8-2023

Forecasting Retention Among At-Risk College Freshmen Students Through Completion of a STEM Intervention

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FORECASTING RETENTION AMONG AT-RISK COLLEGE FRESHMEN STUDENTS THROUGH COMPLETION OF A STEM INTERVENTION.

A Dissertation

by

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Submitted in Partial Fulfillment of the

Requirements for the Degree of

DOCTOR OF EDUCATION

Major Subject: Educational Leadership

The University of Texas Rio Grande Valley

August 2023

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August 2023

ABSTRACT

Orozco, Edna, Forecasting Retention Among At-Risk College Freshmen Students Through Completion of a STEM Intervention. Doctor of Education (Ed. D), August, 2023, 151 pp., 12 tables, 4 figures, references, 117 titles.

Science, Technology, Engineering, and Mathematics (STEM) areas are one of the fastest-growing majors in the nation, engineering, is projected to add the second largest number of new jobs from 2016 to 2026 with 140,000 new jobs (Torpey, 2018). Unfortunately, there is a disparity between enrollment and graduation rates (Chen, 2015; Lucas & Spina, 2022). According to the National Center for Education Statistics (NCES) (2017) despite all the research done throughout decades to improve the issue of retention in STEM areas about half of the students who pursue a degree in Science, Technology, Engineering, or Mathematics (STEM) will either leave or change majors. There are still high attrition rates and underrepresentation of Hispanics, minorities, women, and those vulnerable populations in STEM education and the workforce. The STEM labor force represents 23% of the total U.S. labor force, with higher proportions of men (Chen, 2012, 2013; Lukas & Spina, 2022; National Science Board, 2020).

There are few studies done on STEM interventions for at-risk college freshmen students (Hite & Spott, 2022; Reena, 2018; Tomasko et al., 2016). This study aimed to sample at-risk college freshmen students from the College of Engineering & Computer Science, to describe and explain the association between retention after the first year of at-risk college freshmen students

in a STEM program and completion of a STEM intervention. The second purpose of this study was to identify find the reasons STEM students decided to stay in the program after completing a STEM intervention. The third purpose was to identify how to improve the STEM intervention.

This study consisted of mixed methods of data collection. The quantitative part of the research study consisted of a group of students who have completed a STEM intervention. A Chi-square test of independence (X^2) was used to find if there was an association between the completion of a STEM intervention and the retention rate of at-risk freshmen students. The qualitative part of the research study consisted of the perceptions of at-risk college freshmen students who completed the STEM intervention shared in a focus group interview. These students were asked to provide information about why they decided to continue in the STEM program after completing the STEM intervention. They were also asked to provide information about how to improve the STEM intervention. The qualitative approach was to provide an opportunity to develop a deeper understanding of the impact of the STEM intervention and how to improve its construction. Additionally, the qualitative information would better inform the development of a sense of belonging to comprehend what motivated students to remain in the STEM program.

The hypothesis of this study was to identify if there is an association between students who completed the STEM intervention and retention in the engineering program. This hypothesis uses an alpha of 0.05 to determine whether to reject it or fail to reject it.

DEDICATION

In dedication to
My mom Irene Lopez,

and my daughters Renata and Regina C. Leonhardt

the motors of my life.

To my family, friends, and coworkers

who provided support in this journey

Thank you! Gracias! Danke!

ACKNOWLEDGMENTS

I would like to offer acknowledgment to Dr. George Padilla, dissertation chair and mentor, as well as committee members, Dr. Michelle Abrego, Dr. Alejandro Garcia, and Dr. Ralph Carlson. Thank you for your guidance and support throughout this process.

I also want to acknowledge those who have been key to this journey. Rene Leonhardt, thank you for your support and love. Dr. Ala Qubbaj and Dr. Nambiar, thank you for your advice and support. I could have never imagined myself in this field and honestly, without your guidance, I would have never shifted degrees. I am grateful for the professional support as well. It is not easy to find a supportive boss who pushes you to grow, and for that I am thankful.

Amigas Leticia Ocanas, and Elizabeth Rodriguez, you were there through thick and thin, Gracias por estar ahi. Dr. Arturo Fuentes and Dr. Noe Vargas, thank you for your advice and support during the STEM intervention and outside of it. Sister, Lesly Orozco. Thank you for being there and providing a shoulder on this lonely journey (TQM). Mama, te quiero mucho. Y tu siempre has sido una persona muy especial en mi vida. Le doy gracias a Dios por darme la oportunidad de compartir estos logros contigo.

I also want to also say Thank you to the "GT" group of students who provided guidance and support, you guys were the ones understanding the struggles we faced as doctoral students. Thank you, Yadira Mejia, Alejandro Carranza, Francisco Rios, Alma Perez, and Susana Arredondo. Cohort 7 all the way!

Thanks to each and every one of you, I could not have done this without you.

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CHAPTER I

INTRODUCTION

Despite the rapid growth of student enrollment at university programs and student graduation rates and ample opportunities in the workforce for college graduates, there is still a need to increase the number of students entering, graduating, and working in Science, Technology, Engineering, and Mathematics (STEM) fields, especially minority groups such as Hispanics (Archer et al., 2012; National Science Board, 2020; Ruarte, 2018). Even though students enroll in STEM programs at universities, there is a high probability that minority groups, during the first semester or first year of school, will decide to drop out or change majors for varied reasons (Chen & DesJardins, 2010; Chen 2015; Kena et al., 2013, Lucas & Spina, 2022). Despite decades of research towards the retention of students in STEM programs, there is little research related to interventions at the university level, especially interventions that aim to help minority groups (Davis & Finelli, 2007; Hite & Spott, 2022; Reena, 2018; Tomasko et al., 2016).

The purpose of this study was to identify if there is a significant difference in engineering program retention between at-risk college freshmen engineering students who complete a STEM intervention and similar students who do not complete a STEM intervention, and as perceived by these engineering students who completed the intervention, find out how does a STEM intervention impact engineering program retention along with ways to improve the STEM intervention to support engineering program retention. The characteristics of at-risk college freshmen students in this research study are students who did not meet the University of Texas Rio Grande Valley (UTRGV) admission requirements. UTRGV is designated a Hispanic-Serving Institution (HSI) located in the Rio Grande Valley in South Texas near the US-Mexico border. Latino(a) students, especially those in the Rio Grande Valley, face unique challenges like education in proximity to family, cost of education, and employment opportunities (Avila & Pankake, 2016; De la Trinidad et al., 2017). Students at Hispanic-Serving institutions also face limited resources while attending higher education (Cortez, 2011). At UTRGV, at-risk college freshmen students are those who score below UTRGV's ACT and high school rank admission standards. UTRGV's complete admission requirements are the following:

1. Average ACT 19.74
2. Average SAT 1030
3. 46% Rank in the Top 25% of Class
4. 64.5% Begin UTRGV with Prior College Hours

(UTRGV Strategic Enrollment & Student Affairs, 2021)

Statement of the problem

Student retention has been studied for years, although it initially started as an area analyzed through psychology (Tinto, 2006). A significant number of university students drop out in their freshmen year (Jeno et al., 2018), possibly because students vary in their readiness for college (Komarraju et al., 2013). The results of the many decades of studies completed on this issue have concluded that many factors affect attrition rates, graduation rates, and student enrollment (Chen & DesJardins, 2010; Chen, 2015; Chen et al., 2020; Cooper, 2011). Low retention rates especially impact minority groups, including Hispanics who are underrepresented in STEM college programs and also in the STEM workforce sector (Davis & Finelli, 2007; Chen & DesJardins, 2010; Chen 2015; Kendricks et al., 2013, Lucas & Spina, 2022).

Studies have found academic performance, and retention rates correlate to the academic success of students, but they have also found that grades alone are not effective motivators to improve performance in a program (Anderson, 2014; Koretz et. al, 2016; Thompson & Bolin, 2011). STEM interventions have been used to support retention of STEM college students, but studies focused on their impact are few or very specific (Reena, 2018; Tabacchi, 2017, Tomasko et al., 2016). Moreover, Ayuk and Jacobs (2018) state that there seems to be a gap between what higher education institutions are saying, and what they are doing to help students achieve graduation. The retention rate of students adds doubt to how well higher education institutions are fulfilling their purpose to fully prepare students to succeed and graduate with a degree (Ayuk & Jacobs, 2018). According to the UTRGV Strategic Enrollment & Student Affairs (2023), the expected retention rate at the UTRGV College of Engineering and Computer Science (CECS) for the academic year Fall 2020-Spring 2021 for all freshmen students was:

1. fulltime students 3718/4852 = 76.6%
2. part-time students 321/486 = 66.1%
3. overall, 4039/5338 = 75.7%

For the academic year 2021-2022, CECS first year student's expected retention was:

1. fulltime students 3329/4241 = 78.5%
2. part-time students 695/1198 = 58.0%
3. overall, 4024/ 5439 = 74.0%

A majority of students enrolled in the CECS are considered at-risk students (Marquez et al., 2022). Yet, UTRGV Strategic Enrollment & Student Affairs (2023) has no retention data on

CECS at-risk freshmen students. This study aims to sample at-risk college freshmen students from the CECS to examine if an association exists between completion of a STEM intervention and retention after the first year of at-risk college freshmen students in a STEM program. The second purpose of this study is to identify the reasons STEM students decided to stay in the program after completing a STEM intervention. The third purpose is to identify suggestions from students who completed the STEM intervention on how to improve the STEM intervention.

Need for the Study

Having high school students drop out of school creates a community that lacks a well-educated population and, as a result, not only is the student affected but also the community itself (Leppel, 2001). It is important to be concerned about students failing or not finishing their university degrees. Brekke (2014) reported that youths who drop out of school have a lower probability of being employed than school completers, and these results are even more significant for immigrant and minority youth than for white youth.

STEM occupations include computer, mathematical, architecture and engineering, life, and physical science occupations as well as managerial and postsecondary teaching occupations related to these functional areas, and sales occupations requiring scientific or technical knowledge at the postsecondary level (U.S. Bureau of Labor Statistics, 2022). These occupations are considered high contributors to global competitiveness; therefore, it is important to continue researching and improving the retention rate of freshmen college students in STEM education, especially in the community where we know students are at risk of a higher attrition rate (Chen, 2012; National Science Foundation 2007; U.S. Bureau of Labor Statistics, 2022).

The lack of diversity and underrepresentation of minorities, especially Hispanics in education and the STEM workforce, is concerning, not only for the STEM careers but also for the growth in global leadership and the global economy for our nation (Bowman & St. John, 2011). Producing enough numbers of graduates who are prepared for STEM occupations has become a national priority in the United States (Chen, 2015; The White House, 2016; The White House, 2022). However, this priority will not be met with high attrition rates in STEM university programs (U.S. Bureau of Labor Statistics, 2022).

Theoretical Framework

Student success is identified by the fulfillment of certain expectations often used as a metric for an institution's performance (Alyahyan & Düştegör 2020). Student success is considered a crucial component in higher education institutions (Alyahyan & Düştegör 2020). Student success is defined as

> "Academic achievement, engagement in educationally purposeful activities, satisfaction, acquisition of desired knowledge, skills and competencies, persistence, attainment of educational outcomes, and post-college performance (Kuh et al., 2006, p. 5)."

Student success can be achieved through academic achievement support, feedback, resources available, and other factors (Tinto, 2010). Students and faculty need to develop well-rounded relationships and communication; however, it is the duty of the faculty to foster these relationships (Khan, 2015). It is also important to provide an environment of academic and social support systems to foster student growth and create a sense of involvement and engagement not only in their program of education but also at the institution (Tinto, 2010; Abrica et al., 2022). Students who learn in this supportive environment develop self-efficacy which ultimately sets them up for success in their academic and social structure (Tomasko et al., 2016). STEM intervention programs aim to create an environment of preparedness and a sense of belonging by:

1) Helping students with feedback on their performance,

2) Creating opportunities to interact and engage with other students, mentors, and faculty,
3) Promote the use and awareness of academic support at the institution. (Hoffman et al, 2016).

Hence, STEM interventions can help to create a sense of clarity for academic expectations, learning communities for students, and exposure to challenges and stressors among other factors that promote a sense of belonging and ultimately student success. Research has shown STEM interventions have a positive impact on student retention (Hoffman et al, 2016; Tomasko et al., 2016; Strayhorn, 2012). The theoretical framework used for this research study is based on the sense of belonging by Baumeister and Leary (1995).

The College of Engineering & Computer Science (CECS) at UTRGV, aside from STEM intervention, has also implemented other initiatives to increase, retain, and graduate students in STEM-related disciplines by promoting student-centered programs such as mentoring, coaching, and professional development (Marquez et al., 2022).

Purpose of the study

The purpose of this study was to sample at-risk college freshmen students from the UTRGV College of Engineering & Computer Science to describe and explain the association between retention after the first year of at-risk college freshmen students in a STEM program and completion of a STEM intervention. Mills and Gay (2019) suggest that in order to determine whether the association happens it is important to collect data by setting variables on the basis of the rationale suggested by theory. A second purpose of this study was to identify the reasons STEM students decided to stay in the program after completing a STEM intervention. Finally, the third purpose was to identify how to improve the STEM intervention. These two purposes were investigated through a qualitative study. The qualitative study was crucial to understand these reasons and ultimately complement the quantitative research study.

Significance of the study

The U.S. science and engineering workforce is critical to the United States to remain competitive as a global economy and sustain the capability to continue technological and innovative advancements (Varma & Freehill, 2010). STEM occupations are considered high contributors to global competitiveness, and communities, and the U.S. may be impacted by having an increase in professionals in this area (Hira, 2010). Therefore, it is important to continue researching and improving the retention rate of college students in these areas, especially in the Rio Grande Valley which in includes a high proportion of Hispanics, because we know Hispanic students are at risk of a higher attrition rate (Ruarte, 2018). Several stakeholders may benefit from this study: students enrolled in a STEM program, communities with at-risk students, Hispanic Serving Institutions (HSI), and the STEM workforce. These benefits are especially true because STEM occupations have been described as the highest paying, fastest growing, and most influential in driving economic growth and innovation in the United States (Thomasian, 2011). Critically, identifying potential improvements to STEM intervention will support universities in effectively allocating their resources and increasing the quality of the future lives of their students, families, and communities.

Research questions

The following research questions will be used to guide the researcher in the proposed study.

RQ1: Is there an association between the retention rate of at-risk college freshmen UTRGV CECS students who complete a STEM intervention and similar students who do not complete a STEM intervention?

RQ2a: As perceived by at-risk college freshmen UTRGV CECS students who completed the intervention, how does a STEM intervention impact program retention?

RQ2b: As perceived by at-risk college freshmen UTRGV CECS students who completed the intervention, how can a STEM intervention be improved to support program retention?

Definition of terms

The following terms are defined to help the reader understand the context of each term in this study:

Academic Achievement: Academic achievement is measured by the final grade earned in the course (Atchley et. al, 2013).

At-risk college freshmen students: Students who score below UTRGV's ACT admission standards, and below UTRGV high school rank admission standard (UTRGV Office of Student Success—Division of Academic Affairs, C. Saldivar, personal communication, March 03, 2023).

Student Attrition: Tinto (1975) defined student attrition as a longitudinal process of interactions between the individual and the academic and social systems of the college during which a person's experiences in those systems continually modify their goals and institutional commitments in ways which lead to persistence and/or to varying forms of dropout.

Engineering Professions: Engineering managers, surveyors, aerospace engineers, civil engineers, computer and hardware engineers, electrical engineers, industrial engineers, mechanical engineers, drafters, and engineering technicians (United States Census Bureau, 2016).

Graduation Rate: School's percentage of first-time, first-year undergraduate students who complete their program within 150% of the published time for the program. For example, for a four-year degree program, entering students who complete within six years are graduates. (FAFSA, 2023).

Retention: It is a school's percentage of first-time, first-year undergraduate students who continue at that school the next year. For example, a student who studies full-time in the fall semester and stays in the program the next fall semester is part of this rate (FAFSA, 2023).

Science, Technology Engineering, and Math (STEM): STEM is often used interchangeably with Science, Engineering, and Technology. Medical professionals are often not included in estimates of the scientific and engineering fields (National Science Board [NSB], 2020).

STEM Intervention Programs: According to Rincon and George-Jackson (2016) STEM intervention program, as defined by the United States Government Accountability Office, includes one or more of the following objectives:

1. Attract or prepare students to pursue classes or coursework in STEM degrees
2. Provide undergraduate or graduate training in STEM
3. Attract graduates to pursue STEM careers
4. Increase the ability of K-12 or postsecondary institutions to promote education in the STEM fields.

Science Professions: Life scientists, physical scientists, social scientists, natural science managers, scientific research, and development services (United States Census Bureau, 2016).

Technology Professions: Computer systems design and related services, computer specialists, software publishers, computer and peripheral equipment manufacturing, Internet service providers, data processing, hosting, and related services, Internet publishing, and broadcasting (United States Census Bureau, 2016).

Conclusion

Chapter One explains why it is important to focus on closing the gap between student enrollment and graduation rates by retaining those students who are considered at-risk, especially in the STEM areas. Specifically, there is a need for representation in STEM areas not only in education but also in the workforce to maintain our nation's international status as a leader. A group of students who completed a STEM intervention will be compared to a group of students who did not complete a STEM intervention to analyze whether there is an association between student retention and completion of a STEM intervention. A focus group of students will also be organized and interviewed to discuss how the STEM intervention supported their retention and how to improve the STEM intervention.

Chapter Two will present a literature review supporting the impact of college education on the lives of Americans, identify the international status of the United States in innovation and technology, provide the college graduation rates of various social groups, and review past research related to STEM intervention and retention.

CHAPTER II

LITERATURE REVIEW

The purpose of this chapter was to review the research literature about the retention of at-risk college freshmen students in a STEM program along with how STEM interventions impact the student's decision to continue or drop a STEM program. The literature review is divided into three sections. Section One reviewed the literature related to the need of having student representation in the STEM areas and why it is important for our nation to focus on this area of education. Section Two described student academic performance and retention rate during the first year at a university. Section Three focused on STEM interventions, especially the STEM intervention at the University of Texas Rio Grande Valley for engineering freshmen and at-risk college students which will be the focus of the study (Chen, 2012; Kuenzi, 2008; Reason, 2009).

The Importance of Science, Technology, Engineering, and Mathematics (STEM) Education in the United States

STEM field plays a crucial role in our nation because it brings minds to the levels of critical thinkers and innovators, especially now when we live in a globally connected, technology-driven world. In the last decade, the United States has been looking to increase the number of skilled STEM workers because STEM areas promote critical thinking, science literacy, and innovation (Eberle, 2010; Handelsman & Smith, 2022; Altman & Bastian, 2021). In a globally connected technology-driven world, it is important to promote those careers that will eventually support the need for connectedness. Students in STEM develop skills that allow them to become critical thinkers, solve problems and observe the work scientifically. Why is globalization important? Globalization measures the country's integration with the rest of the world (Altman & Bastian, 2021). The factors measured in globalization constitute.

1. Trade: Merchandise trade (imports & exports), services trade
2. Capital: Investments, stocks, portfolio equity stocks, portfolio equity flows
3. Information: Telephone calls, scientific research collaboration, internet, trade in printed publications.
4. People: tourists, university students, migrants, faculty, and researchers (foreigners born population)

(Altman & Bastian, 2021)

It is known that STEM careers are among the highest-paying occupations aside from being the fastest growing and most influential in driving economic growth and innovation (U.S. Bureau of Labor Statistics, 2022; Knox, 2023; Thomasian, 2011). STEM fields are considered more lucrative majors because they are often awarded a higher salary than less technical majors, such as liberal arts (Knox, 2023). An entry-level STEM position has a higher salary compared to a non-STEM position 55,000 compared to 33,000 (Okrent & Burke, 2021) According to Krutsch & Roderick (2022) 93 out of 100 STEM occupations had wages above the national average. The national average wage for all STEM occupations was $87,570, nearly double the national average wage for non-STEM occupations which averages $45,700. Why is the nation pushing for STEM workers and students? The United States has one of the lowest rates of STEM to non-STEM degree production in the world (Kuenzi, 2008) These STEM workers and students will be the ones who will drive innovation and competitiveness in the United States to higher levels compared to other countries (Khan, 2015). Employment in STEM occupations grew by 10.5%, or 817,260 jobs, between May 2009 and May 2015, compared with the 5.2% net growth in non-STEM occupations (Fayer et al., 2017). STEM workers will not only work on innovation but also will generate new ideas, new companies, and ultimately new industries in our nation (Khan, 2015). STEM innovators support the United States into being one of the nation's leading the world economically and scientifically due to the advances in science and technology (Goldin & Katz, 2008; Xie & Killewald, 2012). Employment in STEM occupations is projected to increase by 12.5% from 2014 to 2024, and due to its large employment size, this growth is expected to result in nearly half a million new jobs. The group projected to add the second largest number of new jobs from 2014 to 2024 is engineering occupations, with 65,000 new jobs (Fayer et al., 2017).

Although resources and opportunities have become available for STEM fields, research studies have shown that the demand is not being met in the STEM area, and skilled professionals are still needed (Thiel et al., 2008). The lack of representation in the STEM field has created a decline in the U.S. lead compared to other nations (Hossain & Robinson, 2012). In recent decades, educational standards, innovations, and global activity have declined in the U.S., while other nations have improved significantly and ultimately have worked towards becoming better represented in the STEM field (Johnson, 2012). Hence, Biden Administration announce in 2022 the effort to expand STEM opportunities. The aim is to provide access to STEM educational opportunities and resources as a national priority in the United States (Riddell, 2022). The current administration is working toward several initiatives that will empower and train the next generation of innovators (Riddell, 2022). Some of the initiatives in place are:

1. NASA Community Anchor awards program to increase local access to STEM with NASA content for those underserved and underrepresented.
2. Robert Noyce Teacher Scholarship Program to recruit, retain and prepare science and math teachers.
3. $10 million partnership between the Micron Foundation and the National Science Foundation to accelerate the preparation, training, and retention of STEM teachers
4. Implementing and scaling equitable STEM education opportunities from pre-K to higher education.

   Collaboration between the Smithsonian Science Education Center and experts nationwide on improving universal design for learning in K-12 STEM classrooms to ensure equitable access and support for students with disabilities.

   (Riddell, 2022)

These initiatives are led by the American Association for the Advancement of Science and the Doris Duke Charitable Foundation with an investment of $1.2 billion focusing on student attrition from STEM fields and increasing STEM retention to produce STEM professionals to contribute substantially to the STEM workforce (Riddell, 2022).

According to Krutsch & Roderick (2022) nearly 10 million Americans work in STEM occupations and is projected to grow by almost 11% by 2031, over two times faster than the total of all occupations in the nation, and yet, higher education students entering STEM programs are not retained. Low STEM program retention rates create a disparity between entering STEM students and students successfully completing a STEM program (Fayer et al., 2017). The STEM field is vital to the nation because of the rise of the economy and scientific and technological innovation (Chen, 2015). Although, according to the National Science Board (2020) STEM enrollment and retention are not keeping up with the demand (Chen, 2015).

Student Academic Performance and Retention Rates

The issue of low retention of students in higher education is not only a STEM problem (Desilver, 2017). The problem starts in secondary education. The success of the U.S. education system in comparison with other countries falls short (Desilver, 2017). There are different tests applied across nations to compare the academics of different countries (Desilver, 2017). Programme for International Student Assessment (PISA) takes place every three years, and it measures reading ability math, and science (Desilver, 2017). Another assessment is the Trends in International Mathematics and Science Study (TIMSS) which is a similar cross-national assessment (Desilver, 2017). Other similar tests include: the National Assessment of Educational Progress (NAES) (Desilver, 2017) and the most recent National Assessment of Educational Progress (NAEP) (Desilver, 2017). The 2022 results from these assessments in reading ability, math, and science have dropped dramatically around the world; one of the reasons has been the impact of the global pandemic (Mervosh, 2022). However, before COVID-19 the United States was already ranked below some countries (Kena et al., 2016). According to the U.S. Department of Education National Center for Education Statistics (2018), average reading literacy scores ranged from 340 to 555, and the U.S. average reading score was 505. Compared to the 76 other national education systems in PISA 2018, the U.S. average reading literacy score was lower than the average in 8 education systems, higher than the average in 57 education systems, and not measurably different from the average in 11 education systems. In 2019, in grade 4, the U.S. average mathematics score was 535 which was higher than the TIMSS score of 500. However, fourteen education systems had higher average mathematics scores than the U.S., seven had scores that were not measurably different, and 42 education systems had lower average scores. In the U.S., the science cut score for high-performing 4th graders was 641 points, and the cut score for low-performing 4th-graders was 426 points (U.S. Department of Education, National Center for Education Statistics, 2018). In conclusion, regardless of the type of academic assessment, either PISA, TIMSS, NAES, or NAEP, the United States' academics in reading, math, and science averages lower than 14 other countries in the world (Kena et al., 2016).

Once students make it to university or college, their academic performance is reflected in retention rates (Jeno et al., 2018). Reports on dropouts in higher education suggest that 25% of students never complete their bachelor in STEM education degree. Only 43% of the students complete their degree within the stipulated time. Similar results are found in other European countries and in the United States (Jeno et al., 2018), and this may be due to college students varying in their readiness for college (Komarraju et al., 2013). First year student attrition is financially critical for the government in the United States, as state and federal governments spend billions of dollars on educating 30% of full-time first-year students seeking baccalaureate degrees who do not return for a second year (Aulck et al., 2019; Schneider, 2010). Even though the government gives financial support to improve higher education programs, the problem remains that many university freshmen students are not college-ready which creates high attrition rates among freshmen students at university (Baker & Yacef, 2009; Ergün, 2019).

High school ranking based on the grade point average (GPA) of selected courses predicts student dropping out of college, no matter the student's race, gender, or school district (Chen, 2015). However, this does not mean that students with low rankings will not be successful in STEM majors, and evidence demonstrates that along with high school GPA, placement test scores, such as the Scholastic Aptitude Test (SAT) and American College Test (ACT) assessments, are also strong indicators of success, i.e., graduating from the STEM program (Chen, 2015; Koretz, 2018; Reena, 2018; Thompson & Bolin, 2011). Research studies have shown that there is a correlation between retention rate and high school academic factors (Johnson, 2012). The higher the GPA and placement test scores, the lower the possibility of dropping out from college, and, vice versa, the lower the GPA and SAT and ACT scores, the higher the possibility of the students not graduating (Anderson, 2014; Koretz et. al, 2016; Thompson & Bolin, 2011).

As a recommendation to address academic challenges to college graduation, Sithole et al., (2017) suggest two steps. The first step is to create collaboration between higher education faculty and K-12 educators, especially in the basic skills of language proficiency and arithmetic skills, since these are the academic areas that students seem to be at greater risk. Second, universities should create a mentoring system for at-risk freshmen, also known as interventions. Colleges should review student admission and registration regularly, identify students at risk, and categorize them in probation status. These recommended sets of steps could be implemented by STEM programs in collaboration with other departments available at the university level. These collaborations can work towards ensuring that students have the support to continue their education from high school to higher education graduation.

Other factors that impact student academic performance and retention rate have to do with gender, ethnicity, socioeconomic status, and language proficiency among others. These factors define when a student falls under the category of at-risk (Han et al., 2015). According to the National Center for Education Statistics (NCES, 1992), at-risk students are those who belong to low-socioeconomic backgrounds, minority groups, whose parents are not directly involved in their education. Ultimately at-risk student experience educational failure by failing to learn while in school, or by dropping out of school altogether. In other words, an at-risk student is generally defined as a student who is likely to fail school (NCES, 1992).

UTRGV is a major Hispanic-Serving Institution (HSI), primarily a nonresidential, four-year, public institution. UTRGV's 2021 student demographics mirror those of the Lower Rio Grande Valley, with over 95% of the 32,000 students are of Hispanic or Latinx origin (Region One Education Service Center, 2021). The pool of UTRGV CECS potential students comes from economically and socially disadvantaged backgrounds. Over 97% are eligible for Title 1 programs which include free and reduced meals, with nearly 35% requiring assistance to overcome a learning disability, and nearly 40% classified as having limited English proficiency (Region One Education Service Center, 2021). Additionally, the majority of the UTRGV CECS students are first-generation college students and lack social capital—such as family and community role models, the ability to participate in extra-curricular activities due to time or financial constraints, and the mobility needed to engage in professional preparation opportunities (Avila & Pancake, 2016). Hence, there is a need to find ways to improve student retention, especially in the STEM area with the characteristics of at-risk college freshmen.

Section Three: STEM Interventions

There is an assumption that students who leave the STEM areas are weak students who cannot manage the rigor of scientific fields—as noted previously, poor educational preparation is certainly an issue (Kassaee, 2016). The issue of not completing a degree does not necessarily mean that the program was difficult. Higher education students have expressed dissatisfaction due to the curriculum offered not being relevant, faculty not providing strategies to improve students' attention towards learning, lack of resources available for students, financial aid, endowments, research funds, and structural factors (Kassaee, 2016; Sterling, 2018). Universities are working on identifying a support system for college students to address retention in the programs. These support systems are trying to address the following:

1) Knowledge and skills, academic preparation,

2) Performance capability,

3) Motivation, values, and self-concept,

4) Rewards, recognition, incentives, and

5) Tools, environment, processes,

6) Expectations and feedback.

(Araque et al., 2009; Hardy & Aruguete 2014; Reena, 2018)

The National Science Foundation has funded many programs and interventions to assure STEM recruitment and retention (Khan, 2015). STEM curriculum development, professional development, retention, and mentoring among others, are targeted areas in STEM interventions (Kuenzi, 2008). STEM interventions are designed to target the specific needs of a target population of students, resulting in a variety of program designs, purposes, and services (Rincon & George-Jackson, 2016). These intervention programs have been established not only to increase access to STEM programs but also to improve and retain those who have chosen to pursue a career in STEM, especially women, students of color, at-risk students, first-generation students, and low-income students (Rincon & George-Jackson, 2016). STEM intervention programs are unique and vary depending on the location the intervention program is established within the university, participant characteristics, funding resources available, and services offered (Rincon & George-Jackson, 2016). STEM intervention programs are varied and some of them are managed by student affairs or student services, others by academic colleges or departments, and others by hybrid efforts among various stakeholders on campus (Castro, 2014). Colquitt (2021) found that some STEM interventions include a summer component, internships, partnerships, and undergraduate research programs, and others provide STEM curricula throughout the academic year. The length of the STEM interventions also varies from a couple of hours to multiple years. Generally, the longest intervention lasts four years and the shortest intervention goes from 1.5 hours to a 2.5-hour session with students (Colquitt, 2021).

According to Building Engineering and Science Talent (BEST) (2004), agencies of the federal government recommended that universities adopt and enforce certain criteria taking diversity into account especially to nurture the talents of women, underrepresented minorities, and students with disabilities in those interventions. Seven program principles were recommended:

1. Focus on diversity in STEM leadership and faculty development.
2. Focus on integrative initiatives across multiple programs and include multiple organizations, such as professional societies and private industry.
3. Focus on identifying and strengthening transition points along STEM pathways.
4. Focus on centers of excellence that address multiple aspects of STEM pathways.
5. Focus on developing assessment methodologies and metrics to measure success.
6. Focus on the long-term sustainability of successful programs.
7. Focus on national dissemination of results from exemplary programs.

(BEST, 2004)

Other institutional factors that have been identified as potential factors associated with STEM retention are institutional climate, support, and resources for STEM interventions (Chang et al., 2011; Eagan et al., 2011; Espinosa, 2011).

Different intervention programs in higher education for students in STEM programs are identified below including the UTRGV College of Engineering STEM intervention—this study's targeted program.

The Emerging Scholars Program (ESP) is a STEM intervention used in different universities. This intervention was initiated by Uri Treisman at the University of California in the 1970s known as the Math Workshop, later renamed the Emerging Scholars Program by the University of Texas (Powell et al., 2012). In 1988 was formed by the Department of Mathematics at the University of Texas at Austin. ESP's purpose focused on increasing diversity among mathematics students, especially Latinos, and women, now the program is open to any student regardless of race (Moreno & Muller, 1999). The findings of the study showed that ESP students achieved higher calculus grades compared to a control group of students who were most likely to reenroll in a calculus class. ESP consisted of students taking a two-hour workshop three days a week, a three-hour calculus lecture, and development of a collaborative relationship through participation in small group problem-solving workshops compared to the control group, which only attended one-hour discussion sessions twice a week (Moreno & Muller, 1999).

Another ESP program is located in the Computer Science at the University of Pennsylvania Department of Computer and Information Science completing its nine iterations in 2012. This intervention focuses on peer mentors to work on computational problems and exposes students to different disciplines within computer science majors (Powell et al., 2012). Results from this intervention showed a 47% increase in enrollment in the area of Computer Science. Results reports also that students were enthusiastic and engaged to the point that they recommended the intervention to other students in their major (Powell et al., 2012).

Summer Bridge Programs (SBP) like many other STEM interventions have the purpose of assisting students to enhance their academic success and increase retention rates in higher education (Reena, 2018). The length of these programs is about 4 to 6 weeks in length, and they are hosted mainly on campus (Reena, 2018). Summer programs have shown an impact on enrollment, retention, and graduation in higher education, especially for the population of at-risk students (Reena, 2018). Tomasko et al. (2016) mixed-methods research study analyzed four different cohorts of students, participating in summer bridge programs. Students spent six weeks in an intense research program before starting their first year of school. Quantitative results showed gains in retention of students in their program, especially for African American Hispanic, Native American, first-generation college students, and females. Qualitative results were associated with improvement in college course preparation, sense of belonging, and use of academic support structure (Tomasko et al., 2016).

However, not all summer programs show the same results (Reena, 2018). An example of a summer bridge program with no academic impact is at the University of South Carolina This university opened a summer bridge program that analyzes the impact of the intervention on first-year students. Success is measured by comparing first-year fall semester GPA and end-of-first-year GPA, first-year fall semester credit hours earned compared to first-year spring semester credit hours earned, end-of-first-year credit hours earned, and retention to the second year at the university (Smith & Clayton, 2021). The program compared student success with those participants of the STEM intervention and a similar group of students who were non-participants in the STEM intervention. Results did not show any difference in academic success between participants and non-participants of the STEM intervention however, qualitative results on the research study revealed that student excitement about school for first-year students improved after participation in the summer bridge program (Smith & Clayton, 2021).

Undergraduate Research (UR) has also been considered a STEM intervention to introduce and retain students in STEM programs (Reena, 2018). According to Lopatto (2007), undergraduate research programs enhance the educational experience of undergraduates, attract, and retain talented students to careers in science, and promote pathways for minority students into science careers. Some research programs use the Survey of Undergraduate Research Experiences (SURE) funded by Howard Hughes Medical Institute as a tool for assessing undergraduate research experiences (Lopatto, 2007). 87% of 1135 students who completed an undergraduate research program continued further education in science (Loppatto, 2004). Other studies have shown that there is intellectual stimulation and personal relationship with other students, and faculty (Falconer & Holcomb, 2008).

Undergraduate Research programs generally involve students from different disciplines, who conduct independent scholarly projects with the guidance of mentors (e.g., teacher assistants, faculty, and graduate research assistants) (Bauer & Bennett, 2003; Falconer & Holcomb (2008); Loppatto, 2004; Reena, 2018). Falconer and Holcomb (2008) studied student perceptions of independence scholarly experience after completing an undergraduate research intervention. According to students' perceptions, Undergraduate Research intervention complements conventional classroom learning. The relationship between students and mentors is what makes these interventions successful. While the Undergraduate Research interventions may look impressive with their poster showcasing or end-of-the-program oral presentations, a lack of mentorship or bond between mentor and mentee may result in poor quality and a lack of student interest in continuation in higher education program (Falconer & Holcomb, 2008; Friedman et al., 2004). Undergraduate Research also contributes to the development of a higher cumulative GPA, graduation status, application, and admission to graduate programs. academic (Stormes et al., 2022).

Financial Support / Scholarships: Some other types of interventions include financial support for STEM majors, colleges and universities have found that scholarships combined with other financial, academic, and social support increase the rate of success in increasing the retention rate in freshmen students (Wright et al., 2021). Examples of support combined with scholarships include a network of scholars, access to computers, webinars, workshops, peer tutoring, faculty mentoring, social activities, and field trips among others (Wright et al., 2021).

Mentor Program Intervention: Manpower Demonstration Research Corporation (MDRC) researched interventions over a period of 15 years, they found that constant advising, or coaching students is fundamental to increasing academic progress (Wright et al., 2021). MDRC suggests that advising or coaching works best when the advisors are actively and frequently in contact with students. Faculty work as coaches supporting students in different areas, support ranges from student daily activities to long-term goals such as time management, self-advocacy, and study skills among others (Wright et al., 2021). According to Summers and Hracowski (2006), mentoring intervention provides a core support system for underrepresented students especially in the STEM areas, since some of the time they do not have a role model at home familiar with STEM. Mentoring also takes place among students, known as peer mentoring. Usually, this involves an upper-level student or graduate student advising a lower-level student either a freshman or sophomore (Khan, 2015). Generally, freshmen students need peer mentoring either because they are faced with challenges related to social and academic adjustment; students also need to develop a sense of belonging particularly groups of students with underrepresented backgrounds, first-generation, commuters, and low socio-economic status (Hayman et al., 2022). Ultimately peer mentoring also provides an opportunity not only for the mentee but also for the mentor, this type of relationship develops forms of capital for both participants (Hayman et al., 2022; Khan, 2015).

The University of Texas Rio Grande Valley (UTRGV) College of Engineering STEM Intervention. The College of Engineering and Computer Science (CECS) conducted the first STEM intervention at the college before the start of the academic year 2021-2022. Participants are first-generation students, labeled at-risk students by the UTRGV Office of student success. The characteristics of UTRGV at-risk college freshmen students is a holistic approach of several factors:

- High school quartile (students in the 3rd or 4th quarter of their graduating course)
- Missing TSI scores at the time of recommendation or did not meet TSI requirements in one or more areas.
- No SAT/ACT scores submitted or earned an ACT score of 19 or less or an SAT score of 1050 or less. (UTRGV Office of Student Success—Division of Academic Affairs, C. Saldivar, personal communication, March 3, 2023)

The main purpose of the UTRGV STEM intervention is to improve the retention rate among full-time at-risk college freshmen students in the area of STEM particularly in the engineering field. These students are enrolled in the College of Engineering & Computer Science. According to Marquez et al., (2022), the STEM intervention follows Design Thinking and solution-focused approaches. Students spend a week among faculty, peer mentors, and classmates. They work on the development of a Design framework based on six steps; each step allows the development of different skills daily. Marquez et al. (2022) identify the different skills and objectives of the UTRGV STEM intervention:

1. Frame a Question
2. Gather Inspiration
3. Generate Ideas
4. Make Ideas Tangible
5. Test to Learn.
6. Share The Story.

Once students completed the STEM intervention, professors analyzed pretests and posttests along with their academic performance in the Introduction to Engineering course, along with some non-formal interviews of the students. Their results showed that 75% of the students who completed the STEM intervention passed the Introduction to Mechanical Engineering course on their first attempt in the Fall of 2021. These numbers are higher by about 6% of the passing rate compared to the Fall of 2020 (Marquez et al., 2022). All the students, 100%, who participated in the STEM intervention, remained enrolled in the spring semester of 2021, or retention for the next semester. If students continue until the end of the semester, there is a high probability that students will remain and finish their STEM program since the first year is one of the hardest and most crucial for student retention in higher education (Jeno et al., 2018).

Table 1 depicts the daily activities taking place in the one-week STEM intervention. These activities have a learning objective on a daily basis. Activities also look to develop certain skills that will be useful in the first year of university for the at-risk college freshmen students enrolled at the CECS.

Table 1: STEM Intervention Five5-Day Program Activities

Activity	Learning Objectives	Skills	Assessment
Monday: Demolition Derby	Resourcefulness Time Management Finding Alternative Plans Open Mind Listening to Others	Creativity: the ability to generate ideas that are novel, varied, abundant, and functional.	Ideation Metrics: developed by Vargas Hernandez et al. the metrics are quantity, quality, novelty, and variety.
Tuesday: Blade Design	Strategizing Considering Multiple Factors Taking Informed Decisions Explaining Decisions Communicating Alternatives	Decision Making: Ability to organize info, define options, evaluate choices, and tradeoffs, and communicate decisions.	Self-efficacy student surveys: students will evaluate their perceptions.
Wednesday Reverse Engineering	Problem Framing Effective Communication of technical ideas to non-engineers; Writing Skills Conflict Management	Problem Framing: the ability to understand, define and prioritize complex problems.	Peer Reviews: students will evaluate their work, individually and as a team.
Thursday: Blast Off	Safety Considerations Prioritization of Information Project Management Delegating Deadlines and Responsibility	Project Management: the ability to break a problem into tasks and schedule them to meet a required deadline.	External Reviews: faculty and senior students will be invited to provide real-time direct feedback to students on their project plans.
Friday: Drone Task	Design Creativity Literature Review Time Management Conciseness Presentation Skills	Oral Communication: the ability to deliver an effective and engaging presentation.	Evaluation Rubrics: Faculty and TAs will use these rubrics to evaluate student presentation skills.

(Marquez et al., 2022)

Summary of Chapter Two

This chapter reviews the retention of at-risk college freshmen students in a STEM program along with how STEM interventions impact the student's decision to continue in a STEM program. Research has shown that STEM interventions have a positive impact on student retention (Hoffman et al, 2016; Tomasko et al., 2016; Strayhorn, 2012). The idea behind STEM intervention is based on the theory that students who are part of them receive a sense of clarity for academic expectations, learning communities, exposure to challenges, and stressors among other factors that promote a sense of belonging and ultimately student success (Hoffman et al, 2016).

This chapter highlighted the following three areas:

1) The importance of the STEM areas and why as a nation this area is crucial not only for its citizens but also for the nation.
2) Student's academic performance and retention rate, and
3) STEM interventions and UTRGV STEM intervention.

The following section presents the methodology of this research study. A mix-methods approach is presented: a quantitative test of the independence X^2 (Chi-square) method is used to measure any association between STEM intervention and program retention and a focus group interview will be conducted to enhance the results of the quantitative part of the research study by identifying how the STEM intervention helped students stay in the program and what suggestions students have to improve the STEM interventions.

CHAPTER III

METHODOLOGY

This chapter focused on a mix-methods research study. The quantitative research part focused on finding an association between at-risk college freshmen students' retention and completion of a STEM intervention. The qualitative part of the research study consisted of the perceptions of a focus group of at-risk college freshmen students who completed a STEM intervention. These students were interviewed and asked to provide information about why they decided to continue in the STEM program after completing a STEM intervention. They were also asked to provide information about how to improve the STEM intervention. The qualitative approach provided an opportunity to develop a deeper understanding of the impact of the STEM intervention and how to improve its construction. The research plan includes the following sections: research questions, research design, population and sample, instrumentation, null hypothesis, treatment, data collection procedures, data analysis procedures, and finally the limitations of the study.

Research Questions

The following research questions were used to guide the researcher in the proposed study.

RQ1: Is there an association between the retention rate of at-risk college freshmen UTRGV CECS students who complete a STEM intervention and similar students who do not complete a STEM intervention?

RQ1 Research Hypothesis, H_1: There is an association between the retention rate of at-risk college freshmen UTRGV CECS students who complete a STEM intervention and similar students who do not complete a STEM intervention

RQ1 Null Hypothesis, H_o: There is no association between the retention rate of at-risk college freshmen UTRGV CECS students who complete a STEM intervention and similar students who do not complete a STEM intervention

RQ2a: As perceived by at-risk college freshmen UTRGV CECS students who completed the intervention, how does a STEM intervention impact program retention?

RQ2b: As perceived by at-risk college freshmen UTRGV CECS students who completed the intervention, how can a STEM intervention be improved to support program retention?

Research Design

This is a mixed methods research study. The quantitative approach is appropriate when the researcher is trying to find out the relationship between different variables (Creswell, 2015). This research study aimed to use quantitative data analysis of two UTRGV STEM student cohorts, from 2021 and 2022, to find if there was an association between the completion of a STEM intervention and the retention of at-risk college freshmen students in the Engineering program.

A qualitative approach was used as well to explain a phenomenon by relying on the perception of a person's experience in a given situation (Stake, 2010). The purpose of the qualitative part of this research was to find the reasons STEM students give for continuing in the program after their freshmen semester and completion of the STEM intervention and what suggestions they had to improve the STEM intervention.

A test of independence X^2 (chi-square) was used for the quantitative part. This type of research study is commonly known as the X^2 test of independence or association (Mills & Gay, 2019). Chi-square analysis has two main limitations. One of the limitations is that all participants measured must be independent, meaning that an individual cannot fit into more than one category. If a participant can fit into two categories a chi-square analysis is not appropriate. Another consideration one must make is that the chi-square statistic is sensitive to sample size. Most recommend that chi-square not be used if the sample size is less than 50 (McHugh, 2013). Generally, data will be provided in the form of frequency counts or percentages and proportions. Comparison of these frequencies occurs in different categories (Mills & Gay, 2019). This study aimed to find if there was an association between the retention rate of UTRGV STEM students who completed the STEM intervention and students who did not complete it. Categories in this study are retention of at-risk college freshmen students in an Engineering program and STEM intervention completion.

Population and Sample

The University of Texas Rio Grande Valley (UTRGV) was formed in 2013 in Edinburg, Texas, as a consolidation of the former University of Texas-Pan American (UTPA) and the University of Texas at Brownsville (UTB) (UTRGV University Library Special Collections & Archives, 2022). According to the 2021-2022 University Enrollment Explorer (The University of Texas Rio Grande Valley, 2023), the following statistics represent the population of students at the university.

UTRGV Student Population: UTRGV has a total enrollment of 31,940 with a gender distribution of 39.79% male (12,709 students) and 60.21% female (19,231 students). There are 10,751 male and 15,654 female students in undergraduate school and 1,958 male and 3,577 female students are attending graduate school.

UTRGV Student Gender Distribution: There are 31,940 students including 26,405 undergraduate and 5,535 graduate students for the academic year 2021-2022.

UTRGV Enrollment by Attending Status: There are 21,522 full-time and 10,418 part-time students with a gender distribution of 12,709 male and 19,231 female students. UTRGV is offering a distance learning opportunity (online degree program) and a total of 23,608 students have enrolled online program exclusively.

UTRGV Race/Ethnicity Distribution: There are 17 American Indian/Native American, 1,052 White, 279 Black/African American, 458 Asian, 29,001 Hispanic, 20 Native Hawaiian or Other Pacific Islander, and 135 students with other races.

UTRGV is considered the second largest federally certified Hispanic Serving Institution in the United States with more than 32,000 students, almost 90% of whom are Hispanic, mainly Mexican American students (Marquez et al., 2022). The engineering program at UTPA started in 1992, and the first Accreditation Board for Engineering and Technology (ABET) was accredited in 1996. Currently, the College of Engineering & Computer Science (CECS) has six departments that offer eight bachelor's degrees and seven master's degrees serving about 3900 students mostly undergraduates (The University of Texas Rio Grande Valley, 2023).

A description of participants in a research study should identify the number, source, and characteristics of the sample (Mills & Gay, 2019). Quantitative research samples tend to be large and broadly representative (Mills & Gay, 2019). The participant sampling group for this study consisted of only at-risk college freshmen first year students who were identified as at-risk by the UTRGV Office of student success by the Division of Academic Affairs. Participants were selected from a population of 1620 at-risk freshmen students enrolled in CECS program at the UTRGV according to the academic years 2021-2022 (The University of Texas Rio Grande Valley, 2023).

Students who completed the CECS STEM intervention in years 2021 and 2022 were analyzed as shown in Tables 2 and 3. Students were identified by the UTRGV Office of Student Success. These students met the requirements of labeled at-risk students, first-generation, and incoming freshmen. The 2021 and 2022 cohorts of students were used as one data set, since both STEM interventions were done identically, with the same faculty in charge. A total of N=484 students with the same characteristics were identified as at-risk college freshmen CECS students from the 2021 and 2022 cohorts. Initially, the study was separating STEM intervention students into students who accepted participation and students who did not accept participation in the STEM intervention. However, initial review of the data indicated a group of students who accepted to participate in the STEM intervention and participated but did not complete it. There were also a few students who accepted to participate in the STEM program but did not participate at all. These few students became a part of the group that did not accept participation since they did not participate at all. Therefore, three groups were organized to examine if there is an association between the retention of STEM students and STEM intervention completion. The three groups are as follows:

1. COMP: Students who COMPLETED the STEM intervention
2. PNCOMP: Students who ACCEPTED, PARTICIPATED, BUT DID NOT COMPLETE the STEM intervention.

3. NCOMP: Students DID NOT ACCEPT to participate in the STEM intervention and the few students who ACCEPTED BUT DID NOT PARTICIPATE AT ALL in the STEM intervention.

Instrumentation and Data Sources

This study consisted of mixed methods of data collection. The quantitative part consisted of data gathered from the UTRGV Office of Student Success. Student criteria to be part of the research study consisted of being enrolled in their first year of school, being first-generation students, and being labeled at-risk students by the Office of student success at UTRGV. Collected data was coded and inputted into Statistical Package for the Social Sciences (SPSS) and analyzed by the test of the independence X^2 method. The quantitative part of the research study consisted of a group of students who completed the CECS STEM intervention and a group of students who did not complete and did not participate to any degree in the CECS STEM intervention. Group designation was nominal and the independent variable. Retention after the first year in CECS was identified for the students in these two groups. The completion and retention variables were both nominal data. The completion variable was considered the true category of the X^2 method which was the independent variable for this research study (Mills & Gay, 2019). In the Chi square test of the independence (X^2) method, two or more categories are mutually exclusive. Simple frequency counts from the variables will be shown in contingency tables. A contingency table in the Chi square test of the independence (X^2) method presents basic descriptive data (Mills & Gay, 2019). A Chi square test of the independence (X^2) method analysis helped determine any observed differences between the at-risk college freshmen students who completed the STEM intervention versus the at-risk college students who did not complete and did not participate in the STEM intervention. The few students who participated but did not complete the STEM intervention were analyzed as a separate group in order to maintain the non-completer group homogeneous and without any exposure to the STEM intervention and the completer homogeneous also by including only completers of the whole STEM intervention five-day program. The inclusion of this third group was critical because one of the limitations of the Chi square test of independence is that it cannot include an individual that fits into more than one category (McHugh, 2013).

Participants for the qualitative research part were selected through homogenous purposeful sampling. According to Creswell (2015), purposeful sampling is used in qualitative research because participants in the study can purposely inform an understanding of the research problem and central phenomena of the study. The focus of the qualitative approach was to understand the reasons at-risk college freshmen students give for continuing in the engineering program after successfully completing a STEM intervention. *Case Study Data collection* was done through focus groups (Creswell, 2015). One of the characteristics of qualitative research methods is that it follows an inductive research design (Mills & Gay, 2019). The focus group consisted of interviewing a group of students who participated and completed STEM Intervention at the College of Engineering & Computer Science during the first and second cohorts in the years 2021 and 2022 respectively. The focus group included open-ended questions to try to identify the reasons these students decided to remain in the Engineering program, and suggestions they provided to improve the STEM intervention. According to Ravitch and Carl (2021), the selection and sampling process for the qualitative part of the research study is best when it follows these steps:

1. Site selection
2. Identification of situations that are relevant to the topic

3. Section of concrete situations in which issues related to the topic.
4. Identify other types of situations that influence the topic issues.

Considering these steps, the site selected was the maker space classroom at the engineering building, the classroom where students had the STEM intervention. Creating the focus group in this site or setting allowed students to remember those situations that took place while they were participating in the STEM intervention. The focus group consisted of those students who completed the STEM intervention and were willing to participate in the process of a focus group interview. These participants were required to have a clear understanding of the goal of the questions by the researcher. Participation selection followed strategic, purposive, or purposeful sampling. This type of technique provides content-rich and detailed accounts of specific populations and locations (Ravitch & Carl, 2021). Individuals were purposefully chosen to participate in the research for specific reasons, including that they have had a certain experience, know about a specific phenomenon, reside and in a specific location, this strategy selection allowed them to obtain information needed to answer the research questions in this study (Ravitch & Carl, 2021). Sample size differs from quantitative research, in qualitative research sample size is less important. The goal of qualitative research is to rigorously, ethically, and thoroughly answer the research questions to achieve a complex and multi-perspective understanding that is valid and contextualized (Ravitch & Carl, 2021). In the selection process of students in the focus group, an engagement of multiple conversations took place with peers and mentors to get a range of critical perspectives on issues of inclusion and representation in the participation of the group. The ideal number of participants in a focus group is debatable, however, research has found that an effective focus group can consist of as few as five participants (Ravitch & Carl, 2021). The desired selection in this research study consisted of 10 to 12 participants who completed the STEM intervention and are currently enrolled in a STEM program.

Since the research study was based on the theory of sense of belonging, the protocol questions asked were based on the following guidelines for the focus group:

What were participants' most notable experiences of belonging during their first year of college?

1. Describe what it feels like to belong to a place like UTRGV. (Rapport)
2. Describe the feeling of getting to university in your first semester.
3. Explain what resources you knew in your first semester. Did you have any college credits?
4. How familiar where you with engineering, the college, the department, the faculty, the building, and the institution?
5. Describe how it felt when you started your first semester at school.
6. Describe how it felt to be part of the Engineering intervention. Research
7. Was the information presented in the intervention useful?
8. Tell me about the relationship between you and the mentor.
9. What was the feeling you had meeting other students in the intervention?

How did participants' perceived sense of belonging change over time throughout their first year of college?

10. Think back to when you arrived on campus and the time when you were part of the intervention: Tell me about a time during those first few weeks when you felt particularly accepted or respected. What made you feel accepted or respected?
11. Compared to the first few weeks of the fall semester, how has your sense of being in the engineering program changed? What are the circumstances impacting this change?
12. How important do you think it is to feel a sense of belonging after the intervention?

How did others, including peers, faculty, and staff, feature in their accounts of developing a sense of belonging?

13. Describe what it feels like when you belong to a group of people in the engineering intervention.
14. Describe an interaction with one of your professors that made you feel cared about, accepted, or valued compared to the engineering intervention.

Null Hypothesis

The Null Hypothesis for the present study was tested with the test of independence X^2 distribution at the 0.05 level of significance.

RQ1 Research Hypothesis, H_1: There is an association between the retention rate of at-risk college freshmen UTRGV CECS students who complete a STEM intervention and similar students who do not complete a STEM intervention.

RQ1 Null Hypothesis, H_o: There is no association between the retention rate of at-risk college freshmen UTRGV CECS students who complete a STEM intervention and similar students who do not complete a STEM intervention.

The quantitative study was tested with a 95% confidence interval and a total population of N=484. If the data collected were to reject H_o's hypothesis, the data would support an association between the completion of a STEM intervention and the retention of at-risk college freshmen students in the engineering program. If there is no association, then the data would support no relation between the variables presented in this research study and fails to reject the null hypothesis.

Treatment

Data collected was retrieved from the UTRGV Student Success office and CECS records. Two nominal variables were considered:

1) A group of at-risk college freshmen students who participated and completed the STEM intervention and

2) A group of at-risk college freshmen students who did not complete and did not participate in the STEM intervention.

A basic contingency table determined whether CECS STEM intervention had any association with student completion and student retention in the STEM program. To determine whether the variables were independent or not, the frequencies observed were compared. The association of CECS STEM intervention was determined by students' retention in the same STEM program.

Interview Protocol

The protocol was guided by Research Questions 2a and 2b. First, participants were asked about their most notable experiences of belonging during their first year at the university. The second set of questions emphasized on how the participants perceived the changes in their sense of belonging throughout the first year in college. These questions provided a sense of changes during the STEM intervention and after the STEM intervention during the first year at school for STEM intervention completers. Also, these questions allowed to understand whether students knew about resources, mentors, faculty relationships, and classmates' relationships. The last set of questions focused on improvements in STEM intervention and the development a of sense of belonging. These questions were based on the theoretical framework of a sense of belonging.

Sampling

As the research study was trying to identify the reasons STEM students decided to stay in the program after completing a STEM intervention and identification on how to improve the STEM intervention, participants recruited for the focus group interview had to successfully complete the STEM intervention. This type of selection of participants is called purposeful sampling. According to Creswell (2015), purposeful sampling can purposefully allow the understanding of certain phenomena in a research study.

Participants

Participants in this research study consisted of those who were able to complete the STEM intervention and provided information that aligned with the research questions. The criteria used were the following:

1. Labeled at-risk college freshmen student.
2. Engineering Major declared.
3. Completed the STEM intervention.

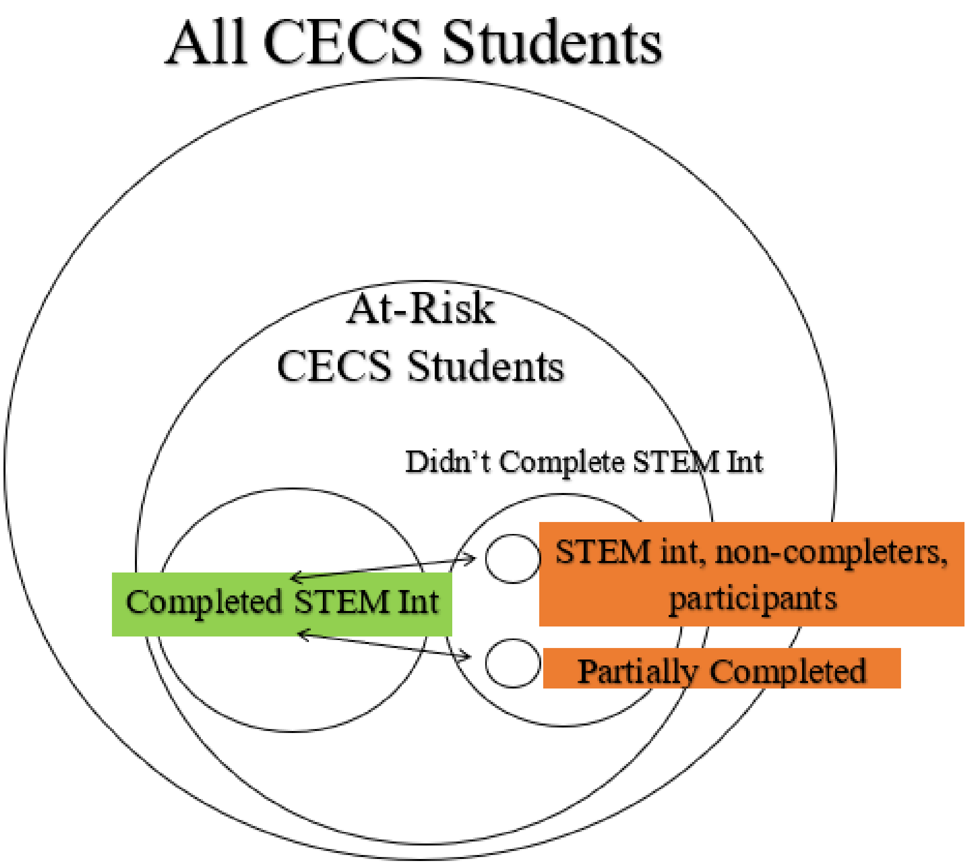

Figure 1: Student population in the research study

Informed Consent

Prior to the focus group interview, students signed an informed consent form, were informed about the research study, and explained how their participation was going to remain confidential. Focus group interviews did not include student real names to avoid identifiable information and protect their identity.

Researcher Positionality

As an advocate for at-risk college freshmen students, this researcher supports the idea of interventions prior to the first of school, and especially during their first year of school. Research has shown that freshmen students are vulnerable and need more support, especially those in the Rio Grande Valley since they are mainly categorized as at-risk (Avila & Pankake, 2016)

Trustworthiness

This research study followed triangulation and validity strategies to ensure that results are transferable and reliable. The first step was to make sure this researcher understood her positionality in order to also understand any assumptions in this research study, along with any personal biases. Second, this researcher used professional faculty members to review and ensure participant interviews were recorded and transcribed correctly. Once transcripts were ready, researcher met with two other faculty members from the CECS. Both professors lead the STEM intervention during the 2021 and 2022 school years. As a group, transcripts were discussed, and researcher received feedback and clarification about the data collected. This process is commonly used to seek credibility and reliability of qualitative study (Creswell, 2015).

Data Collection Procedures

The researcher contacted the dean's office of the college and requested permission to contact students either via Zoom, email, phone, or other suggested mechanisms of communication to ask students if they wished to participate in the study's student focus group.

University and CECS approval were necessary to start collecting information from the students. After approval of data collection and securing consent from students and/or legal guardians, collection from the university records began, information was be coded, all participants names and student identification numbers were secured to ensure confidentiality. Two focus groups were created, and interviews took place as soon as the study was permitted to start. The focus groups consisted of students who completed the STEM intervention in cohorts 2021 and 2022 and were willing to participate in the interview. The interview took place on a face-to-face modality and students who were not able to travel connected over a virtual platform (zoom). Each focus group was set to include approximately five students. Focus groups were considered in this study because they create the conditions to observe communication between those participants on the STEM intervention, and as a result, participants generated qualitative data related to the social interaction process. This type of process aimed to explore attitudes, opinions, and experiences (Ravitch & Carl, 2021). Also focus groups are used to examine how knowledge and ideas develop and operate in a given cultural group or context (Ravitch & Carl, 2021). In this case, the group studied was at-risk college freshmen students who successfully completed a STEM intervention and shared similar characteristics. A focus group allows to generate group thinking which happens when a member of the group introduces a topic, and the rest of the group focuses on the topic generating a group understanding (Ravitch & Carl, 2021). Focus groups provide several advantages over individual interviews. These advantages are:

1. Focus groups provide a primary understanding of a shared attitude, experience, priority, and framework understanding.
2. Allow participants to encourage each other by creating a co-generation of common analyses and experiences.
3. Encourage a variety of communication between participants and allows them to build off other participants' responses.
4. Allow the researcher some sort of quality control since participants can provide an immediate response to false or extreme views within participants.
5. Encourage open dialogue about critical topics.
6. Facilitate the expression of ideas and experiences that might be left underdeveloped in individual interviews.

(Ravitch & Carl, 2021).

Data Analysis Procedures

Once access was granted to the quantitative data, the statistical analysis in SPSS software took place. The statistical analysis for this study included calculations and reports of different descriptive statistics for the variables used in the study. A test of the independence X^2 method was used with an alpha of 0.05 level of significance to determine whether to reject or fail to reject the null hypothesis.

According to Creswell (2015), eight characteristics of qualitative inquiry are important to be considered when conducting qualitative research. Since this is a mixed methods research study, the criteria recommended by Creswell was used by selection of five of the eight characteristics which were: 1) participant natural setting, 2) qualitative inquiry, 3) inductive and deductive data analysis, 4) participant's meaning of the issue being examined, and 5) reflexibility, which are described in detailed below.

1) Participant's natural setting: The engineering laboratory where students participated in the STEM intervention known as the maker space Engineering Building room EENG 2.454 was used.
2) Qualitative inquiry: focus groups were used to gather information rather than surveys or questionnaires.
3) Inductive and deductive data analysis: Analysis of qualitative data was done to establish categories and themes with supporting evidence from the focus groups. In order to established themes, coding took place. Coding is an important process because it assigns meaning to data (Ravitch & Carl, 2021). The review of the literature research provided a list of vocabulary words related to STEM intervention, the study's theoretical framework, research questions, and areas of interest. This list was entitled the Start List. Transcribed student interviews were inputted into NVivo Software. Once the student interviews were entered, then NVivo provided general codes for the student information. This process took several rounds so the codes could become very specific. Figure 2 shows the result of the first round made on NVivo, with a total of 21 codes.

Item	Code	Description
1	University Anxiety	Student transitions from high school to university with a sense of anxiety due to the changes of school
2	Sense of belonging at the university	The student believes they belong to a university
3	Parent Support	The student has support from parents, financially, psychology when entering university
4	Program Uncertainty	The student is not very familiar with the program or bachelor
5	STEM background	Student presents some knowledge in the area of STEM
6	University Environment	Student does not understand the dynamic of the university
7	University Comfort	Student feels comfortable navigating through the university
8	First day of School Feelings	Student feelings on their first day of school
9	Loneliness	Students experience a feeling of not knowing other students
10	STEM Degree familiarity	Student understands the coursework needed for a STEM Degree
11	Academic Rivalry	Student feels a sense to compete academically with other students
12	Lack of Faculty Trust	No relationship between Faculty and Incoming STEM students
13	Lack of knowledge of university resources	Student does not know the different services available at the university for students.
14	Sense of belonging in a new group of people	Student experiences a sense of belonging when part of the STEM intervention
15	Mentorship	Student receives structure and help from a mentor in the STEM intervention
16	Self-confidence addressing faculty	Student feels self-confident to approach faculty after STEM intervention
17	Lack of Student Connections	Student does not interact with college students due to taking core courses instead of engineering courses.
18	Core curriculum advantage	Student earned about two years of core curriculum while in high school
19	Gender Disparity in STEM programs	Lack of women representation in STEM program
20	Student Organization advantage	Students develop a sense of comrade while being part of a student organization
21	English Language Learner disadvantage	Students first language is other than English

Figure 2: NVivo Codebook

Once codes were introduced, then interviews were coded respectively. One of the advantages of NVivo software is the ability to recognize clusters of words in the interviews. According to NVivo, the main cluster in the interviews is divided into three different groups as shown in Figure 3.

- Group 1 includes Student Organization advantages, STEM intervention, Faculty Interaction, Mentorship, Lack of Connections, and Gender Disparity. This group is mainly talking about feelings students have when entering the engineering program and the STEM intervention.
- Group 2 includes the first day of school feelings, university anxiety, academic rivalry, self-confidence, English as a language learner, and self-confidence in addressing faculty. These are more general feelings related to the university. Not necessarily directly related to the engineering program.

- Group 3 Program uncertainty, STEM background, STEM degree familiarity loneliness, parent support, and sense of belonging, these categories are related to some sort of support system and the feelings related to these items.

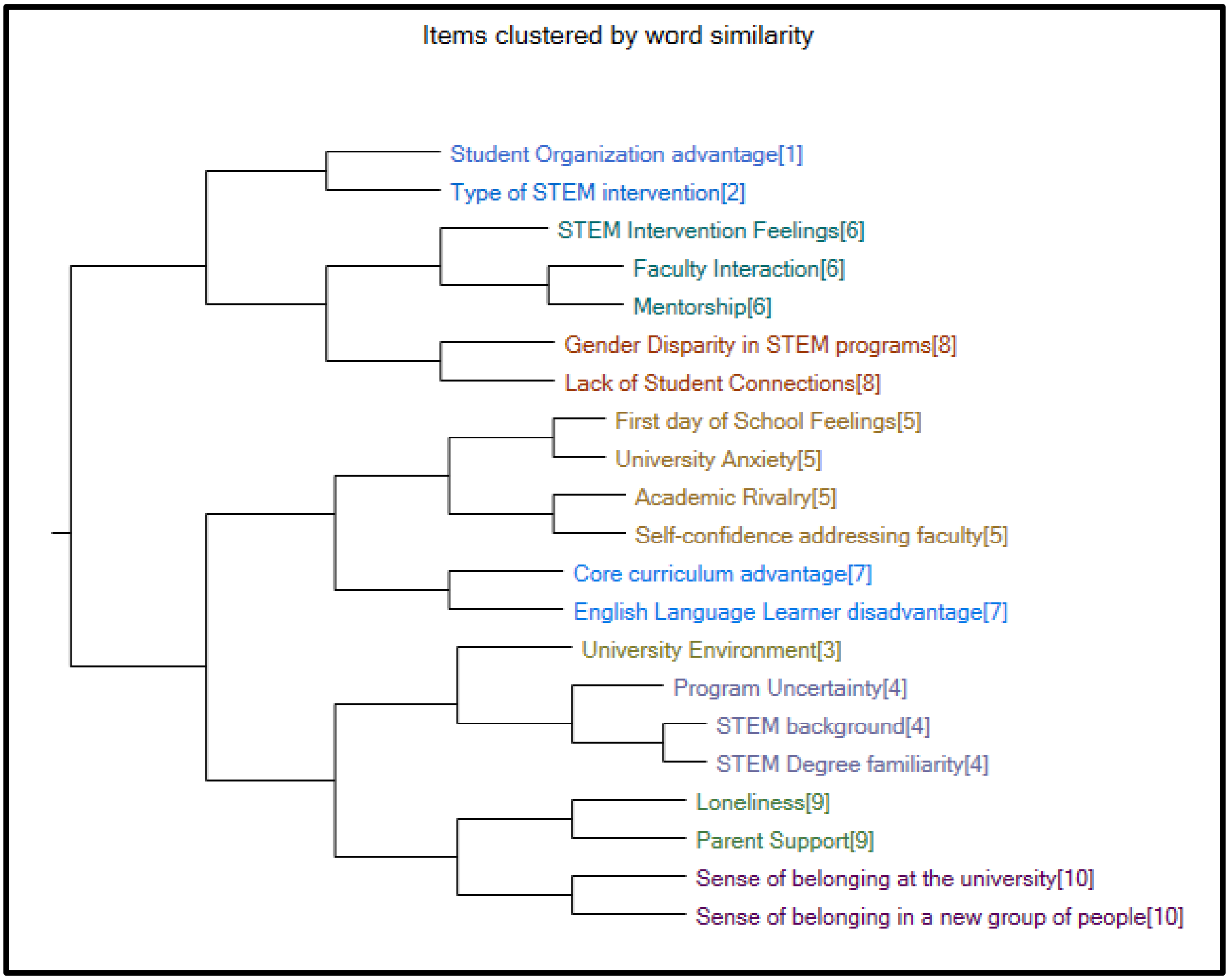

Figure 3: NVivo Cluster of Words

Figure 4 shows the level of frequency in the coding of the interviews. What is important to understand here, is that the majority of the interviewed students talked about their 1) STEM intervention, followed by 2) the mentorship received, and also 3) University Anxiety related to their sense of belonging. Those are the main three topics covered in the interviews. Although, those are not the only topics discussed, others identified were topics related First day of school, faculty interaction, Parent Support, STEM background, Type of STEM intervention.

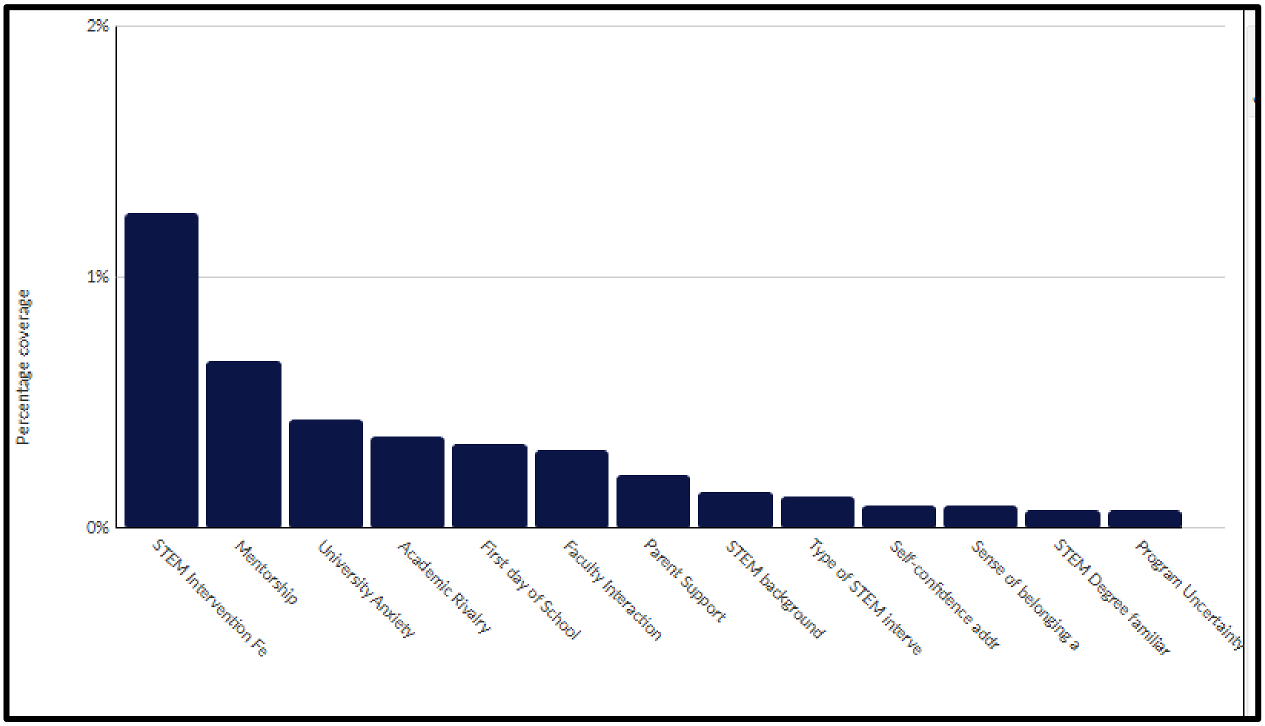

Figure 4: Frequency of Categories in The Interviews

The last item covered on this assignment was the selection of themes. Currently NVivo software identified different themes, which brought the conclusion that clusters needed to be creating to continue reducing the number of themes in the interviews. The main themes presented according to NVivo were the following:

- Theme 1: STEM intervention
- Theme 2: Mentorship
- Theme 3: University Anxiety
- Theme 4: Freshman – New incoming student feelings – Academic Rivalry – Higher Education
- Theme 5: First day of School Coursework – Feelings, knowledge, background in Engineering

- Theme 6: Classes/coursework: Background
- Theme 7: Parent Support
- Theme 8: STEM Background

After meeting with two professional engineers, who currently work on the STEM interventions at the Engineering college, and discussing the eight NVivo themes, the total themes was then reduced to five. These two professors (one an associate chair) currently have been also focusing on the retention rate of students at the College of Engineering. In conclusion, coding provided the opportunity to narrow down the interviews to the themes shown below:

- Theme 1: Projects & Freedom
- Theme 2: Mentorship
- Theme 3: Sense of Belonging
- Theme 4: Family & Higher Education
- Theme 5: Transitioning from High school to Higher Education

4) The participant’s meaning of the issue being examined is the main focus of the research study. At-risk college freshmen students who participated and completed the STEM intervention were the main focus of the research study, these students were interviewed to find out the reasons why they decided to stay in the program and reasons how to improve the STEM intervention in the near future.
5) Reflexibility: This part of the research study allows the researcher to reflect on the researcher's experience and positionality. The researcher followed a list of reflexive data collection questions in a way to allow critical dialogue around

identity and positionality. According to Ravitch and Carl (2021), the following questions help understand reflexibility in a researcher:

- How do I present myself? the research topic and goals. what informs these choices?
- What is my communication style?
- What influences the choices I make around communication with participants within and beyond the interviews and other forms of data collection?
- Do I listen carefully? how might I improve my listening skills?
- Do I impose my opinions or value judgments during data collection?
- Am I probing for context and specifics adequately?

Validity and Reliability

Since interviews were going to take place, it was important to avoid one of the most common problems in the interviews which is bias and a tendency to ask in a particular way the items on the instruments looking for biased answers (Mills & Gay, 2019). Therefore, validity was conducted. Although, validity is mainly rejected by qualitative researchers with the idea that it is used mainly in quantitative research because it is based on epistemological frames (Ravitch & Carl, 2021). However, Lincoln and Guba defined validity to provide quality to qualitative research (Ravitch & Carl, 2021). Hence, validity in qualitative research provided quality and rigor to the study, meaning “the ways that researchers can affirm that their findings are faithful to participant’s experiences” (Ravitch & Carl, 2021, p.166). To comply with the validity of the qualitative research study, four different standards were used:

1. Credibility: To establish credibility in the research study, one of the strategies presented consisted of triangulation. Triangulation allows for different perspectives to form themes or categories in the research study. This research study used Methodological Triangulation. Data collection included one method, which but different strategies associated with the method. Two different comparison groups in the interviews took place. Also, one in-depth interview took place. According to Ravitch and Carl (2021), this type of triangulation method is considered more robust due to the generative of information to the overall research study. The interviews were shared with two faculty from the College of Engineering & Computer Science, these faculty are part of the execution of the STEM intervention at the College and currently work on research in retention at the CECS.
2. Transferability: Qualitative research does not aim to be generalized; however, it needs to be transferable to a broader context while still maintaining its specifics. Hence, it is important to provide detailed descriptions of the data and context of the research study, so that other researchers can compare it to other contexts based on as much information as possible.
3. Dependability is similar to reliability in quantitative data, in this case, qualitative data needs to be consistent and stable over time. Data is dependable in the sense that research questions are being answered. Triangulation also allows for dependability to take place.

Limitations of the Study

Creswell (2015) defined limitations as potential weaknesses or problems with the study which may impact the outcomes of the study and identified by the researchers. This research study has the following limitations:

1) Sample size may limit the generalization of the findings,

2) Sample selected targeted only population in the College of Engineering and Computer Science at UTRGV,

3) Only at-risk college freshmen students were selected, but not returning students,

4) The study was conducted in one specific university, and

5) Participants' academic outcomes may have been influenced by other existing programs at the university.

Additionally, the Chi square test of independence includes limitations. One limitation is that no individual may fit into more than one category (McHugh, 2013). As noted earlier, initial review of data identified this possibility, but it was resolved by creating a separate group for students who participated but did not complete the STEM intervention. By separating these students into their own group, the two main focus groups of the study, STEM intervention completers and non-completers, remained homogeneous in the program completion aspect. A second limitation of Chi square test of independence is that it is very sensitive to population size, mostly in the larger population sizes (McHugh, 2013). Thus, great differences in the sizes of groups included in a study may limit the power of the Chi square test to measure association.

Delimitations refer to those characteristics that limit the scope and define the conceptual boundaries of the research (Simon, 2012). This study delimitations are shown below:

1) population of this study was limited to at-risk first-generation freshmen students and

2) quantitative methods were used to find an association between participation in the STEM intervention and the retention rate of students in the program.

Summary

Chapter III presented an overview of the research methodology of this study. At-risk college freshmen student data was retrieved from the UTRGV Student Success office and CECS records. Two nominal variables were considered: 1) a group of at-risk college freshmen students who completed the CECS STEM intervention and 2) a group of at-risk college freshmen students who did not complete and did not participate in the STEM intervention. A third nominal variable was reviewed for clarification purposes: a group of at-risk college freshmen students who participated but did not complete the STEM intervention.

A Chi-square test of the independence (X^2) method analysis helped to determine any observed differences between the at-risk college freshmen students who completed the CECS STEM intervention versus the at-risk college students who did not did not complete and did not participate in the STEM intervention. The third group of at-risk college students who participated but did not complete the STEM intervention was reviewed as well. Also, a contingency table with basic descriptive data was presented. Interviews were part of the data association of this study.

In summary, using quantitative research techniques, this research study aimed to assess an association between completion of a STEM intervention by at-risk freshmen students in CECS and retention after one year. Also, this research study aimed to find the reasons STEM students give for staying in the program after they participated in the CECS STEM intervention and how to improve the STEM retention.

CHAPTER IV

RESULTS

Chapter IV depicts the results from a mixed-method collection of data. The first section explains the results of the quantitative data that focuses on sampling at-risk college freshmen STEM students from the College of Engineering & Computer Science (CECS) to describe and explain the association between the retention of at-risk college freshmen STEM students and the completion of a STEM intervention. The second section includes the results of the qualitative part of study that focused on identifying the reasons STEM students who completed the STEM intervention decided to stay in the program. The third section includes perceptions of at-risk college freshmen STEM students who completed the STEM intervention on how to improve the intervention. This research study followed a mixed methods analysis.

Research Questions

RQ1: Is there an association between the retention rate of at-risk college freshmen UTRGV CECS students who complete a STEM intervention and similar students who do not complete a STEM intervention?

Quantitative Data Results

Data analysis consisted of a group of 2021 and 2022 UTRGV at-risk college freshmen students who declared themselves engineering majors. According to the UTRGV University Enrollment Explorer (UTRGV The Division of Strategic Enrollment and Student Affairs, 2023), CECS had an enrollment of 860 students in the Fall of 2021 and about 760 in the Fall of 2022.

Table 2 shows a total all freshmen CECS student population of 1620 for the Fall 2021 and 2022 cohorts. Out of the whole student population 484 students were identified as at-risk college freshmen students.

Table 2: Total Population of Student Data in the Research Study

Student population from Fall cohorts 2021 & 2022	
Total all freshmen population in CECS	1620
Total At-risk college freshmen students in CECS	484

The College of Engineering and Computer Science was provided with a list of a total of 484 students who were identified as at-risk college freshmen by the UTRGV Office of student success. Hence the total study data set consisted of N= 484 at-risk college freshmen students with engineering as their declared major. Table 3 depicts the total number of students who were sent a study survey that invited them to participate in the one-week program STEM intervention. The response rate consisted of 122 (25%) surveyed students accepting to participate in the STEM intervention.

Table 3: UTRGV *CECS STEM* Intervention Acceptance Rate

STEM Intervention Acceptance Rate: UTRGV CECS At-Risk Freshmen Students		
	Total	Percentage
Students who answered the survey and accepted to participate	122	25.2
Students who did not answer a survey to participate	362	74.8
Total Number of students invited to participate	484	100.0

Also noted in Table 3, 362 students did not answer the survey to participate. These students are classified as non-Completers for this research. The total number of students who responded to the survey and accepted to participate in the STEM intervention was 122. However, not all these students completed the five-day STEM intervention. Table 3 notes that 35 of the 122 students who accepted participation in the STEM intervention did not attend any part of the intervention. These students were classified as non-Completers. Table 3 also notes that 37 students participated but did not complete the STEM intervention. These students may have attended one to four days of the intervention, but not all five required days. These students were classified as Participant-Non-Completers. Finally, Table 4 notes that 50 students did complete the STEM intervention—they were classified as Completers. Thus, a total of 87 students participated in the STEM intervention but only 50 completed the STEM intervention. The 50 students who completed the STEM intervention reflect 40.9% of all students who accepted to participate in the intervention and 10% of all identified CECS 2021 and 2022 at-risk freshmen students who declared engineering as their major.

Table 4: CECS At-Risk Freshmen - Accepted To Participate In STEM Intervention

CECS At-Risk Freshmen Students Who Accepted To Participate In STEM Intervention

	Count	Percentage
Students who completed the STEM intervention	50	41.0
Students who did not participate and did not complete the STEM intervention	37	30.3
Students who participated and did not complete the STEM intervention	35	28.7
Total Students who answered the survey and accepted to participate	122	100

Given the data and the need to not contaminate the study's two main focus groups—STEM intervention completers and non-completers, the CECS at-risk freshmen student population to be studied was divided into three groups, as mentioned in the previous chapter, and as shown in Table 5 with the acronyms that will be used in data reporting.

- Group 1 COMP: Students who COMPLETED the STEM intervention.

- Group 2 PNCOMP: Students who ACCEPTED, PARTICIPATED, BUT DID NOT COMPLETE the STEM intervention.
- Group 3 NCOMP: Students DID NOT ACCEPT to participate in the STEM intervention and the few students who ACCEPTED BUT DID NOT PARTICIPATE AT ALL in the STEM intervention.

Table 5: At-risk College Freshmen Students Considered for the Research Study

At-risk College Freshmen Students Considered for the Research Study		
Students who agreed to participate and COMPLETED STEM intervention (COMP)	50	10%
Students who agreed to PARTICIPATE and did NOT COMPLETE the STEM intervention (PNCOMP)	35	7%
Students who did NOT PARTICIPATE or did NOT COMPLETE the STEM intervention (NCOMP)	399	83%
Total At-risk college freshmen students identified in Engineering	484	100%

Comparison of Students Who Completed the STEM Intervention (COMP) versus Students Who Did Not Accept to Participate and Did Not Complete The STEM Intervention (NCOMP)

The data analysis using the chi-square test of independence was used to compared if there was a significance difference in between the groups studied. Data results were used to determine the retention rates of the three groups of students in the study population. Table 6 presents the retention rates for each group and for the overall at-risk student sample population, and Table 7 shows the difference in percentages of those students who were retained in the STEM program between each group and all students.

Table 6: Count and Percent Retained by Group

Count and Percent Retained by Group

		Not Retained	Retained	Total
COMP	Count	12	38	50
	Percent	24.0	76.0	100.0
NCOMP	Count	121	278	399
	Percent	30.3	69.7	100.0
PNCOMP	Count	13	22	35
	Percent	37.1	62.9	100.0
All	Count	146	338	484
	Percent	30.2	69.8	100.0

Table 7: Retention Rate of Students in the Research Study

Retention Rate of Students in the Research Study

Group	% Of Students Retained	% Difference from All
COMP	76.0	6.2
NCOMP	69.7	-0.1
PNCOMP	62.9	-6.9
PNCOMP/NCOMP	69.1	-0.7
All	69.8	

Table 7 shows the STEM intervention completers (COMP) had the highest retention rate (76.0%) followed by students who did not participate and did not complete the STEM intervention (NCOMP, 69.7%), and finally the students who participated and did not complete the STEM intervention (PNCOMP, 62.9%). The data clearly shows that STEM intervention completers had a much higher retention rate than non-completer students and those students who participated and did not complete STEM intervention. The relevant question then becomes, is this difference in retention rates statistically significant to substantiate an association between STEM intervention completion and retention or not? The answer to this question requires answering the study's foundational research questions.

The first research question is:

RQ1: Is there an association between the retention rate of at-risk college freshmen UTRGV CECS students who complete a STEM intervention and similar students who do not complete a STEM intervention?

After student data was reviewed, the groups were identified as noted above. A Chi-square test of independence (X^2) was used to compare students two groups at a time. The Null Hypothesis for the present study was tested at the 0.05 level of significance. This quantitative study had a 95% confidence interval.

Comparison of Students Who COMPLETED the STEM Intervention (COMP) versus Students Who Did Not Participate and Did Not Complete the STEM Intervention (NCOMP)

The first analysis of association between STEM intervention completion and retention includes the students who completed the STEM intervention (COMP) and students who did not participate and did not complete STEM intervention (NCOMP). The COMP and NCOMP groups consisted of a total population of N = 449, 50 students who completed the STEM intervention (COMP) and 399 students who did not participate and did not complete the STEM intervention

(NCOMP). The Chi-square was completed in SPSS between these two groups (See Table >). As noted in the Table 8, the Chi-square results are as follows: X^2 (1, N=399) =.853, *p*=.356). The parameter in question needs to be different from zero or else randomness will be predicted (Mills & Gay, 2019). Thus, if the parameter in this research study is different from zero then the data is statistically significant. As mentioned earlier, three groups are going to be analyzed to compare if there is an association between STEM completion and retention rate.

Table 8: Chi-Square Test For COMP and NCOMP

Chi-Square Test For COMP and NCOMP

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. 2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.853[a]	1	.356		
Continuity Correction[b]	.576	1	.448		
Likelihood Ratio	.884	1	.347		
Fisher's Exact Test				.414	.226
Linear-by-Linear Association	.851	1	.356		
N of Valid Cases	449				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 14.81.

b. Computed only for a 2x2 table

Even though the data shows that at-risk freshmen STEM students who completed the STEM intervention (COMP, 76.0%) had a retention percent rate 6.5 points higher that the retention rate of at-risk freshmen STEM students who did not participate and did not complete STEM intervention (NCOMP, 69.7%), the Chi-square test showed no statistically significant association.

Comparison of Students Who COMPLETED the STEM Intervention (COMP) versus Students Who Participated and Did Not Complete the STEM Intervention (PNCOMP)

The focus of this study's quantitative part was the association between COMP and NCOMP. However, because a third group formulated in the population analysis, the group of at-risk freshmen STEM students who participated and did not complete the STEM intervention (PNCOMP) was also analyzed for association with the other two groups through Chi-square. This third group included the lowest retention rate, 62.9%.

This group consisted of a total population of N=85. The group of students who completed the STEM intervention was 50 (COMP), and 35 participated and did not complete the STEM intervention (PNCOMP). Table 9 shows the Chi-square results for association between PNCOMP and the COMP group: X^2 (1, N=85) =1.71, p=.19).

Table 9: Chi-Square Test for COMP and PNCOMP

Chi-Square Test for COMP and PNCOMP

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.713[a]	1	.191		
Continuity Correction[b]	1.138	1	.286		
Likelihood Ratio	1.698	1	.193		
Fisher's Exact Test				.230	.143
Linear-by-Linear Association	1.693	1	.193		
N of Valid Cases	85				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 10.29.

b. Computed only for a 2x2 table

Even though the data shows that at-risk freshmen STEM students who completed the STEM intervention (COMP, 76.0%) had a retention percent rate 13.1 points higher that the retention rate of at-risk freshmen STEM students who did participate and did not complete STEM intervention (PNCOMP, 62.9%), the Chi-square test showed no statistically significant association.

Comparison of Students Who Participated and Did Not Complete the STEM Intervention (PNCOMP) versus Students Who Did Not Participate and Did Not Complete The STEM Intervention (NCOMP)

This population consisted of an N=434, including 35 students who participated in the STEM intervention and did not complete (PNCOMP) and 399 students who did not participate and did not complete the STEM intervention (NCOMP). Table 10 shows the Chi-square test of independence results for association between STEM intervention completion and retention for the PNCOMP and the NCOMP groups: $X^2(1, N=434) = 0.70, p=.40$).

Even though the data shows that at-risk freshmen STEM students who participated and did not complete the STEM intervention (PNCOMP, 62.9%) had a retention percent rate 6.8 points lower than the retention rate of at-risk freshmen STEM students who did not participate and did not complete STEM intervention (NCOMP, 69.7%), the Chi-square test of independence showed no statistically significant association between STEM intervention completion and retention in this group.

Table 10: Chi-Square Test for PNCOMP and NCOMP

Chi-Square Test for PNCOMP and NCOMP

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.701[a]		.403		
Continuity Correction[b]	.418		.518		
Likelihood Ratio	.680		.410		
Fisher's Exact Test				.446	.255
Linear-by-Linear Association	.699		.403		
N of Valid Cases	434				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 10.81.

b. Computed only for a 2x2 table

In summary, the Chi square test of independence (X^2) results showed no statistical significance in any of the groups studied. However, there was a difference in retention rates between the general population, those who did not accept to participate in the STEM intervention, and the students who completed the STEM intervention.

Although not a part of this research study, data was available to show what happened to STEM intervention completers where were not retained after a year. Some of these students changed their majors to History, Kinesiology, Criminal Justice, Marketing, Management, Accountancy Music, Multidisciplinary studies, and other majors. Additionally, some students had a grade point average (GPA) below or close to the 2.0 average. In the CECS, a student with such a low GPA is classified as probationary. Usually, these students fail Calculus which lowers their GPA. Students with low GPA are not allowed to continue taking upper-level engineering courses according to the prerequisite violations established by the Accreditation Board for Engineering and Technology (ABET, 2023).

Hypothesis Testing

The results of the test of independence showed no association between STEM intervention completion and retention in the research study in any comparison pairing of the three groups. The data does not support a difference between the variables presented in this research study. Thus, there is no association between completion of a STEM intervention and the retention rate of at-risk college freshmen students. The study data failed to reject the Null Hypothesis.

Qualitative Data Results

Answers to study's research questions 2a and 2b restated below were explored using Creswell's characteristics of qualitative research inquiry (2015) and through a semi-structured focus group interview. Questions were selected in advance, and participants could add information to the topic if they felt it was important.

RQ2a: As perceived by at-risk college freshmen UTRGV CECS students who completed the intervention, how does a STEM intervention impact program retention?

The first research question was addressed by two semi-structured focus group interviews were conducted face-to-face and via conference using the Zoom platform. The duration of the interviews lasted about 45-60 minutes. To build rapport, students were emailed and described the voluntary process of participating in the research study. A time and place were agreed upon to conduct the protocol questionnaire. During the focus group, introductions between students and researchers took place. Additionally, one student was interviewed individually because the student was unable to attend the focus group interviews. The focus group and individual interviews were recorded. This researcher's positionality for conducting this study was shared with all student participants. Any questions student participants had during the interview process were answered.

The recordings from the two focus group interviews and the one individual interview were transcribed. Using the NVIVO program themes of the qualitative data gathered were identified, discussed, and agreed upon by the researcher and two UTRGV Engineering faculty: an associate chair and an assistant professor as mentioned and detailed earlier on Chapter III. This coding process is known as the Open Coding (Ravitch & Carl, 2021). Open coding is when the interviews are highlighted in sections, those sections are entered into the software, which in this case NVivo was used. Three rounds of coding were done and ultimately vocabulary was turn into codes, codes into general themes and then general themes were narrowed down into specific themes. Finally, a triangulation process took place with two faculty members who organized and lead the STEM intervention. They have been the main instructors of the intervention program and are in constant interaction with the engineering student population. A discussion with them helped with the analysis of data and included by discussing and agreeing on the characteristics of vocabulary used by students, identifying general themes in the information provided by students, and ultimately selecting the five specific themes. The five main themes identified and agreed upon were:

1. Projects & freedom
2. Mentorship
3. Sense of Belonging
4. Family & Higher Education

5. Transitioning from High school to Higher Education

Theme 1: Projects & Freedom

The reason for presenting this theme first is that when the interview started, students felt more comfortable talking about the projects and topics that were not personal. Students liked the idea of working on projects during the STEM intervention, projects that were executed as a group. During this week, students had the opportunity to decide how to execute the different projects. As a group, they decided to come up with innovative ways of reaching a goal requested by the instructors. The most impactful part of the projects was the freedom it gave to students to make their own decisions about their execution of the projects and how even though their ideas did not work some of the time, students were not penalized even if the goal was not met.

"Everything was with the purpose to be innovative, creative, and come out with different ideas."

STEM intervention provided students with the opportunity for learning, being innovative, creative, and able to propose different ideas without being penalized, something students miss nowadays in their courses. They believe that this type of freedom presented in the STEM intervention is no longer provided in regular classes. Having this interview with the students a year complete the STEM intervention, the majority of them reflected that the STEM intervention was important for their immersion in the engineering program. Even though students felt that they were prepared for engineering, during the focus group, they shared how they realized after the STEM intervention, once school started, that attending the university was something completely different from high school to the point they felt overwhelmed and afraid.

"We don't enter into this university already with like a lot of information and knowledge. Right now, we gain information, and later experience."

Going back to the projects in the STEM intervention, students felt the pressure of time constraints and rigor. Students recommended to also allow time to debrief, to relax, and to allow their minds to rest.

> *"Sometimes the STEM intervention was overwhelming, it would be too much work, too much information. Where you feel like you need to take a break because every hour is scheduled non-stop, I mean it's good that they follow the schedule. But after the third day, you start feeling it. You start feeling heavy, and you're like oh, wow! This is a lot of information."*

In general, students enjoyed the STEM intervention, even though they felt it was not that easy, and they were required to work on projects from day one until the end of the week.

> *"What I learned with the projects was time management. It was like a limit of time to do our things, and we had to think really fast.*

Students also recommended to expand the number of days in the STEM intervention to more than one week, if possible, to two weeks.

Theme 1 responses corroborated how STEM interventions provide a support system in which knowledge and skills are developed. As research shows, administrators in higher education are working toward a support system that addresses different categories that will ultimately foster student success. The categories identified by the students in this study address:

1) Knowledge and skills, academic preparation,

2) Performance capability,

3) Motivation, values, and self-concept,

4) Rewards, recognition, incentives, and

5) Tools, environment, processes,

6) Expectations and feedback.

These six categories are specifically supported by past researchers (Araque et al., 2009; Hardy & Aruguete 2014; Reena, 2018)

As students in the interview stated,

> *"We had to learn team member skills because one person wanted to do something the other wanted to do something else, and we know that if we do different things, we're never going to achieve something together."*

Theme 2: Mentorship

Once, students felt more comfortable about expressing their feedback about the STEM intervention, the focus group started talking about how they perceived other aspects of the week at the intervention. Students participating in the STEM intervention were placed with mentors during the whole week. These mentors were graduate assistants enrolled in the same area of study where at-risk college freshmen students enrolled, i.e., if the student was enrolled in manufacturing, then the student was placed with a manufacturing graduate student. Electrical engineering students had an electrical graduate student and so on. During the week, participants of the STEM intervention created a bond with the graduate students. They saw them as mentors and took their advice in many ways. Mentors shared their experiences with classwork, professors, courses, and many other topics.

> *"Not that they're telling me what I had to do, but mentors gave me a lot of a lot of advice, for example, getting into internships, and taking advantage of opportunities the Department of Engineering offers. That is what I'm doing right now, and thank God, everything is going well now."*

STEM intervention participants appreciated the opportunity to be paired with mentors, they understood that this was an opportunity to ask questions, to make friends, and to learn from those who have experienced higher education struggles. Students agreed that it was easier to approach mentors and that their advice meant more than the advice of faculty. This was especially true since some of the participants' concerns were about where to go, and whom to ask at the university. Students mentioned how it felt easier to approach these mentors than faculty, and how the relationship student-mentor felt more natural, compared to having to ask faculty for advice in higher education.

> *"I mean faculty telling you how the college is here, they can only see it from not a student perspective, because the student has a schedule, and he goes to the classes. He knows that this test is going to be hard, and he knows more details in the student life, than the faculty. Mentors know more about it."*

When talking to the students, they shared how they had so many questions, and these questions were more pertinent to mentors, instead of faculty or staff. This response had to do with the little or nonexistent relationship students have with their university faculty and staff. Some of the questions students felt more comfortable asking mentors were the following:

> *"How's engineering? Is it hard? What are you studying? What class should I look out for? Any recommendations on teachers that you take? or how's your experience as a student here? Has it been good? Has it been bad? Are you overwhelmed, or are you stressed?*

Also, students talked about how somehow the STEM intervention and mentors helped during the first days of school to alleviate the anxiety of not knowing where to go and whom to ask questions.

"When I arrived there on my first day, official first thing in the college. I had an idea of who were the staff, whom I could talk to in case there was any question. I don't know the class schedule. I have more questions about engineering. The boot camp showed me who I can talk to and so that gave me a lot of confidence. And that's one of the main things that it gives you that familiarity when you start with your official school year."

Students provided information about how useful it was to be paired with mentors. After the STEM intervention took place, some of the time, students would encounter their mentors at school, at the gym, or the cafeteria, and would still hold conversations about struggles and concerns from student to student. Mentors would still provide advice to the STEM intervention participants during the semester.

"The relationship with the mentor continued because he was very friendly. He helped us out during the boot camp, and then, even afterward I would see him, and I would ask him questions, and he would be more than happy to help me.

However, STEM intervention participants expressed their disbelief when they realized that the mentorship did not last longer than their first semester of school. Most of the mentors were graduate students, who ended up graduating towards the end of the semester. STEM intervention participants recommended to provide the opportunity to have undergraduate students as mentors who would still be available at school longer than just a semester or two. This conversation about undergraduate mentors energized all the participants in the interview group, and they began to share how they would like to be mentors of incoming students. Slowly the majority of the students started agreeing with the idea.

"Yeah, because at the end of the boot camp, I really enjoyed like that mentorship thing, and I want to give back."

Students' responses concluded that it is important to have a support that not necessarily comes from faculty. Students believed that shared experiences with other students was more significant in their journey of higher education. Mentoring research for at-risk students has shown positive impact related to career outcome, career interest, knowledge, and confidence (Sowers et al., 2017). These results align with one purpose of this research study which was find the reasons why students decided to stay in the Engineering program after the STEM intervention was completed. As per students' comments, peer mentoring definitely made a difference in their higher education transition and journey.

Theme 3: Sense of Belonging

Once the conversation became more personal, this researcher had the opportunity to ask students about their sense of belonging in higher education during the STEM intervention and after the STEM intervention took place. Responses varied on this topic. Some students were not aware of this topic. However, students shared how their only focus was to survive the first year knowing that engineering is a tough field of study.

> *"I did feel a little discouraged. In the beginning, I was intimidated. I mean, as nice as they want to say it. Still, engineering is very hard, and everyone knows that it is so. I did feel a little intimidated then. I didn't think of dropping yet, but I knew that it was not gonna be easy."*

Students who participated in the STEM intervention believed that it was normal to feel lonely because they were no longer with their friends from high school, they had new courses, and they were basically on their own. Another important discovery in the interview was the reflection of students stating how being part of the STEM intervention made them feel welcomed, made them feel at home. Nonetheless, when the STEM intervention was over, students shared they did not continue to have the same sense of belonging in their classes or the College of Engineering & Computer Science.

> *"I did feel like a sense of belonging because everyone was in the same boat after boot camp. Then I started feeling like I didn't belong there because everyone was way more knowledgeable. There were seniors, juniors, sophomores, and me. I had just gotten out of high school, and I just joined. I just joined the engineering program in college, so for the first semester, I would say, I didn't feel like I belong there, because everyone already, or at least to me already it looked like they knew what they were doing, and they already had some goals. Oh, I'm gonna accomplish this and this and this and this and this. When to me, I'm barely just figuring out what I'm gonna do."*

The same sentiment was shared by the students about when they started attending college. Incoming college students are usually presented with student organizations, upper-level students, and other mentors. However, according to the STEM intervention students, this encounter was overwhelming because they, as incoming students, were trying to understand a new system to which they did not belong yet. A system in which they believe they are at the bottom of it since most students they interact with already have experience either in their area of study, engineering in this case, or other students already have developed relationships with faculty and/or even have internships.

> *"The first semester I didn't feel like I belonged there. People were a step ahead of me, and yeah, second semester though, after making friends and starting to take more classes in engineering. That's when my belonging started to grow. that's when I started having some friends like-minded"*

Some of the comments of students regarding belonging were related to the general courses taken at the university. It is important to understand that the group of students in the STEM intervention have no college credits, no dual enrollment courses, and are labeled at-risk college freshmen students. These students must take their core curriculum courses mandated by the state. These courses are English, Math, Political Science, History, and Art among others (Texas General Education Core Curriculum, 2023). Students during this transition did not feel that they were able to make friends, and, at times, the same opportunities offered in the STEM intervention were not part of their first courses in higher education.

> *"Your activities got us into talking. So, we can break the ice, you know. Sometimes we are so quiet because nobody says anything. But when somebody starts talking and starts directing an activity then we do talk. We break the ice. We had like more freedom to do things and we don't feel that pressure, like embarrassed and stuff like that, because the first day when I entered, I remember I was like so quiet, I was a little bit, you know, nervous because it was my first time."*

Another important discovery in this part of the interview was the different sentiments shared by international students. These students already had in mind that coming to the United States was not going to be easy and that they were going to struggle. Mentally they were prepared for these changes. Still, this did not mean it was any easier for them. Also, according to them, schools overseas do not implement this much effort toward a sense of belonging. They focus more on the academic side of education.

> *"I'm going to say that for me it was a different experience, well for me.*
> *because I was in high school in Mexico, I had a major change. It was great.*

And I was expecting something difficult, something different. I believe that the sense of belonging is powered by the university here because they all make you feel like a family."

This theme validated students' beliefs about the need to belong and the need for social connectedness. As Baumeister and Leary (1995) stated, human beings have a need to form and maintain at least a minimum quantity of lasting, positive, and significant interpersonal relationships, otherwise, lack of this need ends up in detrimental well-being. As students stated in their responses, they struggle during their first year because going to university is a major change in life, and this change requires the effort to connect with others. However, during school there is little to no time to connect with others. As students mentioned, their routine consisted of going to class, going to work, heading home, and then repeating the same routine the next day. These were their daily routines until they realized the semester was over. The lack of sense of belonging resulted in leaving students with self-doubts or the need to be validated in a program where they believed they had no support. The feelings shared by students support Pillow and others (2015) research on the detriment of well-being that results from the lack of sense of belonging.

Theme 4: Family & Higher Education

The next theme identified was Family and Higher Education. This topic is very particular for our students in the Rio Grande Valley. Avila and Pankake (2016) found that students from this region weigh the decision of education based on

1. Proximity to their family
2. Cost of education
3. Employment opportunities

In the interview, students mentioned how UTRGV, particularly the College of Engineering, was not their first choice. But, because they grew up in this area, their families are here, and financially it was a better decision to stay in the Valley, so they enrolled at UTRGV.

"I'm from Edinburg. Actually. So, I went to high school here in Edinburg, and when I graduated a lot of my friends, came here."

"When I first graduated High school, I was thinking about going to UT Austin, but when I got that financial aid package. It was nice not having to worry about finances coming here at UTRGV and getting like the money I did. I decided to live on campus. So, I live on campus, and I go home like every weekend. So, it's really nice to be on your own, but also be here next to your family."

"Another reason why I am here, is for the family reason, since the majority of them are lawyers, I wanted to be like on some kind of pedestal that's similar to my other brothers. But not exactly the same"

Students took into consideration their roots, class size, and friends, and tried to be in a place that was similar to their experience in high school. However, when they were asked about their familiarity with the campus, faculty, and resources, they responded not having much information about the program, the faculty background, or the institution.

"Ultimately, I'm here on scholarship so kind of helps that I don't really have to pay much, also living at home, so no housing expenses either. So financially, it's the better option."

Their responses were just that they were comfortable in this setting and did not have any idea about the program of engineering, aside from the fact that it is available to us here.

“In respect to being like Hispanic, and I know, like a lot of the people I have a class with. They're Hispanic as well, and of course, they like from all different places. But I feel like that makes me feel that there is a sense of belonging here”

“In high school, it was a small class. So almost everyone knew each other and it. And so, with engineering here, since it is like, I wouldn't say it’s a lot but it’s enough. Where you can almost recognize almost anyone. It’s similar in that sense. It's nice.

Some of the students had no full interest in engineering, but due to the boot camp they decided to stay:

Originally, I wanted to be a pediatrician in high school I went to a medical Oriented high school, but then, later on, I realized like it really wasn't for me. When I got into the boot camp I went into computer engineering, due to like the creativity behind it and a little research I decided to stay.

Another student responded similarly with the same enthusiasm that the STEM intervention or Bootcamp was the reason why Engineering was the major he now wanted to pursue.

“The thing that kind of kept me in the program was the boot camp because I’m not big on math, but the thing that keeps me motivated to stay in the program is the desire to want to know how to understand the mechanism of things, to understand things better, and how they work better. and to maybe the future product or something regarding that and the boot camp itself well was a lot more fun.

As stated by Avila & Pancake (2016), there is a need to create support systems for students in the South Texas region, especially when the support consists of financial support, since we live in a system that grants advantages to those of privilege. Students in the study’s focus groups verified that their decisions to attend UTRGV was based on financial needs, family proximity, and job search opportunities. It is critical for administrators in higher education to provide well-structured and executed STEM interventions to college students to support their needs. STEM interventions can serve as such long-term strategies, as suggested by Avila and Pancake (2016), to reduce inequities in our education system.

Theme 5: The transition from high school to higher education

The majority of students recognized that their first year at school was not the best. They encountered several obstacles, felt lonely, and did not have many friends, despite going to school where the majority of their high school friends were.

> *"The first year here wasn't the best, it was more of a mental block need for me. It was just a mental blockage where I kind of just go to class, go home, go to class, go home. it was mainly my experience during the first year, but it changed totally."*

Students even felt alienated in their core courses. As mentioned before, at-risk college freshmen students are required to take their core courses, which already means they are somehow behind as compared to those students who came with college credits, dual enrollment credits, and advanced courses. The students in the focused group expressed a sentiment in which they felt vulnerable to the point that they believe there was no community, no sense of belonging and they just had to pull through those courses.

> *"Obviously, people are more passionate about political science, whereas, like myself, I'm kind of laid back. I'm just kind of there for the grade, and that's it. But in engineering, you know, I'm actually trying to learn and trying to apply what I learned."*

As soon as one of the students started talking about the sentiment for the core courses, more and more students started expressing the same feeling about these types of courses.

“Engineering just felt like more natural compared to like Texas Government. In Texas governed you feel like kind of like an alien. because it's something I’m not really interested in, and I just wanted to get over it.

Although, when students started taking engineering courses, they felt some excitement because, at this point, they were going to move into the hands-on building, dismantling, and innovating. Now they were going to focus on learning what they thought was going to be “cool”

“I notice you know, within all my engineering classes that pretty much everybody's excited.”

What is remarkable about this conversation was that students enrolled in engineering did not see their core courses as relevant. They have this idea that these courses are part of their curriculum, but ultimately, they will not apply their learning as they will with their engineering courses. They emphasized that they felt this way because the required core courses are not as challenging as the engineering courses.

“I just felt an inclination about the engineering classes. This really didn't happen with the core ones. So, as I started taking more specific courses. I felt more passionate. This is my third engineering class. I like taking engineering materials, for example, mechanical analysis one, more specific towards, I guess, what I’m truly interested in.

The chemistry and physics classes are kind of, I mean, they were obviously interesting, but I want to start taking the harder the more important classes.”

“I will say the same, I do like that, challenges, that's what keeps me engaged, and what helps me to stay in this major.”

“I can't see myself doing history or not. That's not interesting to me.”

Students felt that when they transition to their engineering courses, they will have more contact with engineering student organizations. They could then focus on projects that mattered and where they can utilize their learning. They also start having friends with similar mindlike and goals.

> *"So, in my second semester here I was thinking about dropping out or changing majors. but I have that mentality of just kind of go with it. See how it goes, and the more I continued, the more I said, yeah, I am gonna stick to engineering. And since I like to work with my hands, I felt staying with mechanical engineering was my best bet."*

Finally, the last question asked the STEM intervention completers during the focus group interviews was what improvements or changes they would recommend for the STEM intervention. Several responses and opinions arose during this part of the conversation. The majority of the students agreed that it was a great opportunity to spend some time at the STEM intervention with students who are also going to study engineering. This allows them to recognize faces when going to their core courses. Also, the STEM intervention provided an opportunity to humanize the faculty members who presented in the intervention. Students definitely enjoyed this part of the intervention because they felt some sort of connection with the faculty members.

> *"I remember one of the faculty there. I do not remember her name. I think she's from another place, but I remember she told us her story about how much she struggled when she was a student with a baby, and she said she had a lot of stress. One of the things she knew is that she never gave up, and she had time management. I remember her advice to us whenever we woke up. Do not go straight to the phone, because that takes a lot of your time to like to not do other important things, you know. So that is what keeps me going."*

Students also liked the structure of the STEM intervention, lectures, and projects, but had some mixed feelings about the grouping. Some students agreed on setting up groups by majors, while others enjoyed being grouped across interdisciplinary majors instead. The schedule timing was also not a problem for the students. They enjoyed being there all day.

As stated earlier, over 97% of UTRGV students are eligible for Title 1 programs which include free and reduced meals, with nearly 35% of them requiring assistance to overcome a learning disability, and nearly 40% classified as having limited English proficiency (Region One Education Service Center, 2021). Students in this research study are students who do not have college credits, they met the minimum requirements to be accepted to UTRGV, hence, were labeled at-risk college freshmen students. Transition to Higher education was definitely a challenge for them. Sithole et al., (2017) suggests that in order for these at-risk students to be successful it is important that universities create a system of mentoring known as interventions. Students in the focus groups expressed their concerns through their first year of school and how the STEM intervention was a temporary system support for them. While students went back to what they learn from the STEM intervention, they believed that there was the need of a follow up to check on them, a continuation of the initial STEM intervention.

RQ2b: As perceived by at-risk college freshmen UTRGV CECS students who completed the intervention, how can a STEM intervention be improved to support program retention?

Improvements recommended for STEM Intervention

In response to finding recommendations for the STEM intervention, several items were discussed:

1. Mentors,
2. Grouping of students

3. Time management of the projects
4. STEM intervention duration

1) Mentors: Students agreed that mentors were crucial to gather advice and information on higher education. However, the time they could take advantage of them was only for one semester. Hence, their recommendation was to employ students who are not about to graduate. Some participants provided their information so they could be mentors for the upcoming STEM intervention in the summer of 2023.

2) Grouping of Students: Participants were well divided with several students preferring to be grouped with students in their same major, while other participants preferred grouping with students with different majors. The reasons some participants preferred to be grouped with the same major included starting to know those people who in the future will be in the same engineering courses, have similar likes, and even a similar major. Participants who preferred to be grouped with other majors wanted to get to know other people in engineering and begin increasing their network in engineering.

3) Time management of the projects: Students felt somehow overwhelmed by the structure of the STEM intervention projects, to the point that there was no resting time, except for lunch. They felt that it was a constant stress going over and over different projects. Their advice was to pick fewer projects and to make them a two-day project instead of an hour project. According to students, this was going to bring a sense of challenge, but at the same time less stressful time. Some of the feedback the participants shared included having sports integrated so they would be able to relax their minds from so much fast-paced engineering.

4) STEM intervention duration: The majority of the participants wished the STEM intervention to last more than one week. They recommended two weeks. Another important

aspect was the follow-up. Some of the participants recommended STEM intervention follow-ups in the middle of the semester. Students who participated in the STEM intervention were boosted with energy to start their semester; however, they felt lonely, and not belonging to engineering or higher education towards the middle or end of the semester. Their recommendation was to have the STEM intervention reach out to them and check on them, maybe not for a whole STEM intervention week, but for some time to talk about their semester, their struggles, and their thinking. They strongly suggested this follow-up could be done by engineering students, rather than by faculty.

In summary, this chapter presented the results of a mixed-method study. Quantitative results of the chi-square test of independence method focused on the association between completion of a STEM intervention and retention rate of at-risk college STEM freshmen students. The sample student population was organized into three different groups: at-risk STEM freshmen students who completed the STEM intervention, at-risk STEM freshmen students who did not participate and did not complete the STEM intervention, and at-risk STEM freshmen students who participated but did not complete the STEM intervention. Results of the Chi-square test of independence showed no statistically significant association between STEM intervention completion and retention among these three groups. Thus, no association between STEM intervention completion and retention of at-risk college STEM freshmen students was supported by this study's data and results. Thus, the data failed to reject the study's Null Hypothesis. However, as noted in the prior data analyses, retention rates among the different study groups were strikingly different:

- Completed STEM intervention or completers (COMP) retention rate: 76.0%

- Did not participate and did not complete STEM intervention or non-completers (NCOMP) retention rate 69.7%
- Did participate and did not complete STEM intervention (PNCOMP) retention fate 62.9%
- All sample population retention rate 69.8%

It is important to point out that those students with the highest retention rate are the students who completed the STEM intervention at 76% retention compared to the whole sample population retention rate of 69.8%, the non-completers with a 69.7% retention rate, and the students who participated and did not complete with a 62.9% retention rate. It is critical to note that that the Chi-square test includes limitations. One limitation is that it is very sensitive to sample size (McHugh, 2013). Since the population size of the non-completers was almost eight times larger, this large difference in group sample size may have limited identifying association. Another Chi-square test limitation is that an individual cannot fit in more than one category (McHugh, 2013). This limitation, however, was accommodated by separating the students who participated in but did not complete the STEM intervention into their own group for analysis.

Additionally, students who were not retained and completed the STEM intervention switched majors to History, Kinesiology, Criminal Justice, Marketing, Management, Accountancy Music, Multidisciplinary studies, and other majors. Moreover, these students earned a grade point average (GPA) below or close to 2.0, restricting their college progress.

The qualitative part of the research study consisted of two focus groups and one interview protocol. Participants for the qualitative research part were selected through homogenous purposeful sampling. The results of these semi-structured interviews provided the reasons at-risk college STEM freshmen students decided to continue in the STEM program and provided student input on how to improve STEM intervention. The next chapter will present the summary of the study, research questions, review of the study design, population and data collection, data analysis, and summary of major findings along with conclusions and recommendations for further studies.

CHAPTER V

CONCLUSION

This research study was conducted with at-risk college freshmen students from the College of Engineering & Computer Science (CECS) at the University of Texas Rio Grande Valley (UTRGV). This mixed methods study had three purposes. The first purpose was to describe and explain if there was an association between completion of a STEM intervention and retention after the first year of at-risk college freshmen students in a STEM program. The second purpose of this study was to identify the reasons STEM students decided to stay in the program after completing a STEM intervention. The third purpose was to identify student suggestions on how to improve the STEM intervention.

In this chapter, the researcher provides a summary of this mixed methods study including research questions, a review of the study design, population and data collection, data analysis, and a summary of major findings along with conclusions and recommendations for further studies.

Research questions

This mixed methods study aimed to answer the following research questions:

RQ1: Is there an association between the retention rate of at-risk college freshmen UTRGV CECS students who complete a STEM intervention and similar students who do not complete a STEM intervention?

RQ2a: As perceived by at-risk college freshmen UTRGV CECS students who completed the intervention, how does a STEM intervention impact program retention?

RQ2b: As perceived by at-risk college freshmen UTRGV CECS students who completed the intervention, how can a STEM intervention be improved to support program retention?

Study Design

This study consisted of mixed methods of data collection. The quantitative part of the research study focused on identifying if an association existed between at-risk STEM freshmen students completing a STEM intervention and STEM program retention. A test of independence X^2 (chi-square) was used to find if there was an association between the retention rate of students and the completion of a STEM intervention. The hypothesis of this study is to identify if there is an association between students who completed the STEM intervention and retention in the engineering program. This hypothesis used an alpha of 0.05 to determine whether to reject or fail to reject the null hypothesis that no association exists between STEM intervention and retention among at-risk STEM freshmen students.

The two main groups that were compared are:

1) A group of at-risk college STEM freshmen students who completed the STEM intervention and

2) A group of at-risk college STEM freshmen students who did not participate and did not complete the STEM intervention.

A third group was identified and separately measured to ensure the two main groups were not tainted by their inclusion: at-risk college STEM freshmen students who participated and did not complete the STEM intervention. These groups were categorized as shown below.

- Group 1 COMP: Students who COMPLETED the STEM intervention

- Group 2 PNCOMP: Students who ACCEPTED, PARTICIPATED, BUT DID NOT COMPLETE the STEM intervention.
- Group 3 NCOMP: Students DID NOT ACCEPT to participate in the STEM intervention and the few students who ACCEPTED BUT DID NOT PARTICIPATE AT ALL in the STEM intervention.

The qualitative part of the research study consisted of the perceptions of a focus group of at-risk college STEM freshmen students who completed the STEM intervention. These students were asked to provide information about why they decided to continue in the STEM program after completing the STEM intervention. Information about how to improve the STEM intervention was also gathered.

Population and data collection

The quantitative research part of the study was conducted by comparing three groups of UTRGV 2021 and 2022 at-risk freshmen students. One group was comprised of at-risk college STEM freshmen students who declared engineering as their major and completed the STEM intervention. A second group was comprised of at-risk college STEM freshmen students who declared engineering as their major and did not participate participated and did not complete the STEM intervention. A third group materialized after reviewing the data: at-risk college STEM freshmen students who participated and did not complete the STEM intervention. This part of the research aimed to find if there was an association between the completion of the STEM intervention and the retention rate of at-risk college STEM freshmen students.

The qualitative research part of this study was conducted by inviting students who successfully completed the STEM intervention to participate in a focus group interview. A semi-structured interview of at-risk CECS freshmen students who completed the STEM intervention took place with two focus groups and one individual student.

Data analysis

Once UTRGV Institutional Review Board for Human Subjects Research approved the research study, data from the Office of Student Success was retrieved. A list of at-risk college freshmen students who declared their major in Engineering for the years 2021 and 2022 was retrieved. Attendance lists for the STEM intervention for these two freshmen cohorts were requested from the faculty in charge of the program. The collection of this data allowed us to categorize students who completed the STEM intervention and students who were retained in the program. This information was analyzed in SPSS. To answer RQ1, a statistical analysis was completed. This analysis included descriptive statistical analysis, a Chi-square test of independence with an alpha level of confidence of 0.05.

RQ2a and RQ2b required a qualitative approach. The case study method was used to answer these research questions and to gain an understanding the in-depth context of the at-risk college freshmen students and the STEM intervention impact. Two focus student group interviews and one individual interview took place. The selection of participants was done through homogenous purposeful sampling. The theoretical framework used for this research study is based on the sense of belonging by Baumeister and Leary (1995).

Summary of major findings

This mixed methods research study aimed to sample at-risk college freshmen students from the College of Engineering & Computer Science (CECS) to describe and explain the association between completion of a STEM intervention and retention after the first year. The second purpose of this study was to find the reasons STEM students decided to stay in the program after completing a STEM intervention. The third purpose was to solicit student suggestions on how to improve the STEM intervention.

RQ1: Is there an association between the retention rate of at-risk college freshmen UTRGV CECS students who complete a STEM intervention and similar students who do not complete a STEM intervention?

This research study included the following Fall 2021 and Fall 2022 at-risk CECS freshmen students. A population of N= 484 of the students were labeled to be UTRGV CECS at-risk college freshmen students. Table 11 shows the participation on the STEM intervention from the at-risk students.

Table 11: CECS At-risk Student Participation

	Students	
Students who agreed to participate and COMPLETED STEM intervention (COMP)	50	10%
Students who agreed to PARTICIPATE and did NOT COMPLETE the STEM intervention (PNCOMP)	35	7%
Students who did NOT PARTICIPATE or did NOT COMPLETE the STEM intervention (NCOMP)	399	83%
Total At-risk college freshmen students identified in Engineering	484	100%

A summary of the retention rates of students who either completed the STEM intervention, participated, or did not participate is presented below on Table 12.

Table 12: Retention Rate of Students in the Research Study

Retention Rate of Students in the Research Study		
Group	% Of Students Retained	% Difference from All
COMP	76.0	6.2
NCOMP	69.7	-0.1
PNCOMP	62.9	-6.9
PNCOMP/NCOMP	69.1	-0.7
All	69.8	

A test of independence X^2 (chi-square) was used to answer the first research question. The Null Hypothesis for the present study was tested at the 0.05 level of significance. This quantitative study had a 95% confidence interval. The parameter in question needs to be different from zero. The Chi square test of independence (X^2) results showed no statistical significance in the comparison of the groups in the research study. No association was found in the research study.

RQ1 Research Hypothesis, H_1: There is an association between the retention rate of at-risk college freshmen UTRGV CECS students who complete a STEM intervention and similar students who do not complete a STEM intervention.

RQ1 Null Hypothesis, H_o: There is no association between the retention rate of at-risk college freshmen UTRGV CECS students who complete a STEM intervention and similar students who do not complete a STEM intervention.

Results of the test of independence showed no statistical significance, hence, there is no association between the completion of a STEM intervention and the retention rate of at-risk college freshmen students. The data failed to reject the Null Hypothesis. However, as noted in

Table 12 the data showed that students who completed the STEM intervention had a much higher retention rate than students who did not complete the STEM intervention. Failure to reject the null hypothesis may be due to limitations in the Chi square test of independence related to group sizes. This will be discussed further.

RQ2a: As perceived by at-risk college freshmen UTRGV CECS students who completed the intervention, how does a STEM intervention impact program retention?

RQ2b: As perceived by at-risk college freshmen UTRGV CECS students who completed the intervention, how can a STEM intervention be improved to support program retention?

The qualitative data results identified five major themes.

1. Theme 1- Projects & freedom: Students appreciated the fact that they were allowed to “think outside the box.” They believed that hands-on projects were challenging, however, that sparked their interest in engineering. The difference between the STEM intervention and regular coursework made students feel a disconnect. Regular coursework does not allow that much freedom.
2. Theme 2 - Mentorship: Students in the STEM intervention connected with faculty, student organizations, graduate students, and among themselves, incoming freshmen. The strongest bond happened between STEM intervention participants and graduate student mentors. However, this relationship did not last more than a semester in most of the cases.
3. Theme 3 - Sense of Belonging: Students believed that during the STEM intervention, they had a group of people to support them, however, when the regular school year started, they felt alienated from their core curriculum courses, and from the College of Engineering & Computer Science. Also, these students

who participated in the STEM intervention felt they did not belong to the program in Engineering because they had no experience or knowledge in the field compared to the rest of the students who had been already longer in the program.

4. Theme 4 - Family & Higher Education: Students in this program showed a level of importance to family and education. Even though some students received acceptance into other programs and universities, their final decision came down to being close to family and to the resources available locally. Family places a big role, in these student's life. Students who decided to attend UTRGV College of Engineering & Computer Science mentioned how they were seeking that feeling of being close to or almost at home.
5. Theme 5- Transitioning from High School to Higher Education: Students interviewed understood that the engineering discipline is not easy. Transitioning from high school to higher education was not easy either. Students mentioned how, in their first year they either thought about changing their majors or quitting higher education. However, family, friends, faculty, and mentors made a difference. Also, personal resilience. Students mentioned how their future was uncertain, but small changes could make a difference in their present, and maybe this would have an impact on their future.

Additionally, analysis of data from those students who completed the STEM intervention and were not retained in the program showed that students decided to change majors. Some of these non-retained students earned GPA below or close to the 2.0 average. This low GPA is considered a probationary at the CECS and restricts students from taking higher level courses.

Conclusion and Implications

This research investigated whether a statistically significant association between STEM intervention completion and the retention rate of at-risk college CECS freshmen students existed. Feedback from the qualitative research part of the study provided the opportunity to understand the reasons why students decided to enter the UTRGV Engineering program. Participants provided information about why they decided to remain in the Engineering program past their first year and how the STEM intervention had impacted their journey in their first year in higher education. Although there was no association between STEM intervention completion and retention, the CECS can still make changes to the STEM intervention and seek a new data study. In conclusion, the following recommendations based on student feedback and research studies are provided.

Recommendations

STEM intervention marketing

The research study failed to reject the null hypothesis concluding that there was an association between STEM intervention completion and the retention rate of at-risk college freshmen students. The population of students who completed the STEM intervention had a retention rate of 76% compared to the general population with a retention rate of 69.8% retention rate. The recommendation is to promote the STEM intervention during the orientation of students, the Round-up event, and during the tours provided to the incoming freshmen students. Increasing the number of students may provide a different outcome in the association of the variables in the research study. The College of Engineering and Computer Science has started to be more proactive about the STEM intervention, and students are aware that this support system is available, however, incoming freshmen are not familiar with this opportunity.

Mentors

Every year the STEM intervention called Bootcamp at the College of Engineering takes place. Mentors tend to be graduate students who provide a sense of belonging and friendship to the STEM intervention participants. The recommendation suggested by the study is to hire those students who have been part of the previous STEM interventions to work with the new students in the STEM intervention. CECS should create opportunities for STEM intervention completers to be mentors. Because they were once STEM Intervention participants, they understand the challenges faced by at-risk college freshman students and the benefits students can learn from STEM Intervention. Past STEM Intervention completer students could be undergraduate students or graduate students. According to Hendry et al. (2022), mentorship provides benefits to both mentor and mentee students, such as improving their academic abilities and professional skills. Mentor and mentees can also increase their confidence and awareness of their academic journey. Specifically, graduate students could share information about a research interest with STEM intervention students. Thus, they can spark interest in research areas more so than undergraduate STEM intervention mentors. A combination of undergraduate and graduate STEM students can provide a well-rounded mentorship for STEM intervention participants.

STEM Intervention follow-up

The length of the STEM interventions can vary in time, they can be done in as little as two hours or can take up to four years, which is generally the time it takes an undergraduate student to finish a degree (Colquitt, 2021). The CECS provides the opportunity to participate in a STEM intervention every year a week prior to entering the regular semester. However, participants in the research study mentioned several points.

1. During the STEM intervention, participants feel a sense of belonging. They incorporate a group of people that recognizes them as part of the engineering student body.
2. Students receive plenty of information about the engineering program. This information allows students to interact with other students in the engineering program, staff, and faculty at the CECS. This information provided ranged from information about their degree plan, undergraduate coordinators, Dean's office, faculty in the program, scholarships, student organizations, internships, and research opportunities.
3. Through mentorship during the STEM intervention week, students established friendships with some of their mentors. They were able to get to know people they will spend the following four years of undergraduate courses.

Students expressed their gratitude for the opportunity provided by the STEM intervention. However, once students go to their first regular classes, students expressed how their sense of belonging appeared compromised. Their recommendation was to provide a follow-up after STEM intervention. Follow-up does not necessarily have to be a whole week program, but maybe a one-day intervention during the middle of the semester, or once a month over during a weekend. These short STEM interventions help follow up with the students academically and mentally. Short-term interventions have proven to also have a positive impact on student attitudes (Boeve-de Pauw et al., 2022).

Recommendations for Future Research

The present study focused on finding if association existed between student STEM intervention completion and retention and identifying student suggestions on how to improve retention the STEM intervention. There are multiple opportunities to continue studying this topic since there are few or very specific studies about STEM interventions in higher education (Hite & Spott, 2022; Reena, 2018; Tomasko et al., 2016). Research and publication on this topic are relevant and in need. Producing enough numbers of graduates who are prepared for STEM occupations has become a national priority in the United States (Chen, 2015; The White House, 2016; The White House, 2022). Hence, future research on how to retain these students in STEM programs has great potential to support this national priority. Future research should work toward finding a larger number of students completing the STEM intervention and more comparable to the number of students who do not complete the STEM intervention to minimize possible population size effect. Additionally, the current study was a mix method research study focused on a one-week STEM intervention program. Future research is recommended to focus on an association between longer than one-week STEM intervention completion and retention of at-risk students. This research study focuses only on at-risk college freshmen students according to the description of UTRGV student success. Another recommendation for future research is to expand the student population to first-year students, first-generation students, low socioeconomic status students, females, minority students, and other student groups that need greater support in college STEM program retention. Increasing the number of participants, would help improve one of the limitations of sample size in a chi-square research method.

In addition, those students who dropout from the program could be another focus. A research study could focus on why they decided to dropout and how to be able to retain them into the STEM program.

Closing remarks

STEM interventions in higher education are trying to close an existing gap between representation in education and the workforce among other disciplines (Ayuk & Jacobs, 2018). Although this research study did not find an association between at-risk college freshmen student retention and STEM intervention completion, results from other studies support that these STEM interventions do make an impact on students. This study did find that STEM intervention can have an impact on student completers beyond just retention. An example is a student in the study who stated he was not even considering engineering, however, by participating in the STEM intervention, the student decided to stick to engineering:

> *"Originally, I wanted to be a pediatrician in High School, I went to a medical-oriented high school, but later, I realized that it wasn't for me. Then when I got into the boot camp (STEM Intervention), what I could really call out on is the egg drop. There are multiple ways to do it, and everyone has the freedom to choose which way they want to do it. There are many ways to do it right. You know what I mean. Like the way that I did it. It could be right. But then the way someone else did it could be completely different. But it could still be right as well. So that's sort of just solidified my decision, and just push me into engineering. So, I went into Computer Engineering."*

Freshmen students in higher education need to be nurtured and validated, they need a system of support based on peer relationships, and the feeling of integration (Sáinz et al., 2022). Sometimes, students do not believe in themselves. They do not believe Engineering is for them. However, with STEM interventions aimed at helping students succeed, as one student commented, students can gain confidence that Engineering is not only about being good in math, difficult classes, or about your IQ, but about resilience and dedication, grit, and mentors:

"I'm not big on math, but the thing that keeps me motivated to stay in the program is the desire to want to know how to understand the mechanism of things, to understand things better, and how they work. And maybe in the future, I'll be able to produce something. The boot camp itself, well, is a lot more fun than the classes I'm taking right now, but boot camp made me appreciate engineering a lot more because harder courses themselves are discomforting, and they may push us away. But as I learned in the boot camp and that's what I was saying to others. Because a group of students was sending me messages that they were very discouraged in one of the classes, and I told them to find resources, find mentors, to find different ways to continue. Don't, get discouraged."

Allowing students, the opportunity to continue and to believe they can succeed in STEM can be achieved by having a good structured methodological STEM intervention (Sáinz et al., 2022). It is strongly recommended that STEM interventions not be taken for granted, because at-risk students will benefit from these programs and, in time, they will be able to increase their representation in the STEM areas. This study was conducted by a Latina, female engineer who beat the odds by succeeding in a male-dominated field known as ENGINEERING. Currently, in 2023, this Latina female is the only female faculty member at UTRGV College of Engineering & Computer Science in the Manufacturing & Industrial Engineering Department. With strong STEM interventions, there will be greater representation of at-risk and minority students in STEM college programs.

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APPENDIX A

APPENDIX A

CITI Certificate 1

The Collaborative Institutional Training Initiative (CITI) Program certifies that Edna Orozco successfully completed the Web-based training program Responsible Conduct of Research, Social and Behavioral Responsible Conduct of Research Course 1.

1.-Basic Course

CITI PROGRAM

Completion Date 01-Sep-2020
Expiration Date 31-Aug-2024
Record ID 38181635

This is to certify that:

Edna Orozco

Has completed the following CITI Program course:

Not valid for renewal of certification through CME. Do not use for TransCelerate mutual recognition (see Completion Report).

Responsible Conduct of Research (Curriculum Group)
Social and Behavioral Responsible Conduct of Research Course 1. (Course Learner Group)
1 - Basic Course (Stage)

Under requirements set by:

University of Texas Rio Grande Valley (UTRGV)

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?wf1e973ef-ba5c-4f86-afe6-38f1dc85dba4-38181635

APPENDIX B

APPENDIX B

CITI Certificate 2

The Collaborative Institutional Training Initiative (CITI) Program certifies that Edna Orozco successfully completed the Web-based training program Basic/Refresher Course – Human Subjects Research Social Behavioral Research Investigators and Key Personnel.

1.- Basic Course

CITI PROGRAM

Completion Date 01-Sep-2020
Expiration Date 31-Aug-2024
Record ID 38181621

This is to certify that:

Edna Orozco

Has completed the following CITI Program course:

Not valid for renewal of certification through CME. Do not use for TransCelerate mutual recognition (see Completion Report).

Basic/Refresher Course - Human Subjects Research (Curriculum Group)
Social Behavioral Research Investigators and Key Personnel (Course Learner Group)
1 - Basic Course (Stage)

Under requirements set by:

University of Texas Rio Grande Valley (UTRGV)

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?wa2d03351-7a5c-4f13-bac3-cad618dd38c8-38181621

APPENDIX C

APPENDIX C

Letter to request archival data information from the Office of Strategic Analysis and Institutional Reporting

To may whom it corresponds:

I am a doctoral student at the University of Texas Rio Grande Valley, I am researching to fulfill the requirement for Doctorate in Educational Leadership (EdD) degree. The purpose of this research study is to sample UTRGV at-risk college freshmen students from the College of Engineering & Computer Science, to describe and explain the association between retention after the first semester of at-risk college freshmen students in a STEM program and completion of a STEM intervention. The second purpose of this study is to identify find the reasons STEM students decided to stay in the program after completing a STEM intervention. The third purpose is to identify how to improve the STEM intervention.

This letter is to request permission to get information from the Office of Strategic Analysis and Institutional Reporting of students enrolled in the College of Engineering and Computer Science. I will need access to demographic information, socioeconomic status, parental education, ACT/SAT scores, academic major, Grade Point Average (GPA) at the time of enrollment, year of admission, gender, and college readiness information. All information collected will be completely confidential and be coded in a manner that keeps the data anonymous, and no individual names or institutions will be recorded. The data will be stored electronically in a secure place. Upon completion of this study, I will share a summary of the findings with you. If you have any questions regarding the study, please do not hesitate to contact me.

Sincerely

Edna Orozco, edna.orozco01@utrgv.edu, Principal Researcher
Dr. George Padilla, george.padilla@utrgv.edu, Chair of the Dissertation Committee.

APPENDIX D

APPENDIX D

Letter to Dr. Ala Qubbaj, Dean of the College of Engineering and Computer Science

Dr. Ala Qubbaj
Dean of CECS
Dear Dr., Qubbaj

I am a doctoral student at the University of Texas Rio Grande Valley, I am researching to fulfill the requirement for Doctorate in Educational Leadership (EdD) degree. The purpose of this research study is to sample UTRGV at-risk college freshmen students from the College of Engineering & Computer Science, to describe and explain the association between retention after the first semester of at-risk college freshmen students in a STEM program and completion of a STEM intervention. The second purpose of this study is to identify find the reasons STEM students decided to stay in the program after completing a STEM intervention. The third purpose is to identify how to improve the STEM intervention.

This letter is to request permission to get conduct a research study with students from the College of Engineering and Computer Science. Upon approval, all information collected will be completely confidential and be coded in a manner that keeps the data anonymous, and no individual names or institutions will be recorded. The data will be stored electronically in a secure place. Upon completion of this study, I will share a summary of the findings with you. If you have any questions regarding the study, please do not hesitate to contact me.

Sincerely

Edna Orozco, edna.orozco01@utrgv.edu, Principal Researcher
Dr. George Padilla, george.padilla@utrgv.edu, Chair of the Dissertation Committee.

APPENDIX E

APPENDIX E

Open Ended Questionnaire for the Qualitative part of the research study.

The purpose of using a mixed methods research study is to understand a phenomenon more fully than is possible using either quantitative or qualitative design alone (Mills & Gay, 2019).

Participants for the qualitative research part will be selected through Snowball sampling known as ***homogenous purposeful sampling***. According to Creswell (2015), purposeful sampling is used in qualitative research because participants in the study can purposely inform an understanding of the research problem and central phenomena of the study. The focus of the qualitative approach is to understand the reasons UTRGV at-risk college freshmen students give for continuing in a STEM program after being part of a STEM intervention. ***Case Study Data collection*** will be through individual open-ended interviews and focused groups (Creswell, 2015). One of the characteristics of qualitative research methods is that it follows an inductive research design (Mills & Gay, 2019).

RQ1: Is there an association between the engineering program retention of at-risk college freshmen engineering students who complete a STEM intervention and similar students who do not complete a STEM intervention?

RQ2a: As perceived by at-risk college freshmen engineering students who completed the intervention, how does a STEM intervention impact engineering program retention?

RQ2b: As perceived by at-risk college freshmen engineering students who completed the intervention, how can a STEM intervention be improved to support engineering program retention?

What were participants' most notable experiences of belonging during their first year of college?

1. Describe what it feels like to belong to a place like UTRGV. (Rapport)
2. Describe the feeling of getting to university in your first semester.
3. Explain what resources you knew in your first semester. Did you have any college credits?
4. How familiar were you with engineering, the college, the department, the faculty, the building, and the institution before participating in the STEM intervention?
5. Describe how it felt when you started your first semester at school.
6. Describe how it felt to be part of the STEM Engineering intervention. Research
7. Was the information presented in the intervention useful?
8. Tell me about the relationship between you and the mentors (students, faculty, graduate assistants) in the STEM intervention.
9. What was the feeling you had meeting other students in the intervention?

Continuation of APPENDIX E

How did participants' perceived sense of belonging change over time throughout their first year of college?

10. Think back to when you arrived on campus and the time when you were part of the STEM intervention: Tell me about a time during those first few weeks when you felt particularly accepted or respected. What made you feel accepted or respected?
11. Compared to the first few weeks of the fall semester, how has your sense of being in the engineering program changed? What are the circumstances impacting this change?
12. How important do you think it is to feel a sense of belonging after the STEM intervention?

How did others, including peers, faculty, and staff, feature in their accounts of developing a sense of belonging?

13. Describe what it feels like when you belong to a group of people in the STEM engineering intervention.
14. Describe an interaction with one of your professors that made you feel cared about, accepted, or valued compared to the engineering intervention.
15. What reasons would you provide that made you stay in the STEM program?
16. What information could you provide about how to improve the STEM intervention?

APPENDIX F

APPENDIX F

Hello,

My name is Edna Orozco, I am a student from the Department of Educational Leadership at the University of Texas Rio Grande Valley (UTRGV). I would like to invite you to participate in my research study to participate in a focus group. The study consists of

"FORECASTING RETENTION AMONG AT-RISK COLLEGE FRESHMAN STUDENTS THROUGH COMPLETION OF A STEM INTERVENTION"

This research study has been reviewed and approved by the Institutional Review Board for the Protection of Human Subjects (IRB) at the University of Texas Rio Grande Valley.

Participation in this research is completely voluntary, you may choose not to participate without penalty.

As a participant, you will be asked to be part of a focus group (group interview) which should take about 1 hour to complete. All data will be treated as confidential***; no names will be recorded, and the responses will be confidential and will not identify the individuals in the group.***

If you would like to participate in this research study, please reply to this email with "I agree". If not, simply reply "I do not want to participate." If you agree further information about the time will be sent in another email.

A $50 gift card will be provided to those completing the group interview (focus group)

If you have questions related to the research, please contact me by telephone at 956-681-6259 or by email at edna.orozco01@utrgv.edu

Thank you for your cooperation!

UTRGV
The University of Texas
Rio Grande Valley
UTRGV.edu

Edna Orozco-Leonhardt
Lecturer II
Assessment Coordinator MAIE
Undergraduate Coordinator MAIE
Department of Manufacturing & Industrial Engineering
EENG 3.2104
(956) 665- 2606 edna.orozco01@utrgv.edu
Brownsville • Edinburg • Harlingen

APPENDIX G

APPENDIX G

IN-PERSON RECRUITMENT LETTER

My name is Edna Orozco, I am a student from the Department of Educational Leadership at the University of Texas Rio Grande Valley (UTRGV). I would like to invite you to participate in my research study to participate in a focus group. The study consists of

"FORECASTING RETENTION AMONG AT-RISK COLLEGE FRESHMAN STUDENTS THROUGH COMPLETION OF A STEM INTERVENTION"

This research study has been reviewed and approved by the UTRGV Institutional Review Board for the Protection of Human Subjects (IRB).

In order to participate you must have participated and completed the STEM intervention (boot camp) in the year of 2021 or 2022.

Participation in this research is completely voluntary, you may choose not to participate without penalty.

As a participant, you will be asked to be part of a focus group (group interview) which should take about 1 hour to complete. All data will be treated as confidential***; no names will be recorded, and the responses will be confidential and will not identify the individuals in the group.***

If you would like to participate in this research study, please sign in this paper and provide your email address and phone number, you will be sent an email with further information about the time of the focus group.

Do you have any questions now? If you have questions later, please contact me by telephone or email.

A $50 gift card will be provided to those completing the group interview (focus group)

My telephone is 956-681-6259 or by email at edna.orozco01@utrgv.edu

"You may also contact my faculty advisor Dr. George Padilla at geroge.padilla@utrgv.edu

APPENDIX H

APPENDIX H

COMPENSATION TO HUMAN SUBJECT PARTICIPANTS PROVIDED BY RESEARCHERS' PERSONAL FUNDS Agreement

I Edna Orozco acknowledge that I am submitting a human subject study for Institutional Review Board (IRB) approval where I propose to provide compensation in the form of a Gift card to participants who complete the Focus Group.

I understand that the payment of compensation is subject to Internal Revenue Service (IRS) and that I am responsible for complying with such regulations. I also understand that I will need to provide the corresponding disclaimers in the participants' consent form, to the effect that: (1) compensation is to be provided by me and not UTRGV, and (2) compensation received is considered income for tax purposes.

I agree to keep track of the amount and quantity of compensation provided to study participants for a minimum period of 3 years after the study is completed.

Name of Researcher: Edna Orozco

Title of Study:

FORECASTING RETENTION AMONG AT-RISK COLLEGE FRESHMEN STUDENTS THROUGH COMPLETION OF A STEM INTERVENTION.

Signature:

Date:_ March 15, 2023

APPENDIX I

APPENDIX I

Internal Permission Letter

March 15, 2023

Dr. Noe Vargas
Noe.vargas@utrgv.edu

RE: "FORECASTING RETENTION AMONG AT-RISK COLLEGE FRESHMAN STUDENTS THROUGH COMPLETION OF A STEM INTERVENTION"

Dear Edna Orozco

I am acknowledging that you will be conducting your UTRGV research project, "FORECASTING RETENTION AMONG AT-RISK COLLEGE FRESHMAN STUDENTS THROUGH COMPLETION OF A STEM INTERVENTION" here at the maker space EENGR 2.454 and have no objections as long as IRB approval is obtained prior to data collection. I understand that participants will be asked to conduct a focus group in order to obtain the data needed for the study.

Sincerely,

Dr. Noe Vargas Assistant Professor Edinburg:
EENGR 3.272 (956) 665-3727
noe.vargas@utrgv.edu.

APPENDIX J

APPENDIX J

INFORMED CONSENT FORM

Study Title: "FORECASTING RETENTION AMONG AT-RISK COLLEGE FRESHMAN STUDENTS THROUGH COMPLETION OF A STEM INTERVENTION"

Consent Name:

Principal Investigator:	Edna Orozco	Telephone: 956-681-6259
Emergency Contact:	Dr. George Padilla	Telephone: 956-458-3653

Key points you should know

We are inviting you to be in a research study we are conducting. Your participation is voluntary. This means it is up to you and only you to decide if you want to be in the study. Even if you decide to join the study, you are free to leave at any time if you change your mind.

Take your time and ask to have any words or information that you do not understand explained to you.

We are doing this study because we want to describe and explain the association between retention after the first semester of at-risk college freshman students in a STEM program and completion of a STEM intervention

You participated and completed a STEM intervention at the College of Engineering & Computer Science during the 2021 or 2022 school academic year.

What will you do if you agree to be in the study?

You will be part of a focus group, which is a group interview.

Participation in this study requires [audiotape] of [all procedures/list of procedures], by signing this consent form you are giving us permission to make and use these recordings.

Please indicate whether you will allow us to do so by initialing one of the following:

_____(initials) Yes, I give permission for [videotaping/audiotaping]

_____ (initials) No, I do not give permission for [videotaping/audiotaping]

Can you be harmed by being in this study? Being in this study involves no greater risk than what you ordinarily encounter in daily life.

Risks to your personal privacy and confidentiality: Your participation in this research will be held strictly confidential and only a code number will be used to identify your stored data. However, because there will be a link between the code and your identity, confidentiality cannot be guaranteed. If we learn something new and important while doing this study that would likely

affect whether you would want to be in the study, we will contact you to let you know what we have learned.
What are the costs of being in the study? No cost
Will you get anything for being in this study? A $50 gift card will be provided to those completing the group interview (focus group)
Could you be taken out of the study? You could be removed from the study at any point in the interview
Can the information we collect be used for other studies? Information that could identify you will be removed and the information you gave us may be used for future research by us or other researchers; we will not contact you to sign another consent form if we decide to do this.
We will not use or distribute information you gave us for any other research by us or other researchers in the future.
What happens if I say no or change my mind? You can say you do not want to be in the study now or if you change your mind later, you can stop participating at any time. No one will treat your differently. You will not be penalized.
How will my privacy be protected? We will share your information with the PI and advisor of this research study only. Your information will be stored with a code instead of identifiers (such as name, date of birth, email address, etc.).Even though we will make efforts to keep your information private, we cannot guarantee confidently because it is always possible that someone could figure out a way to find out what you do on a computer. No published scientific reports will identify you directly. If it is possible that your participation in this study might reveal behavior that must be reported according to state law (e.g. abuse, intent to harm self or others); disclosure of such information will be reported to the extent required by law.

Who to contact for research related questions.
For questions about this study or to report any problems your child experiences as a result of being in this study contact Edna Orozco at 956-681-6259 or by email at edna.orozco01@utrgv.edu

Who to contact regarding your rights as a participant.
This research has been reviewed and approved by the University of Texas Rio Grande Valley Institutional Review Board for Human Subjects Protections (IRB). If you have any questions about your rights as a participant, or if you feel that your rights as a participant were not adequately met by the researcher, please contact the IRB at (956) 665-3598 or irb@utrgv.edu.

Signatures

By signing below, you indicate that you are voluntarily agreeing to participate in this study and that the procedures involved have been described to your satisfaction. The researcher will provide you with a copy of this form for your own reference. To participate, you must be at least 18 years of age. If you are under 18, please inform the researcher.

____
____/_____/______

Participant's Signature Date

BIOGRAPHICAL SKETCH

Edna Ingrid Orozco Lopez, ACUE, MSE, EdD

Edna graduated with a bachelor's in manufacturing engineering in 2007, received her master's in Manufacturing Engineering in 2009 with a Thesis Topic "A Study On Gas Penetration And Fingering Behavior In Injection Molding Of Polymer And Powder Metal Feedstock. Edna has 7 years of experience as a Lecturer II at the University of Texas Rio Grande Valley College of Engineering & Computer Science. She also works as the undergraduate coordinator, and assessment coordinator for the Department of Manufacturing & Industrial Engineering. Edna has been key for the Department of Manufacturing & Industrial Engineering in many facets. The department opened in the year of 1993 and since then the department has hired only two faculty women, Dr. Karen Lozano, which currently works in the mechanical engineering department, and Edna Orozco, who is the female that has been working the longest at the department despite of being the only female. This is important to mention because she has been able to collaborate with all tenure, tenure track, and lecturers at the department. She currently leads the accreditation process and undergraduate curriculum of the department and has been greatly involved in outreach not only for the department but also for the College of Engineering & Computer Science. Her contribution to the engineering college was to bring the Girl Day in Engineering, a national celebration that focuses only on female students along with the 2023 First Latina Summer Camp at the College of Engineering for Edinburg and Brownsville Campus. Edna Orozco is a former Specialist in the Texas Army National Guard and has worked as an administrator in secondary education K-12 for 7 years. Edna Orozco earned her degree in Educational Leadership with concentration in higher education at the University of Texas Rio Grande in August 2023. She can be contacted by email to edna.orozco@gmail.com.