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This dissertation, RETENTION OF COLLEGE STUDENTS IN STEM MAJORS: STUDENT INVOLVEMENT, PERSISTENCE, AND CHALLENGES, was prepared under the direction of the candidate's Dissertation Committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree of Doctor of Education in the School of Education, Concordia University Irvine.

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RETENTION OF COLLEGE STUDENTS IN STEM MAJORS:
STUDENT INVOLVEMENT, PERSISTENCE, AND CHALLENGES

by

Hulya S. Odabas

A Dissertation

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ABSTRACT

In the United States, ensuring adequate numbers of students graduate with science, technology, engineering, and mathematics (STEM) majors has become a national priority. However, STEM degree retention among underrepresented minority students (URM) is lower than in other students' populations (NCES, 2014).

This research used quantitative and qualitative methods to understand the factors that influence the retention of college students in STEM fields. Furthermore, this research examined the relationship between student involvement at the campus and student retention by using Astin's (1984, 1999) and Tinto's (1975) frameworks. It aimed to learn what affects the URMs students' motivation and persistence in the STEM major.

The target group for this mixed-method study was undergraduate college students. The snowball sampling technique was used. A total of 204 college students completed a survey, and nine interviews were conducted with the participants. Pearson correlations and ANOVA were run for the quantitative data. Interview transcripts were reviewed, and students' quotes were organized into themes and combined with quantitative data results to give an entire story of students' experiences.

Eight factors and eight types of people who influenced students to pursue a STEM major were listed. This study shows a significant correlation between STEM major retention and student involvement in campus sports and study groups. Results indicate that building relationships and creating a safe environment where students feel that they belong, and they matter is key.

Keywords: *STEM education, mixed methods, persistence, underrepresented minority students, STEM degree retention*

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ACKNOWLEDGEMENTS

I was born into a loving and hardworking family in Istanbul, and my dad named me Hulya. He hoped I would live up to the meaning of my name, "dreamer." I dedicate this degree to my dad Ali Tuncer and all the uncompleted dreams in his short life.

Without God, this journey would not have been possible. God provided the people and resources I needed at every stage of this journey, and for that, I am extremely grateful.

A special thank you to my committee chair, Dr. Eugene Kim, for his expertise, guidance, and support. I want to extend my heartfelt appreciation to each of my committee members. Dr. Helene Cunningham's endless encouragement and mentorship was a true miracle that God sent when I needed it most. Dr. Paul Woo's wisdom and expertise in supporting my passion was a blessing. I would also like to thank all Concordia Irvine faculty. You made this place so special!

I would like to thank my family and friends for encouraging me to start this journey. My mom inspired me to be fearless to get in the places I needed to go and to be comfortable with the idea of being uncomfortable. My husband, Omer, believed me, he encouraged me and helped me see the value in myself. This dream would not be complete without his love and endless support. My sister Dr. Nuran Tuncer taught me joy should win over fear during this journey. I am very thankful for my sister Dr. Fatma Deniz; my life would be empty without her.

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CHAPTER 1: INTRODUCTION

In the United States, data has shown that ensuring adequate numbers of students graduate with science, technology, engineering, and mathematics (STEM) majors has become a national priority (NCES, 2014). Higher education institutions and educational policymakers are facing the challenge of increasing the number of undergraduate underrepresented minority students who persist in STEM (Shiroma, 2015). The United States is falling behind other developed countries in regard to producing college graduates with STEM majors and skills (NAP, 2012). This gap has vital implications for future U.S. global competitiveness for jobs. The United States desires to increase the number and diversity of students pursuing degrees in STEM fields (National Research Council, 2012). In 2009, the Obama administration started the "Educate to Innovate" campaign to increase the participation and performance of U.S. students in STEM (The White House, 2009).

The researcher grew up in a single-mother household as a first-generation female and was faced with many barriers to attending college. Going to college, applying for a STEM major, and graduating in four years was a dream. The researcher achieved this dream when she graduated with a degree in chemistry at the age of 21. As the researcher reflected on her own journey, she was motivated to research retention of minority students in STEM majors. In addition, her experience helped her connect to the students who have had the similar barriers for pursuing a STEM degree.

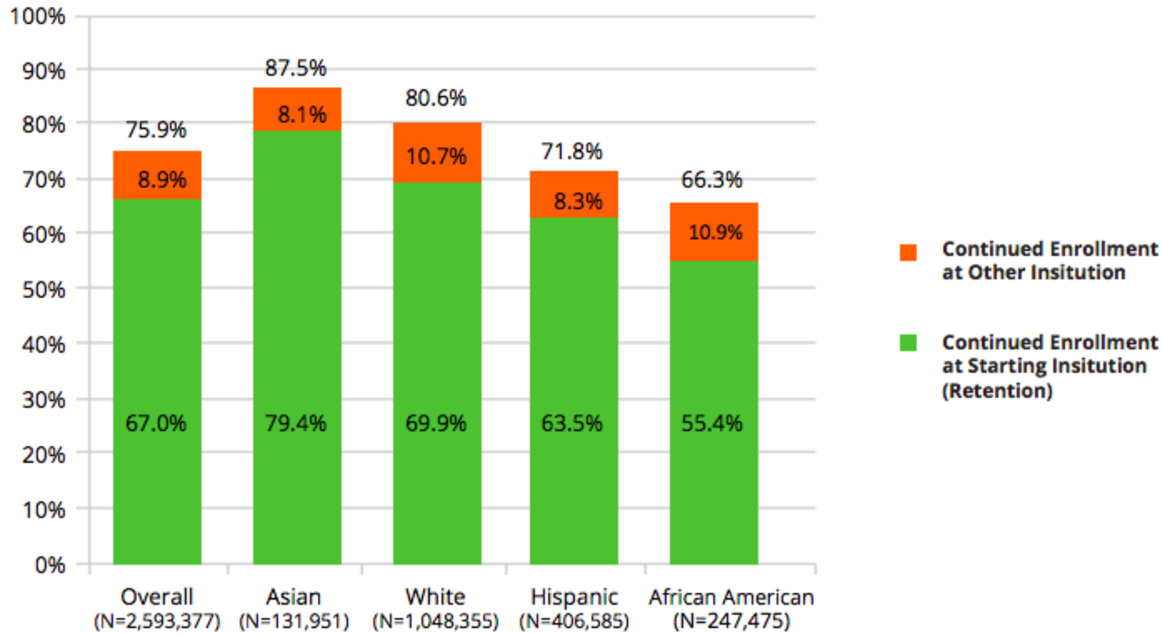
The goal of this dissertation research was to understand the factors that influence the retention of college students in STEM fields. Primarily, this study aimed to learn what affects underrepresented minority students' (URMs) motivation and persistence in STEM majors.

Statement of the Problem

This research was conducted to understand the factors that influence the retention of URM college students in STEM fields. URM college students face many obstacles in their pursuit of college completion. As a result, the retention rates for this student population have traditionally been lower than for other student populations. Figure 1 shows large racial/ethnic gaps in persistence and retention rates. Asians and whites had significantly higher persistence rates than Hispanics or African Americans (National Student Clearinghouse, 2018). Compared to white students' persistence rate, there was an 8.8 percent point difference for Hispanic students, and a 14.3 percent point difference for African American students (National Student Clearinghouse, 2018).

Figure 1

Persistence and Retention Rates by Race/Ethnicity: All Institutions



Note. Reprinted from *Persistence and retention–2018,* by National Student Clearinghouse Research Center, 2018 (https://nscresearchcenter.org/snapshotreport33-first-year-persistence-and-retention/).

Especially in STEM majors, studies have repeatedly found that underrepresented minorities, first-generation students, women, and students who have low-income backgrounds drop STEM majors at higher rates than their counterparts (Anderson & Kim, 2006; Hill et al., 2010; Huang et al., 2000; Shaw & Barbuti, 2010). To sustain the persistence of this student population, it is crucial to study the experiences of those students who are persisting in a STEM major in college.

Today's workforce demands highly skilled, knowledgeable, and adaptable personnel to meet the challenges of a rapidly changing economy and society (Marsh, 2013). The demand for science, technology, engineering, and mathematics (STEM) talent is growing globally and in the

USA. Between 2014 and 2024, computing jobs are expected to grow 19%, advanced manufacturing jobs 16%, and engineering positions 12% (Stevens et al., 2016). However, the number of minority students graduating from post-secondary institutions with bachelor's degrees in the STEM fields is decreasing because students are changing their major from STEM majors to non-STEM majors (Robinson et al., 2008). It is concerning that there is a continuing decline in the numbers of students pursuing STEM majors.

Purpose of the Study

The primary purpose of this mixed-methods phenomenological study was to examine the factors that influence students' persistence in undergraduate STEM majors. It also aimed to determine the relationship between the factors that affect the students' motivation and persistence.

Students' success in STEM majors has been addressed through research, policy implementation, studies, and intervention programs. However, there is a need to use evidence-based research to find an impactful resolution that is easy to follow and accomplish. The researcher hypothesized that students' involvement in campus life and extracurricular activities are predictive of minority college students' retention in STEM programs.

Research Questions

The following was the primary research question explored in this study:

RQ1: What factors influence the retention of college students in STEM fields?

The following sub-questions were also explored:

RQ2: What is the relationship between student involvement at the campus and students' retention?

RQ3: What affects their motivation and persistence?

RQ4: What are the differences between public and private universities related to STEM retention?

The researcher hypothesized that students' involvement in campus life and extracurricular activities are predictive of minority college students' retention in STEM programs.

Theoretical Framework

Certain factors motivate students to pursue majors in STEM. Several theories focus on student involvement and persistence. The researcher chose two theories to focus on in this research study. Using Astin's (1984, 1999) and Tinto's (1975) frameworks for this study allowed the researcher to explore the students' motivations, which impact student persistence in college.

Astin's (1984, 1999) student involvement theory focuses on student engagement on campus. According to this theory, if a student dedicates time and energy to academic work, gets involved in campus extracurricular activities, and spends time on campus, then that student's retention and success are higher than a student who is not engaged (Astin, 1984, 1999).

Tinto's (1975) theory centers on the students' perspective of their interactions with the academic and social communities of their college or university. Tinto's theory presents an approach to frame the relationship between academic and environmental advising as essential to student persistence, but it has been criticized for its inability to explain racial minority student persistence and departure (Attinasi, 1989; Kraemer, 1997; Rendón et al., 2000; Tierney, 1992, 1999).

Astin's Theory

The higher education literature refers to various factors that affect college student persistence, such as prior academic readiness and performance, and college environmental variables, such as peer interactions, faculty interactions, and co-curricular experiences (Astin, 1993; Reason, 2010; Tinto, 1993). Most models of student retention include a measure of student-faculty interaction because studies show that it is strongly associated with college satisfaction (Tinto, 2012, 1993). Oseguera (2005) contended that among all the variables, the GPA is the best predictor of student achievement in college. Astin (1993) found that students who prefer science from the very beginning and declare their majors in their freshman year have a higher graduation rate in STEM majors.

Astin's (1984, 1999) involvement theory suggests that students' involvement will increase if the students are satisfied with the college experience. Moreover, Astin's (1984, 1999) involvement theory provides a more culturally neutral framework for viewing persistence and degree completion among diverse college student populations. According to this theory, the higher education administration and faculty members play a significant role in supporting the student's involvement in activities and helping them take advantage of the opportunities at college. The involvement theory suggests that students should be at the center of the learning process, which will help the students' persistence at college.

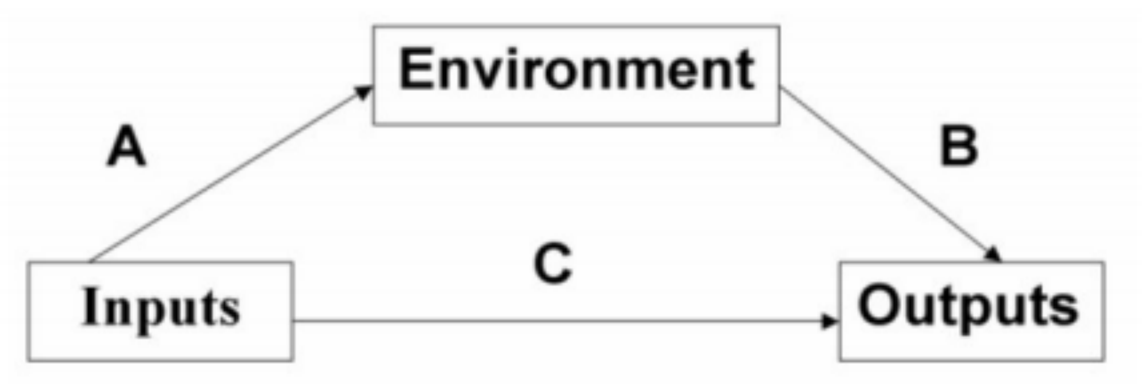
Astin (1999) described student involvement as the amount of energy a student devotes to their academic experience. According to his theory, if a student dedicates time and energy to academic work, is involved in campus extracurricular activities, and spends time on campus, the students' retention and success rates are higher than those who are not engaged (Astin, 1984, 1999). The more time and energy undergraduate students invest in their college academic and social experience, the higher the rate of students' persistence in college.

Much research has been conducted by using Astin's theory. Cole and Espinoza (2008) used Astin's input-environment-outcome (I-E-O) model to explore factors that impacted the academic success of Latino students in STEM. Cole and Espinoza (2008) found that both student inputs (e.g., gender, high school GPA) and college environmental factors (e.g., time studying, faculty support) were positively related to STEM academic performance. Astin's I-E-O model empowers researchers to examine students on a holistic level that includes both pre-college and college-level factors.

As seen in Figure 2, Astin's Input-Environment-Output (I-E-O) model includes three elements. The first is a student's "inputs," such as their demographics and background. The second is the student's "environment," which considers all the experiences a student would have during college. Lastly, there are "outcomes," including a student's attributes, knowledge, perspectives, and beliefs that exist after a student has graduated from college.

Figure 2

Alexander Astin's Input-Environment-Output (I-E-O) Model



Note. Reprinted from *Assessment for Excellence* (p. 18), by A.W. Astin, 1993, The Oryx Press. Copyright 1993 by The Oryx Press.

Astin's Input-Environment-Output (I-E-O) college impact model was used as a framework with Tinto's retention theory to have a holistic review of URM students' retention in

STEM majors. In this study, the researcher attempted to determine the factors motivating students to complete a STEM degree in college.

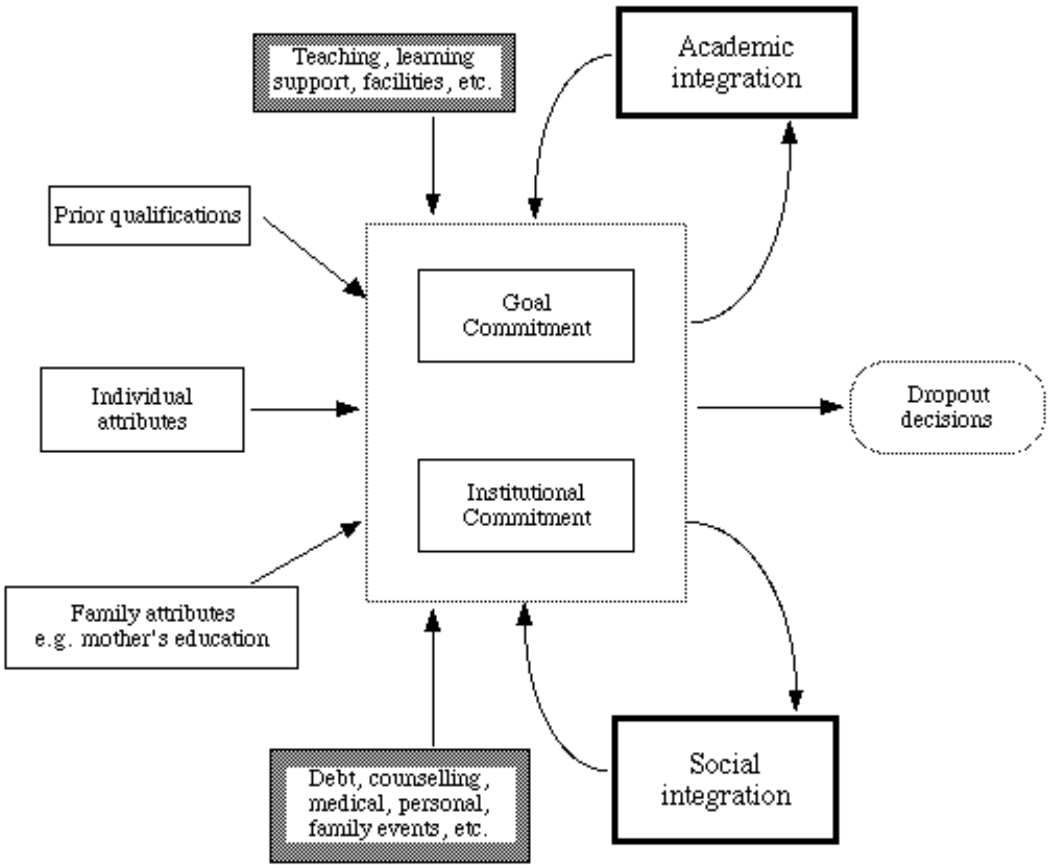
Tinto's Theory

The goal of this research was to understand the factors that influence the retention of college students in STEM fields. Furthermore, this research aimed to learn what affects the URM students' motivation and persistence in the STEM major. Research has shown many URMs students in engineering do not continue to graduate, but instead switch to non-STEM disciplines (Lowery, 2010; Strayhorn, 2009). Many researchers have recommended that a holistic approach to addressing this issue is one that considers the experiences of first-generation college students during their pre-college years, throughout college, and after graduation, and then compares these experiences to those of their non-first-generation college colleagues (Pascarella & Terenzini, 1991; Hicks & Wood, 2006; Hurtado et al., 2007; Harper & Quaye, 2013; Hicks, 2003). Tinto's longitudinal model of college retention is one of the most significant frameworks for explaining student persistence (Tinto, 1993). As seen in Figure 3, Tinto's main idea focuses on the concept of "Integration." It claims that whether a student persists or drops out is heavily predicted by their social and academic integration.

According to Tinto (1993), study group participation can influence students' social integration into their institution. Recent research by Uche (2015), which focuses on the retention of first-generation college student's retention in STEM by using Tinto's model, found that study group participation increases the likelihood of graduating STEM by 88 %.

Figure 3

Tinto's Longitudinal Model



Note. Reprinted from *Tinto's model of student retention,* by Draper, S. W., 2003, University of Glasgow (https://www.psy.gla.ac.uk/~steve/localed/tinto.html).

Tinto's (1993) research significantly contributed to higher education in regards to understanding the role of faculty and institutional characteristics in the college withdrawal decision (Guiffrida et al., 2013). His research has been broadly utilized to analyze student retention in different institutional environments (Braxton, 2000; Keup & Barefoot, 2005; Pascarella et al., 2004). Significant research has focused on validating the Tinto model (Terenzini & Pascarella, 1980; Braxton, 2004). Additional research has expanded on the Tinto framework to include advising focused on minority students (Metz, 2004). Tinto and Pusser

(2006) discussed the persistence and success rate of low-income students in comparison to higher-income students and finding the need for the new model of action, which will impact colleges to improve students' persistence. Though Tinto has conducted some research on the retention of first-generation college students (Engle & Tinto, 2008), there is a gap in the literature because adequate research has not used Tinto's model to measure the retention of URM college students in STEM. Tinto's model specifies the necessity for students to be well blended into the colleges' academic and social systems and emphasizes the value of relationships and communication with faculty and peers (Tinto, 1993).

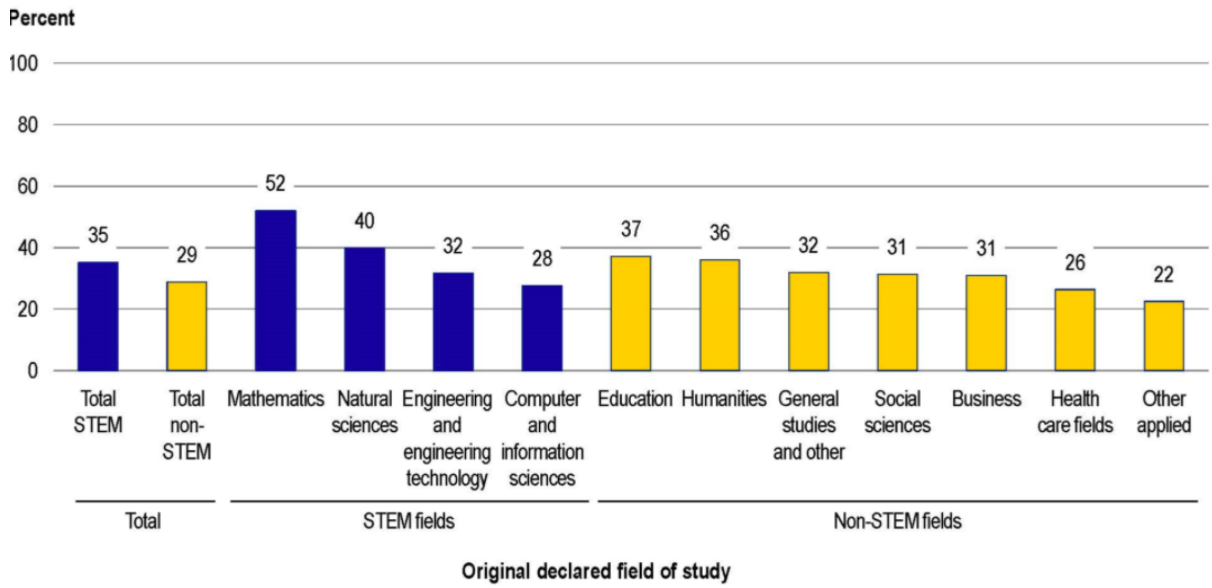
Significance of the Study

It is a national priority in the United States to increase the number of students who graduate with science, technology, engineering, and mathematics STEM majors (NSC). In particular, there are significant concerns that the student population pursuing degrees in STEM fields is not sufficiently diverse (National Research Council, 2012). URM students tend to change their degree from STEM to non-STEM majors at a higher rate than other student populations (NCES, 2014).

In 2016, President Barack Obama made STEM education a priority and asserted that every American student deserves high-quality STEM education for both their future and for the nation's future. That same year, the Obama administration announced that it budgeted 16 million in allowances to develop new ways to increase diversity in STEM fields (Office of the Press Secretary, 2016). Despite all the effort, data shows that underrepresented minority students do not persist in STEM majors at the same rate as other groups of the student population. As Figure 4 shows, STEM retention is also a challenge in the student population, as students in STEM programs are more likely to change their majors than those in non-STEM majors.

Figure 4

Original Declared Field of Study



Note. "Percentage of 2011–12 First Time Postsecondary Students Who Had Ever Declared a Major in an Associate's or Bachelor's Degree Program Within 3 Years of Enrollment, by Type of Degree Program and Control of First Institution: 2014." Reprinted from *Beginning College Students Who Change Their Majors Within 3 Years of Enrollment*, by the National Center for Education Statistics, 2017, (https://nces.ed.gov/pubs2018/2018434.pdf).

Students' persistence and graduation from STEM programs play a significant role in maintaining and growing the STEM workforce, which is key to meeting national policy objectives. In order to meet these objectives, a collaborative effort is needed from students, parents, educators, and policymakers. A National Science Foundation (NSF) study showed that the number of undergraduate students majoring in STEM fields in the U.S. is significantly lower than the number of students majoring in STEM fields abroad, such as in China and South Korea (NSF, 2009). Successful objectives implementation can shape the educational system to fill the diversity gap.

Many research studies address the equity issues in STEM through a longitudinal data set that includes a diverse set of students and institutions. In this study, the researcher aims to uncover the K-12 pre-college and college-level factors that influence students' persistence in STEM majors and strives to present essential policy recommendations to promote the persistence of students in STEM. The knowledge obtained from this research will not only contribute to higher education practice and policy initiatives but also provide insight on future research implications.

Definition of Terms

The following terms were used in this study:

STEM major: This is defined as "The areas of study pertaining to mathematics, statistics, computer/ information science, computer programming, electrical, chemical, mechanical, civil or other engineering, engineering technology, electronics, natural resources, forestry, biological science (including zoology), biophysics, geography, interdisciplinary studies including biopsychology, environmental studies, physical sciences including chemistry, and physics" (Anderson & Kim, 2006, p. 21).

First-generation: A first-generation college student is defined as a student whose parent(s)/legal guardian(s) have not completed a bachelor's degree. This means that the student was the first in her/his family to attend a four-year college/university to attain a bachelor's degree in the USA (Stephen et al., 2012).

The rigor of the pre-college curriculum: The sequence of high school coursework, including students' completion of math courses (Algebra I, Geometry, Algebra II, Precalculus, Calculus, Statistics, AP Calculus AB, AP Calculus BC, and AP Statistics) and science courses

(Biology, AP Biology, Chemistry, AP Chemistry, Physics, AP Physics 1, AP Physics 2, Anatomy/Physiology, AP Anatomy, Environmental Science, and AP Environmental Science).

Students' persistence in undergraduate STEM majors: To continue without change in function or structure. For this study, persistence means being enrolled in an undergraduate STEM major after two years without changing to another major.

Underrepresented students: To be inadequately represented. For this study, underrepresented refers to a group or groups of students that are not equally mainstreamed into the STEM pipeline in the United States.

Minority students: The part of a population that differs from others in some characteristics and are often subjected to differential treatment (Merriam-Webster's Dictionary, 1984). For this study, minority refers to African Americans, Asians, Hispanics, and Native Americans.

Underrepresented Minorities: African Americans, Hispanics, and American Indians/Alaska Natives.

Private University: A private school is a college or university that often operates as an educational profit or nonprofit organization. It does not receive its primary funding from a state government (Department of US Homeland Security, 2021)

Public University:A public school is a college or university primarily funded by a state government (Department of US Homeland Security, 2021).

Summary

The research is presented in a total of five chapters. Chapter 1 explained URM college students' challenges in their pursuit of college completion in STEM fields. It explained that underrepresented minorities, first-generation students, women, and students with low-income backgrounds drop STEM majors at larger rates than their counterparts (Anderson & Kim, 2006; Hill et al., 2010; Huang et al., 2000; Shaw & Barbuti, 2010). The purpose of the study was to examine the factors that influence URM students' persistence in undergraduate STEM majors. It also aimed to determine the relationship between the factors that affect the students' motivation and persistence. The research questions, sub-questions, hypotheses, and definitions of the terms used in this study were also presented in Chapter 1.

Chapter 2 is a detailed review of the literature on the retention and persistence of URM students in STEM majors, followed by the relationship between student involvement at the campus, students' retention, and intervention programs. It examines the factors that affect the students' motivation and persistence and identifies the challenges that URM students face. Chapter 3 outlines the mixed methods used and how the researcher collected data, including surveys and interviews. Chapter 4 presents an examination of the findings and outcomes of the quantitative and qualitative research. Lastly, Chapter 5 summarizes the research inferences, implications of the results, recommendations for further research, and conclusions.

CHAPTER 2: REVIEW OF LITERATURE

This chapter examines the literature on the retention of first-generation college students in STEM majors and on the relationship between students' involvement on campus and students' retention and degree completion. The researcher also discusses factors that affect students' motivation and persistence and challenges that first-generation college students face. Later in the chapter, the researcher examines the literature on intervention programs that prepare the students to succeed in STEM majors.

Retention and Persistence

First-generation college students' numbers are increasing on college campuses (Capriccioso, 2006), but there are concerns about students' persistence and retention rates compared with their peers from college-educated families. The students' persistence has been studied from sociological and psychological perspectives (Yorke & Longden, 2004). Tinto's (1993) longitudinal interactionist model is the most broadly utilized sociological framework for understanding college student retention.

Thayer (2000) investigated differences in academic engagement and retention between first-generation and non-first-generation undergraduate students. His research survey included 1,864 first-year students at a public research university located in the United States. The study results showed that first-generation students have a lower academic engagement than other students; engagement was measured by how students interacted with faculty, their involvement in class discussions, and the questions they asked in class (Thayer, 2000). The research highlighted that in order to reach the equitable educational achievement rate, institution leaders must consider the needs of first-generation students to keep the student's retention rate high (Thayer, 2000). Because first-generation students do not have the same social capital levels as their non-first-generation peers, they are more likely to face challenges and not fully engage in their academic pursuits (Soria et al. l, 2010).

First-generation students who show lack of engagement in academics or whose experiences lack positive faculty communications have higher attrition rates than integrated students (Jewett, 2008). Tinto's (1987) model connected student integration into academic and social communities to university persistence. Pascarella and Terenzini's (1991) research showed that students who were participating in extracurricular activities positively impacted "persistence and degree completion" (p. 391). Specifically, in STEM education, studies have indicated that students with high self-efficacy were likely to perform better and persist more than their peers with lower self-efficacy (Rittmayer & Beyer, 2008).

Lohfink and Paulsen (2005) examined the persistence rates of first-generation and continuing-generation students between their first and second college years. The research results showed that 76.5% of first-generation students persisted between the first and second years, while 82.2% of continuing-generation students persisted. Also, Ishitani (2006) determined that first-generation students are at the most significant risk of dropping out during their second year of college. For the purpose of this study, students who registered in higher education and have junior standing are considered to be persisting (Horn & Kojaku, 2001).

In the next section, relational influence will be examined in connection with college student retention.

Relational Influence

There are various sources of influence that can help students complete STEM degrees, including parents, teachers, college professors, mentors, advisors, and peers. First-generation college students' success and retention mostly correlated with having an inspiring person who supports them throughout their college journey.

Family Influence

Studies have shown that children of college-educated parents are more likely to be expected to pursue and complete an undergraduate degree than those whose parents did not attend college (National Center for Education Statistics, 2017). Three-year continuing research results showed that parents' backgrounds significantly influenced students' college pursuance and confirmed that a person's parental education levels affected their choice of college. Takruri-Rizk et al. (2008) found that having family members in STEM fields played an essential part in a student's college major choice. And students who aspired to STEM careers reported significantly more parental involvement than did students who wanted non-STEM careers (Jiaqi & Wei, 2017).

Another study found that family relationships provide benefits, especially for African American students engaged with STEM. Hrabowski (1999) emphasized the role of parents, especially mothers, who played an essential role in supporting Black American male success in STEM majors. Family members help influence their children to STEM and keep them motivated and encouraged to continue in STEM (Charleston, 2012; Moore III, 2006). This introduction and motivation occur directly through messages of love or support, or vicariously by modeling STEM persistence as a successful member of the STEM community (Charleston, 2012; Moore III, 2006).

Parents' level of education is often incorporated as a control variable in studies of student success (Rinn, 2013). Parents' education levels are identified to affect children's test scores, especially math and science test scores (Yavuz, 2009). Research has shown that test scores correlate with retention in STEM majors (Nicholls et al., 2007). Lopez and Jones's study (2017) indicated that community college students' STEM transfer rate and success are predicted by the father's highest level of education (Lopez & Jones, 2017).

Mentor and Advisor Influence

Underrepresented minority students (URM) in STEM are disadvantaged in their understanding of managing the college process because many of them are first in their families to go to college, which means guidance from parents or siblings is rarely available. Without STEM intervention programs, many URM populations may lack or have negative STEM experiences, which may lead to misconceptions about STEM careers (Valla & Williams, 2012). According to Kramer (2003), one of the most effective ways of promoting student persistence is advising. Tinto (2004) found that advising inevitably affects retention to assist students with selecting majors. Another study shows that strong, effective mentoring is one of the most vital factors for increasing motivation, engagement, and retention for underrepresented minority students in STEM (Rhea, 2017).

Many minority students in higher education lack the level of motivation and confidence necessary due to unequal social support and role models. One program that serves as a model for preparing students for higher education is called The Wright Science Technology and Engineering Preparatory Program (STEPP). It was started in 1988 for URM college students interested in pursuing higher education. The motivation required was provided in Wright STEPP by role models (scientists and engineers) through guest lecturers' presentations with the aim of increasing students' self-efficacy (Kumar & Ruby, 2008).

Research has also shown that creating the pathway to STEM in high school includes offering guest speaker lectures to the students to improve students' interest and influence them to pick a STEM major. It is essential to consider inviting a wide variety of guest speakers from different backgrounds to make the role models as diverse as possible, so more students can relate to them. One example is offering a guest speaker series for students with disabilities. Speakers with disabilities who finish STEM majors can discuss aspects of their college experience and how they overcame barriers to attaining their career goals; in doing so, they can be exceptional role models and inspire students to choose STEM majors (O'Donnell & Kirkner, 2016).

Advisors also play an important role. Brown (2010) stated that "connection is when an individual feels seen, heard, and valued; when they can give and receive without judgment." Advisors provide interactions in which students can be recognized, listened to, and valued for who they are. Recent research indicates that how students connect with advisors may play a role in how effectively students integrated into the college environment and how this integration may contribute to their decision to persist (Smith &Allen, 2008; Frost, 1991).

Peer Influence

Morton's (2017) findings offer useful insights for enhancing undergraduate research experiences by addressing aspects such as STEM culture and student engagements with research mentors, peers, professors, and projects. Relationships established among students and their peers, faculty, and other university personnel are essential in helping URM students sustain and retain their STEM major. Research demonstrates that these relationships develop during the collegiate experience, particularly within the STEM environment (Chang, et al., 2014; Charleston, 2012; Palmer et al., 2011).

Peer relations are most influential in providing motivation and encouragement to persist in STEM via collaboration or conversation, helping students learn the content necessary for success, and companionship (Freeman et al 2008; Good et al., 2011). These types of peer relationships occur on both the secondary and post-secondary levels, whereas in secondary education, peer influence has greater implications for students demonstrating a STEM interest (Charleston, 2012).

Teacher and Faculty Influence

Majoring in STEM can be challenging, but too much challenge with deficient support can block learning and ultimately harm persistence (Nichols & Quaye, 2013). The conditions of the higher education institution are essential to student achievement because it is unrealistic to hold only college students responsible for engaging themselves. It is expected that the school faculty should cultivate the conditions that enable students to be engaged (Harper & Quaye, 2013).

Teacher and faculty connections are also essential for students regarding success in education in general (Brown et al., 2014). Many research studies have illustrated the effect of teacher relationships and expectations on student accomplishment (Corprew III & Cunningham, 2011; Stewart, 2008). Research has shown that when the teacher shares their higher expectations with their students, they will significantly impact students' learning and engagement (Morton, 2017).

Social-Emotional Factors

Social capital in college is essential for URM students to feel supported and welcomed, and to have a sense of belonging, in order to be successful in college degree completion. One study showed that first-year STEM major URM students take charge of their academic success when they are equipped to engage not only in curricular activities but also co-curricular campus activities that help them improve academic performance (Kuh et al., 2008). Student engagement in educationally meaningful activities is positively correlated to measures of academic success such as first-year GPA and persistence to the second year of college. Tierney (2000) noted the importance of cultural and social capital for student retention, whereas Jensen (2011) observed that one of five factors influencing retention and sense of belonging is a sense of importance and social connectedness.

A study by Cho et. al (2008) showed that first-generation female college students were more sensitive to psychological or social nuances such as perceived safety, social climate, and having community belonging on campus. The study found factors for STEM-promising female undergraduate students' success and retention. From the research, the top seven factors were listed as "average class size, campus environment, a visit to the campus, university population size, job/career opportunities for graduates, major/department offered at the institution, and weather/climate" (Cho et al., 2008, p. 3). The study further explained that STEM-promising female undergraduate students reported four factors as influencing their decision. These were categorized as non-academic factors: campus environment/aesthetic, a visit to the campus, university population size, and weather/climate (Cho et al., 2008).

Another study was done to better understand and distinguish which factors influence URM students' success. The UCLA Higher Education Research Institute selected a targeted sample of 44,000 college students who were majoring in STEM fields. The researchers also recruited minority-serving institutions (MSI) and others with reputations for graduating large numbers of URM science undergraduates to intentionally examine issues of URM retention in the sciences (Hurtado et al., 2010). This unique longitudinal study followed students for seven years to examine their degree completion and whether they engaged in STEM-related jobs after graduation. The findings showed that joining a departmental club during the first year of college increased URM student's chances of persisting by more than 150 % (Hurtado et al., 2010). In order to help reinforce the students' science identity and career striving, the study recommended that colleges provide URM students with opportunities to engage with a peer group that shares similar academic and career interests.

It is crucial to highlight the role of the institution regarding URM students' retention. Institutional conditions, such as quality of the academic program and professor accessibility, are affecting persistence in academic majors and graduation. Therefore, academic institutions must invest in creating a supportive learning environment by featuring quality teaching, providing good academic advising, and offering other related functions in order to actively engage STEM students in college education and increase their possibility of degree completion (Xu, 2018).

The Struggles and Challenges of First-Generation URM Students

In this study, the researcher defines first-generation college students as those who come from homes where neither parent nor guardian has graduated from college. Because they will be the first ones attending college, first-generation students face a considerable number of challenges once they get into college. Research shows that first-generation students are more likely to experience financial challenges, racial inequality, lack of self-esteem, isolation, marginalization, and low self-efficacy (Stephens et al., 2014). Higher education literature is filled with research demonstrating that first-generation college students are less likely to persist and graduate when compared to their colleagues whose parents have a college education (Banks-Santilli, 2014; Saenz et al., 2007).

Most first-generation students identify themselves as coming from low socioeconomic status (SES). Since they don't have college-educated parents at home, the students might lack not only the financial resources but also financial literacy skills to make a fully informed decision (Lee & Mueller, 2014). It is also very common for URM first-generation students to work full time while they are in college due to financial issues (Bers & Schuetz, 2014). Research has also shown that many first-generation students leave college to work because of financial problems (Falcon, 2015).

In the United States, racial and ethnic inequality challenges and consequences have been in post-secondary education and have been researched for many years. Sommerfeld and Bowen's (2013) study explained, "In 2008, White students held 63 percent of students enrolling in postsecondary education, a proportion 4.5, 5.25, and 9 times greater than their Black, Hispanic, and Asian peers" (p. 47). Pitre and Pitre (2009) said, "Over several decades in the United States, African American, Hispanic, Native American, and low-income students have completed high school and attended college at consistently lower rates than their white and higher-income student counterparts" (p. 98).

Along with financial and racial barriers, URM first-generation college students suffer from low self-esteem. Research shows first-generation students express that they feel uncomfortable in college settings and have a hard time adapting to the environment because they might not share similar interests and experience among their white peers (Huerta et al., 2013). URM first-generation students also have to fight with blame regarding affirmative action and feel pressured to prove to their peers that their college admission was not entirely based on affirmative action, but on their abilities (Myers, Lindburg & Nied, 2013). After interviewing African American college students, Wilkins (2014) stated, "Non-Black students assumed that all Black students benefited from non-merit-based admissions programs, even though most did not" (p. 184). Stigma about college admission based on a student's ethnicity and background extensively contributes to low self-esteem and feeling of disengagement from peers (Falcon, 2015).

Another study showed that students' perceptions of not fitting in are associated with cultural and racial differences between themselves and the student body majority, contributing to their sense of isolation (Jewett, 2008). Jewett's (2008) research about college persistence for low-income and first-generation students found that feeling isolated negatively influenced students in their academic experiences and the formation of social and support networks with their peers.

Phillippe (2016) described marginalization as the lack of belonging to both the college environment and the student's family of origin. Phillipe (2016) surveyed 257 undergraduate college students across 30 different states to investigate feelings of marginalization. Research results showed that first-generation college students significantly feel less belonging within their family and college environments, suggesting that they are, in fact, more likely to experience marginalization in the higher education setting than continuing-generation college students (CGCS).

Self-efficacy is defined as beliefs about one's ability to successfully achieve a behavior required to perform a certain outcome (Bandura, 1997). Self-efficacy has been associated with students' academic, social, and emotional adjustment, which leads to better adjustment to college (Ramos-Sanchez & Nichols, 2007). Research finds that college students with high self-efficacy were related to better college adjustment and a better outcome. First-generation students report lower academic self-efficacy, greater fear of failing academically, and more uncertainty about their preparedness for college/university (Ramos-Sanchez & Nichols, 2007).

Non-first-generation college students have more support and resources than first-generation college students. Therefore, non-first-generation college students perceive themselves as more capable and confident of performing academically in college by keeping their attitudes more positive and confident (Ramos-Sanchez & Nichols, 2007). On the other hand, first-generation students face numerous obstacles such as lack of financial, academic, and emotional support to attain and finish a college degree (Naumann et al., 2003).

Reasons Students Leave STEM Majors

Although research has shown that more students are choosing and enrolling in STEM majors than before, the persistence of students in STEM majors remains a problem (Daemple, 2003). Data has shown the number of students majoring in STEM declining 40% from freshman year to senior year (Whalen & Shelley, 2010). Research has found that students transfer from STEM majors to non-STEM because of a lack of previous academic preparation and due to suffering from social obstacles such as feeling alone and being in an unwelcoming environment (Friedrich et al., 2007; Johnson, 2007; Hurtado et al., 2010).

First-generation students suffer many academic challenges that may endanger their ability to achieve in STEM disciplines. First-generation STEM major students display alarming decline rates: After six years, only 11% of first-generation students complete their bachelor's degrees, compared to 55% of continuing-generation students (Engle & Tinto, 2008). First-generation students enter college with a lack of academic preparation as indicated by having lower standardized test scores (Bui, 2002), critical thinking skills, and GPAs (Pascarella et al., 2004) compared to those of their peers.

Moreover, research has shown that even students who were well prepared academically were leaving because they were experiencing poor instruction, an undesirable curricular structure using one-way lectures, and faculty who valued their research over their teaching (Seymour & Hewitt, 1997). Some research has entirely focused on women who enroll in STEM and questioned their low retention rates at college. Erwin and Maurutto (1998) found through their research via longitudinal interviews of undergraduate women that it was not about intelligence or success. Rather, social-psychological variables and an unwelcoming climate led to women's departure from the sciences (Whalen & Shelley, 2010).

Additionally, research has shown that first-generation students also suffer from social barriers in college (Terenzini et al.,1996) particularly in STEM disciplines. Kim and Sax (2009) found that first-generation students engage with their faculty members and their peers less frequently, which led to them feeling less supported than their peers in the college environment.

Another factor that presents difficulties for students is higher work responsibilities, since lack of financial resources and living off-campus may impact the potential of creating social bonds in college (Pascarella et al., 2004). Social adaptation in college foretells a successful college outcome (Terenzini, 2005). Consequently, both academic and social barriers jeopardize first-generation students' ability to be successful in STEM majors.

Lastly, research has shown the issues of race and diversity are essential to underrepresented students in STEM. Students continue to face "solo status" or presumptions of under preparedness, despite their individual significant achievements at college (Hurtado et al., 2010).

Intervention Programs

Summer Bridge Programs

In the United States, many higher education institutions offer summer bridge programs to students in their first year to reduce their academic gaps. Summer bridge programs aim to provide a pre-college experience to high school graduates accepted in the program and to prepare these students to succeed in their majors. Gilmer (2007) found that "The 5-week Summer Bridge Program assists students in doing well in their first semester of matriculation and student performance in math during the Summer Bridge Program positively correlates with first-semester overall GPA" (p.13). Summer bridge intervention programs aim to improve students' knowledge and skill development and to provide support and motivation to students (Maton et al., 2000).

In 2016 at the Ohio State University (OSU), researchers studied the retention of students to STEM majors for four cohorts participating in the summer bridge program sponsored by the National Science Foundation. Students joined in a six-week program before their first term of enrollment at the university. Researchers used descriptive statistics and qualitative data to show that the summer bridge program's outcomes were associated with retention in a STEM major. Research results confirmed the theory that students need both senses of belonging and academic support structures to persist in STEM (Tomasko et al., 2016). Between 2009-2013, the researchers administered surveys to each cohort at the beginning and end of the summer bridge program, and they were able to include data for all the cohorts. One student surveyed commented, "It prepared me for my freshman math, chemistry, and physics courses and put me in a position to enter ahead of the curve and excel in the fall" (Tomasko et al., 2016, p. 94). Other students discussed changes in their study habits: "It helped build study skills that I needed to learn"; "It helped me realize, even more so, how serious college is and that from before day one I need to make sure that I have my goals set out and am ready to reach them" (Tomasko et al., 2016, p. 95). Students mentioned that clearer expectations decreased their anxiety and helped them know that they could succeed.

When colleges offer bridge programs and provide a "whole student" approach where social integration and a sense of belonging are present alongside academic support, students are more persistent in STEM majors.

Early STEM Courses in College

Schools have an impact on students entering college. If schools do not offer enough preparation for STEM majors, students are at risk for academic failure or dropping out. Data has recommended to educators that the reduction or elimination of performance gaps in early college is a product of a purposeful implementation of a high-quality learning environment with high expectations and rigorous courses, and instruction early in the college journey is vital (Bernstein et al., 2014).

Sadler et al. (2014) found that the most significant control variable for retention was student interest in a STEM major prior to enrolling in advanced STEM coursework. Student retention is impacted by registering and taking the course early on, and by the completion of the first entry-level college math courses. A study conducted by Paschal and Taggart in 2017 showed that students who passed a first-term college-level mathematics course were retained in a STEM major at a higher rate than students who did not pass a first-term college-level mathematics course (Paschal & Taggart, 2019).

Another program in Connecticut called the STRONG-CT (Science Technology Reaching Out to New Generations in Connecticut) program conducts research (McGonagle et al., 2014). They aim to prove that providing academic support and enrichment courses to build a sense of community and enhance basic science to help students exposed to STEM fields in the early stage will help them retain STEM majors (McGonagle et al., 2014). STRONG-CT seeks to diversify the STEM academic and business communities in Connecticut through increasing enrollment, retention, and graduation of historically URM students in the life sciences at four different higher institutions in Connecticut. The results have shown STRONG-CT to be a promising program with both academic and social benefits for students. Even though most STRONG-CT students come from disadvantaged backgrounds in terms of parents' education and SAT scores, those in the program perform and graduate in STEM majors similar to or better than control group students.

Pre-College Preparation

Research has shown that first-generation minority students have had less rigorous high school courses and are academically not as prepared as the students whose parents attended college (Harrell & Forney, 2003.) Moreover, many studies have addressed how K-12 schooling experiences have affected college performance and enrollment in STEM disciplines.

First-generation minority students typically do not receive an education that prepares or motivates them for a career in mathematics or science. The United States Department of Education (1999) has reported that quality afterschool programs help children develop better social and academic skills, and this is especially true for URM students. The emphasis on reading and math improvement in such programs lends itself to improved academic success in students, which leads to increased self-esteem. Research has shown that implementing hands-on activities for STEM after-school programs with well-trained staff members will help students to choose STEM, feel confident about themselves, and improve their social skills at the same time (Flowers, 2003).

STEM Enrichment Programs

When STEM enrichment programs are properly implemented and maintained, they can reduce the achievement gap in mathematics and science. Research has shown two main factors that contribute to the lack of minority student participation in STEM enrichment programs. The first factor is that all STEM enrichment programs have a financial cost, and the second factor is that all STEM enrichment programs require a time commitment from teachers during after-school hours (Flowers, 2003).

Flowers (2003) researched the following question to determine the relationship between STEM and after-school enrichment curriculum: “Is there a disparity in the academic motivation of students who participate in after-school STEM enrichment programs and their interest in pursuing careers in STEM fields?” (p. 34). It is apparent that reducing the achievement gap will take full collaboration and partnership with the community and legislation. Schools and community-based organizations must keep promoting the need for STEM project-based learning and demonstrate the support within school budgets. When schools financially support and properly train teachers around STEM project-based learning, they will see positive outcomes, which will lead to more URM students’ interest in STEM majors and careers in the future (Flowers, 2003).

Participants reported the YMCA helped them develop social and interpersonal competence and technology skills, all of which have been found to be useful in the transition to higher education and the workforce (Lippman et al., 2008; Warschauer & Matuchinak, 2010).

Athletic Programs

Athletics also have a role in students’ persistence in STEM majors. The common belief about college athletes is that they tend to choose less demanding majors at college (Schneider et al., 2010). Gayles’ research (2010) showed that athletes tend to choose more majors in social and behavioral sciences than the technology, engineering, and math (STEM) degree programs due to differing levels of time commitment. However, despite the hardship of being involved in sports and majoring in STEM, Pierce’s (2007) research found that athletes who pursue demanding academic programs in STEM are often quite successful. His study included surveying student-athletes to identify what characteristics and behaviors contribute to their success in engineering majors in two different research public institutions. In this study, the female and male students identified experiences before and during college that aided their academic success in persisting STEM majors while playing a sport. Pierce (2007) found that time management, organization, and problem-solving are skills that STEM student-athletes excel in. The study showed that students take the ability to concentrate and the ambition to succeed in athletics and apply those characteristics to their academics, resulting in a STEM major completion rate higher than their peers who are not involved in any sports (Pierce, 2007).

Regardless of the time-consuming nature and demanding schedule of college sports, research has shown that skills earned by playing in a team sport help students to complete STEM majors, despite being high in demand and strong academic rigor (Jayakumar & Comeaux, 2016).

STEM Courses in High School

Research has shown that high school preparation in math and science plays a vital role in increasing student interest in pursuing a STEM major (Wang, 2013). Students' mathematics courses play a big role in students persisting in college STEM majors (Whalen & Shelley, 2010). Paschal and Taggart (2019) found that not only taking the course but how a student's ability to define and construct high school mathematical concepts positively predicted a student's achievement in a college calculus course. Literature has shown that students' taking STEM courses, especially high-level math courses, is correlated with students' college success. Wood and Hicks (2005) found that high school math class level was the key to conjecturing student success in college. Hicks's (2012) further research showed that both enrollment and performance in math courses are vital influences in the appeal of STEM majors for underrepresented students, making them a key part of broadening the STEM pipeline.

Advanced Level STEM Courses in High School

Research has shown that students who take Algebra II, Trigonometry, or Calculus in high school are more likely to persist in a STEM major than students who take lower-level mathematics courses (Maltese & Tai, 2011). More studies show that not only taking the class but also increasing the passing rate for Precalculus I and II are also promising factors in increasing STEM retention for underrepresented students (Carver et al., 2017).

Taking advanced level STEM courses in high school also indicates students' STEM persistence beyond sophomore year in college (Griffith, 2010). Passing the Advanced Placement (AP) Exam was also found to predict college majors in research by Mattern et al. (2011). This study was based on 39 four-year colleges and universities for 39,440 students in the entering class of fall 2006. This study showed students who took an AP Exam were more inclined to major in subjects related to their AP courses. Moreover, students who had higher scores from AP tests had an increased likelihood of majoring in that content area (Mattern et al., 2011). Lastly, the same study showed the relationship between AP participation and college majors was stronger for STEM subject areas than other subject areas (Mattern et al., 2011).

As much as the math courses, science courses have a significant impact on students' retention in STEM majors in college. In one study, students who took physics or calculus in high school showed greater odds of earning a STEM degree (Sadler et al., 2014).

Research from the President's Council of Advisors on Science and Technology (2011) showed that having high-quality STEM educators was one of the most crucial elements in ensuring excellence for minority students' success in the STEM discipline. It is vital for the teacher to be competent not only with the content but also to master the pedagogical skills to teach STEM subjects well (President's Council of Advisors on Science and Technology, 2011).

However, much research showed that teachers' beliefs about students' educational achievement affected their decision to recommend and approve the student taking advanced placement classes (You & Sharkey, 2012; Campbell et al., 2012). This belief limits the minority students taking necessary math and science classes and leaves them unprepared for college-level STEM coursework (Campbell et al., 2012; Simpson, 2000).

When students start college, they are mandated to take introductory STEM classes, such as physics, chemistry, and calculus. Studies have revealed that students, especially minorities and first-generation college students, switch to non-STEM majors at this stage due to the difficulty level of the course and non-engaging pedagogy (You & Sharkey, 2012; Seymour & Hewitt, 1997). Wang (2013) found that pursuing a STEM major is directly influenced by high school math achievement and postsecondary experiences. If students are exposed early to the high-level math courses, this will influence positive math attitudes and early achievement, ultimately affecting their choice of a STEM major in college (Wang, 2013).

Student Preparation for Standardized Tests

One of the most valuable STEM retention variables is high school GPA and SAT scores (Nicholls et al., 2007). Oseguera (2005) discovered good study habits were also a predictor of six-year college graduation rates. Findings from a meta-analysis conducted by Robbins et al. (2004) showed that study habits, study skills, and time-management skills ultimately predict college graduation and moderately predict a high college GPA.

Students' high school achievement is measured by many different methods, including standardized test scores. Students' mathematics proficiency, as measured by ACT mathematics score and high school mathematics grade, is a great predictor of completing a STEM major in college (LeBeau et al., 2012).

There are some discrepancies within the research literature regarding which pre-college academic factor is most influential in URM students' persistence in STEM. Some research showed the SAT score as the only significant variable associated with STEM persistence (Hurtado et al., 2010; Palmer et al., 2011). Other studies suggested high school GPA be the only important pre-college indicator of STEM persistence (Espinosa, 2011). Others argued that the number of STEM-based AP courses completed has implications for STEM persistence beyond the sophomore year in college (Griffith, 2010). Despite differences in research findings, the literature showed a correlation between higher SAT and ACT scores and STEM retention (Beasley & Fischer, 2012; Chang et al., 2014).

Recent researchers examined factors influencing STEM majors by researching ninth-grade students using longitudinal study. Research results showed that students who aspired to STEM majors were significantly higher on all of the school/academic variables than their non-STEM counterparts. Specifically, STEM students scored significantly higher on standardized math tests and had higher final grades in their most advanced math and science courses than non-STEM students (Li & Bray, 2017).

Summary

The literature review presented the data and explained the URM student's college retention. Thayer's (2000) study showed students have a lower academic engagement measured by how students interacted with faculty, their involvement in class discussions, and their questions asked in class.

The literature review also examined the multiple sources of influence that can encourage students to declare a STEM major and support them to complete their degree. Takruri-Rizk et al.'s (2008) research showed that family members in STEM played an essential part in a student’s college major choice. Rhea’s (2017) study showed that effective mentoring is one of the most vital factors for increasing student motivation, engagement, and retention for underrepresented minority students in STEM. Another source of influence is peer relations, which provides motivation and encouragement to persist in STEM via study groups or established relationships (Freeman et al., 2008; Good et al., 2011). The literature review also examined the impact of teacher relationships and expectations on student accomplishment (Corprew III & Cunningham, 2011; Stewart, 2008).

Several challenges and struggles faced by URM students were also highlighted: financial challenges, racial inequality, lack of self-esteem, isolation, marginalization, and low self-efficacy (Stephens et al., 2014).

Additionally, the literature review examined intervention programs, such as the summer bridge program, which improves students’ knowledge and provides support and motivation (Maton et al., 2000). Involvement in extracurricular activities, such as STEM after-school programs, inspires students to choose STEM and improves their social skills at the same time (Flowers, 2003). Involvement in a sport at college can help students complete the STEM major (Jayakumar & Comeaux, 2016).

A significant gap in the literature remains for this topic since there is not enough research to show the correlation between involvement in sport athletic programs and STEM major retention rate. Also, the literature review shows that studies are either quantitative or qualitative, but mixed methods are necessary to understand the whole picture.

Connections between high school coursework and choosing and persisting in a STEM major were also discussed, along with standardized testing as it relates to the pursuit of STEM degrees.

CHAPTER 3: METHODOLOGY

This chapter explains the methods the researcher developed to collect and analyze the required data accurately. This mixed methods phenomenological study relied on multiple methods of data collection, including both quantitative and qualitative methods. The researcher combined quantitative descriptive statistical analysis utilizing survey data and qualitative lived experience phenomenological analysis using individual semi-structured interviews.

Research Design and Rationale

The researcher used both quantitative and qualitative methods for this study. When gathering qualitative data, designing research involves choosing subjects, data collection techniques, procedures for gathering the data, and methods for implementing treatments (Schumacher & McMillan, 2010). According to Schumacher and McMillan (2010), research design refers to a plan for selecting subjects, research sites, and data collection procedures to answer the research questions. The researcher chose semi-structured approaches for this study to help ensure the comparability of data across individuals, times, settings, and researchers (Maxwell, 2013). In this research, current college students—both STEM majors and non-STEM majors—were identified as subjects. To get participants' perspectives on what inspires their persistence and success in STEM, student questionnaires were conducted.

The researcher used a phenomenological approach for this mixed methods research. The goal of this approach is to arrive at a description of the nature of a particular phenomenon (Creswell, 2013). In this study, the researcher chose the use of phenomenology for qualitative research, which focuses on the commonality of a lived experience within a group of students studying in STEM majors and students who started college with a STEM major and changed to a non-STEM major. With this study, the researcher hoped to construct the universal meaning of the experience students were having and aimed to find a more profound understanding of the phenomenon.

The researcher used a phenomenological approach to analyze the qualitative data collected from one-on-one interviews and open-ended survey questions. Using the findings from the interview transcripts, the researcher then developed a list of significant statements and provided significant statistical findings to understand the participants' experiences.

Setting and Participants

Persistent and successful STEM participants provided information about their pre-college and undergraduate STEM experiences. Participants of this study were college students. Participants are categorized in three parts: a) students who were currently studying any major at college b) students who were currently studying STEM majors and c) students who had started college with a STEM major and changed later in their college journey. The students' ages varied from 19 to over 30 years old. To participate, students had to meet the inclusion criteria and sign the consent forms. Participant selection was based on students who were currently studying at college and older than 18 years old. For the purpose of this study, students who registered in higher education and have at least junior standing are considered to be persisting.

Participants were administered an online survey based on three research instruments: Unpacking the STEM Gender Gap Survey (Woo, 2019), the STEM Career Interest Survey (Kier et al., 2014), and the GRIT survey (Duckworth et al., 2015).

The researcher sent the online questionnaire with an explanation letter electronically to over 1,000 college students via the Google Suite platform by using Google Forms. It was expected that participants would complete this survey in an average of 10-15 minutes. The survey consisted of 34 questions divided into five sections for all students. Current STEM majors were also given a sixth section, which included eight more questions. Section one was an introduction and description of the study. Section two was informed consent, the point at which students agreed to participate in the study. Section three was the demographic portion for all students to complete. Section four related directly to the students' high school curriculum, the effects of teaching strategies used in high school, and students' agreements about factors that affected their high school success. Section five was about students' college experience, their first declared major, and their current major. Section six was only open to current STEM majors. In that section, students answered questions about student involvement, university activities, and the effects or impact of teachers and faculty support on STEM students' success. The last question in the survey, "Do you have anything else you would like to add about your high school and college STEM curricula's effect on your college success and persistence?" was added to allow the participants to add any pertinent information that they might have omitted or hadn't been asked or addressed previously.

This study's qualitative data was collected using open-ended questions via semi-structured one-on-one interviews with students who volunteered to complete the survey and be interviewed. All participants who completed one-on-one interviews received a $20 gift card. The interviews took about half an hour. They were conducted via video conferencing platform Zoom and recorded. Zoom's functions helped make the process easier for the researcher and participants because they did not have to travel to complete the interviews. The interviews were recorded on Google Drive files for transcription, which was done automatically with a Zoom function. One of the essential elements of the interview process was ensuring the confidentiality of respondents' information. Excellent care was taken to secure personal information by assigning different names instead of using students' real names and ensuring that no identifying information was released in the research. A good interview guide acknowledges four essential human social interactions that influence what people are likely to say (Kennedy, 2006). Many things will occur naturally in every human conversation as people try to find common ground. However, that means researchers might have a tendency to try to find common ground with research subjects. Kennedy (2006) suggested that the best way to defend against the social process is not to accept people's initial answer as a final answer. The researcher needs to design the interview to challenge subjects' claims by asking for elaboration or asking for opposing ideas or other influencing conditions. In this study, the researcher planned for interviews to be semi-structured so there was room to challenge the participants by asking some additional questions if the answers were on a surface level.

Sampling Procedures

This study used the "Snowball Sampling" technique to recruit participants. Student participants were required to have graduated from high school and/or earned a GED and to be enrolled in college either pursuing a STEM major or a non-STEM major at the undergraduate level. The researcher did not limit participation by state and/or region. The participants were of varying ages (the expected range was between 19 and 30), and they identified themselves as college students.

The researcher works in a company called Study Smart Tutors (SST) as a director of education. According to SST's mission statement, "SST partners with educational institutions and college access programs to prepare students for K-12, college, career, and lifelong success." SST serves many federally funded TRIO programs with enrichment, training, and tutoring instruction. One of the TRIO programs, called Student Support Services (SSS), federally funded TRIO programs at colleges and universities and served low-income students and first-generation students (Student Support Services Program, 2007). The researcher had a strong relationship partnering with TRIO directors throughout the states and sent the survey to them to share with their students and other TRIO directors. Participation included signed confidentiality agreements (see Appendix B) and the acknowledgement that participation in this research was voluntary, and that each student's identity would be kept confidential. Participants were also informed they could enter a raffle to win one of 10 $15 Amazon gift cards.

According to McMillan and Schumacher (2010), the general rule in determining sample size is to obtain a sufficient number to provide a credible result. This usually means obtaining as many participants as possible. However, in situations in which a random sample is selected from a large population, a sample size that is only a small percentage of the population can approximate the characteristics of the population satisfactorily (Schumacher & McMillan, 2010). There are two approaches suggested by Schumacher and McMillan to determining adequate sample size. One used published tables or sample size calculators. For this study, it was calculated that 320 students would need to complete the survey, and between 6 and 10 students would need to participate in the one-on-one interview. Schumacher and McMillan explained that "A population is a group of elements or cases, whether individuals, objects, or events, that conform to specific criteria and to which we intend to generalize the results of the research" (p. 119). It is vital for researchers to define both the target population and the sampling frame carefully and completely.

Data Collection

This is a mixed methods phenomenological study that utilized an online survey and one-on-one interviews for the data collection process. Quantitative data collection analysis included questionnaires with closed-ended questions, methods of correlation and regression, mean, mode, and median. Qualitative data collection for this study included open-ended questions via semi-structured one-on-one interviews with volunteer students. A snowball approach was used by the researcher, which allowed this study to not limit participation by state and/or region.

For the data collection, the researcher sent the online questionnaire with an explanation letter electronically to over 1,000 college students via Google Forms. There were 204 college students who consented to participate in this research study. In this research, female students represent 72% of the population, while male students represent 27%. According to previous research, women are more likely to be more willing to participate in online surveys than men (Curtin et al., 2000). It was expected for the participants to complete this survey in an average of 10-15 minutes. The survey consisted of 34 questions, including 14 qualitative (open-ended) questions, 10 Likert scale questions and 10 multiple-choice questions. Questions related directly to the students' high school and college curriculum, the effects of the teaching strategies used in high school and college instruction, student involvement and activities in the university, and the effects or impact of teachers and faculty support on STEM students' success. Current STEM majors answered eight additional questions, including five Likert scale questions and three open-ended questions.

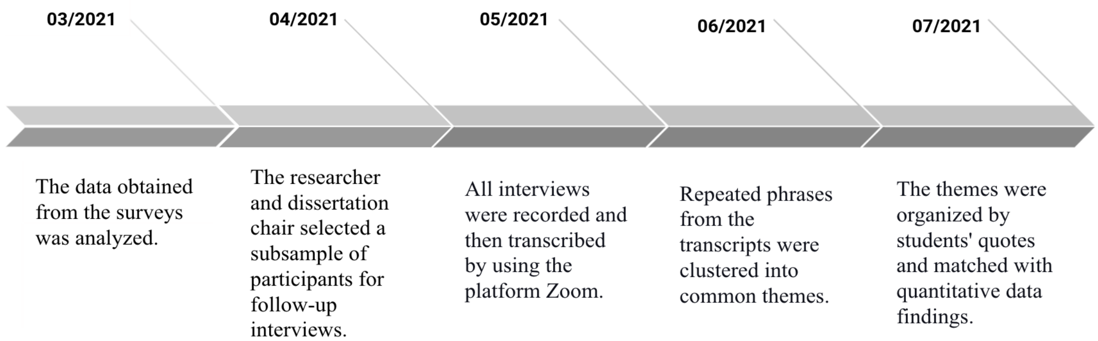
Students were informed with the consent form. Along with the purpose and objectives of the study, the students were informed of the benefits and design of this research and how it could benefit other students in the future. Participants received a clear message in regard to their rights about opting out of the study, which they could do at any time.

This mixed-method phenomenological (Moustakas,1994) study also included one-on-one interviews. The qualitative data researcher planned to follow Creswell's (2013) data collection: locating the site, completing the IRB process, identifying the process for selecting the participants, sampling, collecting data, recording info, and storing data. After the Google Forms survey was completed, the researcher analyzed the data to select a subsample of participants for one-on-one interviews. The researcher interviewed 9 students. Out of 9 students, 6 students were majoring in STEM at the time of the interview, and 3 students had dropped their first declared STEM majors and were pursuing non-STEM majors. Eight students were studying in a public university, and 1 was studying in a private university. Class standing varied among the students who completed the one-on-one interviews. The researcher interviewed 4 senior-standing students with only a quarter left to graduate, 2 juniors, 2 sophomores, and 1 freshman.

To assure the students had a full understanding of the nature of the study, how the data would be managed, and what the researcher would do with the data (Brink, 1993), the researcher planned to interact with the students prior to beginning the phenomenological interview data collection process via video conference. The goal of the phenomenological component of the study was to elicit perceptions and beliefs from the students about their lived experiences (Merriam & Tisdell, 2015). The researcher was interested in how students' involvement at campus may influence undergraduate students to persist in STEM. Therefore, the time invested in creating a feeling of familiarity with the researcher may have stimulated a more open dialogue and less guarded answers during interviews.

Figure 5

Data Collection Procedures and Timeline



Invitations for this research were conducted to college students via email. In this email invitation, the researcher explained the purpose of this study and explained why the students were being invited:

> You have been invited to take part in this study because you are a student at the University and earning your undergraduate degree. We are looking to recruit 300-350 students' participants for this study. This study is completely voluntary. I will describe the study and I will then ask you to sign a consent form to show you have agreed to take part. You are free to withdraw at any time without giving any reason without consequence.

Before the actual interviews, pilot interviews were conducted to enhance the data collection processes. This allowed the researcher to get a more reliable estimate of the interview time, to make some modifications, and to allow for follow-up questions. The researcher conducted and recorded the interviews using video conferencing platform Zoom and then transcribed them. Each interview lasted approximately 25-30 minutes. Each participant in the interview was asked to respond to the following open-ended questions:

1. What led you to pursue a major in STEM?
2. What has been the greatest challenge that you have had to overcome to continue in the STEM major?
3. Describe the encouragement and discouragement you received to pursue a career in STEM.
4. Did anyone or anything open your eyes to the possibilities of STEM at any time during your primary or secondary education? Describe the event.
5. What costs or sacrifices did you associate with a STEM major as you were making that choice? Why did you still choose STEM?
6. Describe someone who influenced you to pursue a STEM major
7. What advice would you give to high school students who were considering majoring in STEM? Why?
8. What kind of things used by your college instructors helped or not helped you to succeed in your college courses?
9. Describe a barrier you had to overcome to get to where you are now in your college journey.
10. What types of faculty support are most helpful to your success in STEM courses? How or why are they helpful?

Responses from the open-ended and interview questions were analyzed to determine common descriptions and themes. The researcher was looking for the correlation between students' campus involvement and the other positive factors contributing to students' retention in STEM majors.

Instrumentation and Measures

Questionnaires are the most frequently used data collection approach in educational research (Radhakrishna, 2007). Surveys help collect information on knowledge, attitudes, opinions, behaviors, facts, and other categories. The development of a valid and reliable questionnaire is crucial for reducing measurement error. The researcher planned to use the students' questionnaire and open-ended interview questions as instruments for this study. It was assumed that the participants' responses would be honest and accurate when responding to the interview questions. However, as typical to most studies, there were some limitations. Creswell (2013) defined a limitation as the potential weaknesses or problems of the design of the study that could potentially reduce the study's validity and scope.

Reliability

To make sure research is reliable, Creswell (2013) suggested the use of intercoder agreements when multiple coders analyze and then compare their code segments to establish the reliability of the data analysis process.

By using a mixed-method design, the researcher was able to use triangulation to validate the congruence of the data collected from both quantitative and qualitative studies for this study. This procedure had the advantage of minimizing the potential risk of bias on the part of the researcher being influenced by the results of a single study methodology and increased the number of study participants (Brink, 1993). This research instrument was used by former researchers, and the researcher obtained permission to use Woo's (2019) questions about women in STEM careers.

Validity

Maxwell (2013) explained the two types of threats to validity that are often raised in relation to qualitative studies: researcher biases and the effect of the researcher on the individuals' studies, often called reactivity (Maxwell, 2013). A researchers' values and expectations may have influenced the conduct and conclusion of the study and avoided the negative consequences of these. The best way to approach this is to explain the researchers' own biases and how the researchers will deal with these; this is a key task of the research proposal (Maxwell, 2013).

Because the researcher used both students' questionnaires and open-ended interviews, there is no mono-method bias that will pose threats to validity in this research. However, the researcher's personal biases would limit the accuracy of this study. Patton (1990) argued that there are limitations to how much can be learned from what people say, therefore, to understand the complexities of many situations, direct participation in and observation of the phenomenon of interest may be the best research method. The use of open-ended interviews could also have created a potential bias toward the researcher because she is a Muslim female with a scarf. In order to prevent this potential threat, answers and questions could potentially be verified to avoid misunderstanding and biases, which is another limitation in qualitative data. Since interview questions in a qualitative study give rise to other questions, as is the case in this study, the effect of interview limitations should be minimal.

Limitations

Limitations are expected when doing research. However, researchers must strive to minimize the scope of limitations throughout the research process. In addition to that, researchers need to provide acknowledgment of the research limitations in the chapter honestly. One limitation identified in this research is that the participant pool is not representative of the different state populations of the United States, so the results cannot be generalized to overall society.

The literature review is an integral part of any research because it helps to identify the scope of work that has been done so far in the research area. There is much research that has been done about first-generation and minority students and their college and career readiness. However, there is little prior research on the topic measuring the correlation between STEM degree resilience and the pre-college curriculum rigor. Schumacher and McMillan (2010) suggested that when there is very little or no prior research on a specific topic, the researcher may need to develop a new research typology. Discovering a limitation can be considered a valuable opportunity to identify new gaps in the prior literature and to present the need for further development in the area of study.

Data Analysis

This research categorized participants who identified themselves as college students. The participants completed an online survey via Google Forms. Some students also agreed to participate in one-on-one interviews. The data was collected and organized into files. Information from both the survey and the interview was analyzed and categorized. The researcher used StatPlus to analyze the data collected. The researcher then arranged the quotes into themes and combined them with StatPlus statistics to give an entire story of the student experiences.

Ethical Issues

Before starting this study, approval for this research was granted by the Institutional Review Board (IRB) for Human Subjects Research of Concordia University Irvine. Ethical guidelines include policies regarding informed consent, deception, confidentiality, anonymity, and privacy (Schumacher & McMillan, 2010). Researchers must adopt these principals in complex situations. The researcher identified possible ethical issues relevant to this study and discussed the possible solutions. Schumacher and McMillan (2010) recommended, "The researcher should be as open and honest with the subject as possible" (p.143). This usually involves full disclosure of the purpose of the researcher, but there are circumstances where the researcher is withholding information about the research. Withholding information means that participants are informed about the only part of the purpose of the study (Schumacher & McMillan, 2010).

The researcher identified that in this research, full disclosure would affect the validity of the results. It was suggested that study should be run partially blindly to prevent those involved from making overly positive comments. It was also suggested that the study's aim and purposes should be worded less evidently in order to help prevent or minimize this threat.

The reason for keeping participants in the dark about what the researchers are looking for is to try to prevent participants from altering their responses to conform to what they think the researchers expect. This is not deception or giving misleading information regarding the research, but full disclosure about the study would affect the validity of the results. From one perspective, this may be justified on the basis of the contribution of the findings (Schumacher & McMillan, 2010). On the other hand, it is an affront to human dignity and self-respect and may encourage mistrust and cynicism toward researchers. There is no solution to these ethical issues. Still, experts have said that it would be okay to run the research where the significance of the potential results is greater in a blind study where validity cannot carry out if the study is not run blindly (Schumacher & McMillan, 2010).

Another ethical issue in this research was that participants could potentially experience mental discomfort while completing the survey questions or conducting the one-on-one interview open-ended questions. According to Schumacher and McMillan (2010), “Participants must be protected from physical and mental discomfort, harm, and danger. If any of these risks is possible, the researcher must inform the subject of these risks.” Participants in this study had a choice about whether to participate. The researcher disclosed the possible harm in the study before participants completed the survey questions by including the following statement on the consent form:

> RISKS: There are no foreseeable risks or discomforts to you associated with this survey; however, some of the questions may bring up some memories that could be associated with negative experiences or unpleasant episodes in your life.
>
> I have read and understood the consent document and agree to participate in your study.

Summary

This study used a phenomenological mixed-methods approach to examine what inspires students to choose STEM majors and what influences their persistence and success. The researcher used both quantitative and qualitative methods. Snowball sampling was used to invite students to participate in this study.

Students were informed that they could enter a raffle to win one of 10 $15 Amazon gift cards when they completed the survey questions. Two hundred four students completed the online survey based on three research instruments: Unpacking the STEM Gender Gap Survey (Woo, 2019), the STEM Career Interest Survey (Kier et al., 2014), and the GRIT survey (Duckworth et al., 2015). The researcher used StatPlus to analyze the quantitative data using methods such as correlations, ANOVA, mean, mode, and median.

Qualitative data collection for this study was conducted using open-ended questions in semi-structured one-on-one interviews with volunteer students. Nine students were selected, and the researcher asked them 10 open-ended questions via online platform Zoom. Out of 9 students from public and private universities, 6 students were currently majoring in STEM, and 3 students had dropped their first declared STEM majors and were pursuing non-STEM majors. All participants who completed one-on-one interviews received a $20 gift card. Interview transcripts were arranged into quotes and combined with StatPlus statistics to give an entire story of the students' experiences.

CHAPTER 4: RESULTS

The purpose of this study was to determine what affects students' motivation and persistence in the STEM major. This researcher was looking for an answer for the following questions:

RQ1: What factors influence the retention of college students in STEM fields?

The following sub-questions were also explored:

RQ2: What is the relationship between student involvement at the campus and students' retention?

RQ3: What affects their motivation and persistence?

RQ4: What are the differences between public and private universities related to STEM retention?

Pearson correlations were carried out to determine the relationship between student retention and high school course rigor and student college involvement. Analysis of Variance (ANOVA) were also carried out to find the factors that affect the student's retention. This chapter presents the descriptive statistics of the sample, including participant demographics, gender, age, and type of college, along with information on parents' education level and income. Then, the chapter presents survey and interview results and examines the factors that influence students' motivation and persistence in pursuing undergraduate STEM majors.

Descriptive Statistics

The demographic information of the participants in the sample is presented below. There were 204 college students who consented to participate in this research study. The total sample included a mix of college students who were currently studying in a STEM major (n =86) and college students majoring in a field of study other than STEM (n =113). Table 1 lists all other characteristics of the student participants. Out of 204, 198 students completed more than 90% of the survey questions. In this research, they are different sample sizes for various table and graph. It is because survey questions are not mandatory to answers for the participants, and sometimes they choose to skip the questions. Also, some questions might not be applicable for the participants, which will result in the different participant numbers (n) in the data result.

Table 1

Student Demographic Information

Characteristics of Students	%
Gender	
Female	72 %
Male	27 %
Other	1 %
College Standing	
Freshman	24 %
Sophomore	27 %
Junior	22 %
Senior	27 %
Major	
STEM	43 %
Non-STEM	57 %
First Generation	41 %
Ethnicity	

White	51 %
Hispanic/Latinx	33 %
Asian	9 %
Black/African American	2 %
Other	5 %
Father's Education Level	
Elementary	8 %
Junior High/Middle School	6 %
High School	25 %
Vocational/Technical/Associates Degree	10 %
Bachelor's Degree	24 %
Master's Degree	20 %
Doctoral Degree	7 %
Mother's Education Level	
Elementary	4 %
Junior High/Middle School	10 %
High School	23 %
Vocational/Technical/Associates Degree	14 %
Bachelor's Degree	25 %
Master's Degree	21 %
Doctoral Degree	3 %

Figure 6

Annual Income Range of Participants' Families

The annual income of the families of the participants was divided into six categories: (a) an annual income below $29,999, (b) an income between $30,000 and $69,999, (c) an income between $70,000 and $99,999, (d) an income between $100,000 and $149,999; (e) an income between $150,000 and $199,999, and (f) an income above $200,000. In this study, 36 % of the participants (n = 198) had an income between $30,000 and $69,999. This is the highest representation in this study. According to U.S. Census Bureau, in 2019, a family of four—two adults and two children—making $50,200 was considered low income (Semega et al., 2020). Most of the participants in this study fall under this low-income category. However, this was not the only range of income represented in the research. Figure 6 summarizes the range of income categories represented in the study.

High School Courses and Experience

Table 2

Students' High School Academic Profile

	N	Mean	Std. Deviation
SAT	109	1254	228.33
ACT	53	25.80	4.55
GPA	197	3.70	0.54

Descriptive data is presented as the mean ± standard deviation (see Table 2). The overall mean scores of the students' high school academic profile are presented for each category. Overall, more students (n =109) reported their high school SAT score than their ACT score (n =53). The overall mean of students' SAT test scores was (1254 ± 228.33), and the overall mean of students' ACT test scores was (25.80 ± 5.55). Almost all participants (n =197) reported their high school GPA, with the overall mean being (3.7 ± 0.54) (see Table 2).

In trying to answer which factors would influence STEM retention, the researcher hypothesized that student's preference for STEM courses and the rigor of their high school courses would have an impact on students' college STEM major selection. Moreover, it was expected that more rigorous high school course options would affect the students' college STEM retention. Table 3 shows that students said they prefer science courses the most (M=3.14), and technology courses the least (M= 2.65). Also, students reported that they were offered more math courses (M=4.17) than science (M=3.87) and technology (M=2.98) courses during high school (see Table 3).

Table 3

Preference for and Rigor of High School Courses

		Preference		Rigor	
Subject	N	Mean	SD	Mean	SD
Science	198	3.14	1.34	3.87	1.09
Math	198	2.78	1.38	4.17	0.91
Technology	196	2.65	1.26	2.98	1.20

Note. Likert scale where 1=completely disagree and 5=completely agree

Descriptive statistics are presented in Table 4 as mean ± standard deviation. Students' responses were in regard to their agreement about their high school experience. The most common experience among students was having peers with the same background (M = 4.04, SD =1.15), and the least common experience reported was experiencing discrimination during high school (M = 2.45, SD =1.38) (see Table 4).

Table 4

High School Experiences

	N	Mean	SD
Having Peers with Same Background	198	4.04	1.15
Positive Social Environment	198	3.96	1.07
Having Teachers with Same Background	198	3.60	1.38
Having Access to Internship	198	2.80	1.28
Experienced Discrimination	196	2.45	1.38

Note. Likert scale where 1=completely disagree and 5=completely agree

Kathy is a college student in a public university. She shared the following about her experience with her peers during her high school years: "My peers were very good. So, the majority of my friends coming from some background, and so they were very, like, encouraging" (Kathy S, personal communication, March 2021).

Descriptive statistics are presented in Table 5 as mean ± standard deviation. Students listed grades as the biggest factors when it comes to their high school success (M = 4.22, SD =0.96). The next-largest factor was reported to be high school teachers, with a similar mean score (M = 4.02, SD =1.15), followed by the factors of friends/peers (M = 4.01, SD =1.12). The factor least related to the students' high school success was identified as other family members (M = 3.09, SD =1.43) (see Table 5).

Table 5

Factors Related to High School Success

Factors	N	Mean	SD
Grades	198	4.22	0.96
High School Teacher	198	4.02	1.15
Friends/Peers	198	4.01	1.12
Parents	197	3.97	1.22
Social Environment	197	3.82	1.26
Role Model	198	3.37	1.43
High School Counselor	198	3.18	1.53
Other Family Members	194	3.09	1.43

Note. Likert scale where 1=completely disagree and 5=completely agree

An ANOVA was computed on the data set (n = 194) to examine gender and factors affecting the students' high school success. The result was statistically significant, $p < .05$. Female students ranked peer and mentor influence higher than male students did. Table 6 summarizes the mean results.

Table 6

Gender and Factors Affecting High School Success (n=194)

Categories	Female	Male
Peer impact	4.20	3.53
Mentor	3.56	2.91

Note. Likert scale where 1=completely disagree and 5=completely agree

Student Retention

The student involvement theory claims that if a student gets involved in campus extracurricular activities and spends time on campus, then that student's retention and success are higher than a student who is not engaged (Astin, 1999). In exploring the relationship between student involvement on campus and student retention, descriptive statistics showed that participants' (n=198) engagement and involvement at the campus most often took the form of socializing with friends (M = 3.37), followed by participating in club membership on campus (M = 2.96), and least being a member of a sports team (M = 1.51) (see Table 7).

Table 7

Student College Campus Involvement (n = 198)

Categories	Mean	*SD*
Socialize with Friends	3.37	1.59
Member of Campus Club	2.96	1.80
Interact with Faculty	2.56	1.36
Volunteer in Campus Events	2.37	1.50
Member of Sport Teams	1.51	1.07

Note. Likert scale where 1=completely disagree and 5=completely agree

Magdalen is currently pursuing a non-STEM major as a senior student at a large public university. She dropped her STEM major in her freshman year. During the interview, she shared her experience with campus involvement:

> In college, I joined the residential government council, so that's, like, I don't know, it's like a group of students who plan events for people who live in the dorms. I joined that, and that might have been, like, the only club I did that year. The second year I did—I joined the environmental club. I think that was about it for my involvement. (Magdalen, Personal Communication, March 2021)

A Pearson linear correlation was computed on the participant sample (n = 197) to find the relationship between students' choice of a STEM major in college and students' favorite subject during high school. There were three subjects that were significant ($p < 0.05$): math, science and technology. The correlation coefficients are summarized in Table 8.

Table 8

Correlation Between Starting College with a STEM Major and Favorite Subject Being Math, Science, or Technology, (n=197)

Subject	*R*
Math	0.41*
Science	0.38*
Technology	0.27*

* Correlation is significant at the 0.05 level.

There was a negative correlation between students changing from a STEM major to a non-STEM major and students' high schools offering rigorous high school course in the following two subjects: science, r (198) = -.15, p < .05; technology r (198) = -.18, p < .05. The correlation coefficients are shown in Table 9.

Table 9

Correlation Between Dropping the STEM Major and High School Offering Rigorous Science and Technology Courses (n=198)

Subject	*R*
Science	- 0.152*
Technology	-0.186**

* Correlation is significant at the 0.05 level.

** Correlation is significant at the 0.01 level.

A Pearson linear correlation was computed on the participant sample (n = 198) to find the relationship between STEM retention and students being members of a sports club on campus, having access to internships, and being first-generation students. The result was significant ($p < 0.05$): If the students were involved in sports and they had access to internship opportunities, they were less likely to drop the STEM major. However, being first-generation correlated with dropping the STEM major. The correlation coefficients are summarized in Table 10.

Table 10

Correlation Between Dropping STEM (Non-Retention) and Other Factors (n=198)

Subject	*R*
Sports Club Member	-0.151*
Having Access to Internship	-0.156*
Being First-Generation Student	0.188*

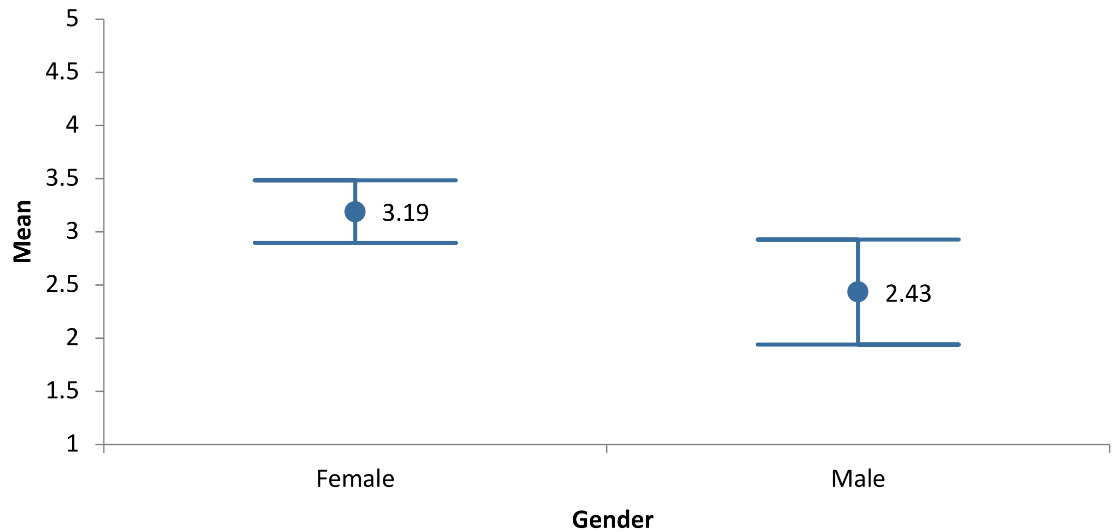
* Correlation is significant at the 0.05 level.

Student Gender

An ANOVA was computed on the data set (n = 95) to examine the difference between female and male agreements regarding being a member of a club in college. The result was statistically significant, F (3.89) and $p < .05$. Club involvement at the campus was higher for females than males. A bar graph summarizes the results (see Figure 7).

Figure 7

Being a Member of a Club on Campus (n =195)



Note. Likert scale where 1=completely disagree and 5=completely agree

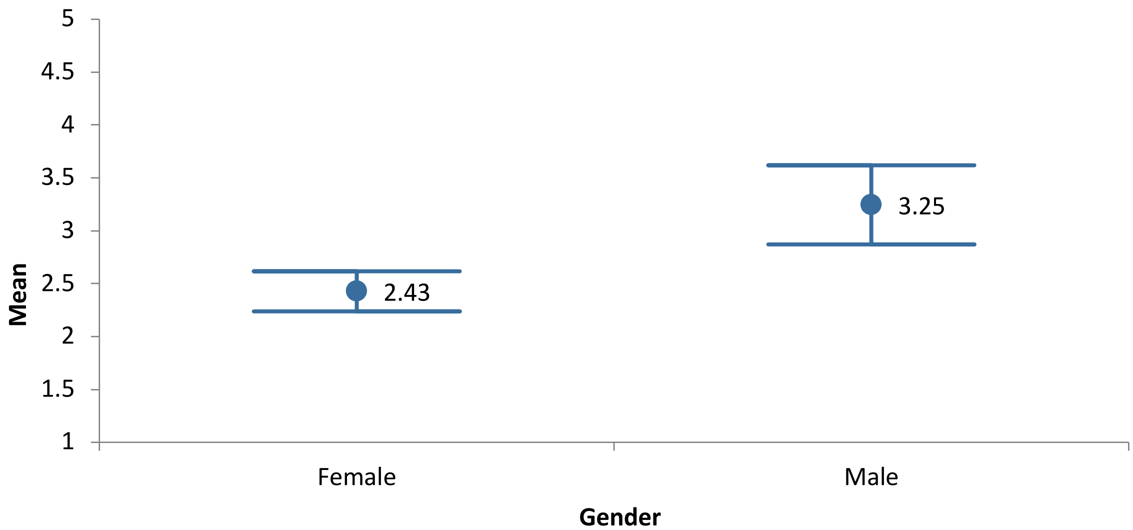
Mimi is a college student who came to the USA as an immigrant. She has been in the U.S for about four years. She is majoring in STEM at a public university. She shared her experience with club involvement at the campus:

> I was forcing myself to meet people and to join clubs, when it was really hard in the beginning, but I really forced myself too much, so I joined the club, and the next year I became the president of the club, because I really wanted to just overcome this obstacle, because I cannot be silent forever, right? I'm living in the United States. (Mimi N, Personal Communication, March 2021)

An ANOVA was computed on the data set (n n = 193) to examine the difference between female and male agreements regarding technology being their favorite subject. The result was statistically significant, F (17.7) and $p < .05$. Male students rate technology as their favorite subject more than female students do (see Figure 8).

Figure 8

Identified Technology as Their Favorite Subject



Note. Likert scale where 1=completely disagree and 5=completely agree

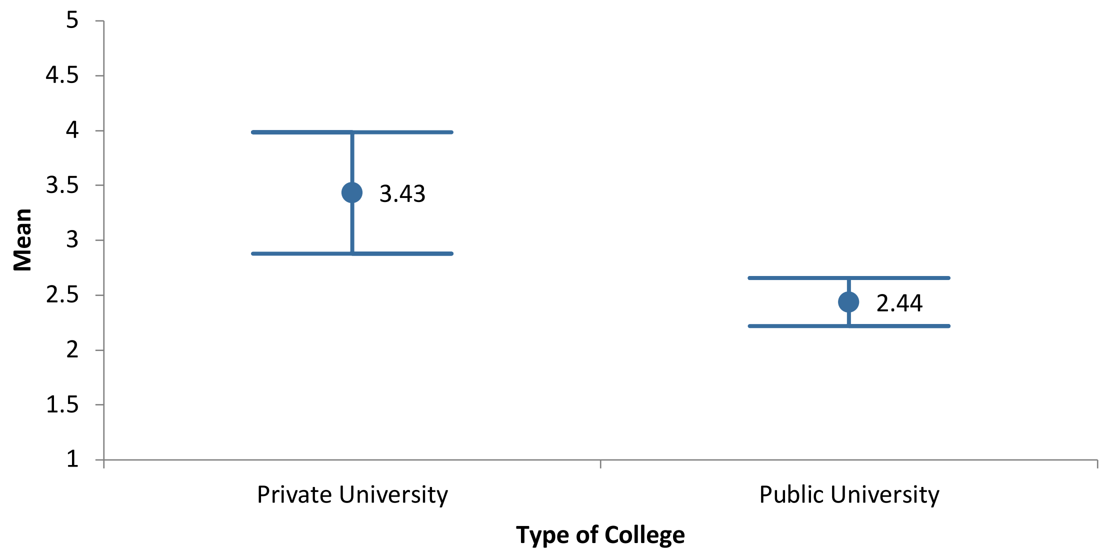
An ANOVA was computed on the data set (n =195) to determine whether female and male students differed about STEM major retention in the university. The result was not statistically significant, $p > .05$.

Type of University

An ANOVA was computed on the data set (n =167) to find out whether student interactions with professors outside the classroom differed at public and private universities. The result was statistically significant, F (13.8) and $p < .05$. Students who attend a private university have more interaction with their professor outside of the classroom than the students who attend public university. Figure 9 summarizes the results.

Figure 9

Student Interactions with Faculty/Professor at Least Once a Week Outside the Classroom (n =167)



Note. Likert scale where 1=completely disagree and 5=completely agree

Stephanie is studying a STEM major at a public university. She is a senior. Her experience supports the finding from the ANOVA results; her interactions with faculty were limited. She shared her experience interacting with her professors:

> Stephanie: I'm honestly always, like, scared to talk to professors outside of class. I could have been a lot better about that, but yeah, I don't think if I wanted to, it would have been easy.
>
> Researcher: What do you think that makes you feel scared to reach out?
>
> Stephanie: I think it depends on, like, the teaching style of the professor and lecture. They seem really approachable to me during lectures. Then, I'll have a lot easier time, like, reaching out to them, but if they're kind of, like, scared in lecture and talk about students' questions that are like, "You should know this one thing," and then I'm scared to go talk

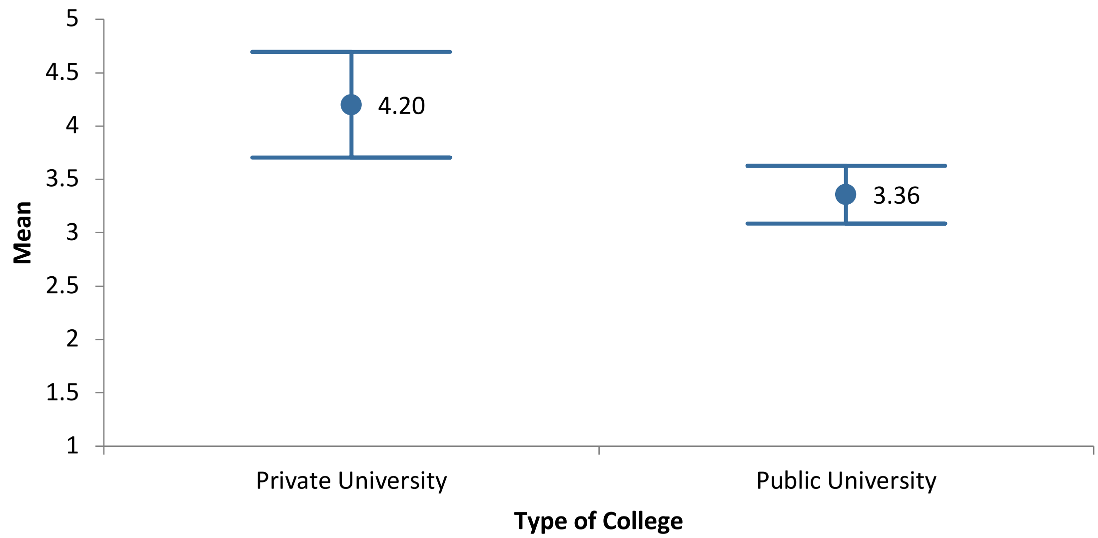
> to them. I always feel like I have, like, a really prepared question to ask them. I don't want them to say, "Oh, you should have known this or you could have found that somewhere else." You know? Yeah, just, like, discourages me from reaching out to them. (Stephanie K., Personal Communication, March 2021)

Insight from Becca, a sophomore STEM major at a private university, also supports the ANOVA findings. Becca's experience with faculty outside the classroom is very positive. She said, "A lot of my friends do go to public, so I knew how difficult it is for them to, like, connect, and I tell them, I'm like, 'Dude, I just go out, like, to coffee with my professor, like, on the weekends" (Becca M, Personal Communication, March 2021).

An ANOVA was computed on the data set (n = 167) to find out whether students' socialization with their friends outside the classroom differed at private and public universities. The result was statistically significant, F (7.16) and $p < .05$. Students who attend private universities have more socialization with their friends outside of the classroom than the students who attend public universities. Figure 10 summarizes the results.

Figure 10

Students Who Socialize with Friends at Least Once a Week on Campus Outside the Classroom



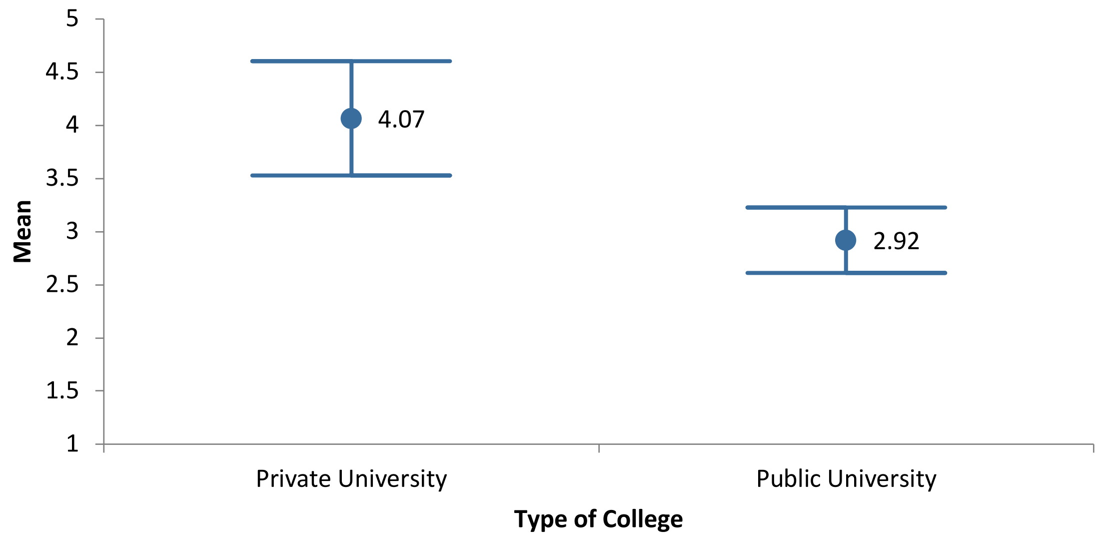
Note. Likert scale where 1=completely disagree and 5=completely agree

Damien is currently a senior studying STEM at a public university. When asked about his involvement with friends, clubs, or internships, he said, “I have a lot of workloads. I cannot have the internship, or I don’t have time to socialize with friends. I’ve already quit the job that I was working at January, so that way I can focus on my last semester” (Damien J, Personal Communication, March 2021).

An ANOVA was computed to investigate the agreement of a student being a member of a club on campus (n = 167). There was a significant difference between students at private universities and public universities, F (10.3), $p < .05$. More private university students than public university students were members of campus clubs. Figure 11 summarizes the results.

Figure 11

Students Who Are Members of Clubs on Campus



Note. Likert scale where 1=completely disagree and 5=completely agree

Elise is a junior majoring in a non-STEM major. When she first started college, she declared her major as STEM, but she dropped it after a semester. She shared her campus involvement in her first years:

> First year that I was in college (majoring STEM), I was very involved. This time around (majoring non-STEM), I'm not interested in doing like clubs, or at least I don't know of any clubs I'm interested in. Maybe there are clubs I would be interested in, but like, attending sporting events and that kind of stuff I don't really have an interest. (Elise P, Personal Communication, March 2021)

Becca, the previously mentioned sophomore STEM major at a private university, compared her high school and college experiences regarding socializing with friends:

> I think I am just trying to find, like, a group of people who feel the same way I do when it comes to STEM. It's really hard to find females like me who are really into STEM, and

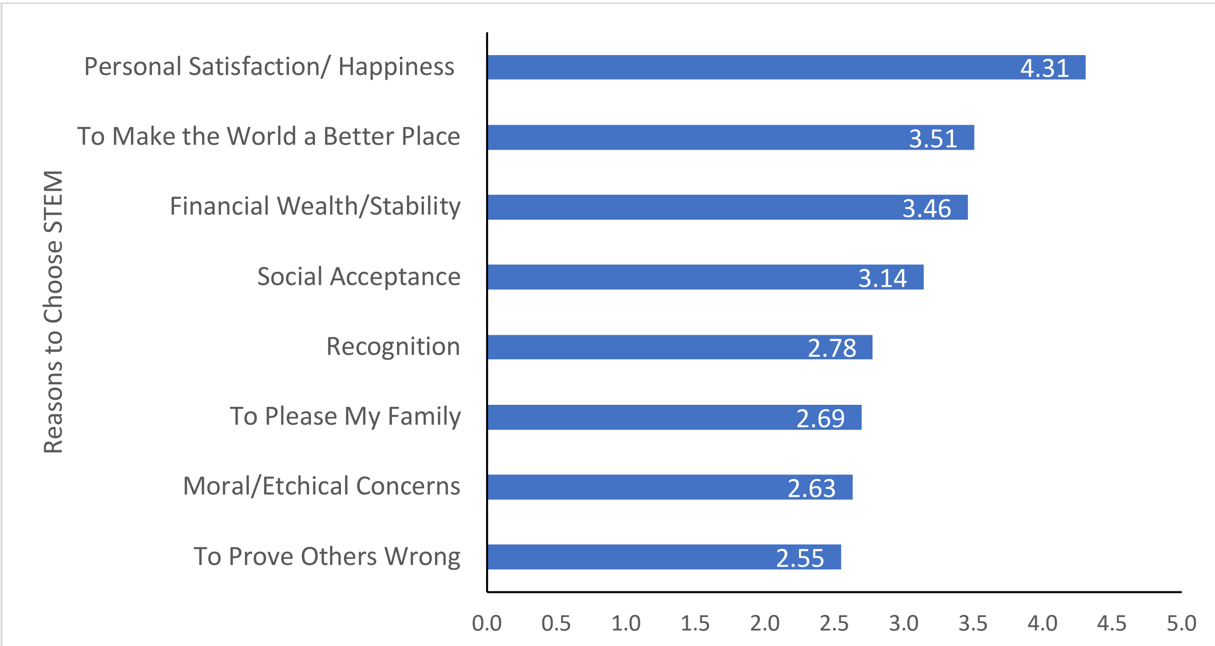
> just be able to just talk to them about anything and everything. During high school most of my friends actually weren't STEM majors, they were, like, either in the arts, or they were into agriculture, and that kind of stuff, so I felt a little bit secluded because I really didn't have anybody to talk to about this kind of stuff until I hit college. I had joined this thing called STEM Academy for my freshman year, and I got to meet a bunch of other STEM majors, not just males versus females from different minorities as well. And I just, I'm still friends with them to this day. (Becca M, Personal Communication, March 2021)

What Influenced Student to Choose STEM

Descriptive statistics showed that participants (n =85) listed their personal satisfaction and happiness as the main influencer for them to choose a STEM major (M = 4.31). Students almost equally weighted making the world a better place (M = 3.51) and financial stability (M = 3.46) in their decision to pursue a STEM degree. To prove others wrong was the lowest mean (M = 2.55) as a reason for students to choose STEM (see Figure 12).

Figure 12

Factors that Influenced Students to Choose STEM

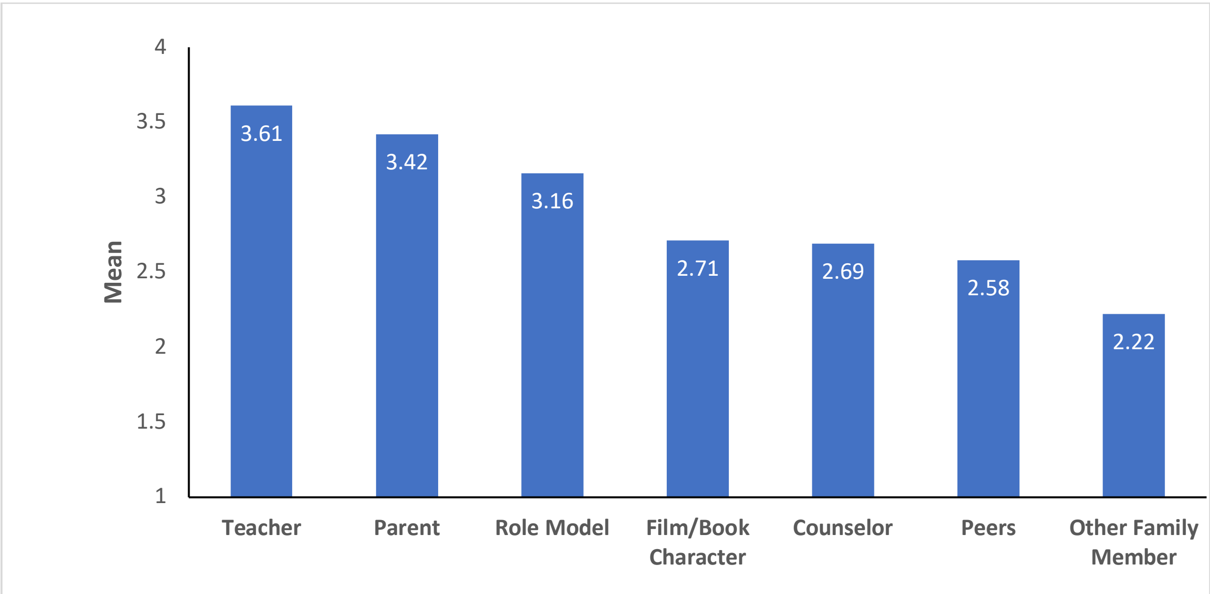


Note. Likert scale where 1=completely disagree and 5=completely agree

Descriptive statistics showed that participants (n=89) listed the teacher (M = 3.61) as the number one person who influenced students to pursue a STEM major. According to the data, parents (M = 3.42) had a similar effect on whether students majored in STEM. As seen in Figure 13, counselors (M = 2.69), peers (M = 2.58), and other family members (M = 2.22) had the least influence when it came to pursuing a STEM major.

Figure 13

People Who Influenced Students to Pursue a STEM Major (n = 89)



Note: Likert scale where 1=completely disagree and 5=completely agree

Sophomore STEM major Becca, mentioned previously, is a first-generation college student. She explained her high school teacher's influence on her pursuit of a STEM major:

> I think the one person that really pushed me to go into STEM was my high school biomedical teacher, because at this point, like, I knew I was going to go into STEM, but I wasn't super passionate about it. It wasn't until I started taking her class, and she pushed me to do, like, different things. Like, she pushed me to get my medical assistance. She pushed me to competitions, like, in the STEM field. She even pushed me to help make this workshop for the middle schools and elementary school girls to, like, what STEM careers they could get into, all that stuff, and I guess just being able to experience that and seeing, like, everything, it really helped me grow my passion for STEM, and it's still going strong to now. (Becca M, Personal Communication, March 2021).

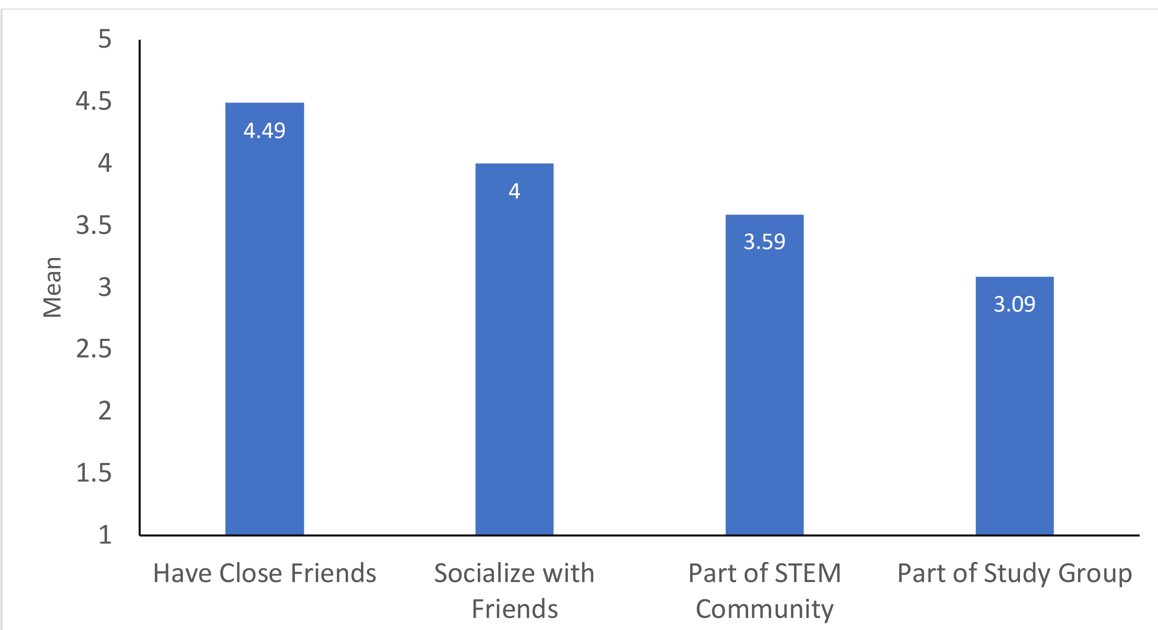
Another student explained how her mom influenced and encouraged her to study STEM:

> My mom was probably the biggest impact. She works in mining, and so I told her about maybe doing, like, mechanical engineering as a major, and she's the one that proposed that I could do both. She said you could always do the vet degree and then do mechanical and working prosthetics for animals. She's always, like, giving me the other options (Liz C, Personal Communication, March 2021).

Figure 14 displays students' agreements on belonging to the school community in different forms. Data showed that the students surveyed feel they have close friends (*M* = 4.49), and they socialize with their friends (*M* = 4.00). Students said they feel the least belonging as a part of a study group (*M* = 3.09).

Figure 14

STEM Major Students' Agreement Regarding Belonging to Group/s (n=89)



Note. Likert scale where 1=completely disagree and 5=completely agree

Magdalen, a senior non-STEM major mentioned previously, shared her feelings and thoughts about belonging and her college experience:

Magdalen: When it was my first year in college, I had no idea how to do anything in college, and I think that it just all brought me down and, like, made me feel like I didn't belong to that school. And I stopped putting in as much effort, because I started to believe, like, that I don't belong at this school. This isn't the major for me.

Researcher: What do you think right now about belonging?

Magdalen: Right now, it's tough. It's tough because it's been four years of convincing myself that I belong so I kind of, like, that idea pops into my head. I say, like, yes, I do belong. But then I also really feel like I don't belong, like, I feel like everyone else has it figured out. And I don't have it figured out. It's my last quarter before my graduation, so I think by now I don't have that feeling as much. It doesn't really hit me as often, and I'm able to shut it down much more quickly, but I do still wonder whether or not I belong. (Magdalen, Personal Communication, March 2021)

There was a positive correlation between students' feeling like part of the STEM community and social interaction. There were six different categories under the campus social interaction that were significant: (a) having a close friend, r (85) = .47, $p < .05$; (b) being member of campus club r (85) = .37, p < .05; (c) volunteering on campus events r (85) = .26, $p < .05$; (d) having a study group r (85) = .23, $p < .05$; (e) socializing with friends r (85) = .22, $p < .05$; and (f) interacting with faculty r (85) = .21, $p < .05$. The correlation coefficients are shown in Table 11.

Table 11

Correlation Between Feeling Like Part of the STEM Community and Social Interaction and Involvement (n=85)

Categories	*R*
Having Close Friends	0.479*
Being Member of Campus Club	0.379*
Volunteering in Campus Events	0.266*
Having Study Group	0.237*
Socializing with friends	0.220*
Interacting with Faculty	0.216*

* Correlation is significant at the 0.05 level.

Magdalen explained her interaction with faculty and involvement in a study group on campus and how those two factors influenced her in feeling like she wasn't part of the STEM community:

> There are a lot of things that impacted it (feeling part of STEM). The professors weren't super welcoming. And they also weren't super helpful. And so, I usually would resort to talking to them. So that was one problem that just in general I didn't like the courses were set up, it was just very difficult for me to find people to help me. And, yeah, like, with my high school education, I took AP calculus and passed, but when I got to college it still really felt like I was really behind, like other people would actually say to me, like, "Oh if

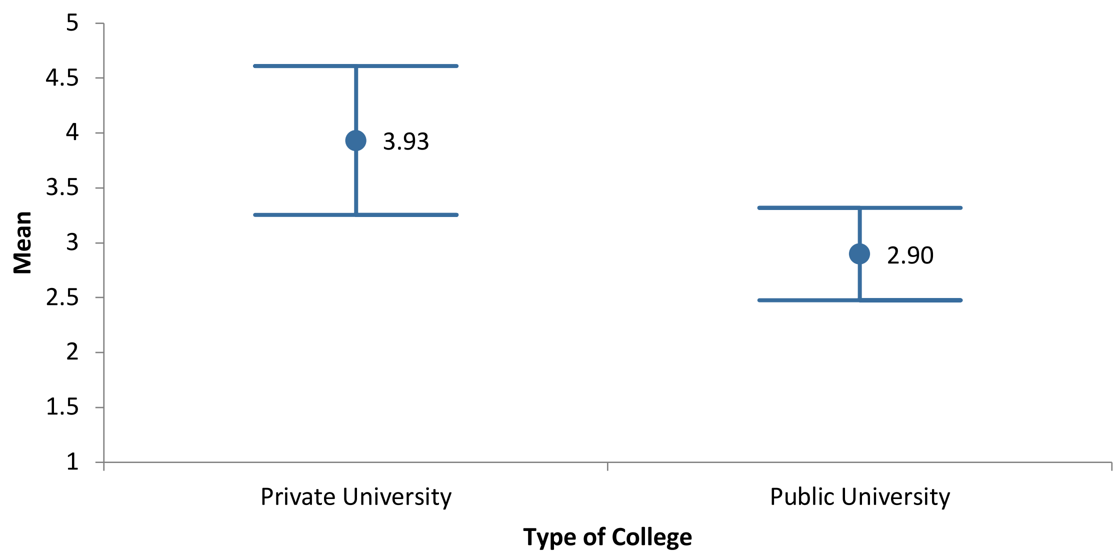
you're not understanding this material right now, how you expect to continue as math major?"

And that really stuck with me… I honestly think the community was a little intimidating. Like, they had people ask me, like, if I wanted to work on homework with them, and those people were some of the ones who would say things like, "How you expect to be a math major, if you don't know these things?" (Magdalen N, Personal Communication, March 2021)

An ANOVA was computed on the dataset (n = 73) to find if there was a statistically significant difference between private universities and public universities on STEM students being part of a study group. There was a significant difference, F (5.40), $p < .05$. More private school students than public school students were part of a study group. Figure 15 summarizes the results.

Figure 15

STEM Major Students Who Are Part of a Study Group

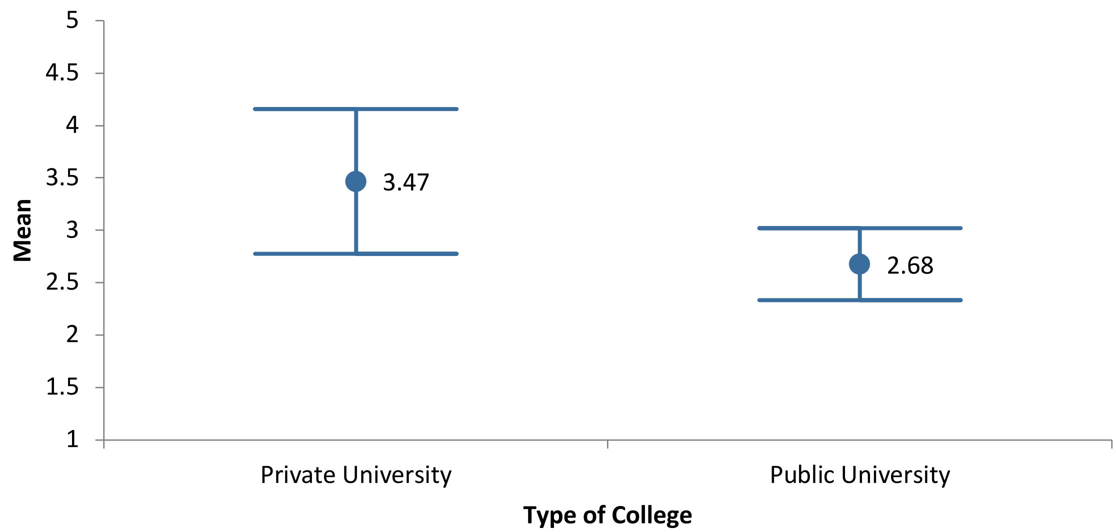


Note. Likert scale where 1=completely disagree and 5=completely agree

An ANOVA was computed on the data set (n = 74) to find out whether private university and public university students differed in reading STEM-related journals outside of schoolwork. The result was statistically significant, F (4.3) and $p < .05$. More private school students than public school students reported that they were reading STEM-related journals. Figure 16 summarizes the results.

Figure 16

Students Who Read STEM-Related Journals Outside of Schoolwork

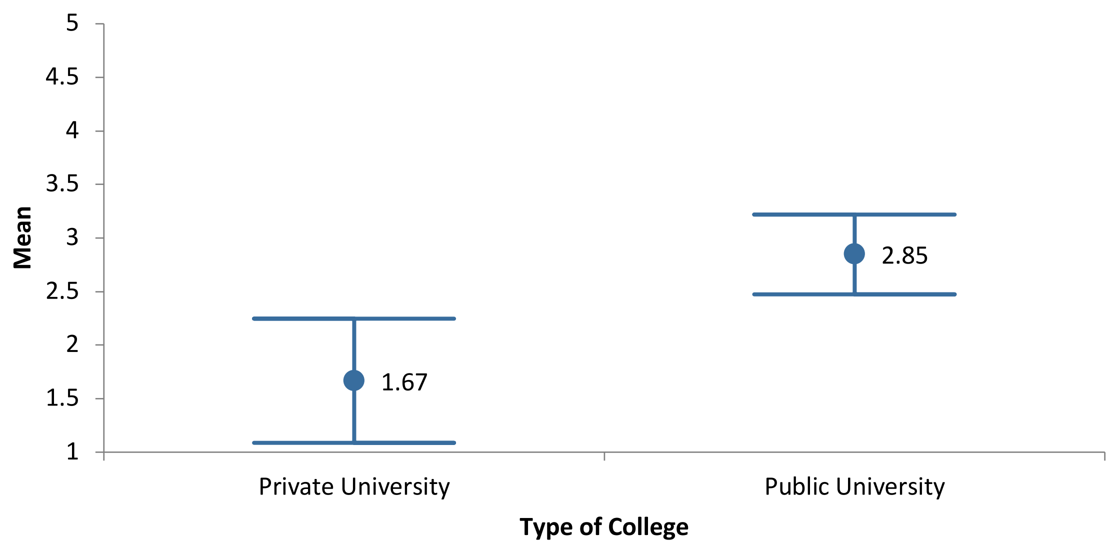


Note. Likert scale where 1=completely disagree and 5=completely agree

An ANOVA was computed to investigate students' agreement with whether they chose a STEM major to please their family and how this differed between students at private and public universities (n = 74). There was a significant difference between students at the two types of universities, F (9.2), $p < .05$. Students who were going to public universities reported that they had chosen STEM to please their family more than the private university students did. Figure 17 summarizes the results.

Figure 17

Students Choosing a STEM Major to Please Their Family



Note. Likert scale where 1=completely disagree and 5=completely agree

Summary

In this chapter, the survey and interview results were presented to examine the factors that influence students' persistence in undergraduate STEM majors and to determine the relationship between which factors affect the students' motivation and persistence. In order to capture students who changed their major from STEM to non-STEM, the survey was completed by 198 current college students.

The first part of the data explained the students' high school experiences. Students listed their high school subject preferences with science being first, followed by math, then technology. Students determined eight factors for their reasons for high school success. Those factors are listed as follows from highest to lowest ranking: grades, high school teacher, friends, parents, social environment, role model, high school counselor, and other family members.

The second part of the data identified student campus involvement and retention. The survey results (n =198) and interviews (n =10) were analyzed. The most common form of students' engagement on campus was socializing with friends, followed by being a member of campus club, then interacting with faculty and professors. Importantly, results showed that if the students were involved in sports and had access to internships, they were less likely to drop their STEM majors. Nonetheless, data showed that being a first-generation student directly correlated with dropping a STEM major.

This study found a strong correlation between students' choice of STEM major in college and students' favorite subjects being math, science, and technology. On the other hand, research showed that when students' high schools did not offer rigorous science and technology courses, students were more likely to drop the STEM majors in college.

An ANOVA was computed to examine the effect of the students' genders, and research results showed two significant results: (1) Female students were members of campus clubs more than the male students, (2) male STEM majors identified technology as their favorite subject at rate significantly higher than the female students did.

The third part of this research analyzed the significant differences between public and private universities. Students at private universities interacted with their professors, socialized with friends, and were involved in clubs more than students at public universities (n =198). Analyzing just the STEM majors, this research shows that students at private universities are more likely to have study groups and read more STEM-related journals compared to public university students.

The last part of the research analyzed only students in STEM majors (n =89) and identified the factors and people who influenced them to pursue STEM and explored their sense of belonging. Students who are currently majoring in STEM listed their personal satisfaction and the possibility of making the world a better place as their main reasons to choose STEM. They reported their high school teacher, parents, and role models as the people who influenced them to select the STEM major. Furthermore, students felt like part of the STEM community if they (a) had close friends, (b) were members of a campus club, (c) volunteered at the college campus, and (d) had a study group.

The advantage of mixed-method research is that qualitative and quantitative data gave a voice to students' experiences and supported triangulation of study findings. The qualitative and quantitative results from this study support findings from previous studies and are discussed in the next chapter.

CHAPTER 5: DISCUSSION

Summary of the Study

In the U.S., STEM skills and workers are in high demand, while the number of students graduating with STEM degrees remains problematic. In addition, underrepresented populations tend to change their field of study from STEM majors to non-STEM majors at a higher rate than other students' populations (NCES, 2014). In STEM majors, studies have repeatedly found that underrepresented minorities, first-generation students, women, and students who have low-income backgrounds drop STEM majors at higher rates than their counterparts (Anderson & Kim, 2006; Hill et al., 2010; Huang et al., 2000; Shaw & Barbuti, 2010; Woo, 2019).

Specifically, there has been an underrepresentation of URM students in STEM fields, leading to lack of diverse representation in the workforce. Although various research has recognized the value of diversity and representation matters in STEM majors and fields, there has been an unsatisfactory increase of underrepresentation over the years.

Increasing diversity in STEM is a complex task. Higher education institutions and educational policymakers are working together to improve undergraduate underrepresented minority student persistence in STEM. Nevertheless, this problem remains with the low number of STEM major URM students.

The primary purpose of this mixed-methods phenomenological study was to examine the factors that influence students' persistence in undergraduate STEM majors. It also aimed to determine the relationship between the factors that affect students' motivation and persistence. It is crucial to study the experiences of those students who persist in a STEM major by identifying these factors. In addition, defining these factors will help higher education institutions and educational policymakers implement new policies and programs.

This research investigated the factors and people that inspired and influenced students' persistence in STEM majors. As a result, eight factors that influenced students to choose STEM were established, and eight types of people who influenced students to pursue a STEM major were ranked. In addition, students' college campus involvement was examined by asking five different questions. Furthermore, students' agreement regarding belonging to groups and feeling like part of the college and STEM community were discovered and listed.

A strong positive correlation was found between students starting college with a STEM major and students' favorite subjects being math, science, and technology in high school. College students listed high school math as their favorite subject, followed by science and then technology. Conversely, there was a negative correlation between students changing from a STEM major to a non-STEM major and students' high school offering rigorous high school courses in science and technology.

Interestingly, the study found that STEM major retention strongly correlates with students being a sports club member on the college campus and students having had access to an internship during high school. The study showed that when students were involved in college campus sports clubs and had an internship opportunity during high school, they were more likely to persist in their STEM major.

There was a strong positive correlation between students' feeling like part of the STEM community and their social interactions. There were six different categories of campus social interaction that were significant: having close friends, being a member of a campus club, volunteering at campus events, having study groups, socializing with friends, and interacting with faculty. Interviews from nine different students who were enrolled in and attending college in the 2020-2021 academic year also support these findings.

ANOVA was computed on the data set to determine the relationship between genders and their campus involvement, as well as their favorite subjects. This research found a strong correlation between female and male students' agreements regarding technology being their favorite subject. Male STEM majors listed technology as their favorite subject significantly more than female students did. Furthermore, the study shows that female students' involvement in campus clubs was significantly higher than the male students' involvement. The study found these differences in favorite subject and club involvement level were not significant when it came to males and females dropping their STEM major.

The type of universities the students attended were categorized as public and private. The ANOVA was computed to determine whether there were differences between the types of institutions regarding students' interactions with professors and friends outside the classroom, as well as students' sense of belonging. The result was statistically significant. Students who attended a private university had more interaction and a greater sense of belonging and engagement at the campus than those who attended a public university.

This study was to examine the factors that influence students' persistence in undergraduate STEM majors. It also aimed to determine the relationship between factors, or to determine which factors affect the students' motivation and perseverance. Finally, this research aimed to offer an impactful resolution that is easy for universities to follow and implement by understanding these factors.

The research questions addressed in this study were as follows:

RQ1: What factors influence the retention of college students in STEM fields?

The sub-questions were as follows:

RQ2: What is the relationship between student involvement at the campus and students' retention?

RQ3: What affects their motivation and persistence?

RQ4: What are the differences between public and private universities related to STEM retention?

In gathering data, the researcher conducted an online survey. The survey included 34 questions in multiple-choice and Likert scale formats for all participants. STEM majors were given eight additional questions. The researcher also conducted one-on-one interviews using 10 open-ended questions. Participants were recruited by using exponential snowball sampling. The researcher sent the online questionnaire with an explanation letter and flyer electronically to over 1,000 college students in the USA. A total of 204 college students consented to participate in the survey, 86 of whom are currently pursuing STEM majors.

The survey questions were divided into four categories:

1. Relating directly to the students' high school and college curriculum
2. The effects of the teaching strategies used in high school and the college instruction
3. Student involvement and activities in the university
4. The effects or impact of teachers and faculty support on STEM students' success

The factors analyzed were parents, parent's education, parents' income, high school teachers, high school counselors, friends/peers, role models/mentors, high school course rigor, students' favorite subject, and grades. Other factors examined were students' college social environment and involvement, access to internships, ethnicity and race of faculty and peers that looked like them, and interaction with faculty outside the classroom. The students answered questions regarding their inspiration and reasons for choosing STEM majors and their feelings about belonging to the campus and STEM community. These factors were determined from Tinto (1993) and Astin's (1999) theoretical framework and previous research, which indicated that these factors had played a significant role in students' decision to choose a STEM major and persistence with that decision.

Research Question 1

Research Question 1 was as follows: What factors influence the retention of college students in STEM fields? The researcher identified three different segments directly related to influence on students and their retention in STEM fields.

The first segment is the eight factors that influenced students to pick STEM majors. The eight factors are listed with students' rating from the most to least influential as follows:

1. Personal satisfaction/happiness
2. To make the world a better place
3. Financial wealth/stability
4. Social acceptance
5. Recognition
6. To please my family
7. Moral/ethical concerns
8. To prove others wrong

Students majoring in STEM rated their personal satisfaction and happiness as the leading influential factors for choosing a STEM major, followed by making the world a better place and desiring financial stability. This ranking list from the research matches the characteristics of the Gen Z students. Research has shown that Gen Z students prioritize and choose their happiness more than anything else (Lin, 2019). In fact, students ranked proving others wrong, looking for recognition, and pleasing their families on the lower side.

The second segment is the individuals who influenced students to pursue a STEM degree; these included (a) teachers, (b) students' parents, and (c) role models. In this research, college students agreed that the most significant influence in pursuing a STEM major came from their high school teacher. This finding is aligned with earlier research in which studies illustrated the impact of teacher relationships and expectations on student accomplishment (Corprew III & Cunningham, 2011; Stewart, 2008).

The literature review showed that family members also help influence their children to get into STEM and keep them motivated and encouraged to continue in STEM (Charleston, 2012; Moore, 2006). Parents significantly influence students' pursuance of STEM majors, and a person's parental education levels also affect their college choice (Takruri-Rizk et al., 2008). Once again, this finding aligns with the earlier research. Lopez and Jones's (2017) study indicated that students' STEM transfer rate and success are predicted by their father's highest level of education.

Lastly, in this research, students listed their role models as individuals who impacted and influenced their college STEM choices. Earlier research showed that offering guest speaker lectures to the students improves their interest and influences them to pick their major in STEM. Moreover, inviting a wide variety of guest speakers from different backgrounds makes the role models as diverse as possible, so more students can relate to them (O'Donnell & Kirkner, 2016).

The last segment that impacts student retention is student involvement on campus. This research found a strong correlation between students being part of a sports club at the campus and retention in a STEM major. This finding is not surprising, since this relates to earlier research showing that joining a departmental club during the first year of college increased students' chances of persisting by more than 150 percent (Hurtado et al., 2010). Regardless of the time-consuming and demanding schedule involving a sport at college, research has shown that skills learned by playing in a team sport help students complete their STEM degrees, despite being high in demand and strong in academic rigor (Jayakumar and Comeaux, 2016).

Earlier research focused on females who enroll in STEM, questioning low retention at college and concluding that low retention was not about female students' intelligence or success (Erwin & Maurutto, 1998). Other studies have supported that finding and have explained that low female retention is a result of social-psychological variables and an unwelcoming climate (Whalen & Shelley, 2010). In this study, it was surprising to see that there were no significant differences between male and female students in retaining their STEM major, though there were some differences in the factors that helped them persist.

In trying to answer the research question, "What factors influence STEM retention?" the researcher hypothesized that students' involvement in campus life and extracurricular activities are predictive of minority college students' retention in STEM programs. In this research, student retention was correlated with their sports involvement.

Research Sub-Question 1

Research sub-question 1 was as follows: What is the relationship between student involvement at the campus and students' retention? This research showed that students ranked having close friends as most important to their level of engagement and involvement, then socializing with their friends, followed by feeling like part of the STEM community. Students listed being part of a study group as the least important to their level of engagement.

This research was conducted in spring 2021, precisely one year after the global Coronavirus pandemic started. Most college students had already spent a full year doing either online or hybrid education; some were still staying with their families, and some were in dorms. Nevertheless, it is an astonishing finding: Even with the COVID-19 restrictions for almost one year, students still listed socializing with their friends as number one for campus involvement.

Previous research has shown that relationships established among students and their peers are essential in helping students sustain and retain a STEM major. Moreover, research has demonstrated that these relationships develop during their collegiate experience, particularly within the STEM environment (Chang et al., 2014; Charleston, 2012; Palmer et al., 2011). Lastly, other research has shown that one of the reasons student's social integrations into their institution can happen is through the student's participation in a study group (Tinto, 1993).

Research Sub-Question 2

Research sub-question 2 was as follows: What affects their motivation and persistence? This study found that peer relations are among the most significant influential factors in students' motivation and encouragement in STEM. This finding aligns with prior researchers' findings that peer connections are most important in contributing motivation and encouragement to persist in STEM (Freeman et al., 2008; Good et al., 2011). In an interview, Magdalen, a senior college student in a public university, shared her experience about her peer relationships, which are the biggest motivation for her to continue in her college. In addition, she described how she leans on her community when she needs it:

> I am in L.A.; when I started college, I was in the dorms, and I lived in the Latino community, like a living-learning community. So, it was all, like, Latino people and a few non-Latino people. However, for the most part, it was just like this very familiar

> community to me, especially because, like Pasadena, I went to was predominantly like Black and Hispanic. So that was my community at college. I, like, quickly made friends. I also joined these programs that were meant to help facilitate first-generation low-income students of color and STEM. And so, I form some friendships..., but my community really was on that. (Magdalen, personal communication, March 2021)

This research also had an exciting finding when ANOVA was computed on the data set to examine whether gender makes a difference when affecting the students' success. The result was statistically significant: Female students ranked peer and mentor influence higher than male students did.

Another factor found in the research is that summer bridge intervention programs affect students' motivation. In this research, students explained how summer bridge programs helped them. Mimi is one example. She is an immigrant college student, and she is majoring in STEM at a public university. She explained how beneficial attending the summer bridge program was not only for her academic success, but also to help ease her anxiety and make her feel more comfortable:

> I would say the language was the biggest barrier for me, especially in, like, first year in college, so I took three classes during the summer bridge program. Sometimes teachers make everything really hard, but it was making me learn the material more and makes me feel comfortable with myself (Mimi N, Personal Communication, March 2021).

Bridge programs aim to impact more students' knowledge and skill development and provide support and motivation to students (Maton et al., 2000). Tomasko et al. (2016) administered surveys to different cohorts at the beginning and end of the summer bridge program. One student commented, "It prepared me for my freshman math, chemistry, and physics courses and put me in a position to enter ahead of the curve and excel in the fall" (Tomasko et al., 2016, p. 94). Other students discussed changes in their study habits: "It helped build study skills that I needed to learn"; "It helped me realize, even more so, how serious college is and that from before day one I need to make sure that I have my goals set out and am ready to reach them" (Tomasko et al., 2016, p.95).

Research Sub-Question 3

Research sub-question 3 was as follows: What are the differences between public and private universities related to STEM retention? In this study, whether the university was public or private had no significant effect on students' STEM major retention. However, Tinto's (1993) theory indicates that student-faculty communication can impact both students' academic and social integration into the institution. This research looked at whether student interactions with their professors differed at private and public universities. It also explored whether there was a difference in how much students at the two types of institutions read STEM journals outside of class assignments. The result was statistically significant: Students who attend a private university had more interaction with their professors outside of the classroom and read more STEM journals than students who attend a public university. A private university can add tremendous value to students because of the professors' individualized attention. The literature review correlated with the research findings that the conditions of the higher education institution are essential to student achievement. It is expected that the school faculty should cultivate the conditions that enable students to be engaged (Harper & Quaye, 2013).

Many different factors have an impact on the subject choices that students make. Research results showed that their parents' backgrounds significantly influenced students' college pursuance and confirmed that a person's parental education levels affected their choice of college (Takruri-Rizk et al., 2008). One notable result showed whether the students at private and public universities differed in choosing a STEM major to please their family. The result was statistically distinguished. Students who attend a public university said they chose STEM to please their families more than the students who attend a private university did. This statistical finding is linked to qualitative findings, as well. Kathy shared the struggle she had with choosing a STEM major to please her parents. She then switched to a non-STEM major. She is now pursuing a non-STEM degree at a public university and shared her experience:

> I don't know why; I felt like my parents wanted kind of something like, you know, like, something within, like, Biology, like go to med school or become a nurse. So, I felt like that's kind of what they wanted for me. So, yeah, it's just very hard to kind of explain sociology to your parents, and like, they asked me like, "Oh, what are you going to do with that?" They didn't go to high school, like, they don't really know much about the field. So yeah, oftentimes, I am discouraged from all my family. I just don't want them to kind of feel disappointed in me. You know, I would want, like, me to be like a doctor, yeah, but that's not really you know what I want to pursue
>
> Researcher: How long did you stay in Biology before you changed your major?
>
> Kathy: I only stayed for a quarter, then I changed my major. (Kathy S, Personal Communication, March 2021)

Students struggle to please their families when it comes to STEM majors, but they mostly drop STEM and choose a new major based on their interests (Wright, 2018).

Implications for Practice

This study showed that the factors influencing college students' retention in STEM fields come from their teacher, their parents, and role models. This research proved a greater need for involving teachers in college and career choices and providing enough training for teachers to guide students during high school. Teachers are busy completing their agenda and covering the daily lesson and core subject standards. Many of them cannot find time to cover college and career readiness during their class time. They might not want to incorporate STEM-related college and career lessons because they might feel inadequate to inform the students. It is recommended that school counselors, colleges, and career centers collaborate with classroom teachers to inform and educate the teachers during the school professional development. This way, the student can receive direct information and inspiration from their classroom teacher.

This study also showed that parents play a vital role in influencing students to remain in STEM majors. It is essential to offer parent education not only for the college application process, but also for college retention. Often, schools offer a presentation about student course selection, college applications, and financial aid. Schools need to go beyond that by offering parents guidance on helping their students make a smooth transition and making them aware of their role in students' retention. Schools must empower the parents with their role when students start college.

This study showed the importance of student involvement in sports, as it had a strong correlation with student retention. This finding first should be investigated from the high school timeline. In a typical high school, being a part of a sports team comes with some selection or a try-out competition. It is essential to check the school policies and practices to ensure that offering sports teams exhibits equity to all students. Will there be any sport that does not require trying out? Schools need to offer at least one sport that does not require former knowledge and practice. The study showed a strong correlation between being part of a sports team and STEM retention rate. Being part of the team, learning time management skills, working through conflicts, managing the feeling of loss but not giving up, and many other skills learned from sports can be transferred, teaching students in STEM fields how to approach challenges.

The research clarified that one way to help these students is to provide a proper summer bridge program (Maton et al., 2000). Students may have family and work commitments that make attending a week-long summer bridge difficult, especially for first-generation students who may require additional information and support about the college experience. Offering proper summer bridge programs helps students sharpen their academic skills and give them a space to meet with new friends. Moreover, they can form friendships with their peers, get to know the campus resources, have an earlier chance to meet with faculty, and begin to feel like part of the group.

Previous research has explained that some students cannot attend a summer bridge program due to a lack of financial resources. A student might be required to work during the summer bridge time. When colleges offer the program, they require tuition, room and board, or some financial contribution. Lack of financial contribution is one of the reasons students may not attend the summer bridge program. Not joining the summer bridge program will impact students' learning, as they will miss the connection with professors and peers from the beginning. It is recommended that higher education institutions offer the summer bridge program with some incentives and provide opportunities for assistance for students to complete these crucial steps before they start their college journey.

This research also revealed a massive gap between private and public universities in terms of access to certain resources. Generally, a large public institution has larger class sizes than a private institution. This creates a barrier for students by making it more difficult to directly reach their professors and making it harder to feel like they belong in the group because they might not know how to manage such a big community. As Kuh et al. (2006) recommended, higher education institutions need to invest in plans that support relationship building between students and faculty/staff. Institutions play an active role in collaborative learning to create inclusive and affirming institutional environments for the students. Many resources are available in both institutions, but URM students have difficulty navigating the system and finding all of the appropriate resources throughout the campus. It is recommended that higher education institutions consider creating one ample space on the campus where all resources, such as disability support services, financial aid, Educational Opportunity Program (EOP), Student Support Services (SSS), academic advising and tutoring, and others, can be located in the same area. It is recommended that institutions create one space that combines many teams that work together to offer comprehensive support programs. Helping students be informed about what is available to them so they can utilize those resources is crucial to their college retention and their sense of belonging at the campus.

Recommendations for Further Research

Based on the conclusions of this study, the following suggestions are recommended for future research.

1. This research used a mixed methods design to understand college students’ perspectives on whether and how they feel a sense of belonging on campus. Most student retention frameworks incorporate a student-faculty interaction model because research has shown that it is strongly correlated with college satisfaction (Tinto, 2012; Tinto, 1993). Future research should include higher education institution faculty perspectives. It is essential to include their input to make the story complete for a thorough understanding of STEM major retention.

2. This study did not differentiate the students who transferred from a community college or transferred from another institution. As Tinto's (1993) framework explained, a student's transfer status can impact whether or not that student integrates into the institution. Further research should specify this information and look for the outcome if a student properly integrates into the institution socially and academically.
3. This study recruited 208 students; future studies should recruit at least 385 participants from the fields. If there was a large enough sample, the study could also examine how students' first-generation status differs from the rest of the STEM major students.
4. It is recommended that more research be offered on the effect of high school practices on students' ability to declare STEM.
5. Future research should examine the parents' and families' perspectives in their students' college retention. It is crucial to see the whole picture from parents, students, and faculty and present how each of them sees their role in student college retention.

Limitations

Two hundred four college students consented to participate in this research study. The total sample included a mix of college students currently studying in a STEM major (n =86) and college students majoring in a field of study other than STEM (n =113). Out of 204, 198 of the students completed more than 90% of the survey questions. Out of 198 students, 79 are first-generation college students. Out of the 79 first-generation students, 31 started out studying the STEM major. Out of 31 first-generation STEM major students, 12 students changed their major from STEM to non-STEM, and 19 first-generation students continued to major in STEM. One limitation identified in this research was that the URM student participant pool is limited; therefore, the results cannot be generalized to overall society.

Ten college students completed a 30-minute one-one-one interview via video conferencing platform Zoom. However, because of COVID-19 restrictions that led to students experiencing Zoom fatigue from their work and school, it was difficult to schedule an additional follow-up interview with participants.

Lastly, in this study, participants came from a mix of ethnicities: 51 % White, 33% Hispanic/Latinx, 9% Asian, and 2% Black/African American. The researcher hoped to have a higher percentage of students of color for more diverse representation. It is believed that if a larger URM STEM major student sample population had been recruited, they would have provided statistically significant results.

Conclusions

According to Tinto (2014), student achievement can be accomplished with intentional actions and implications from everyone's efforts, but it does not happen by coincidence. The National Center for Education Statistics (2017) reported that the 6-year graduation percentage of undergraduate majors at U.S. colleges and universities was 61%. At the same time, the President's Council of Advisors on Science and Technology, PCAST, (2020) summary shows that the 6-year degree completion percentage of undergraduate STEM majors at U.S. colleges and universities is less than 40%. Students who start out planning to major in STEM graduate at significantly lower rates than their non-STEM classmates. Furthermore, graduation and retention percentages among underrepresented minorities (URM) and first-generation college students are even more troubling (Koch et al., 2018). These students begin university with less confidence and drop STEM majors at greater rates than their counterparts (Riehl, 1994; Hudley et al., 2009). There is an extreme gap that needs to address and offer practical and urgent solutions.

This research explored the factors influencing students' persistence in undergraduate STEM majors and determined the relationship between which factors affect the students' motivation and persistence. The advantage of mixed-method research is that qualitative and quantitative data gives a voice to students' experience and supports triangulation of study findings.

Tinto's (1993) theory offered a model for student retention that has been in continuation for over 30 years. Numerous higher education institutions already offer various programs and policies to support college students, and many of them have been successful. However, some of those initiatives and student support programs need to be intentionally modified to continue to help college students who need them. Overall, the findings of this research supported Tinto's model for the retention of students in STEM. Students are looking for a genuine connection with their peers, faculty, and the general community. This research showed, once again, the importance of study groups and institutional support for college students.

The researchers, countless studies, and higher education institutions have continued to analyze data for student STEM retention in order to make recommendations that will help undergraduates complete STEM majors. Many research and support systems are in place in the higher education institution; however, for students to reach out for that support, ask for help from their peers and professors, and get involved in extracurricular activities ties back to connection and relationships. The researcher completed her master's and doctoral degree at Concordia University Irvine, a small private university. Her own experiences regarding building a connection, spending time with their professor, and feeling connected to the environment also align with this study's findings.

This research found a significant correlation: Students who are involved in sports have a higher chance of completing the STEM major they started. Moreover, if students are part of a study group or if students are able to spend time with their professor outside of the classroom, they feel connected to the environment and feel like they belong. Magdalen was one of the students who said she could not connect with her peers and professors, and she felt incompetent to complete her STEM major. This is how she expressed her struggle:

> When I entered college, I started off as the math for education major. And so, I was hoping to complete the math major, maybe do just applied math, but either way, I wanted to stay with math and teach afterward. And, well, I think during my second year was when I decided that I needed to switch out of the math major because I was scared that I would actually get kicked out because I was doing pretty poorly in my classes. And so, I tried a different, a bunch of different majors. I ended up sticking with philosophy, I think, because it's kind of like math, in some ways, like, there's like logic aspects to philosophy. The community of philosophy students was a bit nicer than the math community. So that's where I am right now. (Magdalen N, Personal Communication, March 2021)

When the researcher asked Magdalen, a senior, how she reflected on the decision she had made to change her major during her freshman year, her response was heartbroken, but also summarized the statistically significant findings from this research and Tinto's theory. Magdalen cited a lack of support from the STEM community, saying her professors weren't very helpful, and her peers made disparaging remarks about her ability to grasp the material. Ultimately, she felt like she didn't belong at that school or in the math major (Magdalen N, Personal Communication, March 2021).

All the findings from this research show the importance of connection, building relationships and creating a community where students feel like they belong, they matter, and they can achieve their dreams in college. This collective work starts from the students' secondary education teachers and extends to advisors and role models to support students, help them get involved in extracurricular activities, and create pathways for them to be involved in sports to gain skills. These suggestions will help them retain their STEM majors and beat the statistics to have a higher retention outcome.

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APPENDICES

Appendix A: Research Instrument

College Retention Students Survey

INTRODUCTION: This study is designed to investigate college retention and is being conducted by Hulya S. Odabas, M.A. under the supervision of Dr. Eugune Kim, Professor, Educational Leadership School of Education at Concordia University Irvine. This study has been approved by the Institutional Review Board of Concordia University Irvine.

PURPOSE: The primary purpose of this mixed-methods phenomenological study was to examine the factors that influence students' persistence in undergraduate STEM (Science, Technology, Engineering, and Mathematics) majors. It also aimed to determine the relationship between which factors affect the students' motivation and persistence.

DESCRIPTION: There are two parts to this study. First, all participants are asked to complete this College Retention Students survey anonymously. For the second part, those who meet the criteria (a college student who is studying a STEM major) may be asked to participate in one-on-one virtual, recorded interviews.

* Required

1. *

Mark only one oval.

( ) Ok

2. Informed Consent Statement	PARTICIPATION: Participation in this survey is completely voluntary and you must be 18 or older to take part in the survey and interviews. You have the right to refuse, withdraw, or discontinue participation at any time without any type of penalty or loss of benefits to which you are otherwise entitled. ANONYMITY: Your responses to this survey will be recorded by an on-line survey, and your personal or identifiable information will be kept strictly confidential. Anonymity will be provided, so your responses or your participation will never be associated or connected to you. This survey will be conducted with the highest level of professionalism and ethics, there will be no dissemination of the data. After the study is completed the data will be safely stored in a password-protected, secured, and safe environment for a period of 5 years. RISKS: There are no foreseeable risks or discomforts to you associated with this survey; however, some of the questions may bring up some memories that could be associated with negative experiences or unpleasant episodes in your life.

2. Participant Consent *

Mark only one oval.

- YES, I have read the above information and agreed to participate in this study. I am at least 18 years of age.
- NO, I do not want to participate at this time.

Section 3

Please complete the demographic portion of this survey before beginning. If any question makes you uncomfortable you may leave it blank.

3. Gender

Mark only one oval.

- ◯ Female
- ◯ Male
- ◯ Other: ______________________

4. How would you describe your ethnicity? *

Mark only one oval.

- ◯ African American
- ◯ Asian
- ◯ Hispanic or Latino
- ◯ White
- ◯ Other: ______________________

5. What is your age?

____

6. What is the highest level of education your father completed?

Mark only one oval.

- ( ) Elementary school
- ( ) Junior High/Middle School
- ( ) High School/ GED/ HS Equivalency
- ( ) Vocational/Technical/Associates Degree
- ( ) Bachelors degree
- ( ) Masters degree
- ( ) Doctorate

7. What is the highest level of education your mother completed?

Mark only one oval.

- ( ) Elementary school
- ( ) Junior High/Middle School
- ( ) High school
- ( ) Vocational/Technical/Associates Degree
- ( ) Bachelors degree
- ( ) Masters degree
- ( ) Doctorate

8. What is your family's total annual income? (Round to the nearest $10,000)

6. What is the highest level of education your father completed?

Mark only one oval.

- Elementary school
- Junior High/Middle School
- High School/ GED/ HS Equivalency
- Vocational/Technical/Associates Degree
- Bachelors degree
- Masters degree
- Doctorate

7. What is the highest level of education your mother completed?

Mark only one oval.

- Elementary school
- Junior High/Middle School
- High school
- Vocational/Technical/Associates Degree
- Bachelors degree
- Masters degree
- Doctorate

8. What is your family's total annual income? (Round to the nearest $10,000)

The Rigor of Pre-College Courses

9. What year did you graduate from high school?

____

10. Name of high school, City, and State?

____

11. Which math courses did you complete in high school? Check all that apply.

Check all that apply.

- [ ] Algebra I
- [ ] Geometry
- [ ] Algebra II
- [ ] Precalculus
- [ ] Calculus
- [ ] Statistics
- [ ] AP Calculus AB
- [ ] AP Calculus BC
- [ ] AP Statistics

Other: [ ] ________________________________

12. Which science courses did you complete in high school? Check all that apply.

Check all that apply.

- [ ] Biology
- [ ] AP Biology
- [ ] Chemistry
- [ ] AP Chemistry
- [ ] Physics
- [ ] AP Physics 1
- [ ] AP Physics 2
- [ ] Anatomy/Physiology
- [ ] AP Anatomy
- [ ] Environmental Science
- [ ] AP Environmental Science

Other: [ ] ________________________________

13. Which technology courses did you complete in high school? Check all that apply.

Check all that apply.

- [ ] Computer Science
- [ ] Computer Technology
- [ ] AP Computer
- [ ] Information Technology
- [ ] Biomedical Technology
- [ ] Engineering and Technology
- [ ] Robotics Technology
- [ ] Automotive Technology

Other: [ ] ____________________

14. To what extent would you agree that your high school offered rigorous:

Mark only one oval per row.

	1-Completely Disagree	2	3-Neutral	4	5-Completely Agree
Mathematics Classes	◯	◯	◯	◯	◯
Science Classes	◯	◯	◯	◯	◯
Technology Classes	◯	◯	◯	◯	◯

15. To what extent would you agree with the following statements?

Mark only one oval per row.

	1-Completely Disagree	2	3-Neutral	4	5-Completely Agree
Math is my favorite subject					
Science is my favorite subject					
Technology is my favorite subject					

16. Please indicate your level of agreement with the following statements in regards to your high school experience.

Mark only one oval per row.

	1-Completely Disagree	2	3-Neutral	4	5-Completely Agree
I had a positive social environment					
I had access to internships and research opportunities					
I had teachers that looked like me					
I had peers that looked like me					
I experienced or witnessed discrimination					

17. To what extent would you agree that the following affected your success in high school?

Mark only one oval per row.

	1-Completely Disagree	2	3-Neutral	4	5-Completely Agree
Social Environment	⬭	⬭	⬭	⬭	⬭
Grades	⬭	⬭	⬭	⬭	⬭
Parents	⬭	⬭	⬭	⬭	⬭
Other Family Member	⬭	⬭	⬭	⬭	⬭
High School Teacher	⬭	⬭	⬭	⬭	⬭
High School Counselor	⬭	⬭	⬭	⬭	⬭
Friend/Peer	⬭	⬭	⬭	⬭	⬭
Role Model/Mentor	⬭	⬭	⬭	⬭	⬭

18. What STEM clubs or organizations did you participate in while in high school? If none please skip to the next question.

____

____

____

19. Please list any summer enrichment programs you participated in while in high school. If you did not participate please skip to the next question.

20. What was your high school overall GPA? (Approximate)

21. What was your ACT and/or SAT test score?

College Experience

22. Name of College or University, City, and State? *

23. College class standing *

Mark only one oval.

- ( ) Freshman
- ( ) Sophomore
- ( ) Junior
- ( ) Senior

24. What is your undergraduate major now?

____

25. What was your undergraduate major you first declared?

____

26. How many times have you changed majors?

Mark only one oval.

- ( ) Have not changed
- ( ) 1
- ( ) 2
- ( ) 3
- ( ) Other: ____________________

27. What is your agreement with the following sentences?

Mark only one oval per row.

	1- Completely Disagree	2	3- Neutral	4	5- Completely Agree
I socialize with friends at least once a week on campus outside the classroom	⬭	⬭	⬭	⬭	⬭
I interact with faculty/professor at least once a week outside the classroom	⬭	⬭	⬭	⬭	⬭
I volunteer at campus events	⬭	⬭	⬭	⬭	⬭
I am a member of a club on campus	⬭	⬭	⬭	⬭	⬭
I am a member of a sports club on campus	⬭	⬭	⬭	⬭	⬭

28. If you are currently studying in STEM major, please continue to the next section *

Mark only one oval.

- ⬭ Yes, I am a college student and majoring STEM (Science, Technology, Engineering and Mathematics)
- ⬭ No, my college major is not STEM (Science, Technology, Engineering and Mathematics) *Skip to question 39*

STEM (Science, Technology, Engineering and Mathematics) Major

29. Who influenced you to pursue a STEM (Science, Technology, Engineering, and Mathematics) major?

Mark only one oval per row.

	1-Completely Disagree	2	3-Neutral	4	5-Completely Agree
Peers	⬭	⬭	⬭	⬭	⬭
Parents	⬭	⬭	⬭	⬭	⬭
Teacher/Instructor	⬭	⬭	⬭	⬭	⬭
Counselor/Advisor	⬭	⬭	⬭	⬭	⬭
Role Model/Mentor	⬭	⬭	⬭	⬭	⬭
Film/Book Character	⬭	⬭	⬭	⬭	⬭
Other Family Member	⬭	⬭	⬭	⬭	⬭

30. What is your agreement with the following sentences?

Mark only one oval per row.

	1- Completely Disagree	2	3-Neutral	4	5-Completely Agree
I am part of the study group	⬭	⬭	⬭	⬭	⬭
I have close friends	⬭	⬭	⬭	⬭	⬭
I feel I am part of the STEM community	⬭	⬭	⬭	⬭	⬭
I socialize with friends at least once a week	⬭	⬭	⬭	⬭	⬭
I read STEM related journals outside of school work	⬭	⬭	⬭	⬭	⬭

31. The primary reason I choose a STEM Major

Mark only one oval per row.

	1-Completely Disagree	2	3-Neutral	4	5-Completely Agree
Personal Satisfaction/ Happiness	◯	◯	◯	◯	◯
Financial Wealth/Stability	◯	◯	◯	◯	◯
Recognition	◯	◯	◯	◯	◯
Social Acceptance	◯	◯	◯	◯	◯
To Make the World Better Place	◯	◯	◯	◯	◯
To Please my Family	◯	◯	◯	◯	◯
To Prove Others Wrong	◯	◯	◯	◯	◯
Moral/Ethical Concerns	◯	◯	◯	◯	◯

32. I am thinking about changing from my STEM major to a different STEM major

Mark only one oval.

	1	2	3	4	5	
Completely Disagree	◯	◯	◯	◯	◯	Completely Agree

33. I am thinking about changing from my STEM major to a non-STEM major

Mark only one oval.

	1	2	3	4	5	
Completely Disagree	⬭	⬭	⬭	⬭	⬭	Completely Agree

34. The likelihood that I will change my major to a non-STEM major by the time I graduate is ________ %

____

35. Describe why someone you know dropped out of STEM during or after college. (Approximately 100 words or less).

____

____

____

36. What advice would you give to high school students who were considering a majoring in STEM? (Approximately 100 words or less).

____

____

____

37. Would you be willing to participate in a follow-up one-on-one interview? (All participants who completed one-on-one interviews will receive a $20 gift card)

Mark only one oval.

- Yes
- No *Skip to question 39*

38. If you answered yes, please enter your name, email address, and phone number.

____

Gift Card

39. Would you like to enter a chance to earn one of the ten $15 Amazon Gift Card? If yes, please enter your email address below.

____

Appendix B: Interview Questions

1. What led you to pursue a major in STEM?
2. What has been the greatest challenge that you have had to overcome to continue in the STEM major?
3. Describe the encouragement and discouragement you received to pursue a career in STEM.
4. Did anyone or anything open your eyes to the possibilities of STEM at any time during your primary or secondary education? Describe the event.
5. What costs or sacrifices did you associate with a STEM major as you were making that choice? Why did you still choose STEM?
6. Describe someone who influenced you to pursue a STEM major
7. What advice would you give to high school students who were considering majoring in STEM? Why?
8. What kind of things used by your college instructors helped or not helped you to succeed in your college courses?
9. Describe a barrier you had to overcome to get to where you are now in your college journey.
10. What types of faculty support are most helpful to your success in STEM courses? How or why are they helpful?

Appendix C: Survey Consent Form

INFORMED CONSENT: RETENTION OF COLLEGE STUDENTS IN STEM MAJORS

The study in which you are being asked to participate is designed to investigate to understand the factors that influence the retention of college students in STEM fields. This study is being conducted by Hulya Sarah Odabas under the supervision of Dr. Eugene Kim, Dissertation Chair, Concordia University Irvine, School of Education. This study has been approved by the Institutional Review Board, Concordia University Irvine, in Irvine, CA.

PURPOSE: The primary purpose of this study was to examine the factors that influence students' persistence in undergraduate STEM majors.

PARTICIPATION: Participation in this survey is completely voluntary. You have the right to refuse, withdraw, or discontinue participation at any time without any type of penalty or loss of benefits to which you are otherwise entitled.

Your responses to this survey will be recorded by an on-line survey, and your personal or identifiable information will be kept strictly confidential. Anonymity will be provided, so your responses or your participation will never be associated or connected to you. This survey will be conducted with the highest level of professionalism and ethics, there will be no dissemination of the data. After the study is completed, the data will be safely stored in a password-protected, secured, and safe environment for a period of 5 years.

DURATION: The participant should expect to spend between 15 to 30 minutes completing the survey.

RISKS: There are no foreseeable risks or discomforts to you associated with this survey, however, some of the questions may bring up some memories that could be associated with negative experiences or unpleasant episodes in your life. The risk of confidentiality breach is always there, due to the evolving and unstable environment associated with electronic data security, and theft.

BENEFITS: When you complete the survey, you'll enter a raffle to win one of 10 $15 Amazon gift cards. The winning participants will receive an email to claim a $15 Amazon e-gift card which will be sent to the participants' email. The researcher will be responsible for randomizing the winners and sending the incentive. The researcher will be using Woobox's "Pick a Winner" tool to draw raffle winners. Your participation also will be a potential direct contributor to bringing diversity and equity to the College STEM major and eventually in the STEM workforce.

VIDEO/AUDIO/PHOTOGRAPH: Only those who voluntarily participate in the one-on-one interviews will be recorded. These videos will be safely stored in a password-protected, secured, and safe environment for a period of 5 years.

CONTACT: If you have any questions or would like additional information about this study please contact Dr. Eugene Kim, Eugene.Kim@cui.edu. A copy of this form will be given to you if you wish to keep it. The CUI Institutional Review Board has approved this project. You may contact the CUI Board with any questions, irb@cui.edu.

CONFIRMATION STATEMENT: I have read and understood the consent document and agree to participate in your study.

YES ________ NO ________

Appendix D: IRB Approval Email

CONCORDIA UNIVERSITY IRVINE

INSTITUTIONAL REVIEW BOARD (IRB) DECISION FORM

Review Date January 25, 2021
Reviewer ID# **Reviewer 162506**
Category ☒ Expedited Review 45 CFR 46.110
☐ Full Board Review 45 CFR 46

IRB Application	# 5845
Title of Project	**Retention of college student in STEM majors; Student involvement, persistence and challenges**
Principal Investigator Name (PI)	**Hulya Sarah Obabas**
PI Email (use CUI email, if applicable)	**Hulya.obabas@eagles.cui.edu**

DECISION

☒ **Approved**

Effective duration of the IRB Approval: _1/_22/_2021 to _1/22/_2022__

For Expedited and Full Board Approved, Please Note:

a. *The IRB's approval is only for the project protocol named above. Any changes are subject to review and approval by the IRB.*
b. *Any adverse events must be reported to the IRB.*
c. *An annual report or report upon completion is required for each project. If the project is to continue beyond the twelve month period, a request for continuation of approval should be made in writing. Any deviations from the approved protocol should be noted.*

☐ **Needs revision and resubmission**

☐ **Not approved**