federal agency. Section 304 of this act transferred science education programs established initially by the National Science Foundation to the Department of Education, such as the Elementary and Pre-school Science Teacher Training and Minority Institutions Science Improvement programs (96th Congress, Department of Education Act, 1980). However, the act maintained the NSF's authority to establish programs under the original act. Programs related to scientific career development, programs geared to amplify career participation, research, and development in science learning programs, as well as programs to inform the public about science and technology policy, were excluded from the transfer.

In 1984, the Education for Economic Security Act was instituted as a result of a series of publications highlighting that the United States was at risk due to the deplorable state of the nation's educational system and the growing concern about U.S. competitiveness in the international arena during the 1970s recession. During these times, Japan and Germany appeared to be at the forefront of scientific innovations (National Commission of Excellence in Education, 1983). The act provided federal funding to states and local STEM agencies for the professional development of teachers directed by the U.S. Department of Education and delivered by the National Science Foundation. In addition, it provided presidential awards for teaching science and mathematics (U.S. Department of Education, 1984).

In 2006, the Carl D. Perkins Career and Technical Education Act (109th congress S. 250, 2006) was instituted. This act is the primary federal law funding the development of career and technical education skills for students participating in secondary and postsecondary education. The Carl D. Perkins Career and Technical Education Act was instituted to improve academic preparedness/outcomes for higher education students or students enrolled in career and technical education programs. These programs include STEM occupational fields such as information technology and advanced manufacturing (109th Congress S. 250, 2006). In 2018, the Strengthening Career and Technical Education for the 21st Century Act reauthorized the Carl D. Perkins Career and Technical Education Act, which ended in the 2013 fiscal year. The Strengthening Career and Technical Education for the 21st Century Act offers more flexibility to states regarding annual performance targets and consequences for not meeting them (115th Congress, H.R. 2353, 2018).

In 2007, the America COMPETES Act was established and later reauthorized in 2010. The act instituted educational programs in multiple federal agencies, including the Department of Education and the National Science Foundation. Furthermore, the act outlines specific STEM educational provisions for NASA, the Department of Energy, and the National Oceanic and Atmospheric Administration. The reauthorization of 2010 improved original provisions and established the federal coordinating Committee on STEM Education (U.S. Department of Education, 2011).

In 2015, President Obama signed Every Student Succeed Act, which reauthorized the 1965 ESEA into law. ESSA amended previous reauthorizations. However, the most significant STEM change is the elimination of mathematics and science partnership programs. Under ESSA, STEM education is now an allowable expense in the new Title IV block grant, which indicates, "Provide all students with access to a well-rounded education." In addition, ESSA founded the STEM Master Teacher Corps program, which will grant professional development and salary bonuses to exemplary STEM teachers (Every Student Succeed Act, 2015).

In 2017, the American Innovation and Competitiveness Act was enacted. The law reauthorized parts of the America COMPETES Act, including provisions for federal investments in STEM education. The AICA increased the participation of underrepresented populations in STEM fields by directing the National Science Foundation to award grants for this goal. In addition, it established the interagency advisory panel and working group on STEM to guide the responsibilities of the National Science and Technology Council's Committee on STEM Education and the Office of Science and Technology Policy. Additionally, the law demanded that the National Science Foundation increase program grants for STEM education, including funding for computer science research, STEM apprenticeship opportunities, and the expansion of undergraduate research opportunities in the STEM field **(**117th Congress, H.R. 4221, 2012).

The Inspiring the Next Space Pioneers, Innovators, Researchers, and Explorers (INSPIRE) Women Act of 2017 established that NASA shall encourage women and girls to study and pursue careers in the STEM fields, specifically aerospace careers, with NASA's support. This support could be provided through existing programs such as NASA Girls, NASA Boys, the Summer Institute in STEM, and the Aspire to Inspire program (115th Congress H.R.321, 2018).

STEM Education

Science, technology, engineering, and mathematics (STEM) education has gained popularity as a strategy to improve ELLs' academic achievement and graduation rates. STEM is essential in our daily life and has a significant impact on the economy and the health of society (Bybee, 2010; Reed, 2018; Wang, 2013). STEM education has been found to be beneficial for ELLs as it promotes exploration, student engagement, and the capability for students to make real-world connections and experience individualized learning. STEM curriculum allows ELLs to experience increased inquisitiveness for learning as they explore relevant topics that affect their daily lives through research, multimedia text, and hands-on activities. STEM lessons use various modalities, such as visual, auditory, and kinesthetic, to assist ELLs with language acquisition and content-specific vocabulary. Making real-world connections in the learning process allows ELLs to understand the topic better. In addition, STEM individualized activities such as webinars allow each student to self-pace the lessons and repeat them until they understand the content and are ready to move on to the next academic level promoting independence and ownership of their learning.

STEM courses allow ELLs to gain the necessary skills faster when learning science and math compared to a traditional class setting due to the application of modalities and methodologies aligned to the mathematics and science Next Generation standards. Furthermore, ELLs improve their English language acquisition and content knowledge when encouraged to explore beyond the STEM lesson and apply what they have learned to their daily lives. Hands-on activities and real-world applications accomplish continuous engagement of ELLs in STEM courses.

STEM curriculum promotes STEM efficacy as ELLs acquire English through content. Federal legislation has been the driving force behind changes to promote equitable, culturally relevant ESL/ENL education for ELLs and STEM education. These changes are outlined in the Elementary and Secondary Education Act of 1965 and most recently amended and reauthorized by Every Student Succeed Act in 2015. In the 1965 original ESEA, STEM was not a significant focus. However, subsequent reauthorizations have added STEM-specific provisions (Every Student Succeed Act, 2015).

The Benefits of STEM Education on English Language Learners

In STEM courses, ELLs academic outcomes improve when language and academic concepts are taught simultaneously (Huerta, Dahl & Vo, 2022). Researchers have found that teaching the English language in STEM courses can be effectively done when teachers use cognitive strategies. For example, educators can teach STEM content vocabulary explicitly, provide speaking and writing opportunities in class, teach reading comprehension skills for non-fiction texts, provide the necessary scaffolds for language and content knowledge, and value the students' home language using it to support learning (Jackson, Huerta, & Garza, 2020). When educators teach language explicitly using sentence frames with ELLs discussing STEM content-specific concepts, they can reduce the complexity of the task to increase comprehension.

Sentence frames, which are scaffolds that accentuate the academic language related to content and syntax, help communicate critical concepts of the lesson. Sentence frames provide an opportunity for language practice preventing ELLs from struggling to retrieve the vocabulary and concepts, organizing information into coherent sentences facilitating their ability to explain essential concepts learned (Donelly & Roe, 2010; Fisher, Frey, & Ross, 2009). Sentence frames require teacher modeling/demonstration allowing students to build their capacity for meaningful instructional conversations as they use this effective tool. ELLs can benefit from having meaningful instructional conversations connecting their background knowledge to concrete experiences that can connect with abstract STEM concepts encouraging them to think critically to analyze and synthesize using language as a tool (Dray, Harris, Lobo, López-Leiva, Martínez de la Cueva & Aguilar-Valdez; Torres-Velásquez Westby, 2014). In addition, visual supports/scaffolds such as pictures, graphic organizers, charts, maps, and videos can reduce the load on the verbal working memory of ELLs in the STEM classroom.

STEM classrooms provide a unique setting through experiential learning in which ELLs can strive when they have many opportunities to speak and write, supported by structured communication activities such as flexible groupings, pair work, technology-assisted learning, and teacher and peer feedback. Cognitive self-regulation and learning are embedded in meaningful contexts with realistic, challenging, and open inquiry processes (Warren & Rosebery, 2008); demonstrations and continuous use of the discourse with learners are essential to understanding and using STEM practices (Roth & Lee, 2002) that develop STEM efficacy.

Shi (2017) will inform the current study by providing the only sample study focusing on English Language Learners' STEM course-taking and its impact on achievement and attainment. However, the current study will build on Shi's (2017) study by delineating to what extent is higher STEM efficacy related to STEM course-taking for ELLs and to what extent is higher STEM efficacy related to high school graduation for ELLs. While Shi studied college students' achievement and attainment, the current study will again build on this research by focusing on high school students STEM efficacy (mathematics and science) as independent variables. Like Shi, the current study will examine how STEM course-taking influences achievement and attainment.

Shi’s (2017) quantitative study on English Language Learners (ELLs) science, technology, engineering, and math (STEM) course-taking, achievement, and attainment in college examined the effects of demographic variables, high school math course-taking, and high school GPA on ELL students' STEM course-taking, achievement and attainment in college using data from a longitudinal study conducted by National Center for Education Statistics (NCES). A regression analysis revealed that female ELL students were more likely to take courses and obtain a higher high school GPA in STEM but less likely than males to earn a STEM college credential (Shi, 2017). Findings also revealed that race significantly predicted STEM GPA/attainment. Furthermore, the number of years taking trigonometry and pre-calculus in high school and high school GPA predicted the number of STEM courses and STEM GPA in college for ELLs students.

The current study's independent variables were informed by the work of Gray, Germuth, MacNair, Simpson, Sowa, and Walker (2019), who intended to demonstrate how nontraditional STEM learning builds STEM self-efficacy in ELLs. Gray et al. (2019) conducted a two-year case study in collaboration with the Guilford County School System to examine multi-modal, interdisciplinary approaches to engage English Language Learners (ELL)/Immigrants (Grades 3-8) in STEM learning to build STEM identity and self-efficacy. The study investigated whether and how nontraditional STEM learning methods based on investigation and communicative behaviors production can promote and broaden STEM identity and self-efficacy in ELLs, some of whom were immigrants (Gray, Germuth, MacNair, Simpson, Sowa, and Walker, 2016).ELLs/Immigrants participated in the UBEATS program, comprised of two one-week summer camps per year and a club meeting once-a-month for three-hour over two academic years at the Greensboro Science Center.

The UPBEATS program activities were created based on the BioMusic curriculum developed with a National Science Foundation STEM education grant in alignment with the Next Generation Science Standards ("UPBEATS," 2013). The program activities were designed to promote student participation in various instructional activities to learn how nature's acoustics influence human/animal conduct and communication. Students played games and engaged in scientific investigation using experimental music that amplifies nature sounds, such as animal sounds, to learn content concepts, including animal habitat, behavior, and adaptation. According to Gray, Germuth, MacNair, Simpson, Sowa, and Walker (2019), students were able to deepen their understanding of the musical brain as a neurological communication system awakening their creativity to create presentations and translate artifacts that sparked students' and parents' interest in STEM careers.

The study survey data revealed that 60% to 80% of ELLs/Immigrants that participated in the program acquired multifaceted understandings of the integration of animal behavior, animal communication, environmental factors, and issues related to conservation and sustainability. In addition, ELLs/Immigrant students developed fundamental scientific process skills to address questions about their animals, such as observations 75%, recording data 66%, writing about the animal 56%, reading about the animal 50%, and conducting research on the internet 41% (Gray et al., 2019). Attitudes towards science, ideas about what scientists do, and percentages about improved technology ranged from 77% to 84% in the second year. The most prevalent impact of the UBEATS program is that outcomes represent increased STEM interest and learning in alignment with developing self-efficacy as STEM learners and communicators (Gray, et al., 2019). In contrast to Gray et al.'s (2019) study, the current study will focus on high school students 'STEM course-taking and STEM efficacy in the context of mandated school's hours setting rather than supplemental programs such as summer camps in combination with hours of afterschool STEM instruction.

LaCosse et al. (2020) quantitative study investigated the impact of a social-belonging intervention on anticipated changes in belonging, STEM GPA, and proportion of STEM credits obtained by ELLs students' first semester and first year of college. Researchers used data from the College Transition Collaborative (CTC), which included 12,000 STEM-interested students randomly assigned to receive a brief, online social-belonging intervention (or active control materials). The social intervention for both standardized and customized social-belonging interventions group consisted of high school students reading stories about undergraduate students' transition to college. In addition, high school students answered an essay prompt related to feelings of belonging that emerged during the transition to college. The social-belonging intervention was delivered online before matriculation and was intended to increase the sense of belonging in ELLs students, which could lead to better STEM GPAs in ELLs first semester and first year of college. According to LaCosse et al. (2020), the customized version intervention solved students' transition challenges through focus groups. Intervention materials were the same for both the standard and the control groups.

The results of the study demonstrated simple effects of the interaction on ELL students, $b = 0.21$, $SE = 0.04$, $t\ (12{,}370) = 4.90$, $P < 0.001$, and non-ELL students, $b = 0.30$, $SE = 0.02$, $t\ (12{,}370) = 13.59$, $P < 0.001$ (LaCosse et al., 2020). Examination of the simple effects of the interaction indicated that ELLs students randomly assigned to the social-belonging intervention condition completed a higher proportion of STEM credits, $b = 0.02$, $SE = 0.01$, $t\ (11{,}900) = 2.92$, $P = 0.003$, compared to ELLs students in the control condition. In contrast, treatment effects were not present among non-ELL students, $b = -0.00$, $SE = 0.00$, $t\ (11{,}910) = -0.57$, $P = 0.567$(LaCosse et al.,2020). As it pertains to GPA, results demonstrated a significant main effect of social-belonging intervention condition, $b = 0.05$, $SE = 0.02$, $t\ (10{,}840) = 2.61$, $P = 0.009$. Students who received social-belonging intervention earned a significantly higher GPA than those in the control condition. Furthermore, the results yield a significant main effect of ELL status, $b = 0.13$, $SE = 0.02$, $t\ (10{,}850) = 6.18$, $P < 0.001$, to the extent that ELL students outperformed non-ELL students (LaCosse et al., 2020).

Shaw et al. (2014) conducted a mixed study to analyze the effect of the Effective Science Teaching for English Language Learners (ESTELL) project on science and literacy learning for ELLs. The ESTELL project aimed to prepare pre-service teachers to integrate science content with English language acquisition and literacy. Education faculty and nine teachers from four universities participated in the implementation of the ESTELL instructional framework, which focused on practices that promote science content learning, literacy, and language learning. The ESTELL instructional framework is based on the U.S. Department of Education Center for Research on Education Diversity and Excellence (CREDE) funded project (Doherty & Pinal, 2004; Hilberg, Tharp, & DeGeest, 2000) and the National Science Foundation science-language-literacy integration projects (Cervetti, 2007, Lee, 2008; Stoddart, Pinal et al., 2002). The nine teachers were trained and observed by university teacher supervisors to implement ESTELL instructional framework strategies.

Classroom observation data and the analysis of pre-service teachers revealed that ESTELL project pre-service teachers trained were significantly more knowledgeable of best instructional practices for ELLs using these practices more frequently in their student teaching practicum in comparison to the group of pre-service teachers in a 'business as usual attitude participating in the pre-service teacher education program (Stoddart & Mosqueda, 2013). This study's sample comprised 191 students from grades 3 through 6 who completed pre- and post-assessments. Forty-eight percent of the total student population were ELLs (N=92). Researchers employed three one-way ANOVAs to test for statistical differences in the Science Concepts, Science Writing, and Science Vocabulary gains among ELLs of diverse English language proficiencies (Shaw et al. 2014).

The results of the study revealed that students made statistically significant achievement gains. The pretest mean composite score was 35.07 from a possible 62 (SD = 11.82), and the post-test score was 41.25 (SD = 9.49), yielding an average gain of 6.18 points (SD = 7.55). This gain was statistically significant (p\.001, t = 9.08) with a corresponding effect size of .277 (Shaw et al., 2014). Disaggregated data demonstrated that Early/Advanced ELLs outperformed English-speaking students in science concepts and writing.

Proudfoot & Kebritch (2016) explored the influence of a scenario-based eLearning Mobile STEM Lab program on the STEM interest and achievement of fifth-grade students, including ELLs. This study's sample comprised twelve educators, including teachers, curriculum design experts, and administrators, who participated in a semi-structured interview. The educators were staff members from participating schools of the 17 STEM Lab programs (extension of the STEM curriculum), which provided services to 2,214 fifth graders for a year. The number of ELLs participating in the STEM Lab programs ranged from 15% - 63%, with an average of 24.12%. The goal of the Mobile STEM Lab was to connect students to the future through STEM experiences based on authentic scenarios that required the application of STEM content to solve problems.

The Mobile Lab/ 45-foot motor coach was equipped with seven interactive learning stations. These stations engaged students in hurricane-themed, standards-based learning. The topic was presented using technological tools such as multimedia and special effects to simulate a hurricane. The students were responsible for addressing the problem as community critical response teams (e.g., medical, and biological technology and geological, environmental, electrical, structural, and meteorological engineering). In this real-life simulation, students engaged in cooperative learning to create practical solutions. The results of this study established that students are more engaged in learning during STEM and non-STEM courses when scenario-based learning opportunities are integrated into the lesson. In addition, researchers found that scenario-based eLearning experience provides opportunities for students to develop leadership and collaborative skills that further prepare them for the workforce and college (Proudfoot & Kebritch, 2016). The results also revealed that teachers' knowledge of STEM represented a challenge for adequately implementing the Mobile STEM Lab program.

STEM Education and High School Graduation

STEM education has been found to be related to higher graduation rates. McKim, Velez, and Sorensen (2018) suggest that STEM programming (school-based agricultural education) can positively predict high school graduation for all students. In contrast, the current study will focus on STEM program/course-taking and STEM efficacy to improve ELLs' academic achievement and high school graduation.

McKim, Velez, and Sorensen (2018) conducted a study to explore the relationship between school-based agricultural education (SBAE) enrollment, graduation rates, STEM achievement, and income among a nationally representative sample of secondary school students (N=15,362). Scholars used national data to analyze relationships between SBAE enrollment, graduation rates, postsecondary science, technology, engineering, and mathematics (STEM) achievement, and income explored from an ecological systems perspective (McKim, Velez & Sorensen, 2018). A regression analysis was done using data from the National Center for Educational Statistics Educational Longitudinal Study (ELS: 2002-2012), initially collected from 2002 to 2012. Results of the study revealed that school-based agricultural education (SBAE) students were likely to be of lower socio-economic status white male compared to students not enrolled in SBAE. SBAE enrollment was a positive, statistically significant predictor of high school graduation. In addition, the study demonstrated that students enrolled in school-based agricultural education (SBAE) were 1.16 times more likely to graduate high school than students not enrolled in SBAE (McKim et al. 2018). In the analysis of STEM achievement, school-based agricultural education (SBAE) enrollment was a statistically significant, negative predictor of postsecondary science, math, and overall STEM GPA. Regarding income, each additional Carnegie unit of SBAE was linked to $1,850.67 additional annual income for high school graduates and $457.40 for postsecondary graduates (McKim et al. 2018).

Oemig and Baptiste (2018) investigated the development of science-literate identities from a multicultural perspective. This qualitative case study examined the academic engagement and perceptions regarding the science literacy practices of high school students participating in the Engaging Latino Communities in Education (ENLACE) program. The purpose of the ENLACE program was to increase Latina/o high school graduation rates and students with college admissions requirements. Students were enrolled in diverse science classes to fulfill college admission requirements for graduation. The purpose of the study was to answer the following research questions: What kind of science classroom learning environment supports science-literate identities for ENLACE students? What does multicultural education mean for the science classroom? (Oemig & Baptiste, 2018). The sample of this study consists of 30 students' perceptions of their science practice (N=30). Researchers used Banks's (2016) five dimensions of multicultural education as an interpretative lens to conduct focus group interviews and observations of science classrooms during an academic semester. To evaluate science instruction, the researchers used a K-12 Science Education Framework that promotes engaging students' practices to investigate, communicate and evaluate information (National Research Council, 2012). The study's findings revealed that when Latina/o students are engaged in meaningful laboratory investigations and inquiry activities and when the teaching resembles that of culturally responsive instruction, they are more likely to develop a science-literate identity (Oemig & Baptiste, 2018).

Bicer, Lee, and Perihan (2020) conducted a phenomenological study to understand school factors influencing ethnic minority students' STEM preparation in Inclusive STEM High Schools. The researchers used semi-structured interviews with Hispanic and African American participants (N=13), which included forty-six percent of ELLs. The STEM High School experiences of participants based on the interviews were classified into the following nine categories: (1) Innovative STEM and non-STEM instruction, (2) Rigorous STEM curriculum, (3) Integration of technology and engineering in classrooms, (4) Quality of teachers, (5) Real-world STEM partnership, (6) Informal STEM opportunities, (7) Academic and social support for struggling students, (8) Emphasis on STEM courses, majors, and careers, (9) Preparation for a college workload. The researchers intended to answer the following research question: Which Inclusive STEM High School factors did postsecondary students from ethnic minority populations retrospectively associate with their preparation for a STEM major?

The result of the study revealed that Inclusive STEM High Schools (five) in Texas provide high-quality educational models that integrate technology into STEM and non-STEM classrooms, as proved by the nine categories that emerged from the interviews (Bicer et al. 2020).

Relationship Prior Research and Present Study

The current study intents to extend previous research on STEM and English Language Learners' achievement and attainment. Researchers in this field have suggested a need for future research on the benefits of STEM education and ELLs (Oemig & Baptiste, 2018; Shi, 2017). School districts must prepare high school students, including ELLs, with the necessary 21st-century skills to fulfill the United States of America's STEM education and career demands as we support our country in maintaining its lead in a global economy. STEM fields are considered the fastest-growing jobs in the United States of America (Santiago, 2017), with a projection of over 2 million STEM job openings by 2024, according to the U.S. Bureau of Labor Statistics (Fayer, 2017). However, researchers have found that U.S. schools are not producing qualified graduates to fill STEM jobs, and 40 percent of college students majoring in STEM fields, significantly underrepresented minorities, and women, change their majors or do not finish the degree (e.g., Chen & Soldner, 2013; Peterson et al., 2011). In addition, English Language Learners are considered the fasted growing student population in the United States. According to the National Education Association, by 2025, an estimated 25 percent of public-school students will be ELLs (NEA, 2018), and secondary school ELLs are overlooked and underserved (Menken, 2013).

Prior scholarship has called for research examining STEM education's benefits on English Language Learners. The current study will examine the benefits of STEM education on high school ELLs. Specifically, I would analyze to what extent is higher STEM efficacy related to STEM course-taking of ELLs is related to high school graduation.

The current study will also address the shortcomings of previous scholars by focusing on high school English Language Learners, a population that is often overlooked and underserved (Menken, 2013). Addressing shortcomings in previous literature and expanding on prior studies, this study will contribute to the research in ELL education. Furthermore, this research will provide evidence-based insights into STEM education's benefits for high school ELLs and inform future practices and policies for the education of English Language Learners.

CHAPTER 3

Introduction

The purpose of this chapter is to discuss the research methods for this quantitative correlational study. Creswell (2002) explains that quantitative correlational research establishes whether two or more variables are related. Statistical tests employed in the correlational research approach identify patterns/relationships among variables. The quantitative correlational research imparts a better understanding of how STEM education may improve English Language Learners' academic achievement and high school graduation. To that end, I analyze to what extent STEM course-taking and STEM efficacy relate to English Language Learners' high school graduation.

This chapter will explain the quantitative correlational study as a research design and describe the independent, dependent, and categorical variables employed in the present research. The study's validity, reliability, and trustworthiness will be discussed, followed by an explanation of the sample population, which consists of nationally representative data from the High School Longitudinal Study of 2009 (NCES, 2022). Then, the data analysis will be explained, specifying why two Independent Sample T-Tests, a Chi-square test of independence, a multivariate linear regression, and a logistic regression are the appropriate analytical approach.

Methods and Procedures

Research Questions

1. To what extent do English Language Learners differ from non-English learners in STEM course-taking?

2. To what extent do English Language Learners differ from non-English learners in and high school graduation?

3. To what extent do English Language Learners differ from non-English learners in STEM efficacy?

4. To what extent is higher STEM efficacy related to STEM course-taking for English Language Learners?

5. To what extent is higher STEM efficacy related to high school graduation for English Language Learners?

Hypotheses

H_0 1: The means of the two populations (ELLs and non-ELLs) are equal.

H_1 1: The means of the two populations (ELLs and non-ELLs) are not equal.

H_0 2: There is no association between high school graduation and student type.

H_1 2: There is an association between high school graduation and student type.

H_0 3: The means of the two populations (ELLs and non-ELLs) are equal.

H_1 3: The means of the two populations (ELLs and non-ELLs) are not equal.

H_0 4: βp-1 =0 There is no statistically significant relationship between higher STEM efficacy and STEM course-taking.

H_1 4: βi $\neq$ 0 At least one of the independent variables helps explain/predict Y (number of STEM courses).

H_0 5: β =0 There is no statistically significant relationship between higher STEM efficacy and high school graduation.

H_1 5: $\beta \neq 0$ There is a statistically significant relationship between higher STEM efficacy and high school graduation.

Research Design

This study sought to answer the question, "To what extent can Science, Technology, Engineering, and Mathematics (STEM) Education improve English Language Learners' academic achievement and high school graduation?”. The current quantitative correlational research study aims to describe a correlation between STEM education and the high school graduation of ELLs. According to Anderson and Arsenault (1998), the correlational quantitative research method falls within the positivism paradigm. Correlational quantitative research comprises explaining phenomena by collecting quantitative data based on precise measurements using structured and validated data-collection instruments involving statistical reports with correlations, comparisons of means, and statistical significance of findings (Given, 2008; Johnson & Christensen, 2008).

The current study involves analyzing nationally representative data from the High School Longitudinal Study of 2009 (HSLS:09). The longitudinal study was sponsored by the National Center for Education Statistics (NCES) of the Institute of Education Sciences, U.S. Department of Education, with additional support from the National Science Foundation (NCES,2011). The current study involved examining the independent variables of student type (ELLs and Non-ELLs) and STEM efficacy, in addition to the covariates of gender and socio-economic status, to examine their effect on the dependent variables of STEM course-taking and high school graduation. Table 1 shows the type of analysis for each research question, the independent and dependent variables, and the covariates.

Table 1

Variables for Each Research Question and Type of Analysis

RQ	Analysis Type	Variables
1	Independent Sample T-Test	DV= STEM Course-Taking IV= Student Type (non-ELLs/ELLs)
2	Chi-Square	DV=High School Graduation IV= Student Type (non-ELLs/ELLs)
3	Independent Sample T-Test	DV=STEM Efficacy IV= Student Type (non-ELLs/ELLs)
4	Multivariate Linear Regression	DV= STEM Course-Taking IV= STEM Efficacy Covariates: SES, Gender
5	Logistic Regression	DV=High School Graduation IV=STEM Efficacy Covariates: SES, Gender

There are two independent variables for this study. The first one is the student type which is comprised of English Language Learners and non-English Language Learners. The second independent variable is STEM efficacy, which is a combination of mathematics and science efficacy variables from the HSLS:09 longitudinal study data set. The mathematics efficacy variable (X1MTHEFF) is a sample member's mathematics self-efficacy scale. The variable was created through factor analysis by students (W1STUDENT) standardized to a mean of 0 and standard deviation of 1 (NCES,2013).

These factors included student efficacy questions regarding mathematics assessments, use of instructional materials, mathematics skills, and other self-efficacy components (S1MTEST, S1TEXTBOOK, S1MSKILLS, and S1MASSEXCL). Respondents that provided a complete set of responses were assigned a value.

Students who indicated they were not taking mathematics classes were removed from the current study data analysis. The coefficient alpha reliability for the scale is .65 (NCES,2013).

The science efficacy variable (X1SCIEFF) is also a sample member's science self-efficacy scale. The variable was created through factor analysis by students (W1STUDENT) standardized to a mean of 0 and standard deviation of 1 (NCES,2013). These factors included efficacy for science assessments, use of instructional materials, mathematics skills, and other self-efficacy components (S1MTEST, S1MTEXBOOK, S1MSKILLS, S1MASSEXCL) (NCES 2013). Like the mathematics efficacy, respondents who provided complete responses were assigned a value. As previously mentioned, students who did not take science classes will be removed from the current study data analysis. The coefficient alpha reliability for the science efficacy scale is .65 (NCES,2013). These two variables were combined to form one STEM efficacy variable.

The study utilizes two covariates for external variance: socio-economic status and gender. The HSLS:09 socio-economic status (SES) was constructed in the function of the following components/variables of the parent survey of the longitudinal study: (1) level of the highest education among parent (s), (2) the education level of the other parent. (3) the highest occupation prestige score, (4) the occupation prestige score of the other parent, and (5) family income. The gender covariate encompasses two groups, male and female (NCES 2013).

The dependent variables for the current study are STEM course-taking, high school graduation, STEM efficacy, and ELLs. For more information about the dependent variables aligned with each research question, please refer to Table 1 of this section.

Data Analysis Method

This study employed five statistical tests to answer each dissertation question and address five hypotheses. An independent sample T-test was implemented to explore differences between non-ELLs and ELLs STEM course-taking. To investigate the possibility of a statistically significant difference between ELLs and non-ELLs high school graduation, a Chi-Square test of independence with a $p < .05$ was performed. An independent sample T-test was conducted to examine differences in STEM efficacy between ELLs and non-ELLs.

In addition, multivariate linear regression analysis, which allows us to compare coefficients across outcomes, was conducted to explore STEM course-taking predictability related to STEM efficacy. Hierarchical regressions were performed to measure the unique contribution of independent variables (STEM efficacy, student type) to verify if they explain the socio-economic status and gender covariates.

Furthermore, a logistic regression analysis was performed to investigate the degree to which higher STEM efficacy relates to English Language Learners' high school graduation. For this study, the alpha level will be set to .05 to reach a large effect size as recommended by Maxwell (Pearson's r = .50) and a statistical power level of .80 accounting for potential independent variables interaction effects (Maxwell, 2000).

Reliability and Validity of the Research Design

Statistical Validity

The current study met the criteria for statistical power using an alpha level of .05, a large effect size (Pearson's r = .50), and a statistical power level of .80. The number of participants will consist of 546 ELLs for research questions four and five. However, for research questions one, two, and three, the number of participants consists of the entire HSLS:09 data set, which is over 23,000 participants. The current study uses reliable measures of the dependent variables as the quantitative data being analyzed is obtained from a nationally representative High School Longitudinal Study of 2009 (HSLS:09). The are no assumptions of reliability and validity violations in this data.

Internal Validity

The School Sample HSLS:09 is a two-stage random sample design longitudinal study (2009-2012) with primary sampling units defined as schools selected in the first stage and students randomly selected from the sampled schools within the second stage Mau, W-C &LI (2018). A total of 944 to 1,889 eligible schools participated in the base year resulting in a 55.5 percent weighted response rate or 50.0 percent unweighted (NCES, 2022).

The HSLS:09 target population included in the base year, regular public schools, and public charter schools as well as private schools in the 50 States and the District of Columbia providing instruction to students in both the 9th and 11th grades as of the fall of 2009 (NCES, 2022).

The longitudinal study excluded Schools without a 9th and 11th grade, special education schools for students with disabilities, Bureau of Indian Affairs schools, Career Technical Education (CTE) schools that do not enroll students directly, Department of Defense schools located outside the United States, and Juvenile correction/detention facilities (NCES, File Documentation Report, 2013).

External Validity

This current study has robust external validity due to the large sample size (N=546). One thousand eight hundred eighty-nine schools were part of the nationally representative High School Longitudinal Study of 2009 (HSLS:09) with 23,000 plus student participants. Considering these participants represent the data used in this current study, the results can be generalizable to the entire ELL population of the United States of America, as substantiated by the results of research question two.

The Sample Population

The sample population for the current study consists of a subset of 546 students identified as English Language Learners from the High School Longitudinal Study of 2009 (HSLS:09) for research questions three and four (NCES,2013). However, for research questions one, two, and three, the number of participants will consist of the entire HSLS:09 data set.

The Longitudinal Study involved two follow-ups, the first in 2012 and the second in 2016. The entire data set of the nationally represented data comprised a two-stage random sample design. More than 23,000 students from High Schools in fifty states were randomly selected and followed throughout their secondary and postsecondary years

(NCES, 2022). Thus, the findings are generalizable to the high school student population of the United States of America.

Instruments and Procedures for Collecting Data

The National Center for Education Statistics collected the data set used for the current study. Instruments used for the nationally representative High School Longitudinal Study (HSLS:09) involved student assessment results for 9^{th}, and 11th grades focused on algebraic skills, reasoning, and problem-solving. In addition, the databases included the content areas course-taking for each participant, high schools' GPA/ graduation, postsecondary information including transcripts, student demographics, socio-economic status, measures to establish students' mathematics and science efficacy, and more (NCES, 2022). Furthermore, the longitudinal study included interviews and responses to surveys of students, their parents, science and mathematics teachers, school counselors, and school administrators (NCES, 2022).

Research Ethics

The National Center for Education Statistics establishes the following measures to ensure participant and data collection integrity. To protect participant confidentiality, the National Center for Education Statistics does not identify students by name. Quality control measures for data collection included real-time live monitoring of data collection interviewers, monitoring of recorded interviews, and quality circle meetings for data collection staff. Additionally, field interview verification and frequent meetings to discuss possible areas of data collection protocols and systems improvement (NCES Data File Documentation Report, 2018). The HSLS:09 data collection design included the following structures. Three interested subgroups were established: (1) Subgroup A-high school late/alternative/non-completers. These students were still enrolled in high schools as of the 2013 longitudinal study update and completed high school late as a result of receiving alternative credentials or dropout episodes with unknown completion status (NCES, 2018). (2) Subgroup B-the ultra-cooperative respondents' members who participated in the base year (2009) and were considered high school completers by the 2013 longitudinal study update. (3) Subgroup C- was comprised of high school completers and students with an unknown completion status, including completers that were not identified as ultra-cooperative because they graduated early and were not identified as having a dropout occurrence (NCES Data File Documentation Report, 2018).

The longitudinal study quality control was solidified by establishing that subgroups of interest could have the following customized interventions: phases for data collection with parallel intervention, models of predictable response likelihood to maximize the project resource efficiently and to prevent bias for nonresponse utilized to identify interventions sample cases and, the use of a calibration sample identified eight weeks in advance to test the effectiveness in order to properly plan for experimental intervention (NCES Data File Documentation Report, 2018).

Conclusion

The purpose of this chapter was to explain the selected methodology employed to answer each research question. An in-depth discussion illustrated the quantitative correlational design procedures for data collection, data analysis, reliability, internal and external validity, and research ethics. Chapter four will demonstrate and discuss the methodology described in this chapter.

CHAPTER 4

Introduction

This chapter explains the results of the analysis conducted for the current study to answer the following research questions:

Research Questions

1. To what extent do English Language Learners differ from non-English learners in STEM course-taking?
2. To what extent do English Language Learners differ from non-English learners in and high school graduation?
3. To what extent do English Language Learners differ from non-English learners in STEM efficacy?
4. To what extent is higher STEM efficacy related to STEM course-taking for English Language Learners?
5. To what extent is higher STEM efficacy related to high school graduation for English Language Learners?

The current study analyzed nationally representative data from the High School Longitudinal Study of 2009 (HSLS:09) (NCES,2023). The results were examined using five statistical models aligned with each research question. To investigate the possibility of a statistically significant difference between ELLs and Non-ELLs (independent variable) in STEM course-taking (dependent variable), and STEM efficacy (dependent variable), two independent sample T-tests with a $p < .05$ were performed.

A chi-square test of independence was also implemented to examine differences in high school graduation (dependent variable) between ELLs and non-ELLs (independent variable). In addition, a multivariate linear regression analysis was conducted to explore STEM course-taking (dependent variable) predictability related to STEM efficacy (independent variable). Furthermore, a logistic regression analysis was performed to examine how STEM efficacy (independent variable) relates to ELLs' high school graduation (dependent variable). The gender and socio-economic status variables were also considered in both regression analyses to investigate the possibility of any relationship between these variables, ELLs' STEM efficacy, STEM course-taking, and high school graduation.

Results

This chapter begins with explaining procedures implemented to ensure data accuracy. All variables used for this study were re-coded and cleaned using SPSS to ensure missing cases did not affect the accuracy of results. The variable student type consisted of 21,928 cases, of which 21,382 were non-ELLs, and 546 were ELLs, as shown in the descriptive statistic table 2. The student type variable was coded 0=non-ELLs and 1=ELLs for data interpretation. The variable of STEM course-taking represented 21,928 cases and consisted of the number of STEM credits each student took. The values of the STEM course-taking variable range from 0 STEM credits to 16 STEM credits as a maximum possibility.

The original high school graduation composite variable from the High School Longitudinal Study (HSLS:09) was re-coded to delete missing cases and to tailor it to the focus of the current study. The current study's high school graduation variable consists of

23,503 cases. The high graduation variable is comprised of two values:0=Did not graduated and 1=graduated.

The value of 1 includes students who graduated by fulfilling each state's required high school credits, students who passed the Tests of General Educational Development (GED), certificates of attendance, and other high school equivalents. The value of 0 comprises students who dropped out, status unknown, and students who were still enrolled during the HSLS:09 2016 second follow-up.

The variable STEM efficacy was created for the current study. The STEM efficacy variable is a combination of the mathematics and science students' efficacy variables original to the High School Longitudinal Study (HSLS:09) of the National Center for Education Statistics. The students' mathematics and science efficacy scale values were added to obtain 16,119 valid cases for the STEM efficacy variable of the current study. As described in the descriptive statistics table 2, the values of STEM efficacy range from -5.83 to a maximum of 3.45.

The socio-economic status and gender variables codes are original to the High School Longitudinal Study (HSLS:09) of the National Center for Education Statistics. There were 21,444 valid cases for the SES variable, and values ranged from -1.93 to 2.88. The socio-economic value assigned to each student is an average number related to the family education, occupation, and income (NCES, 2023). The gender variable with 23,497 (11,973 males and 11,524 females) cases is coded as 1=Male and 2=females.

Table 2

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Student Type	21928	.00	1.00	.0249	.15582
STEM Course Taking	21928	.00	16.00	7.4730	2.68630
High School Graduation	23503	.00	1.00	.8478	.35917
STEM Efficacy	16119	-5.83	3.45	.1079	1.66839
SES	21444	-1.93	2.88	.0541	.78030
Gender	23497	1.00	2.00	1.4904	.49992
Valid N (listwise)	15107				

Table 3

Student Type Descriptive Statistics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Non-ELLs	21382	91.0	97.5	97.5
	ELLs	546	2.3	2.5	100.0
	Total	21928	93.3	100.0	
Missing	System	1575	6.7		
Total		23503	100.0		

Research Question 1

Six assumptions were considered to conduct the independent sample t-test, ensuring an appropriate statistical test. The first assumption establishes that the dependent variable of STEM course-taking is measured on a continuous scale (0-16 credits). The second assumption asserts that the independent variable (student type) consists of two categorical independent groups (non-ELLs and ELLs).

The third assumption presents the fact that there is the independence of observations between the two groups constituting the independent variable (non-ELLs and ELLs), considering I have different participants in each group. For the fourth assumption, the box plots shown in Appendix B for non-ELLs and ELLs demonstrate that no significant outliers are contained in the model.

For the fifth assumption, which consists of the normal distribution of the dependent variable (STEM course-taking) for each group of the independent variable (student type), I took into consideration whether the absolute skewness value for both non-ELLs and ELLs was between -2 and +2 in conjunction with observing the absolute value of kurtosis was between -7 and +7. The previous measure was explored considering the Kolmogorov-Smrinov, and Shapiro-Wilk tests may be unreliable because the sample size is larger than 300 participants. As demonstrated in Appendix C, the independent variable groups (non-ELLs and ELLs) fulfilled the criteria previously mentioned. Furthermore, the two-histogram representation in Appendix C shows a normal distribution for both groups of the independent variable (non-ELLs and ELLs). For this reason, the fifth assumption was also met.

The sixth assumption demonstrates homogeneity of variances. As shown in table 4, equal variances were not assumed, considering that Levene's test significance was less than .05. Levene's test for homogeneity of variances was violated in the present analysis, F (1, 566.617) =33.708, p=<.001. Owing to this violated assumption, an independent sample t-test, not assuming homogeneity of variance, was computed, considering that the large sample size would yield accurate results.

An independent samples t-test was performed to address the research question of the extent to which ELLs differ from non-ELLs in STEM course-taking. The sample for research question two consisted of 21,382 non-ELLs and 546 ELLs, constituting valid cases for the STEM course-taking variable. When comparing ELLs and non-ELLs, the results revealed that there were significant differences t (566.62) =5.21, $p < 0.05$) in the STEM course-taking scores, with the mean for non-ELLs (M=7.49, SD=2.67, N = 21,382) being higher than the mean score of ELLs (M=6.80, SD=3.05, N=546). The magnitude of the difference in means (means difference= 0.69, 95% confidence interval was 0.49 to 0.95) was significant. Hence, the alternative hypothesis that the two populations had no equal means was supported, as demonstrated in table 4.

Table 4

STEM Course-Taking by Student Type

Parameter	Non-ELLs		ELLs		t (566.617)	p	Cohen's d
	M	SD	M	SD			
Course-Taking	7.49	2.67	6.80	3.05		<.001	2.68

Note: Mean parameter values for the analysis is shown for non-ELLs (*n* = 21,382) and ELLs (*n* = 546), as well as the results of *t* tests (assuming unequal variance) comparing the parameter between the two-student type.

Research Question 2

A chi-square test of independence was conducted to address the research question of the extent to which ELLs differ from non-ELLs in STEM high school graduation. The sample for research question two consisted of 21,382 non-ELLs and 546 ELLs. When comparing the frequency of high school graduation in ELLs and non-ELLs, a significant difference was found ($\chi 2$ (1), N = 21,928) = 166.353, $p < .05$). The analysis revealed that ELLs were less likely to graduate (69.2 %) than non-ELLs (87.8%), as shown in Table 5. Consequently, the alternative hypothesis was supported, which indicates an association between high school graduation and student type (ELLs and non-ELLs).

Table 5

High School Graduation by Student Type

		Student Type		Total
		Non-ELLs	ELLs	
High School Graduation	Did not graduate	2606	168	2774
		12.2%	30.8%	12.7%
	Graduate	18776	378	19154
		87.8%	69.2%	87.3%
Total		21382	546	21928
		100.0%	100.0%	100.0%

χ^2 (1) = 166.353, p = .001, $p < .05$.

Research Question 3

Six assumptions were considered to conduct another independent sample t-test for the third model. The first assumption establishes that the dependent variable of STEM efficacy is measured on a continuous scale (scores range between - 5.83 to 3.45). The second assumption asserts that the independent variable (student type) consists of two categorical independent groups (non-ELLs and ELLs).

The third assumption establishes the independence of observations between the independent variable groups (non-ELLs and ELLs), considering each group has different participants. The fourth assumption asserts that there are no significant outliers, as shown in the box plots of non-ELLs and ELLs in Appendix D.

For the fifth assumption, which consists of the normal distribution of the dependent variable (STEM efficacy) for each group of the independent variable (student type), I took into consideration that the absolute values of skewness and kurtosis for both non-ELLs and ELLs considering the Kolmogorov-Smrinov and Shapiro-Wilk test may be unreliable due to samples size being are larger than 300 participants.

In addition, histograms to demonstrate the normal distribution of data were created. The absolute value of skewness was between -2 and +2, and the absolute value of kurtosis ranged from -7 to +7. Furthermore, the histograms in Appendix E demonstrate a normal distribution for non-ELLs and ELLs. Consequently, the fifth assumption of normal distribution was met. The sixth assumption demonstrates homogeneity of variances. As shown in Table 6, this assumption was met $F(1, 15105) = 1.749$, $p = .186$, considering Levene's test significance was greater than .05. For this model, all assumptions were met.

An independent samples t-test was performed to address the research question of the extent to which ELLs differ from non-ELLs in STEM efficacy. The sample for research question two consisted of 14,872 non-ELLs and 235 ELLs, constituting valid cases for the STEM efficacy variable. When comparing ELLs and non-ELLs, the results revealed that there were significant differences $t(15105) = 3.02$, $p < .05$) in the STEM efficacy scores, with a mean for non-ELLs ($M = .124$, $SD = 1.67$, $N = 14{,}872$) being higher than the mean score of ELLs ($M = -.207$ $SD = 1.57$, $N = 235$). The magnitude of the difference in means (means difference= 0.33, 95% confidence interval was .166 to .541) was significant. Hence, the alternative hypothesis that there were no equal means between the two populations was supported, as demonstrated in table 6.

Table 6

STEM Efficacy by Student Type

Parameter	Non-ELLs		ELLs		t (15105)	p	Cohen's d
	M	SD	M	SD			
STEM Efficacy	.124	1.67	-.207	1.57		.001	1.666

Note: Mean parameter values for the analysis is shown for non-ELLs (*n* = 14,872) and ELLs (*n* = 235), as well as the results of *t* tests (assuming equal variance) comparing the parameter between the two-student type.

Research Question 4

Five assumptions were considered to ensure that the multilinear regression analysis was appropriate. As demonstrated in Appendix F by scatterplots, there is a positive linear relationship between STEM efficacy, socio-economic status (SES), and STEM course-taking. In addition, Appendix F shows a linear relationship that establishes no correlation between gender and STEM course-taking. Consequently, assumption #1 of the linear relationship is met.

Assumption two of no multicollinearity was also met, as shown in the coefficients table in Appendix F, as represented by the variable inflation factor (VIF) values being one, which means no predictor variables are highly correlated with each other. The third assumption of independence was met, considering observations are independent of each other. The fourth assumption of homoscedasticity was reached, as evidenced by the scatterplot of standardized residuals versus predicted values of the models depicted in Appendix F. The fifth assumption was satisfied, as demonstrated by the model's histogram in Appendix F, which shows that residuals are normally distributed.

A multiple linear regression analysis was conducted to address the research question of to what extent higher STEM efficacy is related to STEM course taking for ELLs. The analysis was conducted with 546 cases from the student type variable, representing the ELLs. The dependent variable for the analysis is STEM course-taking, and the independent/predictor variable is STEM efficacy. In addition, the socio-economic status and gender variables were considered as possible predictors of STEM course taking in the multilinear regression analysis.

A multiple linear regression analysis was conducted to address the research question of to what extent higher STEM efficacy is related to STEM course-taking for ELLs. The analysis was conducted with 546 cases from the student type variable, representing the ELLs. The dependent variable for the analysis is STEM course taking, and the independent/predictor variable is STEM efficacy. In addition, the socio-economic status and gender variables were considered as possible predictors of STEM course taking in the multilinear regression analysis. The results of the multiple linear regression revealed that gender and socio-economic status were not statistically significant predictors of STEM course-taking for ELLs. However, the results revealed a statistically significant association between STEM efficacy and STEM course-taking ($p < .05$).

A significant regression was found (F (3, 231) =4.513, $p < .01$, with R^2 of .235. The model predicts that STEM course-taking equals B=6.742+.335 (STEM efficacy), where STEM efficacy is a scale value of students' math and science efficacy combined. The model suggests that ELLs' STEM courses increased by .335 for one unit increase in STEM efficacy. The regression results shown in table 7 indicate that the STEM efficacy predictor explained 5.5 % of the variance (R^2=.055) in the STEM course-taking variable.

The multilinear regression analysis demonstrates that ELLs with higher STEM efficacy have higher STEM credits. Consequently, the alternative hypothesis that STEM efficacy helps explain/predict STEM course-taking is supported.

Table 7

Model Summary for RQ4

Predictors	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95.0% Confidence Interval for B Lower Bound	95.0% Confidence Interval for B Upper Bound
Constant	6.742	.566		11.918	<.001	5.627	7.856
Gender	.293	.349	.054	.839	.402	-.395	.981
SES	.334	.246	.089	1.359	.175	-.150	.818
STEM Efficacy	.335	.114	.194	2.947	.004	.111	.559

R	R Square Adjusted	R Square	Std. Error of the Estimate	Sum. of Squares	df	Mean Square	F	Sig.
.235	0.055	0.043	2.667	9799.41	3	32.059	4.513	.004

χ^2 (3) =11.329, $p<.05$, Dependent Variable: STEM Course-Taking

Research Question 5

A logistic regression analysis to investigate to what extent is higher STEM efficacy related to high school graduation of ELLs was implemented. In order to conduct the analysis, 546 cases from the student type variable were selected, representing the original number of ELLs for the analysis. However, the final analysis only included 235 ELLs, considering 311 of the 546 were missing information when running the logistic regression analysis, including the high school graduation, STEM efficacy, SES, and gender variables. High school graduation constitutes the dependent/outcome variable, and STEM efficacy is the independent variable/predictor of the analysis. In addition, the socio-economic status and gender variables were considered possible predictors of high school graduation for the analysis.

Six assumptions were considered for the logistic regression. The first assumption of binary response was established by the values of the high school dependent variable (did not graduate=0, graduated=1). The second assumption of independence of observation was accomplished, considering the observations in the dataset are independent of each other. The third assumption of no multicollinearity was reached, as shown in the coefficients table in Appendix G, and represented by the variable inflation factor (VIF) values. The VIF values of one indicate that predictor variables are not correlated with each other.

The fourth assumption was accomplished considering a logistic regression assumes no extreme outliers in the data set. The fifth assumption was met as the logistic regression assumes that a linear relationship exists between the independent/explanatory variable and the logit of the dependent/response variable. The sixth and last assumption of a sufficiently large sample was also accomplished because the sample of this model consisted of 546 ELLs.

The logistic regression results revealed that socio-economic status and gender were not predictors of high school graduation for ELLs. However, the logistic regression was statistically significant $\chi 2$ (3) =11.329, $p<.05$ for STEM efficacy. The model suggests that ELLs' graduation rate increased by .282 for one unit increase in STEM efficacy. The model explained 7.1% (Nagelkerke R^2) of the variance in high school graduation and correctly classified 74.4% of cases. Hence, the alternative hypothesis that there is a statistically significant relationship between STEM efficacy and high school graduation of ELLs was supported as shown in table 8 (model summary).

Table 8

Model Summary for RQ5

Predictors	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B) Lower	Upper
STEM Efficacy	.282	.108	6.743	1	.009	1.325	1.071	1.639
Gender	.197	.320	.379	1	.538	1.218	.650	2.280
SES	.317	.230	1.906	1	.167	1.374	.875	2.155
Constant	1.167	.518	5.068	1	.024	3.211		

Test	-2 Log Likelihood	Cox & Snell R Square	Nagelkerke R Square	Chi-Square
	242.010	.047	.071	11.329

$\chi 2$ (3) =11.329, $p<.05$, Dependent Variable: High School Graduation

Conclusion

This chapter contained the results of the following analyses: two independent sample t-tests, a chi-square test of independence, a multivariate regression, and a logistic regression. These analyses were aligned with each research question to investigate the role of science, technology, engineering, and mathematics (STEM) efficacy for course taking and high school graduation of ELLs.

The chi-square test of independence results revealed a statistically significant association between STEM course-taking and student type (non-ELLs, ELLs). Non-ELL students are more likely to take STEM courses than ELL students. In addition, the chi-square test of independence disclosed a statistically significant association between high school graduation and student type (non-ELLs, ELLs). Non-ELLs are more likely to graduate high school than ELL students.

As a researcher, I wanted to investigate if other aspects influence ELLs' STEM efficacy and high school graduation. For this reason, the covariates' socio-economic status and gender were included in both regression models (multivariate and logistic).

These independent variables were not statistically significant predictors of ELLs' STEM course-taking and high school graduation. In contrast, one of the main findings was the statistically significant relationship between STEM efficacy and STEM course-taking of ELLs for model 4 (multivariate linear regression). The multivariate linear regression model established that higher STEM efficacy is directly related to higher ELL STEM course-taking.

The second main finding was the statistically significant relationship between STEM efficacy and high school graduation of ELLs for model 5 (logistic regression). The logistic regression confirmed that ELLs with higher STEM efficacy are more likely to graduate high school.

Chapter 5 will discuss the implications of the finding and their relationship to prior research. In addition, chapter five will explain the study's limitations and implications for future practice and studies.

CHAPTER 5

Introduction

This quantitative correlational study examines if STEM Education improves English Language Learners' academic achievement and high school graduation. In particular, it highlights the difficulties English Language Learners face in high schools regarding quality education that allows them to graduate on time and attend college. This chapter begins with a discussion of the significant findings related to the self-efficacy component of Albert Bandura's Social Cognitive Theory (Bandura, 1977), and its significance for ELLs education in the context of STEM programs presented in Chapter two. In addition, this chapter will discuss the connections between the study's essential findings and findings from prior research. Furthermore, this chapter will conclude with a discussion of the current study's limitations, recommendations for future research, and a summary.

Implication of Findings

High school graduation can be affected by many variables. However, this study focused on four variables to establish differences between non-ELLs and ELLs in STEM course-taking and high school graduation. In addition, the primary analysis focused on determining if STEM education/STEM efficacy improves the high school graduation of ELLs. The five variables used in this study were STEM efficacy, STEM course-taking, student type (non-ELLs and ELLs), socio-economic status, and gender. Two variables yielded positive results. Those variables were student type and STEM efficacy.

STEM Efficacy and STEM Course-Taking

The opportunity gap between non-ELLs and ELLs necessitates the development of methodologies/strategies to address the disparities between ELLs and non-ELLs. The study's results revealed a statistically significant difference in STEM course-taking, with non-ELLs taking over 7.49 STEM credits on average compared to ELLs, who took 6.80 STEM credits on average. In addition, the study revealed that the average score for STEM efficacy for non-ELLs was higher (.124) than that for ELLs (-.207).

However, the current study demonstrated that ELLs with higher STEM efficacy take more STEM credits and have a greater possibility of graduating high school. An essential factor to notice is that socio-economic status was not a predictor of STEM course-taking. Regardless of ELLs' socio-economic status, STEM efficacy is the most important predictor of STEM course-taking in the model. Furthermore, the results of this study established that one unit increase in 9th-grade STEM efficacy was related to a about a third of a credit increase in STEM credits for ELLs. Consequently, our schools must integrate reading and language acquisition skills into STEM subjects to develop STEM efficacy that results in ELLs' academic achievement and attainment.

In the last decades, several researchers have demonstrated that mastering academic language is vital to the success of ELL students in mathematics and science (Abedi, 2002; Kieffer, 2008; Minicucci, 1996; Short, 2017; Tong et al., 2014). According to Ajayi (2005), Herrera (2010), Lesaux et al., (2014), many school districts in the United States focus on implementing scripted literacy programs that deliberately focus on phonics and fluency to address ELL academic needs rather than considering language development through content.

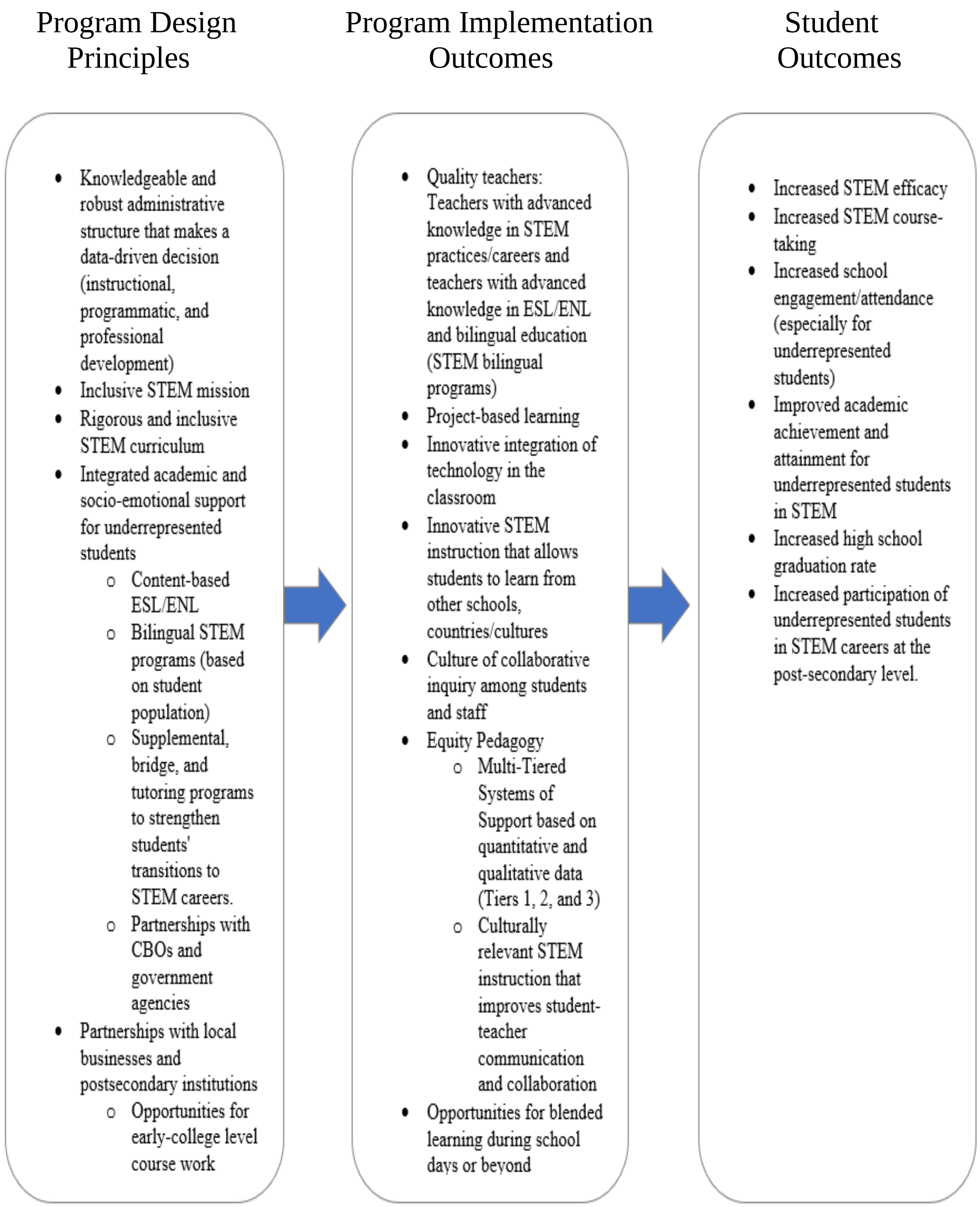
To develop STEM efficacy in ELLs, schools must consider implementing nontraditional STEM methods to investigate, communicate and evaluate information utilizing a multicultural approach, including content integration, the knowledge construction process, prejudice reduction, an equity pedagogy, and empowering school culture and social structure.

STEM Efficacy and High School Graduation of ELLs

Historically, high-quality education for ELLs that allows them to graduate on time has been challenging. The current national graduation rate of English Language Learners is 69.9 % compared to 84% general student population (U.S. Department of Education, NCES, 2017). According to researchers, many factors influence the ability of ELLs to succeed academically and graduate on time. Among those factors, effective STEM education, which prepares students with 21st-century skills such as conducting research, creating, synthesizing, analyzing, hypothesizing, and solving real-world problems, plays an important role (Watson, 2016). In alignment with the national graduation rate, the current study reveals that ELLs graduate at a lower rate (69.2 %) than non-ELLs (87.8%). In addition, the study demonstrates that STEM efficacy was a significant predictor of the high school graduation of ELLs. It is essential to mention that socio-economic status was not a predictor of high school graduation for ELLs. Therefore, the study establishes that ELLs are more likely to graduate regardless of socio-economic status when they have higher STEM efficacy. Considering the results of the current study, I propose the following Inclusive STEM program model to promote STEM efficacy for ELLs from a multicultural perspective.

Figure 3

Inclusive STEM Program Model



Note: This figure of my creation represents an inclusive STEM program model that meets the needs of underrepresented students, including ELLs. The inclusive STEM program model includes program design principles, program implementation outcomes, and student outcomes.

The inclusive STEM program model comprises non-negotiable program design principles as a foundation of a school that is committed to all students' success. These non-negotiable program principles design aligns with federal educational legislation/policy discussed in chapter two, which were created to provide equitable educational opportunities to underrepresented students such as ELLs. The program design principles are also based on extensive research discussed in chapter two (literature review) and the results of the current study. The STEM program model also explains a list of expected program implementation outcomes due to the fruitful enactment of the STEM program design principles. In addition, the inclusive STEM program design describes the desired student outcomes resulting from executing a robust, inclusive STEM program.

Relationship to Prior Research

The current study's major findings support and extend prior research studies in STEM and English Language Learners' achievement and attainment while addressing the research gap by focusing on high school ELLs, a population often overlooked and underserved (Menken, 2013). Prior research in STEM education and ELLs have focused on the elementary level, supplemental programs, and postsecondary education. However, this is the first time to my knowledge that STEM education, and high school ELLs have been studied with a large sample. Most STEM research studies include all students and may use socio-economic status to predict high school graduation. Nevertheless, the current study found that for ELLs, socio-economic status was not a predictor of high school graduation. Variables in this study that produced significant results were student type and STEM efficacy.

This study found that high school ELLs with higher STEM efficacy have higher STEM credits regardless of their socio-economic status. In addition, the current study found that STEM efficacy was a significant predictor of high school graduation for ELLs. Consequently, educators and policymakers should consider implementing inclusive STEM programs that develop the STEM efficacy of ELLs in order to increase graduation rates.

Shi's (2017) work informed the current study by providing the only study focusing on English Language Learners' STEM course-taking and its impact on achievement and attainment. However, the current study builds on Shi's (2017) study delineating to what extent higher STEM efficacy relates to STEM course-taking for ELLs and to what extent higher STEM efficacy relates to high school graduation for ELLs.

Shi's study revealed that female ELL students were more likely to take courses and obtain a higher high school GPA in STEM, but less likely than males to earn a STEM college credential (Shi, 2017). The study also revealed that race significantly predicted STEM GPA/attainment in college. Furthermore, the number of years taking trigonometry and pre-calculus in high school and high school GPA predicted the number of STEM courses and STEM GPA in college for ELLs. In alignment with the current study, STEM course-taking impacted ELL achievement. Unlike Shi's study, gender was not a predictor of high school graduation in the current study.

Congruently with Gray et al.'s (2019) study, the current study establishes that effective STEM instruction develops STEM efficacy in ELLs. Gray et al. (2019)

conducted a two-year case study in collaboration with the Guilford County School System to examine multi-modal, interdisciplinary approaches to engage English Language Learners (ELL)/Immigrants (Grades 3-8) in STEM learning to build STEM identity and self-efficacy. The study investigated whether and how nontraditional STEM learning methods based on investigation and communicative behaviors production can promote and broaden STEM identity and self-efficacy in ELLs, some of whom were immigrants (Gray et al., 2016).

The current study's independent variables were informed by the work of Gray, et al. (2019), who intended to demonstrate how nontraditional STEM learning builds STEM self-efficacy in ELLs. The study revealed that 60% to 80% of ELLs/Immigrants that participated in the UBEATS supplemental program acquired multifaceted scientific understandings, including animal communication, environmental factors, and issues related to conservation and sustainability. The most prevalent impact of the UBEATS program is that outcomes represent increased STEM interest and learning in alignment with developing self-efficacy as STEM learners and communicators (Gray et al., 2019). The current study extended Gray et al., (2019) study by focusing on high school students STEM course-taking and STEM efficacy in the context of mandated school hours setting rather than supplemental programs such as summer camps in combination with hours of afterschool STEM instruction.

In alignment with Bicer, Lee, and Perihan's (2020) study, the current study established that inclusive STEM education benefits underrepresented students. Bicer, Lee, and Perihan (2020) conducted a phenomenological study to understand school factors influencing ethnic minority students' STEM preparation in Inclusive STEM High

Schools. The researchers used semi-structured interviews with Hispanic and African American participants (N=13) enrolled in STEM college programs. Forty-six percent of participants were ELLs.

The result of the study revealed that Inclusive STEM High Schools (five) in Texas provide high-quality educational models that integrate technology into STEM and non-STEM classrooms, as proved by the following nine categories: (1) Innovative STEM and non-STEM instruction, (2) Rigorous STEM curriculum, (3) Integration of technology and engineering in classrooms, (4) Quality of teachers, (5) Real-world STEM partnership, (6) Informal STEM opportunities, (7) Academic and social support for struggling students, (8) Emphasis on STEM courses, majors, and careers, (9) Preparation for a college workload. The current study extends Bicer, Lee, and Perihan's research by utilizing a nationally representative sample of 546 ELLs and examining specific aspects of STEM, such as STEM course-taking and STEM efficacy.

In alignment with the current study, Oemig and Baptiste (2018) suggest that when secondary-level students engage in meaningful laboratory investigations and inquiry activities and the teaching resembles that of culturally responsive instruction, they are more likely to develop scientific identity. However, Oemig and Baptiste (2018) investigated only one aspect of STEM: developing science-literate identities from a multicultural perspective. The qualitative case study examined the academic engagement and perceptions regarding the science literacy practices of 30 high school students participating in the Engaging Latino Communities in Education (ENLACE). The ENLACE supplemental program focused on increasing Latina/o high school graduation rates and students with college admissions requirements.

In contrast, the current study extends Oemig and Baptiste's (2018) research by conducting quantitative correlational research with a sample of 546 ELLs focusing on STEM efficacy/STEM course-taking to improve high school graduation. Unlike Oemig and Baptiste (2018), the current study proposes a robust, inclusive STEM program during the day to develop STEM efficacy, leading to higher STEM course-taking and higher STEM graduation for ELLs.

The current study supports the work of Proudfoot & Kebritch (2016), who explored the influence of a scenario-based eLearning Mobile STEM Lab program on the STEM interest and achievement of fifth-grade students, including ELLs. The goal of the Mobile STEM Lab was to expose students to real-world problem-solving scenarios that required the application of STEM content.

This study was accomplished through semi-structured interviews of twelve educators that were staff members from participating schools of the 17 STEM Lab programs (extension of the STEM curriculum). Educators provided services for a year to 2,214 fifth graders including an average of 24.12% ELLs participants. The results of this study revealed that students are more engaged in learning during STEM and non-STEM courses when scenario-based learning opportunities are integrated into the lesson.

Similar to the current study, Proudfoot & Kebritch (2016) affirm that STEM real-world scenarios integrated into the lesson develop leadership and collaborative skills that further prepare them for the workforce and college (Proudfoot & Kebritch, 2016). The current study extends Proudfoot & Kebrit's work utilizing a larger national representative sample of high school ELLs in a quantitative analysis addressing the research gap by examining STEM efficacy's effects on STEM course-taking and its impact on high school graduation.

Limitation of the Study

The quantitative research design used in this study was conducted with nationally representative data from a longitudinal study (HSLS:09) whose base year was 2009, a first follow-up in 2012, and a second follow-up in 2016. Utilizing data that is a few years old constitutes a limitation of the study. If available, future research should be considered with the most recent nationally representative data.

While the statistical analysis results were robust due to a large sample size, the analysis could not provide context regarding inclusive STEM programs environment and perceptions of STEM efficacy. To this end, more credibility could be given to the current study with a mixed method design that comprises a qualitative component. Interviews with administrators, teachers, and ELL students can help ascertain the results of this study. For example, this study proved that STEM efficacy was a statistically significant predictor of STEM course-taking and high school graduation of ELLs. Semi-structured interviews and observations results could have provided more insights into the activities and strategies that help develop STEM efficacy in high school ELLs.

In addition, interviews with administrators, teachers, and students could help understand essential characteristics of effective inclusive STEM programs that support underrepresented students, including structural and instructional design. Having an in-depth analytical understanding of the contribution of STEM education to high school ELLs' achievement and attainment can inform future educational policy to close the opportunity gap between ELLs and non-ELLs.

Implications for Future Research

Additional research on high school ELLs and STEM education is necessary to inform research-based instructional practices and policies that improve ELLs' achievement and attainment. Employing a mixed-method design would allow researchers to collect quantitative and qualitative data on the benefits of STEM education for high school ELLs. The impact of STEM efficacy can be perceived as a phenomenon of extraordinary effects on ELLs' graduation rates.

Future research could include a more thorough investigation of STEM efficacy when the variable comprises other STEM subjects beyond science and mathematics. In addition, future research can explore characteristics of effective inclusive STEM programs to address the needs of underrepresented students, including ELLs. Possible correlations between ELL education, teacher preparation in STEM subjects, teacher preparation in content-based English as a Second Language/English as a New Language (ESL/ENL), and characteristics of inclusive STEM high schools are areas where further research is warranted.

Additionally, certain STEM-focused high schools that offer bilingual STEM courses have demonstrated higher graduation rates than traditional high schools in the New York City Department of Education. Future research could examine potential correlations between ELL achievement and bilingual STEM education. Considering the extensive research on the benefits of bilingual education and the benefits of STEM education, this could be an exciting and promising investigation. Such research could include a comparison between STEM programs that do not offer bilingual courses, bilingual STEM programs, and traditional high schools and their impact on ELLs' high school graduation.

Subsequent research can also investigate possible connections between culturally relevant STEM education for high school ELLs and teacher cultural biases. Semi-structured interviews and observations with school administrators, teachers, and students can expand our knowledge about culturally relevant STEM education that increases STEM efficacy and STEM course-taking. A mixed-method study could incorporate teacher perceptions/attitudes about ELLs and culturally relevant STEM education. Banks' (1995) five dimensions of multicultural education **(**content integration, the knowledge construction process, prejudice reduction, an equity pedagogy, and empowering school culture and social structure) should be considered as a lens for interpretation results. As each of these factors could potentially affect the high school graduation of ELLs, further investigation of possible correlations is necessary.

Implications for Future Practice

This study found that STEM efficacy was a key predictor for STEM course-taking and high school graduation for ELLs regardless of students' socio-economic status and gender. This study demonstrated that ELLs with higher STEM efficacy take more STEM credits, leading to a greater possibility of graduating high school. The results of this study can inform future policy, changes in instructional practices for high school ELLs, and changes in inclusive STEM program design.

STEM efficacy comes from prior knowledge and learned skills. Therefore, we must consider developing STEM efficacy in ELLs at an early age. Albert Bandura (1986) established that students learn self-efficacy at home. For this reason, districts/schools must consider training ELL parents to foster a culture of active and inquisitive learning at home. Parents can assist their children with making real-world connections in daily conversations, tapping into their curiosity. For example, parents can ask their child, "why do you think triangular shapes can be found in construction and bridges?" fostering their critical thinking. Parents can then elaborate on their response, explaining that triangular shapes provide structural strength in geometry.

Albert Bandura (1986) also explained that school is the primary location where students develop their cognitive efficacy and gain problem-solving and other skills necessary to function in society. Consequently, districts/schools should implement an inclusive STEM curriculum that allows ELLs to experience increased inquisitiveness for learning as they explore relevant topics that affect their daily lives through research, multimedia text, and hands-on activities. STEM lessons are comprised of several modalities, such as visual, auditory, and kinesthetic, assisting ELLs with language acquisition and content-specific vocabulary. When ELLs make real-world connections, they can better understand the topic. In addition, student self-paced STEM individualized activities such as webinars allow students to self-pace the lessons and repeat them until they reach content understanding and are ready to move on to the next academic level. In this regard, self-paced lessons/ activities from a robust, inclusive STEM curriculum promote independence and ownership of learning, resulting in the development of STEM efficacy.

Education policy can be amended to ensure inclusive STEM high schools follow the inclusive STEM program model depicted in figure 3 of this chapter to promote STEM efficacy for ELLs from a multicultural perspective. To this end, policymakers, school districts, and high schools can benefit from learning and implementing the proposed inclusive STEM program model. The STEM inclusive program model proposed in this study considers the challenges our high school ELLs face that influence their ability to graduate on time. These factors include taking high-stakes state exams (Regents) in all content areas and fulfilling an established amount of course credits while learning a second/new language.

The model considers the five dimensions of multicultural education as an anchor for efficacious academic and socio-emotional support to high school ELLs while outlining other structural research-based supports, program implementation outcomes, and student outcomes necessary to address the needs of our diverse ELL population. The five dimensions of multicultural education include content integration, the knowledge construction process, prejudice reduction, an equity pedagogy, and an empowering school culture and social structure (Banks, 1995). These dimensions are integrated into all aspects of the inclusive STEM program model, including the importance of equity pedagogy and content-based ESL/ENL to promote best practices for ELL instruction and district/school structural supports that lead to the development of high STEM efficacy in ELLs.

The results of this study reinforce the benefits of STEM education for ELLs (Shi, Qi, 2017; Oemig & Baptiste,2018; Velez & Sorensen, 2018; LaCosse, Canning, Bowman, Murph, Logel, 2020). According to the results of this study, higher STEM efficacy related to STEM course-taking of ELLs results in increased high school graduation. At the district level, many superintendents with a large population of ELLs are debating whether to focus on strategies, multi-tiered system of support (MTSS), STEM education, or bilingual education. However, it is imperative to understand that a holistic approach that includes all these components, such as inclusive STEM programs or bilingual inclusive STEM programs (when the school has the population as per policy), can yield better results when addressing our culturally and linguistically diverse ELL population.

Conclusion

The National Education Association estimated that by 2025, 25 percent of public-school students would be ELLs (NEA, 2018). As previously mentioned, the current national graduation rate of English Language Learners is 69.9 % compared to 84% general student population (U.S. Department of Education, NCES, 2017). In alignment with the national graduation rate, the current study reveals that ELLs graduate at a lower rate (69.2 %) than non-ELLs (87.8%). Furthermore, STEM fields are considered the fastest-growing jobs in the United States of America (Santiago, 2017), with a projection of over 2 million jobs in STEM by 2024, according to the U.S. Bureau of Labor Statistics (Fayer, 2017). However, researchers have found that U.S. schools are not producing qualified graduates to fill STEM jobs, and 40 percent of college students majoring in STEM fields, significantly underrepresented minorities and women, change their majors or do not finish the degree (e.g., Chen & Soldner, 2013; Peterson et al., 2011).

This study examined the benefits of STEM education on high school ELLs. Specifically, it analyzed the extent to which higher STEM efficacy relates to higher STEM course-taking that leads to high school graduation. This study demonstrates that STEM efficacy was a significant predictor of high school graduation for ELLs. The study's results demonstrated that socio-economic status was not a predictor of high school graduation for ELLs. Therefore, the study establishes that ELLs are more likely to graduate regardless of socio-economic status when they have higher STEM efficacy. Addressing shortcomings in previous literature and expanding on prior studies, the current study contributes to the research in ELL education. Furthermore, this research provides evidence-based insights into STEM education's benefits for high school ELLs and informs future practices and policies for the education of English Language Learners.

The results generated by this study should not be seen as a criticism of our educational system but rather serve to highlight areas needing improvement. This study should inform schools and districts where support is needed to improve ELLs' academic achievement and attainment. Districts and schools are responsible for preparing high school students, including ELLs, with the necessary 21st-century skills to graduate college and career ready. Moreover, educators and policymakers are responsible for assisting the United States of America's STEM education and career demands, supporting our country in maintaining its lead in a global economy.

APPENDIX A St. John's University IRB Memo

ST. JOHN'S UNIVERSITY

Federal Wide Assurance: FWA00009066

Mar 13, 2023 7:17:28 AM EDT

PI: Yazmin Torres
CO-PI: Stephen Kotok
Dept: The School of Education, Ed Admin & Instruc Leadership

Re: Initial - IRB-FY2023-203 *THE ROLE OF SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) EFFICACY FOR COURSE-TAKING AND HIGH SCHOOL GRADUATION OF ENGLISH LANGUAGE LEARNERS*

Dear Yazmin Torres:

The St John's University Institutional Review Board has rendered the decision below for *THE ROLE OF SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) EFFICACY FOR COURSE-TAKING AND HIGH SCHOOL GRADUATION OF ENGLISH LANGUAGE LEARNERS* .

Decision: Exempt

PLEASE NOTE: If you have collected any data prior to this approval date, the data must be discarded.

Selected Category: Category 4. Secondary research for which consent is not required: Secondary research uses of identifiable private information or identifiable biospecimens, if at least one of the following criteria is met:

(i) The identifiable private information or identifiable biospecimens are publicly available;

(ii) Information, which may include information about biospecimens, is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained directly or through identifiers linked to the subjects, the investigator does not contact the subjects, and the investigator will not re-identify subjects;

(iii) The research involves only information collection and analysis involving the investigator's use of identifiable health information when that use is regulated under 45 CFR parts 160 and 164, subparts A and E, for the purposes of "health care operations" or "research" as those terms are defined at 45 CFR 164.501 or for "public health activities and purposes" as described under 45 CFR 164.512(b); or

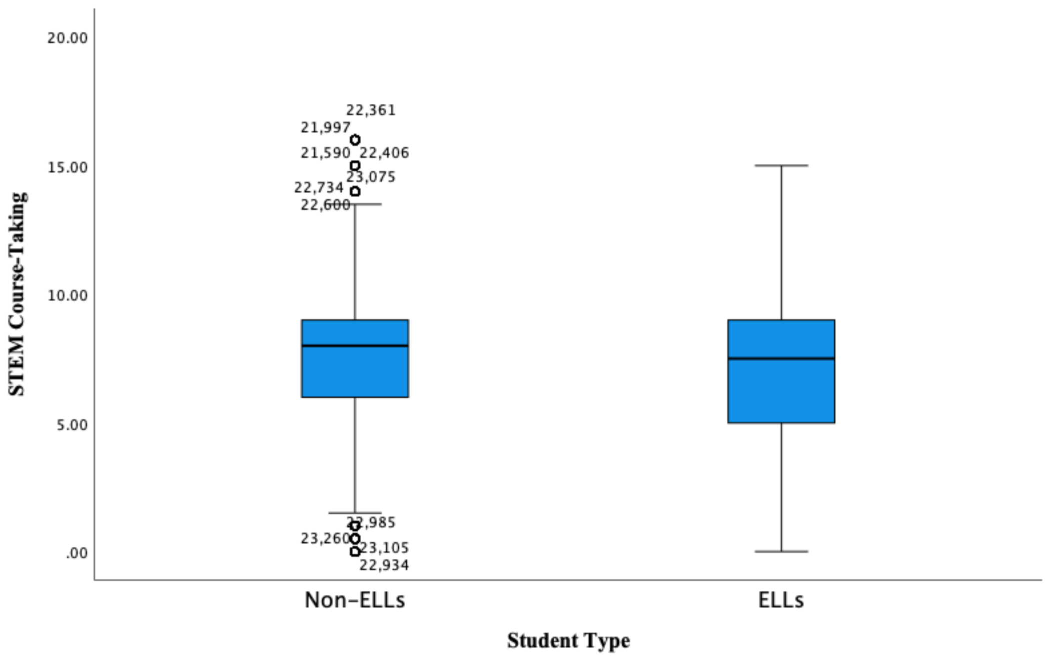
(iv) The research is conducted by, or on behalf of, a Federal department or agency using government-generated or government-collected information obtained for nonresearch activities, if the research generates identifiable private information that is or will be maintained on information technology that is subject to and in compliance with section 208(b) of the E-Government Act of 2002, 44 U.S.C. 3501 note, if all of the identifiable private information collected, used, or generated as part of the activity will be maintained in systems of records subject to the Privacy Act of 1974, 5 U.S.C. 552a, and, if applicable, the information used in the research was collected subject to the Paperwork Reduction Act of 1995, 44 U.S.C. 3501 et seq.

Sincerely,

Raymond DiGiuseppe, PhD, ABPP
Chair, Institutional Review Board
Professor of Psychology

APPENDIX B STEM Course-Taking and Student Type Outliers Box Plots

Independent Sample T-test Assumption #4: No Significant Outliers



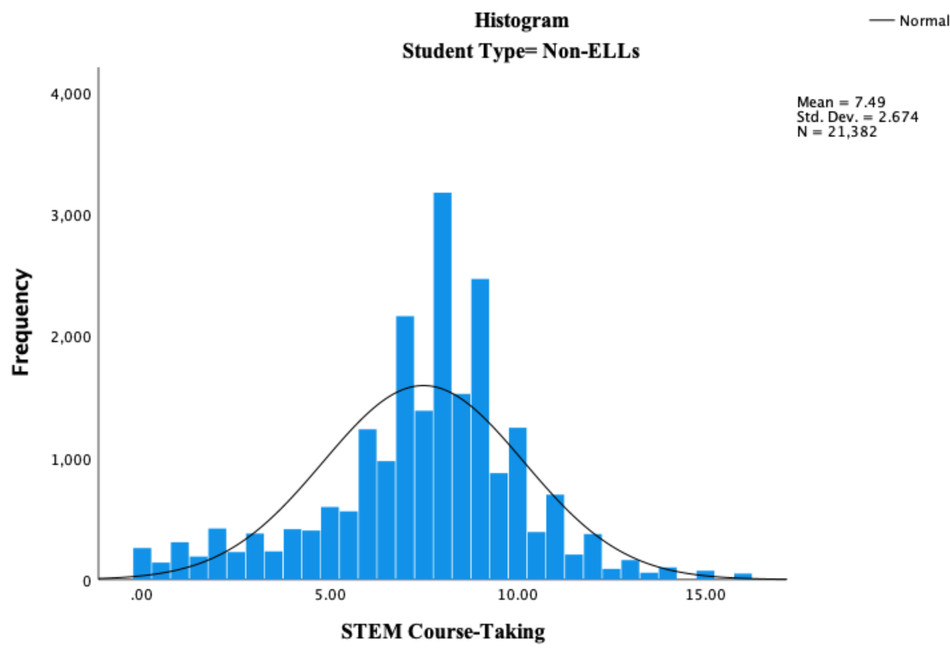
APPENDIX C STEM Course-Taking and Student Type Descriptive Statistics

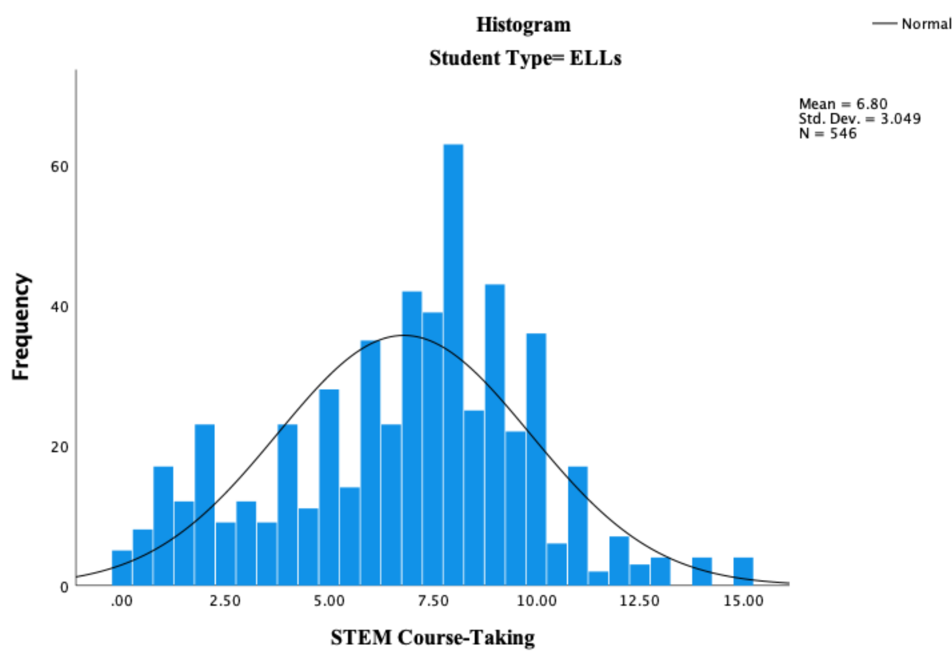
Independent Sample T-Test Assumption #5-Normality

Descriptive Statistics

	Student Type			Statistic	Std. Error
STEM Course-Taking	Non-ELLs	Mean		7.4901	.01829
		95% Confidence Interval for Mean	Lower Bound	7.4543	
			Upper Bound	7.5260	
		5% Trimmed Mean		7.5607	
		Median		8.0000	
		Variance		7.152	
		Std. Deviation		2.67428	
		Minimum		.00	
		Maximum		16.00	
		Range		16.00	
		Interquartile Range		3.00	
		Skewness		-.515	.017
		Kurtosis		.816	.033
	ELLs	Mean		6.8031	.13049
		95% Confidence Interval for Mean	Lower Bound	6.5468	
			Upper Bound	7.0594	
		5% Trimmed Mean		6.8120	
		Median		7.5000	
		Variance		9.296	
		Std. Deviation		3.04901	
		Minimum		.00	
		Maximum		15.00	
		Range		15.00	
		Interquartile Range		4.00	
		Skewness		-.230	.105
		Kurtosis		-.233	.209

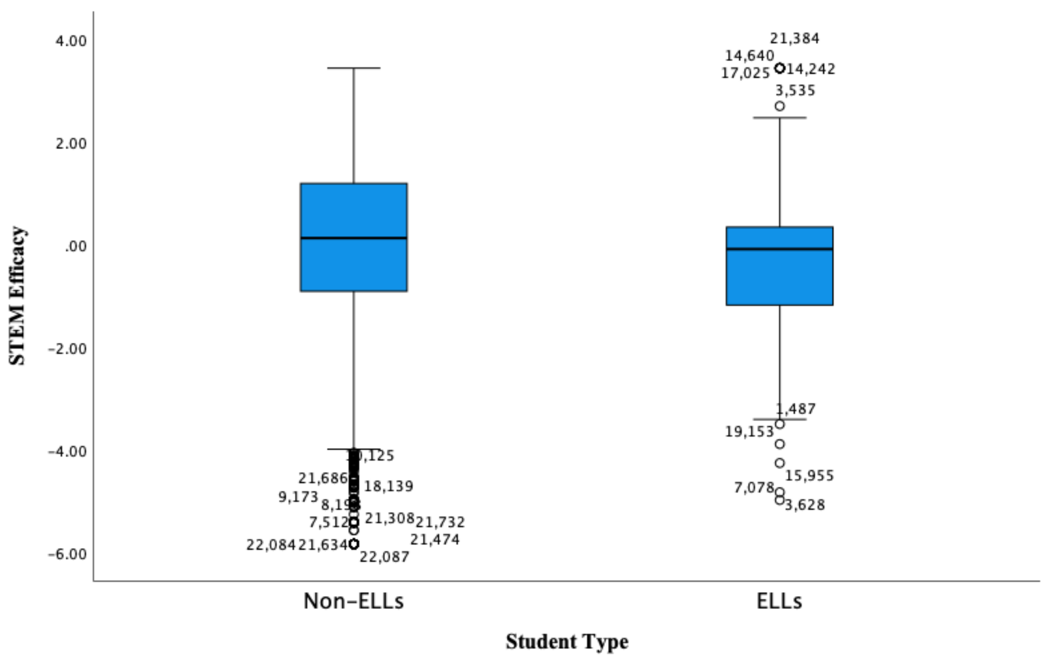
Histograms for non-ELLs and ELLs





APPENDIX D STEM Efficacy and Student Type Outliers Box Plots

Independent Sample T-test Assumption #4: No Significant Outliers



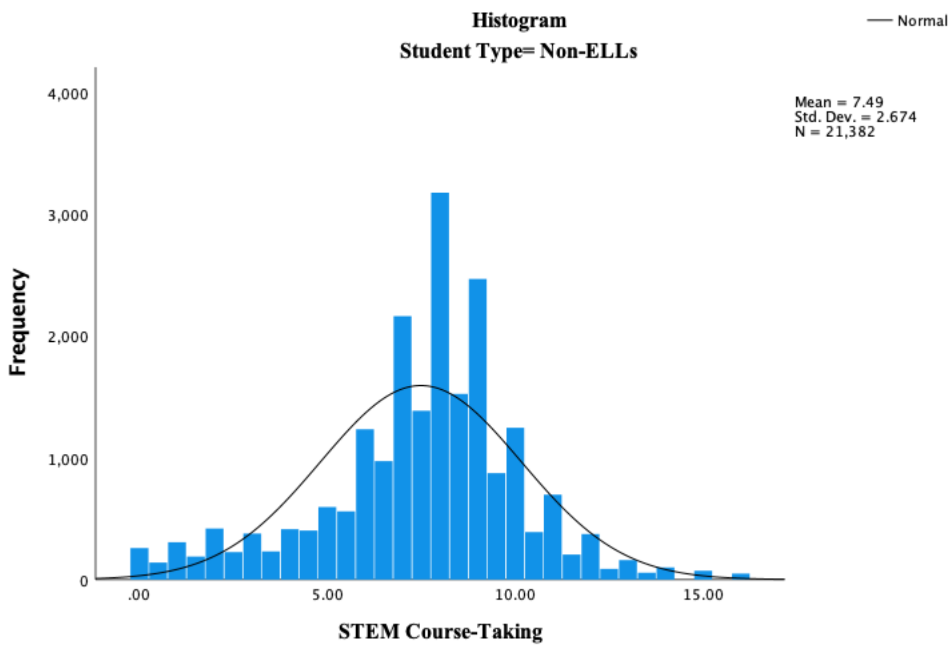
APPENDIX E STEM Efficacy and Student Type Descriptive Statistics

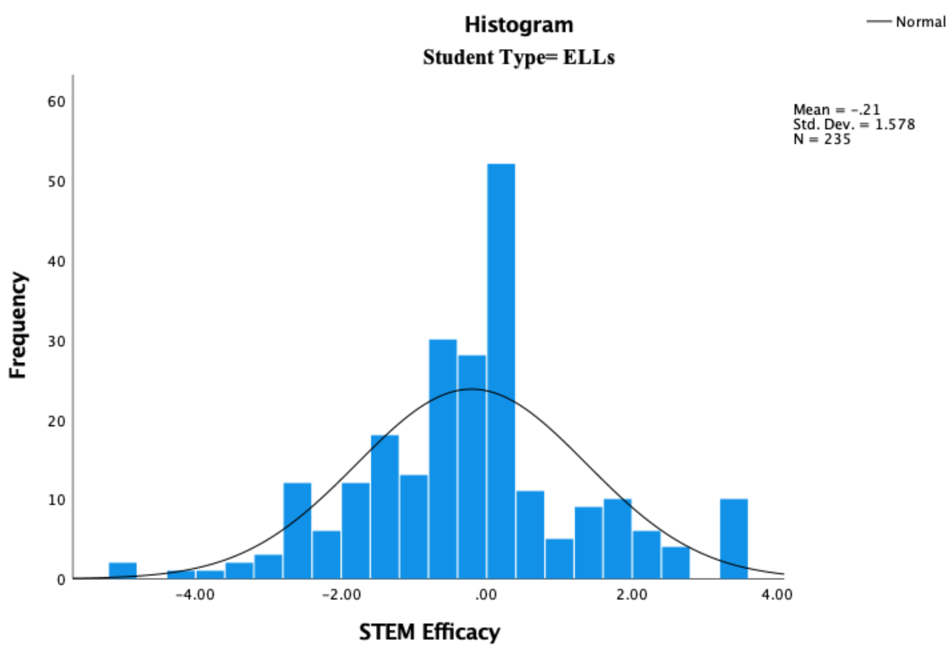
Independent Sample T-Test Assumption #5-Normality

Descriptive Statistics

	Student Type			Statistic	Std. Error
STEM Efficacy	Non-ELLs	Mean		.1242	.01368
		95% Confidence Interval for Mean	Lower Bound	.0974	
			Upper Bound	.1510	
		5% Trimmed Mean		.1515	
		Median		.1350	
		Variance		2.781	
		Std. Deviation		1.66777	
		Minimum		-5.83	
		Maximum		3.45	
		Range		9.28	
		Interquartile Range		2.10	
		Skewness		-.249	.020
		Kurtosis		.378	.040
	ELLs	Mean		-.2068	.10293
		95% Confidence Interval for Mean	Lower Bound	-.4096	
			Upper Bound	-.0040	
		5% Trimmed Mean		-.2193	
		Median		-.0800	
		Variance		2.490	
		Std. Deviation		1.57786	
		Minimum		-4.97	
		Maximum		3.45	
		Range		8.42	
		Interquartile Range		1.53	
		Skewness		.032	.159
		Kurtosis		.490	.316

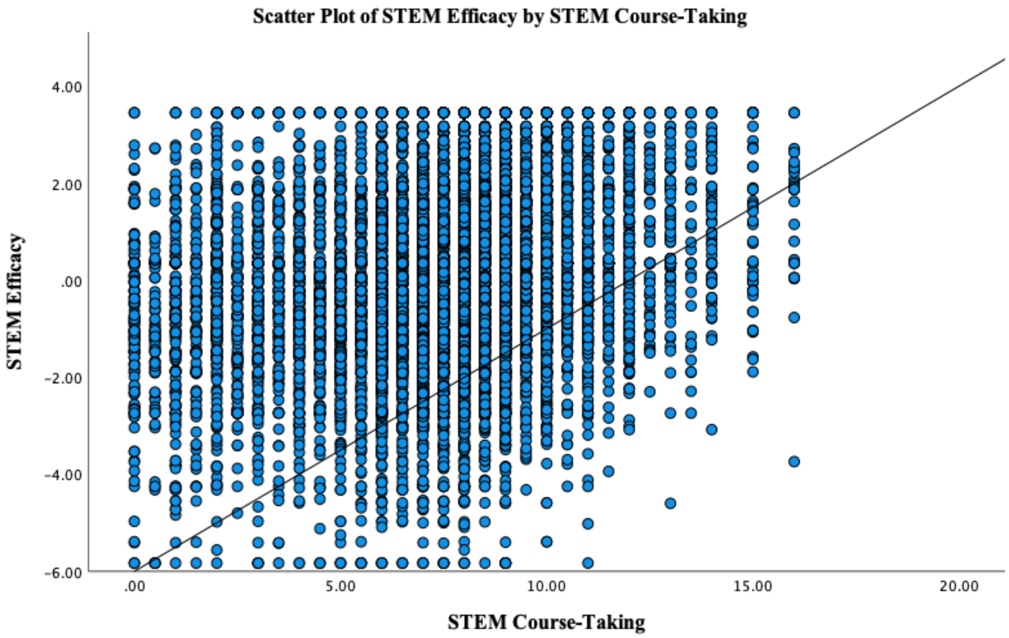
Normality Histograms for Non-ELLs and ELLs

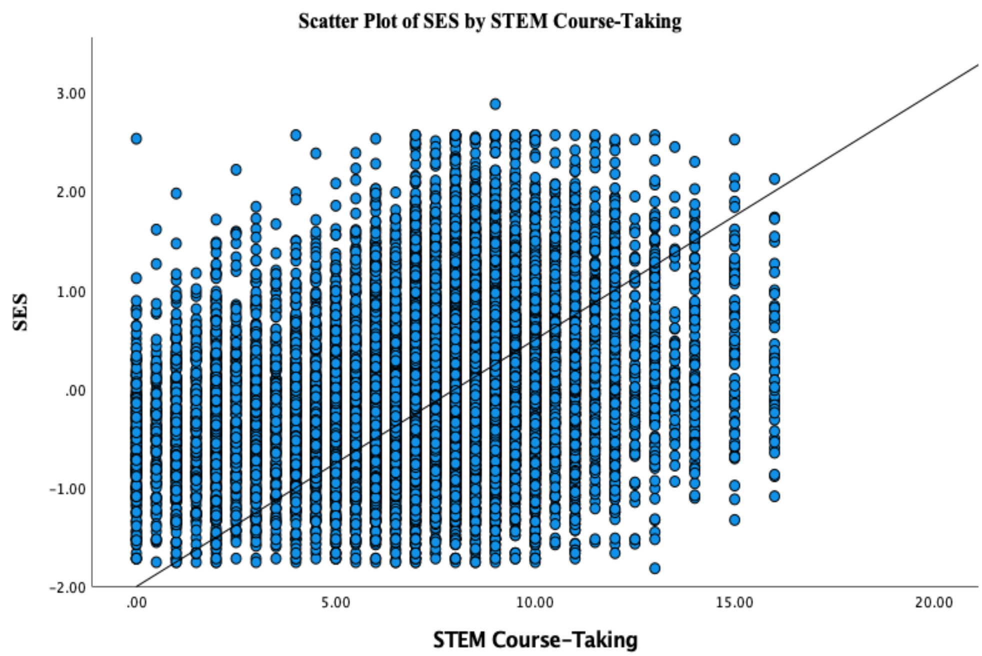


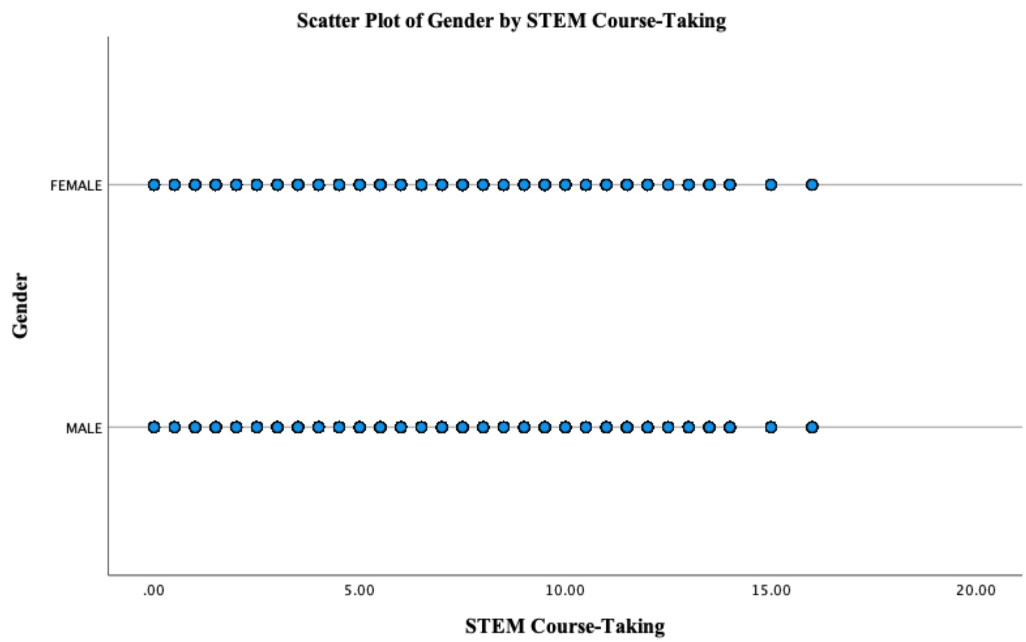


APPENDIX F Multilinear Regression Scatter Plots and Coefficients Table

Multilinear Regression Assumption #1: Linear Relationship







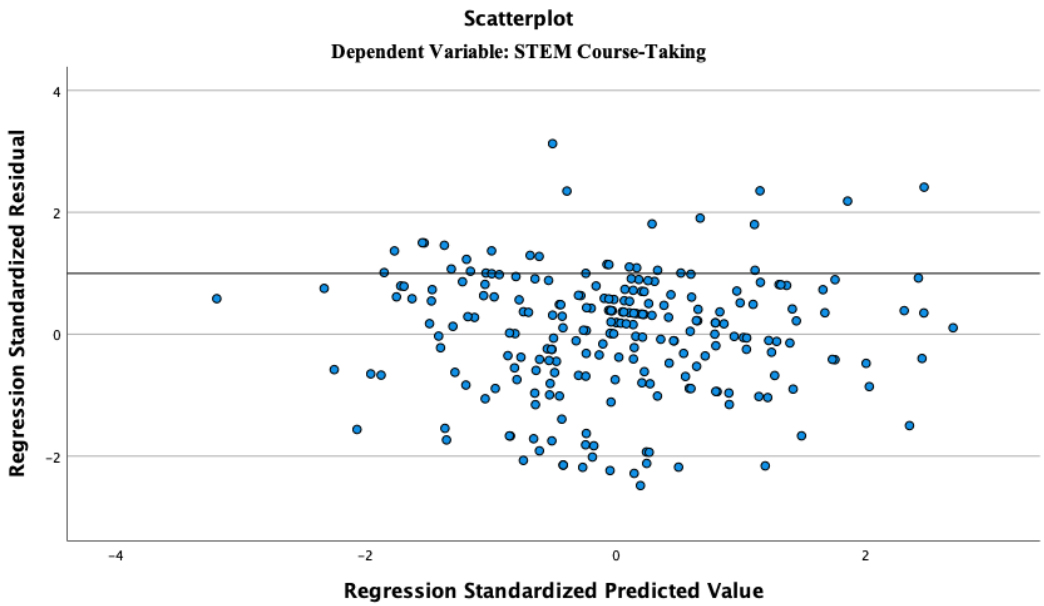
Assumption #2: No Multicollinearity

Coefficients Table

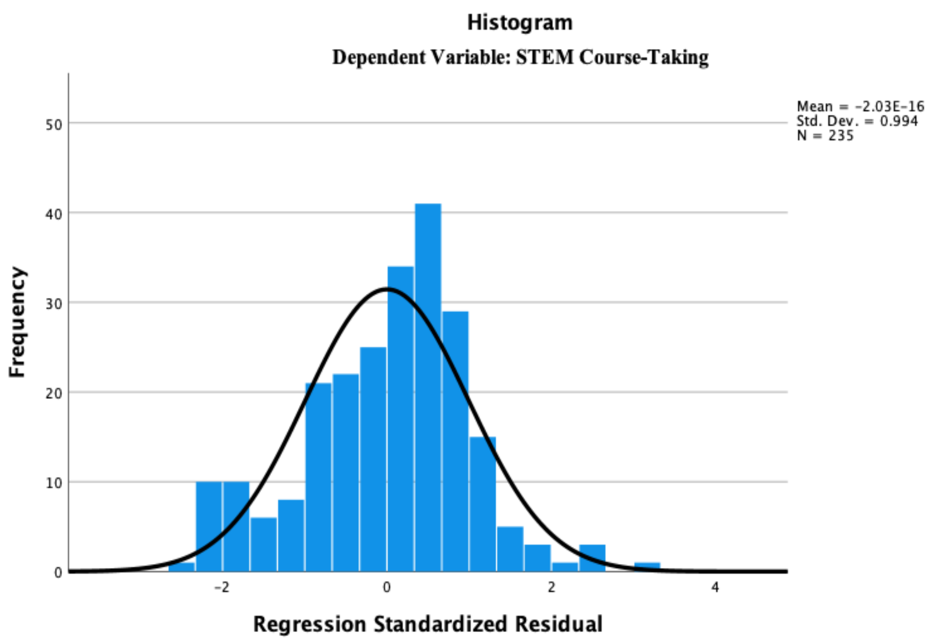
Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	7.416	.063		117.914	.000		
	STEM Efficacy	.290	.012	.190	24.012	<.001	.948	1.055
	SOS	.722	.026	.222	28.247	<.001	.966	1.035
	Gender	.041	.040	.008	1.024	.306	.981	1.019

Dependent Variable: STEM Course-Taking

Assumption #4: Homoscedasticity



Assumption #5: Multivariate Normality



APPENDIX G Logistic Regression Coefficients Table

Assumption #3: No Multicollinearity

Coefficients Table

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.787	.008		95.277	.000		
	STEM Efficacy	.023	.002	.116	14.731	<.001	.949	1.054
	SES	.074	.003	.171	21.940	<.001	.965	1.036
	Gender	.047	.005	.070	9.028	<.001	.982	1.018

Dependent Variable: High School Graduation

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