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The relationship between high school stem courses and students attending low-income schools' college major and career choices: a social cognitive perspective.

Don Bacon
University of Louisville

THE RELATIONSHIP BETWEEN HIGH SCHOOL STEM COURSES AND STUDENTS ATTENDING LOW-INCOME SCHOOLS' COLLEGE MAJOR AND CAREER CHOICES: A SOCIAL COGNITIVE PERSPECTIVE

By

Don Bacon
B.A., Western Kentucky University, 2009
M.Ed., University of Louisville, 2015

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A Dissertation Approved on

August 2, 2023

By the following Dissertation Committee

Dissertation Chair
Jason Immekus, Ph.D.

Kyle Ingle, Ph.D.

Deborah Powers, Ed.D.

Shawn Hinds, Ed.D.

DEDICATION

This dissertation is dedicated to my late father, Perry Lee Bacon. My father was a man of faith, who instilled in our family the importance of maintaining a positive outlook on life. Once my father had decided something was true, it was absolute in his mind. He believed his sons could accomplish anything we put our minds to, and he adored being right about it. He set high expectations for all of us and watching us meet and surpass those expectations brought him the type of parental joy I am only beginning to understand. I am overjoyed to reach this milestone and to carry in my heart, the joy that my father would have over his youngest son defending a dissertation. I love you, dad. Thank you for everything.

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I want to thank the first STEM graduate I ever met, my mother, Kathy Bacon. My mother is a firebrand. She was the first member of her family to graduate from college and she never took for granted the hard work and dedication it took to reach that milestone. I fondly recall the late nights she would spend helping me study for tests as an adolescent and as I headed to bed, she would resume her own work finishing a second degree. I am forever imbued with her tenacity and untiring will because of the example she has set for me.

Secondly, I must thank my brothers, Perry, and Aaron. There are very few steps I have taken in life without them leading the way. My brother Perry is a prolific writer who opened my eyes to the importance of being both a curious adult and one who can recognize the nuance and complexity within public policy. My brother Aaron is of a gregarious nature who taught me how to network and build lasting working relationships. Their combined influence gave me the confidence to begin this dissertation program, write about a topic I find meaningful, and persist through all my struggles.

I want to acknowledge all my students from my time working at Iroquois High School, but most particularly the graduating class of 2018. In 2016, when I transitioned from teaching social studies to teaching engineering and computer science, I worked twice as hard as I had before to make sure I was providing an enriching classroom experience in my new role. I worked diligently to ensure those students would have a great experience from 2016 to 2018 in my engineering courses but was afraid I had

provided a subpar class. I am filled with pride to know how many of those students went on to pursue college majors and careers in technology and engineering. Knowing some part of our time together helped build their interest lit an unquenchable fire in me to create an enriching classroom The work of this dissertation is inspired by those students.

Additionally, I must acknowledge all the teachers and administrators I have had the pleasure of learning from while at Iroquois High school. My colleagues in the social studies and career-technical education departments have encouraged me to be an educational leader and helped me develop as a teacher and a person in more ways than I can count. To each of my principals and assistant principals who taught me the complexities of educational leadership and challenged me to be the best educator I can be, thank you for your inspiration. I want to especially thank all of those who began and finished the dissertation journey while we worked together. Our conversations helped me persist to this point.

One of the biggest inspirations for this work most recently has been my daughter, Jean Marie Bacon. The possibilities of life feel infinite when I hold my daughter. Losing my father during the dissertation process made every task leading to a finished product feel like a herculean effort. My daughter's birth reinvigorated my ability to push forward. Jean is my reason to move forward, and I look forward to the day she can read this and understand how much she means to me.

Last, I must thank my biggest supporter and inspiration, my wife, Elissa. I began taking classes at the University of Louisville for this doctoral cohort just a few months after we got married. This process has come with some sacrifices and the time and energy that we both gave to this dissertation will not be forgotten. Through all the ups and downs

of this process, Elissa’s faith that this finished product would come to fruition never wavered. Her undying support was the fuel behind this work, and I never could have completed this without her. This dissertation could not exist without her love and support.

ABSTRACT

THE RELATIONSHIP BETWEEN HIGH SCHOOL STEM COURSES AND STUDENTS ATTENDING LOW-INCOME SCHOOLS' COLLEGE MAJOR AND CAREER CHOICES: A SOCIAL COGNITIVE PERSPECTIVE

Don Bacon

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Science, technology, engineering, and mathematics (STEM) education has received significant attention in the United States since the Space Race with Russia beginning in the 1950s. Most recently, STEM education has received national attention because of the scarcity of qualified STEM graduates taking on the growing number of STEM jobs in the United States. Additionally, an issue exists within STEM college majors and careers, a lack of Black, Latinx, and female students are pursuing these fields hurting the overall number of STEM college students and career holders and negatively impacts the diversity within STEM fields in the United States. The purpose of this study was to determine the relationship between Black, Latinx, and female students' interest in STEM with four other social cognitive factors, self-efficacy, outcome expectations, personal goals, and environmental supports, to understand which factors are most related to interest in STEM. Through a correlation design, this study investigated the numerical relationships between interest and each of the social cognitive factors in STEM. This study's findings provided strong and positive correlations between STEM interest and

STEM personal goals, self-efficacy, and outcome expectations. The findings of this study have implications for STEM educators, educational leaders invested in the growth of STEM, and future research employing social cognitive factors applied to STEM education.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I: INTRODUCTION

There is a looming job crisis for science, technology, engineering, and mathematics fields (STEM) in the United States. The President's Council of Advisors on Science and Technology (PCAST) reported a need for one million STEM college graduates to fill open STEM jobs by 2022 (PCAST, 2012). Subsequently, school districts, educational institutions, governmental organizations, and businesses alike have sought to create pipelines to direct students toward STEM college degrees and careers (The New York Academy of Sciences, 2015). However, the focus on STEM in the United States has highlighted two problems: (1) the underrepresentation of Black, Latinx, female, and people from low-income backgrounds in STEM careers and college majors, and (2) a lack of members from these communities pursuing STEM after high school (Aschbacher et al., 2009). STEM fields are not devoid of individuals from these backgrounds, but research is needed to understand the factors that can predict these underrepresented groups' interest in pursuing STEM college majors and careers to aid the need for diversity in STEM.

Female, African American, and Latinx students make up the smallest share of STEM college majors and career holders (Fry et al., 2021; Owens & Ramsay-Jordan, 2021). Researchers have shown that many students within these underrepresented groups have declined interest in

STEM during middle and high school, and before they reach college age, many of these students have no interest in pursuing a STEM degree or career (Hall et al., 2011; Knezek et al., 2013). Research shows that all students in elementary, middle, and high schools enjoy STEM subjects and are interested in STEM careers, but a decreased desire to study STEM fields in college or enter STEM careers develops throughout their education (Han & Buchmann, 2016). In this study, high school students' interest in pursuing STEM jobs or college majors was investigated by comparing STEM interest to demographic factors, involvement in STEM curriculum, and the social cognitive influences of self-efficacy, environmental factors, outcome expectations, and personal goals.

Students need to have knowledge about STEM careers before they can be influenced to pursue them. In a study of 132 high school students surveyed during an information technology summer academy, researchers found students were most influenced by their own personal interest to pursue STEM, followed by their parental influence, and the earning potential of STEM jobs (Hall et al., 2011). This study shows the importance of personal interest as a factor for students' matriculation into STEM majors and their pursuit of STEM careers. Understanding what informs the personal interests of underrepresented high school students in STEM could inform how to create and adapt STEM programs to better recruit and serve students to increase the overall diversity of STEM fields.

To identify the social cognitive factors that relate to underrepresented students' interest in pursuing STEM fields, this research is based on Social Cognitive Career Theory (SCCT), a career development framework, expanded from Social Cognitive Theory (SCT), utilized in many recent studies to predict STEM-related career decisions

(Bandura, 1986; Byars-Winston et al., 2010; Chachashvili-Bolotin et al., 2016; Garriott et al., 2016). SCCT as a framework explains the phenomenon of career development using the academic and career self-beliefs of individuals. According to SCCT, people make decisions on their careers based on their self-efficacy, outcome expectations, interests, environmental factors, and their personal goals. SCCT explains the career development outcomes of individuals through its three interlocking models, interests, choice, and performance, which explain how career interests turn into career choices, and develop the career actions of individuals (Lent et al., 1994; Turner et al., 2017). SCCT has been noted for its applicability to research students' academic and career developments regarding STEM (Turner et al., 2017). In this study, the lack of Black, Latinx, female, and students from low-income backgrounds in STEM was the focus to determine the factors most related to their postsecondary STEM intentions.

This research seeks to answer which social cognitive factors are most relatable to low-income, female, Black, and Latinx high school students' interest in pursuing STEM careers and college degrees. Current research notes the low levels of degree attainment, job participation, and college matriculation of these groups into STEM (National Science Board, 2010; Rozek et al., 2019; Yoder & Mattheis, 2016), but fails to address the factors that could predict the positive interest of students from these groups pursuing STEM college degrees and careers. The conclusions drawn from the findings of this study can inform high school STEM career academies and high school STEM courses methods on creating opportunities for a more diverse group of students to pursue STEM college majors and careers.

Background of Study

PCAST's (2012) report on the need for one million more STEM college graduates highlighted an issue in STEM education. Since 2012, STEM education has become a topic influencing educational curriculums, school and business partnerships, and statewide testing models (Maltese et al., 2013). Additionally, The New York Academy of Sciences (2015) noted the STEM problem is not solely a lack of STEM college graduates, but also a dearth of engineers, scientists, health professionals, and individuals with mid-level technical skills in computer programming, information technology, and technical design to fill the available positions. These job openings combined with STEM education's ability to improve high school students' attendance and standardized test scores have led to the creation of the STEM pipeline, which is a collaboration between STEM employers and schools to create a pathway from primary schools through college to produce skilled STEM workers in the United States (Kennedy & Odell, 2014; Sass, 2015). The STEM pipeline continues to grow as more schools, businesses, and community partners work together to enhance STEM education and increase the number of STEM workers.

The STEM pipeline is not only the onus of public schools, but depends upon businesses, cultural attitudes, educational organizations, and local and federal government agencies (The New York Academy of Sciences, 2015). There are several, large stakeholder groups with interests in the growth of STEM education: business and industry, the federal government, and educational institutions (Jiménez Iglesias et al., 2016). Business stakeholders in STEM seek to create partnerships with schools to create a pipeline of students with career relevant skills to fill open positions. The federal government seeks to increase the global competitiveness of the United States in comparison to other countries in mathematics and science (Committee on STEM Education, 2018). School districts and schools, like some in Iowa, New Jersey, and Washington, are implementing STEM because of its ability to increase students' test scores, attendance, and engagement (ACT, 2017). Furthermore, there are different types of educational organizations seeking to strengthen the STEM pipeline through formal and informal influences.

First, there are groups advocating for STEM educational policies, like the STEM Education Coalition (STEM Education Coalition, 2019.), which works to influence policymakers to integrate STEM education into schools across the United States. This is a formal policy creation group, which focuses on the legislation that would allow for the implementation of STEM curriculum, funding for STEM schools and classrooms, and creating recognized teaching licenses for certified STEM teachers (STEM Education Coalition, 2019.). The implementation of STEM education is different between counties and states depending on the level of STEM advocacy from educational stakeholders.

Secondly, there are formal educational organizations, which work to integrate STEM curriculum into classrooms to increase the efficacy of the STEM education pipeline. For example, Project Lead the Way (https://www.pltw.org/) provides a paid service to educators including professional development opportunities, classroom supplies, several STEM course curriculum guides, and other resources for classes ranging from engineering to biomedical fields. Formal educational groups like PLTW, work to train teachers on implementing STEM education into their classes by providing teaching materials and curriculum frameworks. PLTW also provides certificates for teachers to equip existing content teachers with the credentials necessary to teach STEM subjects in their schools. Similar to PLTW, Code.org is a nonprofit providing curriculum and lesson planning for computer science education at all grade levels. Code.org provides teacher training workshops and has created a website for classroom activities and practice meant to prepare students for the Advanced Placement Computer Science Principles Exam (https://code.org/). Formal groups like PLTW and Code.org work to influence classroom pedagogy and district to school level teaching practices to influence the spread of STEM education and help create classroom opportunities which lead students to STEM careers and college majors.

Last, there are STEM educational organizations focused on informal learning opportunities, which happen outside of schools or as after school activities with a purpose of strengthening students' STEM skills. Informal organizations provide students with learning experiences with contextual relevance that can encourage students to pursue STEM by supporting creative problem solving (Bell et al., 2009). Girls Who Code, an informal computer programming educational organization, seeks to create a pipeline of female engineers through summer and after school programs specifically for girls (https://girlswhocode.com/). Black Girls Code is an organization with a similar mission to Girls Who Code, but additionally seeks to address the dearth of black women in computer programming (https://wearebgc.org/.). These informal groups work to change public perception and provide STEM learning opportunities for students that may not have access to STEM learning. Many informal educational organizations provide experiences for Black, Latinx, female, and low-income students to engage in STEM.

In addition to the variety of stakeholders influencing STEM from outside of schools, STEM education within schools is implemented in a variety of ways. STEM education is categorized into four groups. First described are STEM Selective Schools, which are schools with rigorous admissions requirements meant for preparing ambitious students for STEM college experiences and careers. The second category pertains to inclusive STEM-focused Schools. Inclusive STEM-focused schools have a mission to improve upon the inclusion of underrepresented groups in STEM in a school environment geared toward STEM careers. The third category includes STEM-focused Career and Technical Education (CTE), which provides students with an experience to raise the engagement and prevent dropouts while also providing STEM career training. Last are non-STEM focused schools. These are programs where STEM education is part of advanced coursework within a comprehensive high school. From this variety of approaches, STEM in schools can be focused on career engagement, demographic inclusivity, or rigorous college preparation with each providing a different STEM education experience (Beatty, 2011). While each of these approaches fulfills a need, they also contribute to a lack of standardized implementation for STEM in public schools.

Public schools lack a standard method of implementing STEM education because of the conflicting definitions for integrated STEM education from current research. Sanders (2009) defined integrated STEM education through any pedagogy linking any of the STEM subjects together or through teaching practices that combine STEM with one other school subject. Through this definition, integrated STEM education could look like students learning about the mechanical advantage of pulleys while working backstage for a theater production. Moore et al. (2014) described STEM education as a combination of each of the STEM subjects into one course with a focus on solving real world problems. Using this definition, integrated STEM education could be a class or unit where students evaluate real world bridges, create models to fix them, and explore the materials used to make them while focusing on each of the STEM fields throughout the unit or course. Kelley and Knowles (2016) define integrated STEM as a combination of at least two of the STEM subjects within an applicable STEM context meant to enhance student learning. This could be a science and technology course in which students record experimental data and use technology to search for trends. Each of these research approaches provides a different definition for integrated STEM education and can lead to different types of STEM integration in schools.

In addition to a variety of definitions, integrated STEM education also differs from many other learning subjects in schools because integrated STEM does not have a set of nationally recognized learning standards. Learning standards are subject specific documents, created by stakeholders involved in the content, which establish clear guidelines and expectations for students' content knowledge and expected skill level for each grade level of the content. Mathematics learning standards have been nationally recognized from Common Core, the International Society for Technology in Education (ISTE, https://www.iste.org/) has created a set of technology standards that are used in some form by all states, and the Next Generation Science Standards (NGSS, https://www.nextgenscience.org/) cover science for all grades and include engineering learning standards. Without standards, STEM implementation will remain different across states, districts, and schools because their implementation of STEM is dependent on teachers, career field connections, and available facilities (Ejiwale, 2013).

Another barrier to uniform STEM education implementation is the variety of teaching practices seen in STEM classrooms (Ejiwale, 2013). Some schools, such as traditional high schools, teach STEM subjects isolated in separate classrooms with separate teachers because of a lack of interdepartmental collaboration between teachers. A student may learn trigonometric functions in an engineering course with no relation or collaboration with a mathematics teacher who has already taught similar concepts. In contrast, the integrated STEM model incorporates each of the STEM subjects and teaches them interwoven with one another where each subject share equal emphasis (Dugger, 2010). In the integrated STEM model, a student could learn the mechanics of robotics in an engineering course, algorithmic thinking in mathematics class, and a programming language in a technology course. Then, the student would use their knowledge from each of those subjects to create a robot where they would display the learning from each of their courses in its creation. Different from the other two school models, some schools implement an uneven integration where science and mathematics are emphasized while engineering and technology are optional. Schools like these may provide a variety of engineering and technology courses as electives students can choose to take, but do not guarantee the integration of STEM learning in any special way. These differing approaches to STEM integration may match the needs of various student groups, but it also raises a question of which STEM approaches work best for which groups of students?

Current research does not identify the best strategies for Black, Latinx, female, or low-income students' interest in pursuing STEM, but current research explains the variety of inequitable experiences for these groups which lead to their lack of representation within STEM. Inequitable experiences in STEM for students are a result of the various problems in many school districts in the United States. Extensive research reveals the achievement gap in schools between Black and Latinx students compared to their white peers and low-income students compared to their higher-income peers (Ladson-Billings, 2006; Reardon, 2013). Additionally, the lack of female faculty in STEM courses in high schools and colleges remains and issue, resulting in the lack of females in STEM (Bottia et al., 2015). These inequities in K-12 are related to the STEM experiences of students.

Black, Latinx, and low-income students remain underserved in STEM fields. ACT (2014) describes the characteristics of underserved students as at least one of the following: a racial/ethnic minority, a household with combined parental income less than $36,000, or parental educational attainment that is a high school diploma or less. Change the Equation (2017), a nonprofit organization linking business partners and STEM education advocates, released a report on the disparities between public schools' class materials and course offerings based on students' income status. Schools with student populations of 75% or more underserved students had less access to higher level mathematics, science, and computer science courses, their classrooms had less required resources to teach mathematics and science courses, and students were offered less hands-on activities in science courses (Change the Equation, 2017). In a classroom, this could look like students learning about robotics through lecture or worksheets rather than an experiential learning exercise where the students are hands-on with robotics equipment, a known means of promoting comprehension and interest (Freeman et al., 2014). Additionally, schools with high proportions of underserved students have classrooms that focus on discipline rather than learning and classroom activities focus on remediation rather than exposure to new materials (Rothstein, 2014). These issues affecting Black, Latinx, and low-income students are part of the reason for their underrepresentation in STEM fields.

Similar to underserved students, researchers have shown women are also underrepresented in STEM fields after high school (National Science Board, 2010; Yoder & Mattheis, 2016). For engineering degrees earned in the United States between 2006 and 2015, women made up 19.9% of graduates, Latinx 10.7 %, and African Americans made up 4 % (Yoder & Mattheis, 2016). Data collected by the National Science Board (2010) show women comprised of 13%, Latinx 6%, and African Americans 4%, of all engineers employed in the United States. The existence of this gap between Latinx, Black, and female STEM graduates extends to masters and doctoral degrees in STEM fields (National Academies Press, 2019). This underrepresentation of each of these groups in STEM in colleges and the workforce needs greater scrutiny in high school while students are still making academic and career decisions.

School districts, educational organizations, and STEM stakeholders are promoting STEM education by implementing career academies and STEM educational integration at various levels. However, this support fails to improve the diversity of STEM across universities and businesses where the dearth of Black people, Latinx people, women, and people from low-income backgrounds is evident. The consequence of the uneven implementation of STEM education is a lack of diversity and current efforts are not engaging students in STEM education to spark and maintain their interest in pursuing STEM after high school. This research study aims to identify the social cognitive factors that relate to underrepresented groups interest in pursuing STEM after high school and to utilize the implications of this study to aid the growth of currently underrepresented groups' interest in pursuing STEM college majors and careers.

Purpose of the Study

The purpose of this study is to examine the relationship between SCCT career and academic behaviors and interest in STEM careers and college majors of underrepresented students in two STEM experiences in Kentucky, TECH-nique, a STEM summer camp experience, and the STEAM Academy, a STEAM career academy catering to students interested in STEM. The independent variables, established in SCCT for their relationship to academic and career behaviors, self-efficacy, outcome expectations, personal goals, and environmental/contextual factors, were measured for their ability to predict student interest in STEM careers and college majors. The ability to predict interest was examined within and between three student groups: Black, Latinx, and female students. By identifying factors predicting these underrepresented groups involvement in STEM majors and careers, this research can guide teachers, administrators, and educational stakeholders in what opportunities to provide to increase students' STEM interest. The strongest predictive factors for students to pursue STEM college degrees or careers from this research could be used to create a STEM pipeline for women and minorities.

Statement of Research

Data for this study were collected from the STEAM Academy in Lexington and TECH-nique, a STEM organization in Louisville, which offers STEM opportunities to students. Students at the STEAM school are enrolled in an established career path.

Alternatively, TECH-nique students were representative of the numerous public and private schools in Louisville, including Title I schools, a designation from the federal government to receive funds based on a large concentration of students from low-income families attending the school (United States Department of Education, n.d.). Students from grades nine through twelve completed a survey that includes demographic factors, SCCT variables, and measures their interest in pursuing STEM after high school.

The two sites selected for this study were selected for their offering of STEM curriculum. The STEAM Academy uses STEAM curriculum throughout their school to guide student behaviors and learning. Attendance to the STEAM Academy is through a lottery system to establish a diverse student population (https://www.fcps.net/) The TECH-nique participants were from a STEM summer experience called Technology Entrepreneurship to Create Change (TECC) Boss. Students attending TECC Boss engage in learning about user interface design, artificial intelligence, app development, and other STEM related activities. Students in this program participate for six weeks of the summer to create a final culminating STEM project (https://www.tech-nique.org/.). These sites were chosen for their STEM curriculum offerings.

A cross-sectional survey research design was used for data collection to observe current students' interest in STEM fields. Surveys were administered to operationalize students' self-efficacy, environmental factors, outcome expectations, personal goals, involvement in a STEM career academy, and post high school STEM interest. The survey was administered to discover the relationship between the dependent variable, interest in STEM career and college majors, and the independent variables, SCCT factors, career academy involvement, and demographics. Cross-sectional studies collect data at one given point in time to describe a subpopulation's traits, attitudes, or knowledge (Kesmodel, 2018). In this study, the cross-sectional survey design provided a description of students' interest in STEM college majors and careers across gender, race/ethnicity, and career academy involvement.

The survey measured their attitudes towards pursuing STEM after high school. The cross-sectional design was used to find the relationship between student's interest in pursuing STEM majors and college careers for each of the groups observed. This study was performed to answer the following research questions:

RQ: What is the association of outcome expectations, self-efficacy, environmental supports, and personal goals to high school students' interest to pursue STEM careers and college majors?

The implications from this research may inform adaptations to teaching practices for STEM career academy schools. By identifying the social cognitive factors that best relate to students' interest in pursuing STEM, the STEM academies can create experiences that relate to students' likelihood of pursuing STEM after they graduate from high school.

Definition of Terms

Below is a list of key terms used throughout this dissertation. The terms pertain to local practices in the school district studied, factors from SCCT, and terms specific to STEM education in the United States.

ACT: A college entrance exam used to measure students' competencies in English, mathematics, reading, and science (https://www.act.org/content/act/en.html.).

Career Academy: A high school model of a school within a school based on Ford's Next Generation Learning where schools, businesses, and community partners work together to create learning experiences for students that will provide essential skills for colleges and careers.

Career Interest: An individual's inclination for certain tasks or actions that can inform their proclivity toward certain careers. Often, career interests change according to an individual's self-efficacy and outcome expectations (Lent et al., 2002).

College & Career/Transition Ready: The combined knowledge and skills students are expected to possess by the end of high school as measured by students' assessment scores on college entrance exams and/or industry certifications (KDE, 2019).

Environmental Factors: Extra-personal objective and subjective variables that can influence an individual's career decisions, these could be support from family or support from school faculty (Lent et al., 2002).

Goals: A person's capacity to complete tasks for a desired outcome (Bandura, 1986). People use goal setting as a method of self-regulation to motivate their own behaviors without external influences (Lent et al., 2002).

Low-Income School: A school that participates in the federal Community Eligibility Provision (CEP), which provides schools with free breakfast and lunch for all students enrolled. Schools can be included in the CEP if 40% or more of the students' families are enrolled in other federal income assistance programs (United States Department of Agriculture, 2019).

Low-Income Student: A student whose family's taxable income does not exceed the federal poverty level amount by 150% (United States Department of Education, 2021).

Outcome Expectation: An individual's anticipated social, physical, and self-evaluative outcomes (Lent et al., 1994). Outcome expectations change after learning and growth experiences and are influenced by self-efficacy.

Self-Efficacy: A changing set of beliefs that people believe about their own capability to complete certain actions (Bandura, 1986). Four variables develop self-efficacy, personal performance accomplishments, vicarious learning, social persuasion, and physiological states (Bandura, 1997).

STEM: Professions and education in the subjects of science, technology, engineering, and mathematics, which utilize each of the separate subjects in an interconnected manner (Marrero et al., 2014).

STEM pipeline: The progression of students from primary and secondary schools through college and into careers.

TECC Boss: The Technology Entrepreneurship to Create Change is a STEM summer program organized by TECH-nique for high school and college students with a focus on technology and creativity.

TECH-nique: A Louisville community organization committed to providing technology opportunities for historically underrepresented groups in STEM offering technology skill programs for students and adults.

Theoretical Framework

SCCT serves as the guiding theoretical framework for this study because it encompasses theory on an individual's academic and career decisions. SCCT was developed utilizing factors identified and related through several key theories like Bandura's (1986) Social Cognitive Theory (SCT) and Hackett and Betz's (1981) work on self-efficacy in female career development. This section is a brief overview of the key influencing theories, career development factors, and models of SCCT.

SCCT is a career development framework created to explain influences on how individuals make career choices (Lent et al., 1994). Social learning theorist Bandura and his works influenced SCCT's creation. Bandura (1977) presented the concept of self-efficacy, an individual's belief in their ability to complete a task, as a construct of behavior and decision-making. Hackett and Betz (1981) performed a study on the lack of female science and engineering majors, which reported a relationship between individual self-efficacy and career development. Bandura's (1986) SCT also influenced the creation of SCCT. In SCT, personal factors, human behavior, and environment are all integral to the learning process. These works along with several social, personal, environmental, and developmental frameworks were built upon in the creation of SCCT.

The SCCT career development framework built upon these prior works and expounds upon them with three interrelated career development models: interests, choice, and performance as a part of SCCT (Lent et al., 1994). The interests model focuses on how a person develops an enduring interest in an activity based on how they perceive their ability to perform tasks related to that interest. The choice model presents individual's choices in academic and career goals based on their interests and environment. The Performance Model predicts that individuals make career choices based on their perception of their ability to complete a task and the consequences of that task (Lent et al., 1994). The models work together to explain the interests, choices, and actions of individuals as they develop their careers.

The interests model of SCCT is centered on the development of interests for individuals in an activity or subject (Lent et al., 1994). During their developmental years, individuals are exposed to, gain practice in, and receive feedback on a variety of career related activities. Based on their feedback, practice, and exposure, people create a sense of self-efficacy and outcome expectations based on those tasks. Self-efficacy is an individual's self-perceived ability to perform a task. Outcome expectations are an individual's personal beliefs about the consequences of their performance. For an enduring interest to be developed, a person must see themselves as competent at performing the tasks related to the interest and that the outcomes from that task are valuable (Lent et al., 2002). The interests model within this research context would hypothesize that students' STEM interest is related to their self-efficacy in STEM courses and their outcome expectations from STEM activities.

The choices Model of SCCT is an extension of the interests model because self-efficacy and outcome expectations still guide career choices, but the choice model expands to include environmental factors (Lent et al., 1994). In the choice model, self-efficacy, outcome expectations, and environmental factors have a greater and more direct impact on career choices than interests. Environmental factors are obstacles or experiences that exert a change in career decision making like, financial needs, family expectations, or educational barriers. An environmental factor in this study could be a student whose STEM aspirations are hindered by their inability to travel to a university because the student is expected to work after school to help provide for the family. The choice model of SCCT posits that career related choices are impacted when environmental factors, like financial constraints or educational attainment, are so restrictive they become more indicative of career decisions than an individual's interests (Lent et al., 2002).

The performance model of SCCT predicts the educational and occupational levels of success of individuals and their persistence when barriers arise (Lent et al., 1994). In the performance model, an individual's self-efficacy and outcome expectations influence the personal goals they set for themselves. If a person has high self-efficacy and high outcome expectations, they are more likely to create higher performance goals for themselves and persist when barriers to their goals emerge, which could explain their higher levels of success than those of their peers with lower self-efficacy or lower outcome expectations. SCCT defines performance as an individual's ability and motivation and explains that self-efficacy is a complement to ability rather than a substitute (Lent et al., 2002). In this research, students' personal goals have been influenced by their previous and on-going performance in STEM. This study measured how those personal goals interact with their interests in pursuing STEM degrees and careers.

SCCT's three models have been supported through meta-analyses to predict career interests for individuals. The models have found that self-efficacy and outcome expectations are useful predictors of career interests, career choices, and academic choices (Lent et al., 2002). SCCT is a conceptual framework used for this study to understand the STEM academic and career interests of students. Through this study, the factors that highly relate to students' STEM career and academic behaviors were discovered to create educational opportunities, which could influence their postsecondary STEM choices.

Within SCCT, interest, self-efficacy, outcome expectations, environmental factors, and choice goals are specified variables, which lead to career development. Each of these are variables which are part of a continuum in SCCT, self-efficacy, outcome expectations, environmental factors, and choice goals each influence the career development behaviors of individuals (Lent et al., 2002). Each of these variables presented within SCCT were utilized in this study through the interests model, where students' self-efficacy, choice goals, environmental factors, and outcome expectations were the independent variables used to predict students' interest in STEM careers and college majors.

Hypotheses

The following hypotheses were derived from the SCCT framework in their usage of self-efficacy, environmental factors, personal goals, and outcome expectations (Lent et al., 2002). The hypotheses are based on the STEM Semantics Survey (Tyler-Wood et al., 2010), which was developed using SCCT to measure students STEM social cognitive attitudes. Each STEM subject was measured separately through the four independent variables: self-efficacy, environmental factors, personal goals, and outcome expectations, and the dependent variable, interest.

Hypothesis: Science

H_1: Students' science self-efficacy, environmental factors, personal goals, and outcome expectations will be positively related to college or career interests.

Hypothesis: Technology

H_1: Students' technology self-efficacy, environmental factors, personal goals, and outcome expectations will be positively related to college or career interests.

Hypothesis: Engineering

H_1: Students' engineering self-efficacy, environmental factors, personal goals, and outcome expectations will be positively related to college or career interests.

Hypothesis: Mathematics

H_1: Students' mathematics self-efficacy, environmental factors, personal goals, and outcome expectations will be positively related to college or career interests.

Hypothesis: STEM

H_1: Students' STEM self-efficacy, environmental factors, personal goals, and outcome expectations will be positively related to college or career interests.

These hypotheses were tested using a non-experimental design as the variables for this study was not be manipulated (Johnson, 2001). Students' STEM attitudes were measured through a cross-sectional survey design. The cross-sectional design seeks to capture the several student groups surveyed at a single point in time (Cohen et al., 2007). The cross-sectional design allowed this study to measure students' STEM interest, self-efficacy, outcome expectations, personal goals, and environmental supports at one point in time to provide insight on the relationship between their social cognitive attitudes towards STEM, their STEM academy involvement, and their interest in pursuing STEM beyond high school.

Assumptions and Limitations

This section is an explanation of the assumptions and limitations, which were considered for this study. The assumptions are the presumed truths about this study. Limitations are the restrictions for the research due to the chosen methods of the research. This study is affected with each of these in the following ways.

This research relies on the assumption that high school students responded honestly on this survey. The information students provided on the survey was confidential and anonymous. Someone unrelated to the students' STEM courses administered the survey. This ensured that students not provide biased answers to the survey questions. This protected the integrity of the survey from social desirability bias, where students might feel uncomfortable sharing information about their perceptions of STEM classes with their STEM teacher (Kreuter et al., 2008).

Utilizing cross-sectional design presents limitations for this study. Cross-sectional designs are one-time measurements and cannot determine causal relationships (Setia, 2016). This research did not determine the cause for students to pursue STEM college majors or careers but provided information on which SCCT factors relate to students' STEM interest after high school. This limits the generalizability of the study because the data provided a snapshot rather than longitudinal data following students STEM attitudes through their years in high school. Cross-sectional research was chosen for study to view current student attitudes to provide immediate adjustments and establish factors to be observed in longitudinal data.

The cross-sectional design was not able to discern any cause and effect between variables, only their positive or negative correlation (Kesmodel, 2018). Cross-sectional designs can also suffer from report biases, when respondents do not accurately answer questionnaires on their personal lives and cohort differences. Respondents may also answer differently depending on when the groups respond to the survey (Levin, 2006). These could affect this cross-sectional study based on how career academy and non-academy students' respond to the survey and if the initial career academy students responses are based on the novelty of a new program for the school. These limitations were mitigated by surveys being administered by school staff who are not the students' academy teachers.

The assumptions and limitations of this study are derived from the theoretical perspective, research design, and data analysis choices. Controls for each have been decided upon to mitigate drawbacks while maximizing the generalizability of the study. .

Organization of the Study

Chapter 1 serves as an introduction to the study and the background of STEM education, the purpose of the study, the statement of the research questions, hypotheses, limitations, and assumptions of the study. Chapter 2 is a review of the pertinent literature on STEM education and its integration into current education, recent studies on students' interest in STEM, and the persistent problems of STEM education. Chapter 3 explains the cross-sectional research design, the data collection methods, and an explanation on how the data were analyzed. Chapter 4 is a description of data collection and the analysis of the numerical data collected. Chapter 5 includes a discussion of the analysis of data and the implications for future practice and research.

CHAPTER II: REVIEW OF THE LITERATURE

Racial and ethnic minorities, women, and people from low-income backgrounds have been consistently underrepresented in STEM college majors and careers (Byars-Winston et al., 2010; Niu, 2017; Tyszko, 2011). The lack of equity in STEM is often attributed to underrepresented students' attitudes toward STEM fields and differing levels of academic preparation, but these arguments often lack validity from robust quantitative data (Riegle-Crumb & King, 2010). Racial, ethnic, gender, and economic diversity in STEM fields is integral to the growth of STEM institutions and each demographic group provides a unique perspective for the success of companies and the future of STEM in the United States (Funk & Parker, 2018). Current literature exposes the issue of the lack of underrepresented groups in STEM (Xie et al., 2015; Xu, 2008). However, few researchers have identified which factors relate to underrepresented groups intent to pursue STEM fields especially during high school (Chachashvili-Bolotin et al., 2016; Mau & Li, 2018). The purpose of this research is to identify the social cognitive factors related to Black, Latinx, female, and low-income high school students' interest in pursuing STEM college majors and careers. The social cognitive factors with the strongest relationship to students' STEM interest could inform the creation of educational programs aimed at promoting STEM to underrepresented student groups to pursue STEM after high school.

SCCT suggests high school students develop their academic interests in tandem with their career interests (Lent et al., 1994), but STEM interest for high school students matriculating into colleges is hindered. ACT (2017) reported that from 2012 to 2017, 48 to 49 percent of high school graduates were interested in pursuing STEM after high school. Research has linked students' STEM interest to their likelihood of pursuing a STEM degree (Hall et al., 2011), and given this data, STEM major enrollment should have been high. Despite the data of high STEM interest, the National Center for Education Statistics (NCES) reported only 18% of college graduates were STEM majors in 2016 (NCES, 2016). Additionally, the gap in high school to college STEM persistence is exacerbated by race and gender. Female students accounted for 36% of STEM graduates and research shows Black and Latinx students are more likely to drop out of STEM majors (NCES, 2016; Riegle-Crumb et al., 2019). Eight percent of students who attended low-income high schools and graduated from college in 2019 were in STEM majors in comparison to 16% of their higher-income high school peers (National Student Clearinghouse Research Center, 2019). The disparity between high school STEM interest and college graduation rates shows a problem of persistence and attrition, particularly for this study's targeted student populations.

Research has noted there is a need to create opportunities that stimulate interest in STEM career options for students to increase the amount of people in STEM fields (Hall et al., 2011). Prior research identifies interest as a factor in predicting students' STEM career goals and actions (Turner et al., 2017). Interest was chosen as the dependent variable for this research because of its link to career decisions. Findings from this research can then be used to create educational opportunities specifically for Black, Latinx, female, and low-income students to increase their likelihood of majoring in STEM and pursuing a STEM career.

This chapter has five sections. The first section, *The STEM Pipeline* is a review of the various stakeholders in STEM education and the outcomes they produce. *STEM in Education* is a description of the current practices of STEM education from primary to secondary schools. The third section *Persistent Problems in STEM Education*, addresses the negative and biased outcomes of the current practices in STEM education. The literature review also addresses the *Theoretical Framework: Social Cognitive Career Theory* and how the unique SCCT perspective frames this research.

The STEM Pipeline

The STEM pipeline refers to the series of opportunities for individuals to gain an interest in pursuing an advanced STEM degree or career (Lynch et al., 2019). Berryman's (1983) research first coined the pipeline metaphor in a study that explained the underrepresentation of women, Black, and Latinx people from science doctoral degrees and careers. Decades later, the problem of underrepresentation among female, Black, and Latinx people, along with students from low-income backgrounds, persists at all levels of STEM education and STEM career fields (Cage et al., 2018; Sass, 2015). This section is a review of public perception of STEM in the United States and how businesses and government seek to strengthen the STEM pipeline.

Low public perception is one of the issues related to the problems of the STEM pipeline in the United States. NCES performed a longitudinal study on the cohort of 4,012,770 ninth graders who entered high school in 2001. By 2005, 70% of the cohort had graduated, 48% of the cohort had made plans for college, but only 33% of the cohort were college ready based on standardized test scores and grade point averages. The data on the STEM pipeline ends showing only 7% of the 2005 graduating class cohort majored in STEM in college, and only 4% of them graduated with a STEM Degree (NCES, 2008). In addition to the issue of the lack STEM graduates, researchers reported among adults in the US, 42% believe STEM education in K-12 public schools is average in comparison to other nations, while 30% believe STEM education in K-12 schools is below average in comparison to other nations (Funk & Parker, 2018). The low public perception of STEM in the United States stems in part from the low number of graduates and people pursuing STEM but can also be seen from a global perspective.

From an international context, research support the low public perception of STEM. Kocabas et al., (2019) conducted a study on the quality of STEM learning in the United States by comparing the scores of students from the United States on two international STEM assessments to the scores of students from similarly developed nations. The researchers found students' in the US scores on these tests were mediocre in comparison to their international counterparts, and STEM education in the United States does not develop enough teachers, students, or workers well prepared in STEM. The United States' low rank among other countries in STEM and the mediocre perception of STEM has prompted several stakeholder groups to act upon the need for an improved STEM experience in the United States.

The STEM pipeline is largely influenced by external STEM educational stakeholders in government and business. The federal government works with STEM at all levels by funding educational programs, creating out of school STEM opportunities for students, and creating governmental organizations that support STEM involvement

(Gonzalez & Kuenzi, 2012). The federal government's stake is the largest; it seeks to establish the STEM pipeline to reduce reliance on foreign STEM workers in the United States, to advance the competitiveness of United States education by raising mathematics and science test scores, and to boost the United States economy with a supply of STEM qualified workers (Han & Buchmann, 2016; Hossain & Robinson, 2012). Businesses are involved in the STEM pipeline to generate skilled workers who are prepared for currently open STEM positions and to influence school STEM programs to teach students the skills necessary for their open jobs (Carnevale et al., 2011). Business and government organizations each utilize their immense resources to strengthen the STEM pipeline, but also contribute to a disjointed STEM pipeline because of their differing, sometimes opposing goals for the STEM pipeline.

The United States federal government has been supporting the STEM pipeline to increase the competitiveness of the United States in mathematics and science since the 1950s (Atkinson & Mayo, 2010). The support for STEM education in the United States had moved in waves until a Presidential address in 2009. In his address to the National Academy of Sciences, President Obama stated, "American students will move from the middle to the top of the pack in science and mathematics over the next decade. For we know that the nation that out-educates us today- will out compete us tomorrow" (PCAST, 2012). President Obama's words represented a new strive for global competitiveness within mathematics and science education. PCAST reported the United States would need approximately one million more college graduates in STEM fields to make up for shortfalls in STEM professions based on labor projections (PCAST, 2012). This address marked the renewal of STEM efforts in the United States and was the starting point for many of the federal government's recent STEM initiatives.

PCAST (2012) delivered five recommendations for the United States to address the STEM shortfall, which has influenced the federal response to STEM. First, the United States Department of Education must adopt research-based teaching practices for STEM, which would improve student learning in STEM classes. Second, discovery-based STEM courses should be implemented over the standard memorization style courses in many schools. This recommendation aims at student engagement through experiments and allowing creativity within STEM courses. Third, the United States should engage in a national experiment to address the mathematics gap between race and socioeconomic status. Many students do not pursue STEM fields because they lack mathematics skills before entering college and higher educational institutions spend two billion dollars per year on introductory mathematics courses, which often lead students to become disinterested in STEM. Fourth, the Department of Education should encourage partnerships between educators and businesses to strengthen STEM career pathways. Particularly, PCAST recommends that partnerships like these can aim at adult and working students to provide alternative paths to STEM careers. Last, a recommendation was made to create a presidential council on STEM education. This group of educational stakeholders and STEM businesses would work in tandem with the president's executive office to create changes to empower STEM education in the United States (PCAST, 2012). Since that time, the federal government has authorized 105 to 254 STEM programs across 13 to 15 federal agencies and has spent between 2.8 and 3.4 billion dollars annually on STEM education efforts (Granovskiy, 2018).

Graduate student enrollment in STEM has grown by 15% and the number of Black, Latinx, and female STEM college majors has increased over the last decade. However, the United States government is concerned with persistent achievement gaps between several demographic groups, the preparation of STEM teachers, and the performance of United States students on international mathematics and science tests (Granovskiy, 2018). The United States Government Accountability Office (2018) reported that of the hundreds of STEM programs there are not consistent program assessments to measure the effectiveness of the STEM initiatives and these programs provide little to no information on the participation rates of women and underrepresented minorities in these STEM initiatives. The amount of money spent by the federal government in STEM education shows its dedication toward meeting its goals, but the lack of accountability for the involvement of the groups targeted as a part of this study shows the need for targeted intervention for Black, Latinx, female, and low-income students in STEM.

Part of the reason for the push for STEM education in the United States deals with the declining number of foreign students studying STEM in the country. The National Science Board (2010) reported that the supply of immigrant STEM students would diminish in the future based on increased job opportunities abroad, rising tuition costs at universities in the United States, and future difficulties obtaining visas in the United States. In 2020, Immigration and Customs Enforcement began to revoke the visas of foreign students in the United States who were studying solely in online learning environments due to the coronavirus pandemic (Jordan & Hartocollis, 2020). This inspired a response from three large tech companies, Facebook, Google, and Twitter, and a significant online response from international STEM student stakeholders who highlighted the benefits of international STEM students in the US, specifically their additions to the knowledge economy (Jordan & Hartocollis, 2020). In the 2017 – 2018 school year, more than one million foreign students in the United States were studying at colleges and universities with nearly 50% of them studying STEM (Congressional Research Service, 2019). To incentivize international students to remain in the United States after finishing their degrees the United States extended Optional Practical Training, which allows students to remain in the United States to gain experience in their degree of study and created a fund for International Entrepreneurs. However, the success of these programs has not mitigated the labor shortage in STEM fields, revealing the increased need for international STEM student incentives and a need for domestic STEM students (Klimaviciute, 2017).

Business involvement in the STEM pipeline is similar to the federal government as an external influence on STEM education. Industries and companies have a set of unique reasons to support the STEM pipeline: the looming STEM job crisis, the stagnant amount of STEM College graduates, and the low amount of racially diverse and female STEM job candidates (Eagan et al., 2014; PCAST, 2012). Each of these problems is a condition that spurred business involvement in STEM, but each company's contributions are for a specific reason. Andrée and Hansson (2019) studied industry's involvement in STEM education in Sweden. The researchers collected qualitative data from several private sector websites involved in STEM education and analyzed them for value to the company and public good, conflicts of interest, and the potential tensions between them. The study identified seven arguments businesses use to justify their involvement in

STEM initiatives and education: securing competent labor, securing economic growth, improving the public image – marketing, contributing to a bright future, increasing interest in STEM, increasing knowledge in and of STEM, and empowering young people. The researchers concluded the study by urging a recognition of the commercialization of STEM education and how a focus on maintaining school-business partnerships may conflict with pedagogy (Andrée & Hansson, 2019). This research identifies the potential issues of the interactions of public STEM education with commercial organizations. While this research was based on Swedish public education and Swedish businesses, these same conflicts can be seen in STEM education in the United States.

In 2017, some of the largest companies in the United States, Amazon, Facebook, Google, Microsoft, and Salesforce, were part of an effort to put forth 300 million dollars in support of computer science education (Kang et al., 2018). Additionally, some of these companies are involved in STEM education outside of philanthropy. Google created CS First, an education resource with computer science curriculum and teacher professional development (https://csfirst.withgoogle.com/s/en/home). Amazon set up scholarship opportunities for graduating seniors interested in STEM as well as funding robotics programs for schools (https://www.amazonfutureengineer.com/). These large, successful US companies are offering aid to a STEM education structure perceived as mediocre by many Americans (Pew Research Center, 2015). The prestige of these companies and the perception of STEM education in the United States has created conditions where the growth of school and business STEM partnerships are welcomed in U.S. schools.

The economic conditions in the United States have created a setting where the involvement of businesses in schools faces little opposition. In the United States, individual state spending on public education plummeted in 2010 after an economic recession. Public education spending has not returned to previous high levels of spending even with adjustments for inflation (Leachman, 2018). Even though businesses who are supporting K-12 education are not provided with large profits, they do gain an opportunity for branding and improved public perception (Klein, 2020). Business and school partnerships should be evaluated with scrutiny, but schools in need of funding may engage in these partnerships to secure funding for STEM programs in need. Business involvement in the US STEM pipeline faces some scrutiny, but the looming STEM job crisis identified by the federal government agencies have created conditions where businesses' external resources and influence are welcome in schools (PCAST, 2012). These conditions include the stagnant amount of STEM college graduates (Eagan et al., 2014), and the low numbers of racially diverse and female STEM job candidates (Byars-Winston et al., 2010; Niu, 2017; Tyszko, 2011) have created conditions where businesses' external resources and influence are welcomed in schools.

The external influence of businesses and government institutions on the STEM pipeline shows the diverse set of expectations from outputs of STEM education. Their inputs help fund STEM education and bring attention to the field, but their broad perspectives have only begun to address the racial and gender disparities in the STEM pipeline. This study sought to address the demographic differences in STEM college majors and careers, which is addressed through the SCCT framework, which shows that career decisions and academic decisions are created simultaneously by individuals (Lent et al., 1994).

STEM Education

STEM education refers to the combination of each of the four separate subjects into an integrated learning experience meant to enrich students with active and engaging learning experiences (Freeman et al., 2014). Integrated STEM education's implementation has received much attention because of its ability to improve students' attitudes towards STEM careers, prepare students for the 21st century global economy, and prepare students for college (Becker & Park, 2011). The implementation of the integrated STEM learning experience is different across the United States based on the established segregation of learning subjects, the training of teachers in STEM content knowledge and pedagogy, and the challenge of creating a new structure for student learning (Thibaut et al., 2018). In this section, the current literature surrounding the integration of STEM into K-12 school curriculum and the various STEM school models is reviewed.

STEM education curriculum integrates required mathematics and science courses with technology and engineering to create courses rich in active learning, which increases students' comprehension and interest (Freeman et al., 2014). Active learning is a teaching method that stresses the importance of students' ability to apply their knowledge through being an active part of their learning through experiences like working as a team or working in a specific field's workplace (Manfrin et al., 2020). STEM education in primary and secondary schools in the United States is the combination of each of the four STEM subjects into classroom settings centered on active learning pedagogy (Breiner et al., 2012). The interconnected lessons tie together the STEM subjects by linking concepts, skills, and applying learning to real-world problems (Vasquez, 2015). STEM subjects are integrated, in part, to grant greater exposure to engineering and technology education. Science and mathematics are two of the most recognized subject areas in teaching while technology and engineering are two of the least implemented and least funded subjects in education (White, 2014). STEM education in K-12 schools seeks to increase active, integrated learning of STEM subjects in attempt to increase student achievement.

Across all levels of school, STEM subjects tend to create a classroom atmosphere that promotes students to engage in active, hands-on learning (Subramaniam et al., 2012). Using hands-on, classroom activities in STEM enhances students' understanding of processes in collaboration, communication, and critical thinking (Meyrick, 2011). In a study on the effectiveness of hands-on learning, researchers surveyed 127 middle and high school students during a two-week summer program to discover the effectiveness of a robotics engineering design program. The students designed, built, programmed, and used their robots in practical activities. The researchers found that students' engagement and enthusiasm towards science and technology increased based on their engagement level throughout the program (Ziaeefard et al., 2017). Hands-on learning is the departure of textbook-based classes and includes activities where students engage in lessons with experiments and activities that center on movement, which helps in building the interest of students in STEM fields.

The introduction of integrated STEM education in K-12 schools has had a positive impact on student learning. A meta-analysis of 28 integrative STEM approaches was performed by studying groups from all grade levels: 3 for elementary, 9 for middle school, 12 for high school, and 4 for the college level. The meta-analysis utilized articles ranging in publishing dates from 1989 to 2009, the methodology reviewed the integrative efforts in each STEM subject separately, and each article used measured student achievement with empirical quantitative findings. Overall, the study found integrative approaches to STEM education improve student learning, particularly for elementary students (Becker & Park, 2011). Researchers examined ten STEM focused high schools across the United States in a comparative case study method. Data collected included documents, telephone interviews, email communication, and comparative standardized test scores between the STEM schools and their nearby non-STEM counterparts. Of the 10 schools in the study, nine shared standardized test scores and each STEM school's test score average was higher than the state average in reading and mathematics (Scott, 2012). Consequently, the improved student learning outcomes have influenced the establishment of different types of STEM integration schools.

Selective STEM schools focus on one or more of the STEM subjects and use student entry criteria to select the highest-performing students to enroll in their schools (Erdogan & Steussy, 2015). Selective STEM Schools provide advanced, specialized STEM courses, employ master teachers, and create an environment for students motivated in STEM subjects. Within the selective STEM school model, there are four types of schools: residential schools, comprehensive schools, schools within schools, and half-day specialized schools (Almarode et al., 2014). In a study on the effectiveness of STEM selective schools' ability to produce students who earn undergraduate STEM degrees, researchers performed a cross-sectional and comparative study between students who attended selective STEM schools and students who attended comprehensive schools. The findings of this study showed that students who attended a selective STEM school were 59% more likely to earn a STEM degree, particularly students who attended the selective STEM school models of the schools-within-schools and residential schools (Almarode et al., 2014). Selective STEM schools' practices have an impact on students' STEM aspirations, but the criteria for entry exclude some students from attending these programs. Despite their ability to provide students with learning experiences that lead to STEM careers, these STEM selective schools exclude large numbers of Black, Latinx, female, and low-income students who are underrepresented in STEM (Lynch et al., 2017).

In contrast to selective STEM schools, inclusive STEM schools create programs that engage students in STEM to build on their prior knowledge and provide an opportunity for underrepresented students to engage in advanced STEM coursework (Erdogan & Stuessy, 2015). Researchers studying the qualities of inclusive STEM high schools have established ten critical components of these schools. These are: a STEM-focused curriculum; reformed instructional strategies and project-based learning; integrated, innovative technology use; blended formal/informal learning; beyond the typical school day, week, or year, real-world STEM partnerships; early college-level coursework; inclusive STEM mission; administrative structure; and supports for underrepresented students (Peters-Burton et al., 2014).

In a mixed-methods study comparing inclusive STEM high schools to comprehensive high schools in Denver, Colorado and Buffalo, New York, researchers compared the test scores, course offerings, and demographics of STEM schools from each city, and utilized teacher and administrator interviews from each of the schools. The researchers found that the inclusive STEM schools attempted to incorporate the ten critical components from Peters-Burton et al.'s (2014) research, but over time these structures were overwhelmed by attempting to maintain these components and meet their state's graduation and testing requirements (Eisenhart et al., 2014). Inclusive STEM schools create a challenging scenario by attempting to overcome the established STEM exclusionary outcomes for underrepresented students while maintaining the requirements of meeting benchmarks for graduation rates and standardized test scores. These inclusive STEM schools are one of the opportunities available for underrepresented groups in STEM to have a better chance of continuing after high school to a STEM college major or career.

Different from both selective and inclusive models, STEM career academies are school within a school programs. In this school model, STEM career academies integrate a STEM career pathway into the curriculum and course sequence for students while also being a part of the larger overall school (Brand, 2009). In career academies, there are typically partnerships with employers who advise on curriculum and provide support (Stern, 2010). Employer partnerships are an incentive for businesses to have high school graduates who are prepared with the skills necessary for the jobs they provide. A study, performed with 258 alumni of Philadelphia High School Business Academies from 1989 to 1991 compared workers' student data (grades, school attendance, and educational level) to their self-reported work data (job performance and work attendance). The research found strong, positive correlations between high school grades and job performance and school attendance with work attendance (Linnehan, 1996). For businesses, this means students with high grades and better attendance are more likely to be high performers in their careers and have high attendance at work. The potential benefits to investing in STEM education and establishing school to business partnerships can be seen through the actions of big businesses. Subsequently, The United States Chamber of Commerce (2017) lists 11 organizations that work as STEM partnership groups between businesses and schools. If career academies are creating a skilled and prepared workforce then businesses have a stake in how career education.

There is also the T-STEM school model, which is a blend of the inclusive STEM schools and the STEM career academies. T-STEM academies are a model for inclusive STEM schools put in place across a whole state. Their early entrance into the academy model structure and their robust data displays their academic successes in comparison to traditional schools (Erdongan & Stuessy, 2015; Young, House, Wang, & Singleton, 2011). T-STEM is the largest investment in inclusive STEM high schools in the United States. Beginning in the 2006-07 school year, the first T-STEM school was established and as of 2020, 95 T-STEM schools have been established (Texas Education Agency, n.d.; Young et al., 2011). The T-STEM schools are kept small, serving 100 students per grade. The guidelines require the schools to have 50% of their students from low-income families and 50% from ethnic/racial minority groups; the schools must include STEM coursework, personalized learning opportunities, and instruction related to relevant problem-solving (Young et al., 2011). Integrated STEM curriculums in Texas's STEM focused T-STEM schools show higher achievement for students enrolled in these programs.

The STEM schools model mostly focus on high schools; programs for elementary and middle schools help strengthen the STEM pipeline in education. The Engineering is Elementary (EIE) curriculum provides hands-on learning activities for elementary school students across the United States with 9,036 teachers reportedly using the EIE curriculum. The lessons enhance established science curriculum for schools, to encourage collaboration and communication between students, and expose elementary students to different fields of STEM at a young age (Rivoli & Ralston, 2009). Involving elementary school age students in STEM education is integral to closing the racial achievement gap in schools. Researchers have noted a racial gap in mathematics achievement between white and Black students in elementary schools. As that gap remains, it effects students' high school completion, college attendance, and STEM degree attainment (Sass, 2015). The National Society of Black Engineers (NSBE) created the Summer Engineering Experience for Kids (SEEK) to target young, underrepresented students and create a positive STEM experience for them at an early age to strengthen the STEM pipeline (NSBE, n.d.).

Researchers suggest that integrated STEM courses are successful in elementary schools. In a study of elementary school students from low socioeconomic backgrounds, researchers compared 129 students' achievement in STEM subjects based on if their classes STEM classes were taught separately or in an integrated approach. Using a MANOVA approach on this convenience sample, researchers found that the students who received the blended STEM learning approach scored higher than their traditional learning classmates (Seage & Türegün, 2020). At the elementary level, STEM is being used to increase achievement among students.

Middle school is the point at which many students form their career aspirations and many students' interest in STEM is determined at this age (Kang et al., 2018). A quantitative study on middle school students' interest in STEM careers used video interviews of STEM professionals, viewed over an eight-week period, to familiarize students with STEM careers. The students completed survey before, midway through, and after viewing each of the videos. The findings of this study show that when students have accurate information about STEM careers through video interviews, they are more likely to consider STEM careers (Wyss et al., 2012).

Furthermore, integrated STEM learning is making a difference for middle grade students. A project called Middle Schoolers Out to Save the World (MSOSW) was designed for integrated STEM learning for middle school students. It involves hands-on activities and real-world problem solving. Researchers performed a quasi-experimental study using 246 middle school students engaging in MSOSW activities in six schools to determine the effect of MSOSW activities on STEM learning and STEM career aspirations. The study found students who took part in MSOSW project activities had gains in their STEM content knowledge, increased aspirations for STEM careers, and positive dispositions towards STEM (Knezek et al., 2013).

Middle school is a time when students' STEM career interests can begin and be supported. Dönmez and İdin's (2020) study on middle school students in Turkey utilized the STEM-CIS to understand students' STEM interest using self-efficacy, outcome expectations, personal goals, and environmental supports. The researchers determined these middle school students' self-efficacy and outcome expectations drove their interest in STEM, but the students lacked STEM personal goals because of their young age. Additionally, environmental supports showed little impact in this survey, which the researchers concluded was due to a lack of STEM professionals the students worked with prior to the survey (Dönmez and İdin's (2020). Creating opportunities for students at the middle school level to engage in STEM activities to increase their self-efficacy and outcome expectations can help build interest in STEM, but more research is needed to understand how students STEM interest is built and maintained at the high school level.

STEM education has grown from four loosely related subjects to being defined by teachers' and schools' ability to integrate each of these subjects together for a cohesive experience for students. The integration efforts are different across grade levels, states, and schools because of the recent push for an integrated STEM approach. Each of these school contexts and plans reveal an overarching work towards STEM cohesiveness but lacks the direct impact on STEM demographic disparities which this research seeks to address.

Persistent Problems in STEM Education

Gender and racial diversity within the STEM workforce have been noticeable issues for the last decade. Black and Latinx STEM workers make-up nine percent and seven percent, respectively, of the STEM workforce, while 75% of the STEM workforce is made-up of white males (Funk & Parker, 2018). When healthcare professions are considered, women consist of 50% of the STEM workforce, but women remain underrepresented in computer science, physical science, and engineering-related occupations (Funk & Parker, 2018). Research shows demographically homogenous groups make less rigorous decisions and make more mistakes than groups with demographic diversity (Apeflbaum & Mangelsdorf, 2017). The lack of diversity within STEM education and careers stifles the decision-making processes of STEM businesses and companies while also hindering their innovation. The underrepresentation of these groups at the career level relates to their experiences in colleges and K-12 schools

(Griffith, 2010). According to the PCAST (2012) report, three million students per year enter college intending to major in STEM, and less than half of them persist in STEM majors until graduation. Further data shows that 47.5% of STEM college graduates choose careers in non-STEM related jobs after graduating (Wernick & Ledley, 2020). In this section, the persistent issues of lack of achievement, lack of access, stereotype threats, and low public perception for STEM subjects is explained through the relevant literature available.

The perception of STEM education in the United States reveals some of the problems surrounding STEM education. The Pew Research Center (2015) conducted a study utilizing a pair of surveys in conjunction with the American Association of for the Advancement of Science (AAAS) to discover the perceptions of United States citizens and AAAS scientists on the status of scientific fields in the US. Researchers conducted a survey with 3,748 AAAS scientists participating online and interviewed 2,002 United States citizens over the age of 19 by phone. Of those in the study, only 16% of AAAS scientists and 29% of U.S. citizens believed K-12 STEM education in the United States was the best or above average in comparison to other countries. The perceptions of scientists and citizens reveal the low regard for STEM education in the United States, but another issue is educators' perceptions. In a study analyzing the perceptions of teachers' and administrators' perceptions of STEM through 172 student-led interviews, the mixed perceptions of school staff revealed another issue in the perception of STEM education. The researchers found that outside of science and technology teachers, most school staff could not define STEM education, but most school staff agreed that STEM education is important (Brown et al., 2011). The low regard of citizens and scientists and the lack of understanding from teachers and administrators harms perceptions of STEM education in the United States.

Another problem for the growth of STEM education in the United States is a lack of STEM achievement. In a study comparing levels of science achievement and aspirations, Han and Buchmann (2016) compared the Program for International Student Assessment's (PISA) science scores of several developed countries. The researchers sought to compare student science achievement between countries, STEM career aspirant's science performance among countries, and examine the degree of curricular standards in relation to science achievement and STEM aspirations. Among the twenty-seven countries mean science scores, the United States ranked nineteenth, and among STEM aspirant students, ranked twentieth. This lack of preparation is also evident in data collected from the ACT on students' college readiness. ACT (2017) published findings based on their college readiness assessment's STEM benchmark scores, science scores, and their interest inventory that students complete at test registration. From 2015 to 2017, 20% to 21% of students per year met the ACT STEM benchmark, which represents the likelihood of a student passing a first-year college STEM course with a C or higher. Most students who take the ACT are not prepared for STEM at the collegiate level even if they are interested in pursuing a STEM college major or career. Students are underprepared to be successful in collegiate level STEM courses, which contributes to the issue of STEM achievement and enrollment, which is exacerbated for students from underrepresented groups.

ACT's (2017) research findings report a disparity for female, racial and ethnic minorities, students from low-income backgrounds, and first-generation college students.

ACT reported that female graduates were less interested in STEM and fewer female graduates met STEM readiness benchmarks. ACT's research findings also report a disparity for three underserved student groups, racial and ethnic minorities, first generation college students, and low-income students. According to ACT's research, eleven percent of students in one of the underserved categories met the benchmark, five percent of students in two of the categories met the benchmark, and only two percent of students within all three of the student groups met the benchmark for STEM. There is an overall problem for STEM achievement in the United States and it effects this research's targeted student groups, female, Black, Latinx, and low-income students, disproportionately.

The achievement gap in STEM subjects has been an issue in the United States even before the focus on STEM education began. Many schools in lower socioeconomic neighborhoods became the target of school turnaround efforts after the passage of the No Child Left Behind Act (NCLB). Schools were expected to implement reforms to increase reading, writing, and mathematics standardized test scores. The strategies implemented increased the amount of time students were in their English and mathematics courses, which led to a decreased amount of time in their other courses (Darling-Hammond et al., 2014). The consequences were that many low-income schools lacked the ability to expose their students to STEM curriculum. Students attending secondary schools in low-income neighborhoods are less likely to be offered courses in advanced mathematics and science, which are known factors in influencing students' interest and persistence in STEM degrees in college (Hallett & Venegas, 2011). NCLB's efforts to address the achievement gap between students contributed to the STEM gap between schools because of the pressures applied to low-income schools and their inability to provide rigorous STEM courses.

The STEM achievement gap is exacerbated by problems of access and teacher quality. In a study on the correlation between AP science and calculus enrollment with STEM careers, researchers collected data from 15,000 students in a racially and socioeconomically diverse school district. The data supports a correlation between enrollment in AP calculus, biology, chemistry, and physics and a student's interest in pursuing a STEM college degree. The researcher also noted that to increase racial minority involvement in STEM, high schools need to create systems that encourage these students to do so (Robinson, 2003). The research on the correlation between AP courses and STEM degree pursuit has influenced the access to AP courses in all schools but has exposed a problem of instructional quality. Hallett and Venegas (2011) investigated the quality of AP courses in low-income, urban schools by interviewing 48 college-bound students, 90% of whom attended low-income high schools. The researchers gleaned four key findings from their interviews: students took AP courses when they were available, participated in the AP tests with overall low-pass rates, their test scores were low in comparison to their grades in the class, and these students reported a low quality of their AP class experience. The researchers posit that the goal of increasing access to rigorous AP courses for low-income students does not ensure quality. Furthermore, it could be part of an effort to meet lawful requirements as opposed to creating truly equitable experiences (Hallett & Venegas, 2011). These research articles display the issue of an achievement gap in STEM exacerbated by a lack of access to high-quality AP courses.

Black and Latinx students account for less than 16% of STEM graduates in the United States but makeup nearly 32% of students enrolled in colleges and universities in the United States (National Science Board, 2010; United States Department of Education, 2018). Like the low-income NCLB affected schools, schools serving mostly African American and Latino students are less likely to offer AP mathematics and science courses than their mostly white peer schools (Handwerk et al., 2008). High scores on STEM related AP exams are a predictor for students majoring in STEM in college (Mattern et al., 2011). Lack of access is a contributing factor to underrepresented minorities choosing STEM as a major. Less than 30% of high schools serving mostly Black students offer AP Calculus and less than 40% of the high schools serving a majority of African American students offer AP Physics (Handwerk et al., 2008; United States Department of Education, 2018). The lack of access to these courses creates a barrier for students to major in STEM fields.

Access is an overarching issue for students from low-income families. The College Board, a non-profit organization administering advanced placement testing in schools, annually releases a report with details about college price, enrollment, and completion across gender, ethnic, and economic demographics. The 2019 report shows that students from low-income backgrounds are less likely to enroll in college than students from higher-income backgrounds (Ma et al., 2019). Cahalan and Perna (2015) published a study spanning 45 years measuring the equity of postsecondary education enrollment, payments, and graduation rates. This study showed that only 9% of students from low-income families attain bachelor's degrees by the age of 24 as opposed to their highest-income family peers, who attain bachelor's degrees at seventy-seven percent.

College enrollment and completion are significant issues for students from low-income backgrounds, which affects their representation in STEM college majors and careers. A study (Shaw & Barbuti, 2010) utilizing data from 21,000 student questionnaires from the SAT and collected data from colleges and universities were analyzed to discover the characteristics of students who persist in STEM majors based on their GPA, declared college major, degree goals, advanced placement exams, and questionnaire answers. In the study, students from lower-income families were more likely to switch from STEM majors than peers from higher income families. The research shows that socioeconomic status has an impact on students' college enrollment and STEM persistence.

The segregation of women from professions in STEM is a problem of access through vertical and horizontal segregation. In vertical career segregation, women lack access to high-paying managerial positions, and in horizontal career segregation, women are segregated from certain types of jobs, (Tellhed et al., 2016). The problems of these types of segregation are present in STEM fields. Data from the Association of American Universities show that women make-up 31 percent of assistant professors, 22 percent of associate professors and only 13 percent of full professors in STEM in comparison with 51, 46, and 29 percent respectively in non-STEM fields (Trenshaw et al., 2016). In a study on self-efficacy and social belongingness for STEM and healthcare, elementary education, and domestic sphere (HEED) majors, high school students rated their interest, self-efficacy, social belongingness, and the status of each major. The results showed that male and female students expected to have higher social belongingness to majors where their gender was the predominate group and that females were less confident in their ability to handle STEM careers (Tellhed et al., 2016). The research and data show that the lack of representation of women in STEM fields currently is attributing to the lack of women pursuing STEM.

The lack of representation of female individuals in STEM limits the ability for students to be exposed to role models in these fields. In a study conducted with 1,035 STEM and non-STEM college students, researchers measured several variables related to their STEM self-perception, and academics based on gender and race/ethnicity. The study found a positive relationship between exposing students to STEM role models from diverse backgrounds and increasing students' STEM interest (Shin et al., 2016). Similarly, a study on the benefit of female science professors recruited 320 undergraduate students from engineering and chemistry courses and collected data on their implicit associations. The results showed that when female professors were viewed as positive role models, stereotypes about science became more feminine than masculine and increased positive science career aspirations and attitudes for male and female students (Young et al., 2013). These studies show the importance of female role models in STEM to increase STEM interest for all students and to change stereotypes on STEM professions, but the overall lack of women in STEM hinders the ability for students to encounter more female STEM role models.

Additionally, women's STEM degree attainment and representation in the STEM workforce is remarkably low in comparison to males. Women are underrepresented in STEM majors and careers even though their access to STEM education is not hindered in comparison to males and women account for only 30% of STEM degrees attained (Economics and Statistics Administration, 2017). In 2019, data from the United States Census Bureau, which creates a distinction between STEM jobs and many healthcare related jobs, show that women make up 48% of the United States Workforce, but only account for 27% of the STEM workforce. (Martinez & Christnach, 2021). The future of STEM depends upon a diverse set of ideas and cannot be achieved with a homogenous population of STEM students and career holders. STEM fields currently lack female entry because of issues of gender stereotypes and gender occupation segregation.

Some of the gender homogeneity in STEM has been explained through the education and work environments of men and women in STEM. In a study created to understand the gender differences between men and women in STEM, researchers performed a meta-analysis of STEM interest inventories. The researchers found female respondents to desire more people-oriented work environments in comparison to things-oriented work environments in the case of STEM fields. Also, the researchers noted there was not a statistically significant difference between male and female quantitative abilities. The researchers concluded understand women's underrepresentation in STEM fields, further research on their interests is needed (Su & Rounds, 2015). This article illustrates the need for interests-based STEM research to understand and help resolve the underrepresentation of women in STEM fields.

Because of the various problems within STEM education, students may not create positive outcome expectations in relation to STEM. A qualitative study following 95 middle school and high school aged students in focus groups to understand their relationship to STEM. The researchers found while many students have positive outcome expectations in relation to successful performance in math and science, students also held some negative outcome expectations for STEM, especially female students when it came to physical and self-satisfaction outcome expectations (Shoffner et al., 2014). This study shows the positive relationship between STEM outcome expectations and STEM interest, but also shows how some students have already built negative perceptions of STEM education at an early age.

The problems of representation, access, and achievement hinder the growth of STEM from a more demographically diverse set of students. This research seeks to identify factors relating to groups of students often left out of STEM college majors and careers because the abundance of research that shows how they are often left out or left behind. By identifying factors which relate to their interest in pursuing STEM, this research can guide future educational efforts which seek to involve female, Black, Latinx, and low-income students in STEM fields.

Theoretical Framework: Social Cognitive Career Theory

Social Cognitive Career Theory (SCCT) is a framework that explains the career and academic behaviors of individuals by observing their personal behaviors and surrounding supports. SCCT combines elements of Bandura's (1986) Social Cognitive Theory (SCT), which explains how behaviors, personal factors, and environment influence people, and Hackett and Betz's (1981) study on the relationship between self-efficacy and career development. SCCT brings together opposing factors like, self-direction and external influences, to recognize how complex relationships can affect decision making (Lent et al., 2002). Through expansion, the creators of SCCT sought to focus on three aspects. First, SCCT seeks to highlight processes that can help define individuals' career-related interests. Secondly, SCCT is a framework created to understand the development of career behaviors and academic behaviors. Third, SCCT is grounded in Bandura's (1986) SCT, and uses the constructs created within SCT to explain career development (Lent et al., 1994). The three constructs to explain career development are self-efficacy, outcome expectations, and personal goals. Each construct informs the choices, interests, and performance of individuals in their career development actions (Lent et al., 1994). This section describes the key tenets of SCCT and how it serves as a useful framework for examining the relationship between student beliefs and interest in STEM majors and careers.

SCCT is an extension of several career development research theories involving self-efficacy (Lent et al., 1994). The concept of self-efficacy in development research originated from Bandura (1977), who posited that individual's thoughts concerning their own abilities influenced their behaviors. Self-efficacy was first applied to career research in Hackett and Betz's (1981) study on the lack of female science and engineering majors, which employed self-efficacy to explain the academic experiences of women in science. Lent et al. (1994) incorporated several other theoretical frameworks in the creation of SCCT including, personality typology (Holland, 1973), social learning (Krumboltz et al., 1976), life span, life space (Super, 1980), developmental theory (Vondracek & Schulenberg, 1986), and person-environment correspondence (Davis & Lofquist, 1984). By utilizing each of these vocational frameworks, SCCT is an extension of SCT meant to explain broader career and academic interest and development (Lent et al., 1994).

SCCT is based on two assumptions. The first assumption is the conception of person-situation interaction. In this assumption, individuals are affected by their personal attributes, external environmental factors, and their overt behaviors (Lent et al., 1994). This assumption makes SCCT different from other career models because it acknowledges the influence of behavior on career goals where many other career theories acknowledge only personal attributes and external environments (Lent et al., 1994). Further research from Lent et al. (2002) expands on this SCCT assumption to explain that humans possess a capacity for change. As humans change their environments, their environments also change them. An example of this assumption would be if a worker were to develop in their career field, they would experience changes in their work environment, which would influence changes in their personality, and would affect their career. Lent et al. (1994) refer to this exchange of influence on personality, external factors, and behaviors as triadic reciprocity, which is unique to SCCT and how it informs career development.

The second assumption in the creation of SCCT addresses the personal determinants and processes within the triadic reciprocity presented in Bandura's (1986) research: self-efficacy beliefs, outcome expectations, and goal representations (Lent et al., 1994). These three processes were utilized because of their relevance to career development. SCCT assumes that these three constructs are responses to the dynamic nature of individuals and the continuous changes of their environments. With respect to these dynamics, SCCT transcends the idea that behavior is a byproduct of people and their environment, and instead assumes that all three of those factors are interrelated and affect each other. The issue of SCCT is its reliance on the self-efficacy construct as a driver for goals, interest, and outcome expectations. SCCT greatly differs from other career development frameworks in its emphasis on self-efficacy as a key construct in the creation and continuation of career development behaviors (Lent et al., 1994).

Self-Efficacy is the aspect of SCCT most often utilized in other career development theories (Lent et al., 1994). The self-efficacy construct is defined as "people's judgements of their capabilities to organize and execute courses of action required to attain designated types of performances" (Bandura, 1986, p. 391). Self-efficacy helps someone choose actions, effort, environment, thoughts, and emotional reactions (Lent et al., 1994). Since its introduction, research on self-efficacy has revealed relationships between career-related choices and performances on self-efficacy (Hackett & Lent, 1992; Multon et al.,1991; Sadri & Robertson, 1993). In SCCT, self-efficacy is an active, dynamic trait that changes based on a person's performance, behavior, and environmental factors (Lent et al., 1994). Self-efficacy is its own construct and does not always equally measure to objectively assessed skills (Hackett & Betz, 1981). In SCCT, human ability is a dynamic attribute that changes based on performance of complex tasks that require competence in the skills and self-efficacy (Bandura, 1997). Bandura (1986) theorized that self-efficacy has three positive origins: mastery, self-persuasion, and modeling, and one negative origin, anxiety. Mastery, modeling, and self-persuasion are levels of self-efficacy that lessen, respectively. Anxiety is an individual's negative view of their ability to complete a task (Bandura, 1986).

SCCT utilizes the outcome expectations construct, defined as the "imagined consequences of performing particular behaviors" (Lent et al., 1994, p. 85). Bandura (1986) categorized outcome expectations into three domains, physical, social, and self-evaluative. In SCCT, physical outcome expectations are tangible incentives, social outcome expectations are group praise, and self-evaluative expectations include self-satisfaction from the task (Lent et al., 1994). Outcome expectation is another construct of SCCT that differs slightly from self-efficacy. Self-efficacy deals with someone's ability to complete a task, but outcome expectations deal with the consequences of performing action (Brown et al., 2011). Individuals' beliefs on their external motivations, self-directed consequences, and the outcomes of engaging in an activity influence outcome expectation.

One's environment and history shapes people, but people are also are shaped by goals they set for themselves (Lent et al., 2002). Personal goals are the motivation to perform tasks or to affect a future outcome (Bandura, 1986; Lent et al., 2002). The personal goals construct is one of the ways people directly affect their own autonomy within career goals. While other external factors influence behavior, goal setting creates space for people to act against the influences of their environment and shape their own behaviors. Through the combined use of these three constructs, SCCT has been used to build career aspirations for children and encourage career goal setting for young adults across many subpopulations including women of color, persons with disabilities, and a variety of cultural contexts (Ochs & Roessler, 2004). SCCT framework has three connected models: the interests model, the choice model, and the performance model (Lent et al., 1994). Lent et al. (2002) expanded these three interlocking models to explain academic and career development simultaneously.

The interests model is the basis for each of the models of SCCT. Interest in a career develops through cognitive factors and through experiences, which inspire individuals to gain skills and motivates their choices (Lent et al., 2002). SCCT posits that people gain interest in careers and activities when they view the outcomes of the tasks to be something they can proficiently complete, but also posits the antithesis, where people lose interest in tasks they expect to underperform (Lent et al., 2002). As people perform tasks related to their interests, they build goals regarding that interest, which also increase their likelihood of engaging in the activity in the future (Lent et al., 2002). The interests model of SCCT is a circular exercise: self-efficacy increases, outcome goals are made, and new interest is created, which begins the cycle again.

The choice model recognizes the influence of environmental factors and other people on career interest and outcomes (Lent et al., 2002). The choice model expands on the interests model by considering context within the choices that people make regarding their careers (Sheu et al., 2010). The choice model is an incorporation of the actions people take to reach their career goals. The choice model incorporates the circular exercise of the interests model with self-efficacy, outcome goals, and new interest being created. The choice model builds upon the interests model by incorporating environmental factors (Lent et al., 2002). Environmental factors can act as positives that make a career choice more likely, or they can act as negatives, which deter someone from pursuing a career.

The performance model of SCCT explains growth of self-efficacy through the accomplishments of people and their persistence in their pursuit of careers (Lent et al., 2002.). The performance model conveys outcome expectations, self-efficacy and goals as variables affected by performance. When someone has high self-efficacy in a task, they have more favorable outcome expectations, and more ambitious career goals, which all affect their performance behavior. The performance model of SCCT shows a need for congruence between ability and self-efficacy (Lent et al., 2002).

SCCT as a career development framework fits the scope of this study because this research is focused on the personal inputs of high school students. By using SCCT as the theoretical framework of this study, the relationship between students' interest in STEM college majors and careers can be linked to outcome expectations, personal goals, environmental factors, and self-efficacy. It allows for an understanding of which of these factors has a better relationship to students' interest rather than a study on the impact of a certain school's STEM program. Particularly, the interests model of SCCT was used in this study because this study is investigating the SCCT behaviors of students regarding their interest in pursuing a STEM college major or career.

Study Purpose

Black, Latinx, female, and low-income students are underrepresented in STEM college majors and careers, which has been a persistent issue in the United States for a sustained period (Berryman, 1983; Byars-Winston et al., 2010; Ononye & Bong, 2017; Tyszko, 2011). The problem for underrepresentation of these groups is also evident through the inequitable experiences these groups have during their middle and high school years. These experiences lead to their lack of enrollment and sustained interest in pursuing STEM college majors or careers (Han & Buchmann, 2016). Current research does not address why Black, Latinx, female, and students from low-income backgrounds pursue STEM after high school (Brown et al., 2011). This research addressed how self-efficacy, outcome expectations, environmental factors, and personal goals relate to an interest in pursuing STEM after high school. This study targeted high school students to quantify how these social cognitive factors are related to students' interest in STEM college majors and careers. This study was conducted to answer the following research questions:

RQ: What is the association of outcome expectations, self-efficacy, environmental supports, and personal goals to high school students' interest to pursue STEM careers and college majors?

In the following chapter, the SCCT framework is detailed for its ability to answer these research questions along with an explanation of the cross-sectional survey methodology to be used. The implications from this research can be used to create experiences to encourage Black, Latinx, female, and students from low-income backgrounds to pursue STEM college majors and careers.

CHAPTER III: METHODOLOGY

The purpose of this study is to investigate the relationship of self-efficacy, outcome expectations, environmental factors, and personal goals to Black, Latinx, female, and low-income high school students' interest in pursuing STEM college majors and careers. This study was conducted using a cross-sectional survey design to measure students' STEM interest, self-efficacy, outcome expectations, environmental factors, and personal goals, each identified as interlinked social cognitive factors related to Black, Latinx, female, and low-income students' STEM attitudes (Lent et al., 1994). As related to this study, a cross-sectional survey design gathers data during a single period (Cohen et al., 2007), which is appropriate for this study so that the STEM attitudes of students at various levels of their programs can be captured. Obtained scores addressed the following research questions:

RQ: What is the association of outcome expectations, self-efficacy, environmental supports, and personal goals to high school students' interest to pursue STEM careers and college majors?

In this study, Black, Latinx, female, and low-income student groups' interest in pursuing STEM was used as the independent variable while their STEM self-efficacy, outcome expectations, personal goals, and environmental factors were used as the dependent variables. The variables chosen for this study are tied to SCCT, which relates students' academic aspirations to their career aspirations (Lent et al., 1994). Through this study, the targeted student groups' interest in STEM was related to each of the SCCT factors of study to demonstrate which factors are strongly correlated to students' STEM interest. Future educational practices utilizing these factors may encourage the interest of a more diverse group of students to pursue STEM and would further diversify STEM college majors and career holders in the US.

This chapter is organized into seven sections. Research Design is an overview of how this quantitative study was performed and the survey instrument used. The next subsection details the study participants and the sampling method used. The Measures subsection is an explanation of the survey instrument, the STEM-CIS, which was used for the study. Then, the Data Collection subsection is an overview of how data were collected and secured for the study. Data Analysis and Procedures details the statistical procedures to be used to analyze the student data and their rationale. The Assumptions and Limitations section explains the assumptions of the statistical research design and the limitations of the study's findings. The chapter closes with a brief summary of the methods applied to this study.

Research Design

This study was conducted using a non-experimental cross-sectional survey method to measure the STEM attitudes of students' attending low-income schools. Non-experimental studies are typical in educational research because the variables being measured are not manipulated (Johnson, 2001). The STEM attitudes of students in this study were observed without manipulation and the descriptive data collected were used to understand the STEM college and career aspirations of the student groups represented within the study. Cross-sectional survey design is used to capture data from multiple groups during a single window of time (Cohen et al., 2007). This research study surveyed students during a one-month period and provide data on cross-sections of students across grade levels, academy participation, race/ethnicity, gender, and economic status. Cross-sectional design is appropriate for this study because of the number of groups being observed. While previous research shows some relationships between STEM interest and the other SCCT factors (Silva Cardoso et al., 2013; Chachashvili-Bolotin et al., 2016; Turner et al., 2017), the specific factors of STEM interest for Black, Latinx, and female students and these variables are unknown. Using a cross-sectional method, this research established a basis for which SCCT factors are associated with post-secondary STEM interest and can establish a baseline for further research and future educational practices within the school district. The cross-sectional survey design measured students' STEM attitudes during the time of study rather than changes in their STEM attitudes over time. Additionally, the findings from this research can provide a quick insight into the STEM perceptions of the students in the studied school district.

The survey instrument used for this study was the STEM Career Interest Survey (STEM-CIS; Kier et al., 2013). The STEM-CIS was developed using SCCT and measures self-efficacy, personal goals, outcome expectations, interest, and environmental supports for each subject area in STEM. The STEM-CIS was used to collect data on the social cognitive attitudes of students attending the high schools sampled for this study along with demographic information to identify cross-sectional groups. The STEM-CIS provided quantitative data for an analysis, which allowed this study to report findings on the STEM college and career aspirations of the students participating in this study.

Study Participants and Sampling

Study participants were high school students attending the STEAM Academy in Lexington, a career academy focused school, or TECC Boss, a STEM summer experience in Louisville created by TECH-nique, an organization created for community technology opportunities. Each of the study locations offers STEM curriculum to students. The STEAM Academy provides these opportunities throughout the school year. TECC Boss is one of TECH-nique's STEM opportunities for students among their yearly extracurricular offerings.

Surveys at both locations were administered through Qualtrics software online. At the STEAM Academy, the director offered the survey as optional through a meeting with parents and provided directions to obtain consent from them and assent from students. At TECC Boss, surveys were administered during the morning meeting from the camp's advisors, with consent and assent being obtained through parent contact at the meeting. A stratified sampling method, which divides populations into groups with similar characteristics, was used to create groups of students for the cross-sectional research (Cohen et al., 2007). The surveys at the STEAM school were offered electronically from March 2022 to April 2022 and the surveys for TECC Boss were collected during week two of their summer experience taking place in June. After the data collection was complete, data analysis for the group's overall began.

Measures

The STEM-CIS was used as the survey measure for this study (Kier et al., 2013). The STEM-CIS was developed using the SCCT framework for its questions that relate to the STEM career and class interest of students. This survey instrument was chosen for this study because it quantitatively measures students' attitudes towards STEM using the SCCT variables interest, personal goals, outcome expectations, self-efficacy, and environmental supports. Using a survey allows for data collection within a small window of time that would allow this research study to measure the social cognitive attitudes of the students.

This STEM-CIS was based upon Tyler-Wood et al. (2010) STEM Semantics Survey and the Career Interest Questionnaire, but also incorporates Social Cognitive Career Theory (Lent et al., 1994). Its creation was based on a need for a more reliable, age-appropriate measure with a strong theoretical background (Lent et al., 2002). The STEM-CIS consists of 44 items answered on a Likert scale (*1 = Strongly Disagree, to 5 = Strongly Agree*) and measures students' interest, self-efficacy, personal goals, environmental supports, outcome expectations, and outcome expectations in STEM. The 44 STEM-CIS items are divided into four sections, each measuring the SCCT variables for the STEM fields separately as shown in Appendix A. Each section measures students' self-efficacy, personal goals, outcome expectations, interest in subject, and environmental supports with two questions each. The students recorded each of their responses electronically and the numeric value of their responses for interest in the STEM subjects was compared to the numeric value of their self-efficacy, outcome expectations, personal goals, and environmental supports.

Internal consistency reliabilities for the STEM-CIS measured over 1000 students using social cognitive factors, self-efficacy, personal goals, interest, environmental supports, and outcome expectations, on science, technology, engineering, and mathematics, alpha scores ranged from .77 to .89, indicating a respectable range for reliability (Stevens, 2007). To measure validity, the STEM-CIS used a confirmatory factor analysis in a structural equation modeling software. This analysis confirmed each of the STEM constructs model of fit was strong, which showed each subscale represented a factor. The researchers confirmed the scale could be used in a variety of ways, either using as a single-factor model which includes all items or using each of the subject areas separately for measure (Kier et al., 2013).

The survey was administered with demographic questions to capture data needed for cross-sectional analysis. Surveys were collected from each school to identify career academy and non-career academy schools. Students were given optional demographic questions on gender, race/ethnicity, economic status, and grade level. The answers provided on the demographic questions allow the data to be analyzed within and between groups to provided data on the STEM attitudes of gender, racial, and economic groups of students.

Data Collection

Data collection took place for the STEAM Academy from March 2022 to April 2022 and data collection for TECC Boss took place in June of 2022. Surveys were administered electronically for all students. At the STEAM Academy, the director provided consent procedures for parents at an after-school meeting and provide the link to the survey for consent and students can complete the survey. At TECC Boss, adult group facilitators collected electronic consent from parents during their morning meeting and allow students to complete the survey after consent is obtained. Surveys should take no longer than 30 minutes to complete. For STEAM Academy students, the survey must be completed outside of school. TECC Boss students were asked to complete the survey during their morning meeting time. At the conclusion of the open survey windows for each group, the survey instrument was taken offline, and student survey data were securely stored electronically.

The survey instruments were administered in 9^{th} through 12^{th} grade students. Surveys were administered to stratify the groups through grade level. Additionally, teachers administering the surveys in their classes can answer clarifying questions for students about STEM careers. The survey instruments were administered to students using an electronic format with the STEM-CIS data collected along with demographic and school information. Data were collected and stored securely while in electronic format to allow students' information to be kept secure.

Data Analysis and Procedures

After the cross-sectional survey data were collected, the data were analyzed with descriptive and inferential statistics. IBM's Statistical Package for Social Sciences Software (SPSS) was used to for statistical procedures. The relationships between the independent and dependent variables were investigated using a correlation design. Correlation in research is used to demonstrate the numerical relationship between independent and dependent variables (Stevens, 2007). For this research, students' STEM interest is being compared to their self-efficacy, personal goals, outcome expectations, and environmental supports. The study utilized four independent variables, STEM self-efficacy, outcome expectations, personal goals, and environmental supports, and measure the strength of their relationship to the dependent variable, STEM interest.

Upon completion of data collection, descriptive statistics were used to understand characteristics of the sample in which data obtained. In particular, measures of central tendency and variability were estimated to determine students' general self-beliefs and variability. Pearson Product Moment correlations were used to examine the direction and strength of relationship among study variables.

To address the research questions, bivariate correlation analyses were used to examine the relationship of STEM interest to self-efficacy, outcome expectations, personal goals, and environmental supports. Data were analyzed using SPSS and checked for the assumptions of normality and independence before reporting significance. Typically, statistical significance is measured for a 0.05 level. If the value for significance is less than 0.05, then the null hypothesis was rejected and the change in STEM interest based on the independent variables would be statistically significant (Stevens, 2007).

Assumptions and Limitations

Parametric statistics are used to analyze data based on a sample of a population and to be reflective of that population, parametric statistics must meet certain assumptions. This research utilized data from a sample of high school STEM students, using a bivariate correlation design, which must meet the following assumptions: homoscedasticity, independence, normality, and linearity (Shavelson, 1996). To meet the assumption of homoscedasticity the variance of the STEM interest for each of the independent variables must be equal (Shavelson, 1996). This assumption can be reviewed by using a scatter plot to see if the distribution of score is similar across the independent variables.

Normality assumes the data follows a normal distribution with consistent variance, this was checked on the data output using a histogram. Independence of data assumes that independent variables are not dependent on each other (Stevens, 2007). Linearity is the assumption that the relationship between the dependent variable and each of the separate independent variables is linear (Shavelson, 1996). This relationship was reviewed through a scatter plot with a line of fit, which measures the linear relationship between the variables.

This study is also subject to the limitations of bivariate correlation. Causality cannot be determined using correlation design. While two variables may be correlated, a cause-and-effect relationship cannot be established. Outliers on student survey responses could influence the correlation coefficients found.

Summary of the Methodology

Most studies on STEM career interests and correlating factors use a structural equation modeling approach to analyze data (Garriott et al., 2014; Luse, et al., 2014). These studies utilize measures that account for outcome expectations, self-efficacy, and personal goals to be latent variables that are not directly observed by the data. This study's use of the STEM-CIS tested SCCT and applicability to the prediction of the variable interest.

CHAPTER IV: RESULTS

This chapter presents study findings on the association between high school students' interest in STEM and their STEM self-efficacy, outcome expectations, personal goals, and environmental supports. Within this study, the STEM-CIS survey was used to measure students' STEM-related self-beliefs. Correlations were used to examine the strength and direction of the relationships between study variables. The following research questions were used to guide this study:

RQ: What is the association of outcome expectations, self-efficacy, environmental supports, and personal goals with high school students' interest to pursue STEM careers and college majors?

Student Survey Responses

Study participants included high school students ($N = 47$) sampled from two geographic regions in Kentucky (KY), namely Lexington ($n = 11$) and Louisville ($n = 36$). Specifically, study participants from Lexington, KY, included high school students attending the STEAM Academy, based on their STEM-focused academy model (Fayette County Public Schools, 2022). Study participants in Louisville included high school students attending the TECH-nique summer STEM program called TECC Boss (TECH-nique, 2022).

Table 1 reports demographics of study participants, including: gender, ethnicity, grade level, academy enrollment, and their enrollment in a dual credit or AP course. As reported, the sample included 47 (100%) students with complete data. As reported, the sample included 42.5% female, 48.9% male, and 8.5% of students who preferred to not answer for gender. The sample also included a racially diverse student sample comprised of 42.5% black, 21.3% white, 8.5% Latinx, 17% Asian, and 10.6% two or more racial/ethnic identities, respectively. As intended, all participants were high school students with representation across grade levels, 6.3% freshmen, 34% sophomore, 25.5% junior, and 34% senior. Students responded on academy enrollment depending on their school. All students from the STEAM school in Lexington are represented in academy enrollment, and any students involved with TECH-nique self-reported their academy enrollment at their high school. Additionally, 61.7% of students reported they were enrolled in an academy, whereas 29.7% of reported not being enrolled in an academy, and 8.5% of the students were not sure if they were enrolled in a career academy at their school. In addition, 55.3% of the students reported being enrolled in an AP or dual credit course (36.2% not enrolled in an AP or dual credit course) and 8.5% preferred not to answer. The overall group is a small representation of high school students from two urban areas of Kentucky with a variety of backgrounds influencing their STEM attitudes.

Table 1
Participant Demographics

		Male	Female	Prefer not to answer	Total	%
Ethnicity					47	
	Black	8	10	2	20	42.5
	White	5	4	1	10	21.3
	Latinx	2	2	0	4	8.5
	Asian	6	2	0	8	17.0
	Two or More	2	2	1	5	10.6
Grade Level					47	
	Freshman	2	1	0	3	6.3
	Sophomore	8	6	2	16	34
	Junior	5	7	0	12	25.5
	Senior	8	6	2	16	34
Academy Enrollment					47	
	Yes	16	10	3	29	61.7
	No	4	9	1	14	29.7
	Not Sure	3	1	0	4	8.5
Dual Credit/AP Course Enrollment						
	Yes	14	11	1	26	55.3
	No	7	8	2	17	36.2
	Prefer Not to Answer	2	1	1	4	8.5

Descriptive Statistics

Table 2 reports the descriptive statistics for the gender groups represented and their average scores for STEM for interest, self-efficacy, outcome expectations, personal goals, and environmental supports. The scores can range from 1 to 5, with higher scores indicating agreeable opinions. Table 2 also includes the standard deviation and average minimum and maximum scores for each gender group. Only 4 students total indicated prefer not to answer for the gender demographic, but this group had the lowest averages across all STEM social cognitive factors. Male and female students had nearly an identical mean score for STEM interest, but female students averaged higher in outcome expectations and personal goals while male students scored higher on average for self-efficacy and environmental supports. While average STEM interest between male and female students was nearly equal, the difference in other social cognitive factors suggests there were some differences between male and female survey respondents on their STEM social cognitive attitudes.

Table 2
Average SCCT STEM Score by Gender

		STEM Interest	STEM Self - Efficacy	STEM Outcome Expectations	STEM Personal Goals	STEM Environ mental Supports
Prefer not to Answer						
	Mean	2.96	3.08	3.25	3.29	2.75
	SD	.361	.439	.545	.144	.625
	Min.	2.75	2.63	2.63	3.13	2.13
	Max.	3.38	3.50	3.63	3.38	3.38
Female						
	Mean	3.48	3.82	3.82	3.80	2.97
	SD	.78	.59	.67	.60	.84
	Min.	2.13	2.88	2.25	3.00	1.38
	Max.	4.63	4.88	5.00	5.00	4.75
Male						
	Mean	3.49	3.96	3.65	3.71	3.32
	SD	.75	.70	.60	.67	.85
	Min.	2.5	2.50	2.75	2.50	1.25
	Max.	4.75	5.00	5.00	5.00	4.75

Table 3 displays descriptive statistics for each of the STEM social cognitive factors for race and ethnic groups with standard deviations, minimums, and maximums. This table provides insights to the difference in responses between the racial and ethnic groups represented within the study participants. Student respondents who indicated their race as black or two or more showed mean averages lower than other race groups in all STEM social cognitive factors, for black students, this supports much of the existing research on STEM social cognitive attitudes among racial groups. Only 4 survey respondents indicated Latinx as their ethnic group, but these respondents recorded the highest average in all STEM social cognitive factors, which is contradictory of previous research.

Table 3
Average SCCT STEM Score by Race

		STEM Interest	STEM Self - Efficacy	STEM Outcome Expectations	STEM Personal Goals	STEM Environmental Supports
Black						
	Mean	3.22	3.57	3.42	3.43	2.74
	SD	.73	.64	.67	.61	.84
	Min.	2.13	2.50	2.25	2.50	1.25
	Max.	4.63	4.75	4.75	4.88	4.50
White						
	Mean	3.40	3.83	3.83	3.83	3.47
	SD	.73	.45	.63	.50	.91
	Min.	2.75	3.13	2.63	3.38	1.75
	Max.	4.63	4.63	5.00	5.00	4.75
Latinx						
	Mean	4.16	4.5	4.21	4.25	3.63
	SD	.52	.68	.06	.53	.51
	Min.	3.38	3.50	4.13	3.50	3.13
	Max.	4.50	5.00	4.25	4.63	4.13
Asian						
	Mean	3.88	4.16	3.92	4.14	3.64
	SD	.50	.60	.52	.48	.69
	Min.	3.00	2.88	3.38	3.38	2.88
	Max.	4.75	4.75	5.00	5.00	4.75
Two or More						
	Mean	3.20	3.80	3.80	3.55	2.93
	SD	.85	.74	.63	.57	.65
	Min.	3.00	2.88	3.38	3.38	2.88
	Max.	4.75	4.75	5.00	5.00	4.75

Table 4 reports the average STEM social cognitive scores for the survey respondents by their grade level. All high school grade levels participated in this study from the Lexington and Louisville sites. Data from this table revealed students who indicated they were seniors on the survey averaged the lowest scores across all STEM social cognitive attitudes. In contrast, freshmen students averaged the highest in STEM interest and STEM environmental supports. These grade level differences suggest there could be differences among age and grade level groups regarding STEM interest.

Table 4

Average SCCT STEM Score by Grade Level

		STEM Interest	STEM Self - Efficacy	STEM Outcome Expectations	STEM Personal Goals	STEM Environmental Supports
Freshmen						
	Mean	3.75	3.81	3.88	3.63	3.56
	SD	.88	.44	.18	.35	.62
	Min.	3.13	3.50	3.75	3.38	3.13
	Max.	4.38	4.13	4.00	3.88	4.00
Sophomore						
	Mean	3.68	4.05	3.82	3.90	3.06
	SD	.67	.58	.67	.63	.80
	Min.	2.75	3.13	2.63	2.88	1.25
	Max.	4.75	4.88	5.00	5.00	4.25
Junior						
	Mean	3.57	4.10	3.88	3.93	3.44
	SD	.93	.68	.57	.66	.80
	Min.	2.13	2.63	3.00	3.00	1.75
	Max.	4.63	5.00	5.00	5.00	4.75
Senior						
	Mean	3.03	3.45	3.40	3.40	2.83
	SD	.55	.58	.66	.48	.95
	Min.	2.13	2.50	2.25	2.50	1.38
	Max.	4.25	4.38	4.25	4.38	4.75

Table 5 provides the average SCCT STEM scores of survey respondents based on their enrollment in a STEM career academy. Most of the student respondents were enrolled in a career academy (n = 29) and nearly one third of survey respondents were not enrolled in a career academy (n=14). The average scores for students enrolled in a STEM academy was higher for each social cognitive factor than the students who indicated they were not enrolled in a STEM career academy. This difference suggests there may be a difference in STEM social cognitive attitudes between students attending schools with STEM career academies and students who are not enrolled in a STEM career academy.

Table 5
Average SCCT STEM Score by Academy Enrollment

		STEM Interest	STEM Self - Efficacy	STEM Outcome Expectations	STEM Personal Goals	STEM Environmental Supports
Yes						
	Mean	3.61	3.92	3.74	3.85	3.35
	SD	.73	.73	.68	.64	.85
	Min.	2.13	2.50	2.25	2.50	1.38
	Max.	4.75	5.00	5.00	5.00	4.75
No						
	Mean	3.12	3.60	3.63	3.47	2.83
	SD	.60	.42	.50	.50	.88
	Min.	2.13	2.63	2.75	2.88	1.25
	Max.	4.38	4.38	4.25	4.50	4.75
Unsure						
	Mean	3.69	4.19	3.84	3.88	3.03
	SD	.99	.72	.90	.71	.53
	Min.	2.50	3.25	2.75	3.25	2.25
	Max.	4.63	4.75	4.75	4.88	3.38

Correlation Tables

Table 6 reports the average SCCT STEM Scores for survey respondents based on their self-identified enrollment in an AP course. Students who indicated they were enrolled in an AP course show a higher average response rate in each SCCT STEM indicator in comparison to students who were not enrolled in an AP course or preferred not to answer. These data suggest that among student respondents, students enrolled in an AP course have a higher STEM interest and have higher STEM social cognitive attitudes.

Table 6
Average SCCT STEM Score by Advanced Place Course Enrollment

		STEM Interest	STEM Self - Efficacy	STEM Outcome Expectations	STEM Personal Goals	STEM Environmental Supports
Yes						
	Mean	3.71	4.17	3.92	3.98	3.38
	SD	.78	.55	.62	.61.	.73
	Min.	2.13	2.88	2.25	2.88	1.75
	Max.	4.75	5.00	5.00	5.00	4.75
No						
	Mean	3.17	3.47	3.51	3.44	2.92
	SD	.53	.53	.51	.42	.86
	Min.	2.13	2.63	2.63	2.88	1.25
	Max.	4.25	4.38	4.25	4.38	4.75
Prefer Not to Answer						
	Mean	3.00	3.22	3.19	3.28	2.66
	SD	.65	.62	.79	.66	1.32
	Min.	2.50	2.50	2.75	2.50	1.38
	Max.	3.88	4.00	4.38	4.13	4.50

Research Question 1 was addressed using Pearson Product Moment correlations, which are reported in the following tables. Table 7 below shows the relationship between STEM interest and STEM self-efficacy of the survey respondents. As shown, there are moderate to high positive correlations between students' STEM interest and STEM self-efficacy within each STEM subject area and overall STEM with correlations ranging from 0.52 to 0.75, respectively. There are also positive correlations between self-efficacy and interest across some of the subject areas, like mathematics interest with engineering self-efficacy, with *r* values ranging from 0.32 to 0.65. These weak to moderate positive correlations are related to the theoretical association between self-efficacy and interests in SCCT. Students' STEM self-efficacy appears to be associated with their STEM interest. For the surveyed students, if students felt confident in their ability to complete STEM tasks and assignments, they also possessed a higher interest in pursuing a STEM career or college major.

Table 7

Pearson Correlation Coefficients STEM Interest and STEM Self-Efficacy

Variable	1	2	3	4	5	6	7	8	9	10
1. Science Interest	__									
2. Technology Interest	.35*	__								
3. Engineering Interest	.45*	.35*	__							
4. Mathematics Interest	.47**	.25	.54**	__						
5. STEM Interest	.76**	.61**	.81**	.80**	__					
6. Science Self-Efficacy	.52**	.23	.11	.37*	.42**	__				
7. Technology Self-Efficacy	.13	.59**	.45**	.15	.40**	.11	__			
8. Engineering Self-Efficacy	.34*	.23	.75**	.54**	.66**	.31*	.33*	__		
9. Mathematics Self-Efficacy	.42**	.24	.38*	.63**	.58*	.49**	.09	.48**	__	
10. STEM Self-Efficacy	.54**	.40**	.59**	.65**	.74**	.71**	.39**	.77**	.83**	_

*p< .05.
**p<.01.

Table 8 shows the relationship between STEM interest and STEM outcome expectations of the survey respondents. As shown, there is a moderate to strong, positive correlation between students' STEM interest and STEM outcome expectations within each STEM subject area and overall STEM with r values ranging from .65 to .78. There are also moderate positive correlations between outcome expectations and interest cross-circularly, like engineering outcome expectations and math interest (r= .61). These positive correlations are described in SCCT. Students' STEM outcome expectations appear to be associated with their STEM interest. The surveyed students' beliefs about how STEM subjects could help them in a STEM career is numerically related to their interest in STEM careers and courses.

Table 8
Pearson Correlation Coefficients STEM Interest and STEM Outcome Expectations

Variable	1	2	3	4	5	6	7	8	9	10
1. Science Interest	__									
2. Technology Interest	.35*	__								
3. Engineering Interest	.45*	.35*	__							
4. Mathematics Interest	.47**	.25	.54**	__						
5. STEM Interest	.76**	.61**	.81**	.80**	__					
6. Science Outcome Expectations	.68**	.16	.29	.32*	.49**	__				
7. Technology Outcome Expectations	.21	.79**	.41**	.31*	.55**	.07	__			
8. Engineering Outcome Expectations	.27	34*	.69**	.61**	.66**	.36*	.43**	__		
9. Mathematics Outcome Expectations	.47**	.35*	.30	.65**	.60**	.52**	.33*	.52**	__	
10. STEM Outcome Expectations	.60**	.51**	.55**	.66**	.78**	.74**	.55**	.78**	.85**	__

*p< .05.
**p<.01.

Table 9 reports the relationship between STEM interest and STEM personal goals of the survey respondents. As shown, there is a strong, positive correlation between students' STEM interest and STEM personal goals within each STEM subject area and overall STEM with correlations ranging from 0.72 to 0.86. STEM personal goals and STEM interest shared the strongest, positive correlation between all subjects within this study. There are also strong, positive correlations between personal goals and interest cross-circularly sharing positive, strong correlations. Students survey responses indicate a strong, positive correlation between their interest in STEM college majors and careers and the personal goals they have set for themselves involving STEM.

Table 9

Pearson Correlation Coefficients STEM Interest and STEM Personal Goals

Variable	1	2	3	4	5	6	7	8	9	10
1. Science Interest	__									
2. Technology Interest	.35*	__								
3. Engineering Interest	.45*	.35*	__							
4. Mathematics Interest	.47**	.25	.54**	__						
5. STEM Interest	.76**	.61**	.81**	.80**	__					
6. Science Personal Goals	.74**	.29	.30*	.36*	.56**	__				
7. Technology Personal Goals	.27	.72**	.29	.19	.46**	.12	__			
8. Engineering Personal Goals	.32*	.41**	.85**	.55**	.73**	.31*	.34*	__		
9. Mathematics Personal Goals	.50**	.22	.42**	.80**	.68**	.49**	.25	.45**	__	
10. STEM Personal Goals	.65**	.55**	.67**	.69**	.86**	.70**	.56**	.77**	.79**	__

*p< .05.
**p<.01.

Table 10 shows the relationship between STEM interest and STEM environmental supports of the survey respondents. There is a moderate positive correlation between STEM environmental supports and STEM interest (r = .51). The other correlations among STEM subjects between environmental supports and interest show significant, positive weak relationships. The data suggest environmental supports are not strongly related with STEM interests among survey respondents.

Table 10
Pearson Correlation Coefficients STEM Interest and Environmental Supports

Variable	1	2	3	4	5	6	7	8	9	10
1. Science Interest	__									
2. Technology Interest	.36*	__								
3. Engineering Interest	.45*	.35*	__							
4. Mathematics Interest	.47**	.25	.54**	__						
5. STEM Interest	.76**	.61**	.81**	.80**	__					
6. Science Environmental Supports	.42**	.04	.33*	.43**	.43**	__				
7. Technology Environmental Supports	.16	.41**	.51**	.25	.45**	.20	__			
8. Engineering Environmental Supports	.02	.26	.40**	.14	.27	.24	.66**	__		
9. Mathematics Environmental Supports	.18	.02	.27	.25**	.36*	.61**	.31*	.49**	__	
10. STEM Self-Environmental Supports	.28	.25	.51**	.45**	.51**	.70**	.72**	.78**	.80**	__

*p< .05.
**p<.01.

In summary, the associations among students' self-beliefs towards STEM, namely their self-efficacy, outcome expectations, and personal goals, were consistent with previous literature. Through each of the Pearson correlations, this study measured the relationship between students' SCCT STEM factors with their STEM interest. Students' self-efficacy, outcome expectations, personal goals, and environmental supports in STEM were used as the independent variable and interest was used as the dependent variable. Outcome expectations, self-efficacy, and personal goals showed a strong and positive relationship with interest when corresponding within the same subject area. Overall, STEM correlations with interest ranged from a *r* value of .513 to a *r* value of .86 which reports the significant relationship each of the SCCT variables in STEM has on STEM interest. There were also some cross-curricular positive, significant relationships between the independent and dependent variables.

CHAPTER V: DISCUSSION

The purpose of this study was to examine the relationship between high school students’ interest in STEM college majors and careers and their STEM social cognitive attitudes: self-efficacy, outcome expectations, personal goals, and environmental supports. Specifically, this study aimed to discover the social cognitive attitudes most related to STEM interest for Black, Latinx, and female students. The emphasis on promoting STEM in secondary education in the United States provides a basis for this study, particularly how these self-beliefs are related across diverse student groups, including racial, ethnic, and gender diversity (Funk & Parker, 2018). However, the declined interest and underrepresentation of Black, Latinx, and female students in STEM fields is a hindrance to the growth of STEM fields and the lack of equity in representation viewed in STEM professions (Byars-Winston et al., 2010; Niu, 2017; Tyszko, 2011, Riegle-Crumb et al., 2019). This study was conducted to understand the social cognitive factors relating to these underrepresented groups interest in STEM to inform future educational practice on engaging these students in STEM before graduating from high school.

The results of this study indicated a significant and positive relationship between STEM interest and STEM self-efficacy, outcome expectations, personal goals, and environmental supports for all study participants. STEM interest for each of the demographic groups surveyed was high, with male and female students' STEM interest nearly equal, but there were noticeable differences between racial/ethnic groups. Black students participating in this study measured lowest in STEM interest, while Latinx student participants had the highest STEM interest average. The observable interest in STEM and the relationship between interest and the other SCCT variables is discussed in this chapter. In this study, Pearson Product Moment correlations were used to analyze the data to discover the numerical relationships between interest in STEM, the dependent variable and STEM self-efficacy, outcome expectations, personal goals, and environmental supports, the independent variables. Each of the independent variables shared a significant relationship with the dependent variable within science, technology, engineering, mathematics, and STEM overall. The shared positive correlations across each of the variables in this study agree with Lent et al.'s (1994) SCCT model displaying the continual relationship between the SCCT factors and their overall effect on individuals and their choices. With the data analyzed, the following discussion examined the significant relationships between interest in STEM and the independent variables self-efficacy, outcome expectations, personal goals, and environmental factors.

Among the independent variables studied, STEM self-efficacy was found to have a significant relationship to students' intentions to pursue STEM. Previous researchers have noted that self-efficacy is an SCCT factor found to significantly predict students' intentions to pursue STEM (Brown et al., 2011). The link between STEM self-efficacy and STEM interest is particularly strong when students have developed knowledge of STEM careers past their initial stereotypical notions (Luo et al., 2021). Self-efficacy scores for this study's targeted groups found black and female students scored slightly lower on self-efficacy than their white and male counterparts, but Latinx students scored the highest among traditionally underrepresented groups in STEM. Overall, self-efficacy had a positive strong relationship with interest within each of the STEM subject areas and STEM overall. This suggests educational activities meant to build the STEM self-efficacy of high school students could relate to their interest in pursuing STEM after high school. School activities like project-based learning, where students engage in personalized meaningful projects within a subject area, or self-directed learning, where students determine the knowledge and skills needed within a subject area, have been shown to increase students' self-efficacy in STEM (Ghergulescu et al., 2019; Samsudin et al., 2020). These findings emphasize the importance of self-efficacy's link to students' interest in pursuing STEM after high school and the necessity of educational opportunities to enhance the STEM self-efficacy of underrepresented groups.

Similarly, positive STEM outcome expectations were found to be linked to students' interest in STEM careers. This is consistent with previous research that has noted students' positive STEM outcome expectations are linked to their interest in STEM careers (Shoffner et al., 2014). In this study, female students scored higher than their male counterparts in outcome expectations. However, black students had a lower mean outcome expectations core than their white counterparts, while Latinx students had higher average outcome expectations scores than both white and black students. Overall, outcome expectations had a positive strong relationship with STEM interest within each of the STEM subject areas and STEM overall. The findings of this study highlight the need for the development of educational practices to build the outcome expectations of underrepresented students.

In addition to STEM self-efficacy and outcome expectations, this study's findings on the relationship between STEM interest and STEM personal goals revealed a positive strong significant relationship. This research finding is much like Dönmez and İdin's (2020) study on middle school students using the STEM-CIS in Turkey, which established how personal goals, among other factors, were effective in building STEM career interests of students. The findings from this study showed female students had a higher average personal goal score than male students, which may indicate building STEM personal goals for female students could encourage them to seek STEM college majors or careers after high school. This study's findings suggest that efforts to promote STEM interest among high school students should include goal setting behavior.

Finally, this study's findings on environmental supports and STEM interest revealed a positive but weak relationship between the two variables. This suggests STEM environmental factors may be important in promoting STEM interest for high school students but are not as influential of a factor as the other SCCT variables studied. Previous research suggests a stronger link between environmental factors and STEM interest, but many of these studies are context specific. Su and Rounds (2015) study suggests person focused work environments related to female STEM interest. The absence of a specific environment for STEM could explain this study's lack of strong results between STEM interest and STEM environmental factors.

Implications for Policy and Practice

Several implications can be drawn from this study. This study is relevant to high schools adopting the career academy model, extracurricular opportunities with a STEM focus, and other STEM focused educational opportunities. The findings of this study showed a relationship between STEM interest and STEM self-efficacy, outcome expectations, personal goals, and environmental supports at varying degrees of numerical association.

States and districts focusing on increasing STEM interest for their high school students can use the findings of this study. Previous research has noted that many college students enrolled in STEM majors had made the decision to pursue STEM in high school (Hall et al., 2011). State and district policies created to encourage STEM participation could utilize these findings to increase STEM interest among their students in a few ways. First, STEM programs and curriculum created or adopted could be created to increase students' self-efficacy, outcome expectations, and personal goals through school activities. Secondly, high schools could employ career counseling methods for students interested in STEM to build their self-efficacy, outcome expectations, personal goals, and environmental supports for future success. Last, teacher training programs can focus on teaching effective practices that enhance these factors for their students. In addition, this information can aid stakeholders in STEM education outside of high schools. Parents can use these findings to create and provide an environmental support for their children to build their STEM self-efficacy, outcome expectations, and personal goals through activities. Other stakeholders in high school students' STEM interest, like colleges and companies, to offer experiences to students meant to increase their self-efficacy, outcome expectations, personal goals, or environmental supports in STEM.

Limitations

This study includes some limitations. The sample size was small. Due to the COVID-19 pandemic, survey administration through schools was limited by school districts. A sample size of at least 60 students, with 15 per independent variable, could have reached the minimum threshold for a hierarchical linear regression model (Petroclli, 2003). This statistical test could have compared the STEM self-efficacy, outcome expectations, personal goals, and environmental supports to STEM interest within one model to observe their ability to predict STEM interest and compare each of the independent variable's impact on STEM interest. Utilizing hierarchical linear regression would also have allowed for the SCCT variables association with STEM to create a regression model to indicate which variables were best at predicting interest in STEM across the various demographic groups participating in this study.

This study utilized a convenience sample based on availability. Surveys were not distributed to a large sample of schools with different populations and instead convenience samples were chosen from educational sites where students were already engaged in STEM learning through a career academy or summer experience. This limits the generalizability of this study because the sample does not represent the large population of students in Louisville or Lexington. This limits the generalizability of this study and the results from this should be seen as a snapshot of understanding the STEM social cognitive attitudes of students at the STEAM school and attending TECC Boss at the time surveys were administered.

This study is limited by selection bias. Student participants in this study self-selected a STEM program or school to attend and may already have had a predisposition for positive STEM social cognitive attitudes. Due to the COVID-19 pandemic, whole school surveys were not possible during the data collection period of this study. The population of this study does not reflect the full population of high school students in Fayette County or Jefferson County, but instead is limited to this one-time sample of students attending TECC Boss and the STEAM Academy during the times of the survey administration.

Despite these limitations, the results from this study should be beneficial to JCPS, FCPS, and other schools interested in high school students' STEM social cognitive attitudes. While the sample size was small, Latinx student respondents indicated high STEM social cognitive attitudes, which could be explored in further study. Additionally, AP enrollment and academy enrollment showed higher survey responses for social cognitive attitudes from all survey responses. Schools and districts wishing to create a stronger pipeline could use the findings from this study to further their STEM pipeline efforts.

Future Directions

Due to the COVID-19 pandemic, this research surveyed a group of students with less than 100 respondents from two geographic regions. To further investigate STEM interest using SCCT researchers should include a larger sample size of students from more schools or STEM-related activities in Kentucky. Incorporating a larger sample size would allow for more statistical power and offer more generalizability for a deeper analysis of the SCCT variables and their relationship to high school students' STEM interest. Also, reaching a broader audience across within the schools could allow for a more in-depth analysis of how different student groups respond to the STEM-CIS.

Future researchers may more thoroughly utilize the demographic question regarding AP and dual-credit course enrollment in understanding high school students' STEM social cognitive attitudes. This study only asked if students were enrolled in an AP course, but differentiating the AP courses students are enrolled in, like AP Computer Science or AP Calculus, could provide further insights into students' STEM social cognitive attitudes. A study could compare the STEM SCCT averages of students enrolled in AP STEM courses, AP courses outside of STEM, and no AP courses at all.

STEM education has changed over the time this dissertation was written. STEM education has become prevalent in both middle schools and elementary schools. Future research involving high school students could differentiate demographic groups for students who had STEM education experiences during elementary and middle school and those who had not. Not only could this show differences in STEM interest during high school, but a longitudinal study could also follow these students to observe if STEM persistence after high school is prevalent in students with early exposure to STEM education.

To overcome the limited generalizability and selection-bias of this study, a larger sample size for future research should be utilize. Due to the COVID-19 pandemic, the survey collection period of this study was limited to smaller populations. Future research observing students in the academy model could survey students within STEM academies and students in other career focused academies to compare their STEM social cognitive attitudes. This could give further insight into the possible relationship between STEM career academies and students STEM interest and STEM persistence after high school.

A different design approach could also aid future researchers investigating high school students' interest in STEM. A longitudinal approach could be taken, especially if it were possible to follow students from their ninth-grade year to after their high school graduation to see how their interest in STEM changes over time. The longitudinal approach would allow for the relationship between STEM interest and the SCCT variables to viewed over time and could allow predictors in STEM interest to be quantified. Additionally, a mixed-methods approach to this research would allow future research to include students' perceptions of their changing interest. While this study focused solely on self-efficacy, outcome expectations, personal goals, and environmental supports, future research could identify specific types of these SCCT variables, like people-oriented environment supports, to provide a deeper understanding of the influences of students STEM college and career aspirations.

Finally, the results of this dissertation were correlational and the variables within cannot reflect a cause-and-effect relationship. Future research on the STEM interest of high school students could do a full experimental design with STEM academy and non-STEM academy students. In this larger study, the STEM-CIS could be used at the beginning, middle, and end of each group's time in high school to show the differing STEM social cognitive attitudes of students beginning in STEM and non-STEM programs and show how those attitudes change over time. This type of experimental research could produce results reflecting a cause and effect relationship for the STEM program.

Conclusion

The purpose of this study was to identify the relationship between Black, Latinx, and female students' interest in STEM college majors and careers with four other variables defined in SCCT, self-efficacy, outcome expectations, personal goals, and environmental supports in STEM. A total of 47 students from Fayette and Jefferson counties answered questions on the STEM-CIS relating to each of the SCCT variables within each STEM subject. Based on student survey responses, this research determined STEM self-efficacy, outcome expectations, and personal goals each have a positive and strong relationship with STEM interest. Future research should include a longitudinal study following a larger group of students throughout their high school experiences, both within and outside of career academies, to gauge the changes in their STEM interest and its relationship to each of the SCCT factors over time. Future educational practice could use the results from this research study by creating opportunities for students to increase their STEM self-efficacy and personal goals and provide opportunities for students to build their own STEM outcome expectations. These could come from activities like robotics clubs and competitions, real-world STEM design challenges, and using interactive games and activities in educational practice to increase students' connections to STEM related fields.

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APPENDIX A

The STEM-CIS (Kier et al., 2013) includes the following questions to measure students STEM social cognitive attitudes.

1. I am able to get a good grade in my science class.
2. I am able to complete my science homework.
3. I plan to use science in my future career.
4. I will work hard in my science classes.
5. If I do well in science classes, it will help me in my future career.
6. My parents would like it if I chose a science career.
7. I am interested in careers that use science.
8. I like my science class.
9. I have a role model in a science career.
10. I would feel comfortable talking to people who work in science careers.
11. I know of someone in my family who uses science in their career.
12. I am able to do well in activities that involve technology.
13. I am able to learn new technologies.
14. I plan to use technology in my future career.
15. I will learn about new technologies that will help me with school.
16. If I learn a lot about technology, I will be able to do lots of different types of careers.
17. When I use technology in school, I am able to get better grades.
18. I like to use technology for class work.
19. I am interested in careers that use technology.

20. I have a role model who uses technology in their career.

21. I would feel comfortable talking to people who work in technology careers.

22. I know of someone in my family who uses technology in their career.

23. I am able to do well in activities that involve engineering.

24. I am able to complete activities that involve engineering.

25. I plan to use engineering in my future career.

26. I will work hard on activities at school that involve engineering.

27. If I learn a lot about engineering, I will be able to do lots of different types of careers.

28. My parents would like it if I chose an engineering career.

29. I am interested in careers that involve engineering.

30. I like activities that involve engineering.

31. I have a role model in an engineering career.

32. I would feel comfortable talking to people who are engineers.

33. I know of someone in my family who is an engineer.

34. I am able to get a good grade in my mathematics class.

35. I am able to complete my mathematics homework.

36. I plan to use mathematics in my future career.

37. I will work hard in my mathematics classes.

38. If I do well in mathematics classes, it will help me in my future career.

39. My parents would like it if I choose a mathematics career.

40. I am interested in careers that use mathematics.

41. I like my mathematics class.

42. I have a role model in a mathematics career.

43. I would feel comfortable talking to people who work in mathematics careers.

44. I know of someone in my family who uses mathematics in their career.

CURRICULUM VITAE

Don Edward Bacon
don.bacon@jefferson.kyschools.us

Education

Doctorate in Educational Leadership and Organizational Development
August 2023 *University of Louisville, Louisville, KY*

Master of Education in Teacher Leadership
May 2015 *University of Louisville, Louisville, KY*

Bachelor of Arts in Social Studies & Secondary Education
December 2009 *Western Kentucky University, Bowling Green, KY*

CERTIFICATIONS

Professional Certificate for Teaching Social Studies, 8 – 12 2009

Professional Certificate for Teaching Computer Technology, P-12 2015

Professional Certificate for Teacher Leader, All Grades 2015

Professional Certificate for Teaching Project Lead the Way Engineering, 9-12 2016

Professional Certificate for Teaching Computer Science, 8-12 2018

EMPLOYMENT HISTORY

Digital Innovation Specialist Current
IT3 Department, Jefferson County Public Schools, Louisville, KY

Technical Digital Innovation Leader 2022 - 2023
IT3 Department, Jefferson County Public Schools, Louisville, KY

Director of Education 2021 - 2022
Future of Work Initiative, Louisville, KY

Teacher, Mechanical Engineering and Computer Science, Grades 9-12 2016 – 2022
Iroquois High School, Jefferson County Public Schools, Louisville, KY

Teacher, Social Studies, Grades 9 – 12 2009 – 2017
Iroquois High School, Jefferson County Public Schools, Louisville, KY

SELECTED PROFESSIONAL EXPERIENCES

District Racial Equity Committee Member, JCPS 2023

Uncharted Territory: Video Games in the Classroom, KYSTE 2023

Digital Print Technology Certification, Somerset Community College 2022

Butterfly Project 2.0, Future of Work Initiative 2022

Butterfly Project, Global Mayors Challenge 2021

Data Science Cohort Curriculum Developer, Future of Work Initiative 2021

Iroquois High Teacher of the Year 2021

SBDM Teacher Committee Member, Iroquois High School 2015 – 2022

School Technology Coordinator, Iroquois High School 2015 – 2022

Apple's Swift Coding Teacher, Iroquois High School 2020

Research Experience for Teachers, University of Louisville 2019

Code.org Certified Computer Science Teacher, Advance Kentucky 2018

PLTW Computer Integrated Manufacturing Certification, University of Kentucky 2017

PLTW Principles of Engineering Certification, University of Kentucky 2016