EXAMINIG THE IMPACT OF AN HISPANIC-SERVING INSTITUTION (HSI)

GRANT AT A FOUR-YEAR UNIVERSITY

by

PhuongDieu Jennifer Nguyen, MS

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PhuongDieu Jennifer Nguyen

APPROVED BY

____
Renée E. Lastrapes, Ph.D., Chair

____
Suzanne E. Brown, Ph.D., Committee Member

____
Omah Williams-Duncan, Ph.D.,Committee Member

____
Jana M. Willis, Ph.D., Committee Member

RECEIVED/APPROVED BY THE COLLEGE OF EDUCATION:

____
Felix Simieou, Ph.D., Interim Associate Dean

____
Joan Y. Pedro, Ph.D., Dean

Dedication

To my parents, Mr. Nguyễn Khang and Mrs. Lê Thị Minh Nguyệt, who spared nothing when it came to the education of their children, and to my siblings, Lê Dung and Khánh Diễm, for their endless support.

To my sons, Trí (Jonathan) and Tiến (William), who are the reasons of my resilience and hard-working. Most importantly, to my husband, Dr. Phạm Tất Trung, who continuously fueled this academic journey with his love, patience, encouragement and emotional support. I owe this achievement to you!

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Last but not least, I would like to thank my family for all their support.

ABSTRACT

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PhuongDieu Jennifer Nguyen
University of Houston-Clear Lake, 2021

Dissertation Chair: Renée E. Lastrapes, Ph.D.

This study presents a comparative analysis to measure the effect of a special program designed to promote STEM (Science, Technology, Engineering, and Mathematics) among Hispanic students at a Hispanic Serving Institution in Texas. In this study, it was hypothesized that the special program would deliver positive academic effects for the students that it was designed to help.

The study used a matched-group approach to identify two groups of Hispanic students with similar profiles for an equivalent and direct comparison. The first group consists of Hispanic students majoring in STEM areas who participated in the special program. The second group of consists of the same number of Hispanic students, also majoring in STEM areas, but who did not participate in the special program. A total of 380 students were identified, with 190 students for each group from a university in Texas that has a population of 6,500 undergraduate students, of which 2,600 were Hispanics.

The academic performance of the two Hispanic groups in the study is measured with the cumulative GPA of the students during the study period spanning from the inception of the program up to the most recent year that the data are available. This period consists of the calendar years 2016, 2017, 2018, and 2019. The study used the mean difference methodology to compare the academic performance of the two groups in general and in specific demographic subgroups for a cross-sectional analysis. Additionally, repeated measures analysis of variance was used to examine the effects along the time span of the study in a traversal analysis.

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CHAPTER I:

INTRODUCTION

Skill sets in Science, Technology, Engineering, and Mathematics (STEM) are identified as key factors for the United States (U.S.) to be competitive in the global economy (Sargent, 2017). For this reason, STEM jobs have been abundant in the U.S.: according to the U.S. Bureau of Labor Statistics estimation (2015), there were approximately 8.6 million STEM jobs in 2015 and this is expected to increase by 17% between 2010 and 2020, and by 10.8% between 2016 and 2026 (U.S. Congress Joint Economic Committee, 2019). However, there is a major discrepancy in Hispanic representation among STEM job holders: Hispanics made up 18% of the total population in the U.S. and held 16% of the total jobs, but only 8% of the STEM jobs (Pew Research Center, 2018). This unusual disparity has been seen as an opportunity for U.S. universities to explore how to improve Hispanic representation among their graduates and to fulfill the job demands accordingly.

According to the U.S. Department of Education (2017), from 2009 to 2010, Hispanics were the largest minority group in the public-school system, but were enrolled at a significantly lower rate in STEM classes. Approximately 74,000 out of 704,000 college graduates (about 11%) in STEM areas are Hispanic, presenting an approximate 49,000 additional recruiting opportunities (7% more) to match the 18% Hispanic representation in the total population (see Table 1). In the past five to eight years, employers in the greater Houston area have relied heavily on STEM workers recruited from other states and countries to fill one-third of the city's STEM field jobs (Davari, 2015). To address this demand, programs such as Supporting Careers in STEM (SCS; a pseudonym), a university-community college-industry partnership with the objective to increase Hispanic representation in the STEM degrees awarded, was created to focus on helping Hispanics and low-income students achieve mastery and placement within STEM field programs and future careers. These types of programs fulfill the objectives by working with junior colleges to, first and foremost, ensure a smooth transition to universities, both academically and financially, and ultimately retain and finish their degree plan to graduate. Provided supports include: peer mentoring and peer tutoring, learning communities, research assistantships and internships, summer orientation, and culturally responsive teaching.

Table 1

*Total Certificates and Degrees Awarded to Hispanics and to All Students in STEM, by Academic Level: 2016-2017**

Academic Level	Hispanics (n)	Total (n)	Hispanics %
Certificate	13,412	77,571	17.6
Associate	13,846	82,328	17.3
Bachelor	40,387	376,825	11.6
Master’s	5,670	139,312	8.7
Doctoral	1,123	28,544	7.0
Total	74,438	704,580	12.7

*Source: U.S. Department of Education, National Center for Education Statistics, IPEDS. 2016-2017

Research Problem

Many Hispanics and economically disadvantaged students experience one or more of these five difficulties: lack of academic preparation for college, limited finances and knowledge of financial aid resources, social disengagement, distractions from conflicting responsibilities, and identity formation and lack of college-educated role models (Nora, Carales, & Bledsoe, 2018). To help these students, programs such as SCS focus on helping students with limited financial supports to find financial aid resources, and therefore also eliminate some of their conflicting responsibilities to work to support themselves or their family. Such programs also focus on helping these students to improve academic skills and therefore be more prepared for college by creating learning communities and tutoring or tutoring with mentoring services. These programs also provide these students a strong sense of community and belonging by making sure the students engage in campus communities and have college-educated role models to look up to. As a result, retention and graduation should be improved.

Learning communities are groups of students in a common major or in similar courses who rely on each other's knowledge and strengths to overcome the challenges they encounter in class (Lippincott, 2019). All members of these communities contribute by sharing their knowledge, informing each other of external resources on campus, and socially bond with each other (Beachboard et al., 2011; Lenning et al., 2013). Successful learning communities have rapport and share diverse culturally-based values; their connections provide a sense of belonging and support, allowing for trust while solving college-related problems (Beachboard et al., 2011; Bowman, Park, & Denson, 2015). The Hispanic communities of practice have positive effects on the members, especially for members who are first-generation college students or who lack a college-educated role model in their life (Nora, Carales, & Bledsoe, 2018).

Peer tutoring is a program in which upper classmen are hired to support students in difficult subjects (Capp, Benbenishty, Aster, & Pineda, 2018; Pan, Guo, Alikonis, & Bai, 2008). Typically, when students are struggling academically, professors organize remedial sessions to help students with the individual class (Siddiqui & Alghamdi, 2017). In addition, administrators petition the universities for more resources to organize remedial programs to aid students on a broader scale across the university (Jimenez, Sargrad, Morales, & Thompson, 2016). However, a generically-designed intervention might not tailor specifically to fit the background of ethnic groups such as Hispanic students. As a result, these students might choose to not use these services (Giraldo-García, Galletta, & Bagaka, 2019). Therefore, Hispanic tutors should be used to accommodate Hispanic students' language and cultures to achieve expected results (Zamora, Curtis, & Lancaster, 2019).

Peer mentoring is usually conducted by upperclassmen or recent graduates with the objective of helping lowerclassmen to adapt to the university setting with the goal of getting to know the classes, the professors, ways to develop study plans, and the job recruitment process (Hall & Jaugietis, 2010; Roscoe, 2015; Ockene et al., 2017). The students who receive mentoring will be expected to have a broader perspective, to have a sense of purpose and confidence, and to have the emotional strength to work toward graduation (Morales, Ambrose-Roman, & Perez-Maldonado, 2015). Peer mentors implement rapport-building strategies; they seek and share commonalities to increase connections across cultural differences so that students feel a sense of belonging and support. These actions allow the mentoring to be achieved (Bose, Ancin, Frank, & Malik, 2017; Rieske & Benjamin, 2015). Research has shown that Hispanic mentors have profound effects on students who share their cultural identity in peer mentoring programs customized to Hispanic heritage and culture (Moschetti, Plunkett, Efrat, & Yomtov, 2017).

Research assistantships and internships are programs that allow students opportunities to enhance their knowledge in their field of study while earning money (Ocean, Tigertail, Keller, & Woods, 2018). For some students, these programs provide them a sense of self-sufficiency in addition to the opportunity to increase their academic focus (Hemmerich, Hoepner, & Samelson, 2015). For others, who have limited financial support, the research stipends and paid internships may be a key factor (Pierce, 2016) as to whether or not continuing college and reaching the goal of graduation are feasible (Adams, Meyers, & Beidas, 2016).

Summer orientations or Bridge programs are programs that provide high school students or college students with the initial training necessary for transitioning to institutions of higher learning (Ashley et al., 2017). Summer orientation programs are important for first-generation students, especially for the Hispanic population, because they cannot rely on their parents for advice or guidance concerning classes or life in college (Wibrowski, Matthews, & Kitsantas, 2017). Additionally, Bridge programs are important to improve students' learning proficiency in their field of study. Both of these programs allow students an opportunity to interact and develop a connection with members of the faculty and with other students in their field of study (Tomasko et al., 2016). This connection helps increase students' sense of relatedness with the college, the faculty and staff, and the learning community, something their family would not be able to help them develop (Strayhorn, 2018). However, many of these students are from low-income families who have to work during the summer, and therefore they find it very difficult to attend these programs.

Culturally responsive teaching is a teaching pedagogy that includes students' culture in every aspect of learning (Gay, 2018; Ladson-Billings, 1994). Since learning styles are culturally dependent, this teaching pedagogy is important to be used with a multicultural student body, especially with Hispanic students who are still strongly bonded to their heritage (López, 2016). The primary purpose of this concept is to gain cooperation from the students through the teacher's efforts to address their cultural and ethnic needs (Woodley et al., 2017). Thus, teachers must be trained on how to refocus their lessons through deeper global perspectives as well as with culturally enhanced activities (Ebersole, Kanahele-Mossman, & Kawakami, 2016). This requirement represents an economic trade-off between cost and students' success for administrators to consider at the implementation level (Brown & Crippen, 2016).

Significance of the Study

The intervention programs previously mentioned, designed to improve the representation of Hispanics in the STEM area workforce, were studied for the Hispanic students in their first year in college. The SCS Program was a comprehensive program at a regional university in the greater Houston area designed to help Hispanic students throughout the duration of their studies toward obtaining a degree. The project was designed to offer academic, financial, motivational, emotional, and professional supports with the end results measured through the academic performance of the participants and the effecting factors indicated through surveys done by participants. Understanding factors for the success of Hispanic STEM students will allow universities to implement similar comprehensive intervention programs to increase Hispanic representation in STEM professions in order to match their ethnic representation in the population.

From the academic perspective of the accredited universities (Eaton, 2006), a successful student is one who maintains good academic standing and will graduate with a baccalaureate degree within a four-year span. From the perspective of management (Gray, Larson, & Desai, 2017), a successful result must be monitored and managed either continuously or periodically during the traversal course of time. The SCS Program employs a balance between the definitions of a good student and managerial practices to ensure that its intervention programs will achieve the predefined goals and expected results.

Research Purpose and Questions

The purpose of the study is to identify positive effects of the intervention programs implemented for Hispanic students in STEM majors. The following research questions guided this study:

1. Is there a difference in the academic performance of the Hispanic STEM students participating in the SCS Program?
2. Is there a year-to-year improvement for the project SCS Program in terms of the number of the participating Hispanic STEM students maintaining good academic standing?
3. Is it possible to mathematically model the year-to-year improvement to project a saturation point (or a point of diminishing returns) for establishing long-term realistic expectations?

Definitions of Key Terms

Academic Performance: the measurement of how thoroughly a student has achieved the educational goals (Jain & Kapoor, 2015); for this study it was measured using GPA.

Accountability: responsibility to someone or some activity, normally shown through actions and trails of evidences that can be examined by the public through a policy of transparency (Ebrahim, 2019).

Community Learning: learning collaboratively through interaction with peers in a group of many students (Garrison, 2015).

Control Group: the group in an experiment or study that does not receive treatment by the researchers and is then used as a benchmark to measure how the other tested subjects do (Solomon, 1949).

Experimental Group: a group that receives a treatment in an experiment so that researchers can observe and compare to the group that does not receive a treatment in order to identify the effect of the treatment (Solomon, 1949).

Intervention: action taken to improve a situation, often in the context of education to improve the academic performance of the students (DeVries, 2014).

Mentoring: a professional working relationship in which an experienced person (the mentor) assists another (the mentee) in developing specific skills and knowledge that will enhance the less-experienced person's professional and personal growth (Chu, 2013).

Pathway: an intermediate connection between the state of being not ready and the state of being ready for some purpose or requirement (Clark, 1998).

Pathway Program: preparatory courses designed to help students build the skills, knowledge, and qualifications necessary before entering a study program toward a degree (Harrington & Orosz, 2018).

Performance Evaluation: a formal assessment of the work output of a person, a process, or a project in comparison to the expected results serving as a reference point (Guerra-López, 2008).

Performance Tracking: to continuously or intermittently monitor the performance of a person, a process, or a project along a predefined timeframe (Guerra-López, 2008).

Representation: the statistical makeup of a group that shares some common characteristics, such as racial or ethnical traits (Hall, Evans, & Nixon, 2013).

STEM: the abbreviation of the four academic disciplines of sciences, technology, engineering, and mathematics (Brown, Brown, Reardon, & Merrill, 2011).

Tutoring: a one-to-one or one-to-small-group activity where a person who has knowledge and expertise in a specific content area or discipline provides tutelage, help, or clarification to one or more who do not (Kulik & Fletcher, 2016).

Underperform: to perform relatively less than the level of expectation or collectively less than the level of representation (Evans & Lindsay, 2016).

Underrepresentation: to have a statistical makeup in some specific environment that is less than the statistical makeup in a larger population (Mor Barak, 2016).

Conclusion

This chapter identified the need for intervention programs for Hispanic students at a four-year university to excel academically in order to better their representation in the STEM field workforce. The research problem and significance of the study were reviewed and research questions presented: the effects of the intervention programs are examined through the statistical analysis of the academic performance of the Hispanic students participating in the programs, both cross section and traverse. In the next chapter, historical and current perspectives of the community learning, tutoring, and mentoring are discussed further.

CHAPTER II:

REVIEW OF LITERATURE

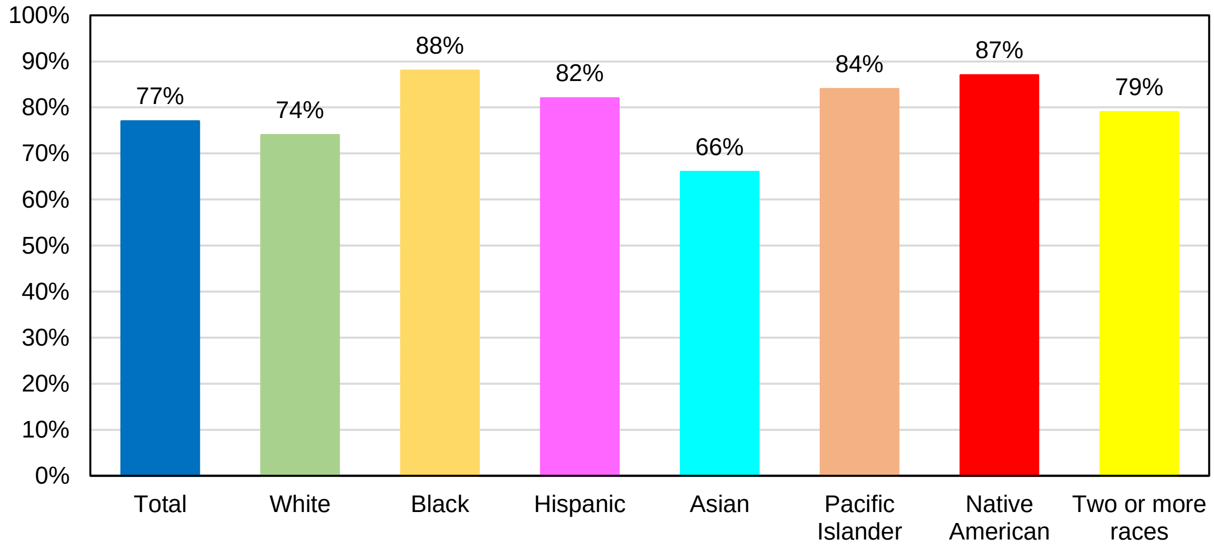
The demand for professionals in the areas of STEM has been exacerbated in recent years due to the rapid development, deployment, and integration of STEM into our national economic competitiveness and national defense (White & Shakibnia, 2019). This situation exerts pressure on universities to produce more graduates in STEM so that they can enter the workforce and alleviate the demand for STEM professionals (Altbach & Rumbley, 2019). To react to the pressure, universities started to look at the segments of the population that are underrepresented in the STEM workforce, recruit more students from these underrepresented segments, and implement intervention programs to help them moving toward graduation with academic success and professional prospects (Covington, Chavis, & Perry, 2017).

Specifically, the Supporting Careers in STEM (SCS) Program was created to focus on helping Hispanics and low-income students achieve mastery and placement within STEM field programs and future careers. The program focuses on improving retention and graduation rates of the Hispanic students in STEM majors through the following: use of financial assistance to ease the economic burden; learning communities to instill interest in learning; peer tutoring to help with difficulties in individual classes; peer mentoring to coach on the future professional life; summer orientation or Bridge programs to help with transitioning to college life; and culturally responsive teaching to customize to the students' individual needs. Thus, literature in these areas was reviewed in this chapter in terms of their effectiveness in relation to the initiatives proposed by the SCS Program.

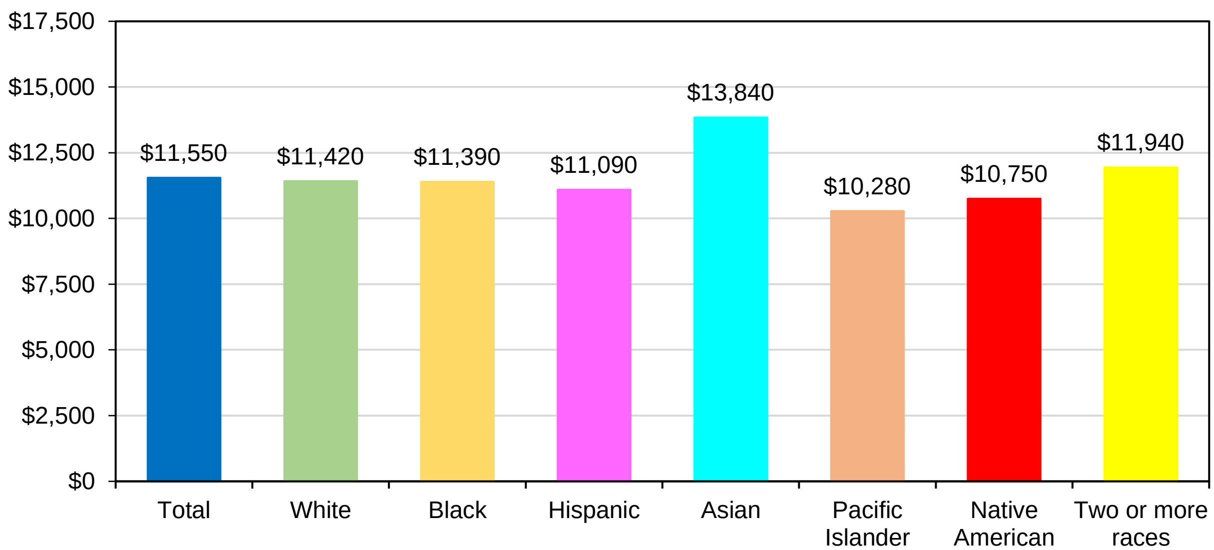
Financial Assistance with Research Assistantships and Internships

Financial burden is the pressure of earning money to fulfill the basic needs of life and the investment in a better future (King & Carey, 2017). It has been noted that minority students, particularly Hispanic students, often experience tremendous financial burdens due to their respective family situations and social inequality (Espinoza-Herold & González-Carriedo, 2017). This burden creates pressure for students to work while enrolled in college, consequently leaving them with less time to study, engage in academic activities, and participate in extracurricular activities (Bennett, McCarty, & Carter, 2015). Not having time for these activities often leads to academic imperilment (Beattie, Laliberté, & Oreopoulos, 2017). For this reason, financial assistance was designed to help these students alleviate the burden so that they can have more time to focus on their studies and to participate in activities designed to help them (Scott-Clayton, 2015). The impacts of these financial assistance programs have been noted in terms of more engagement in academic activities and participation in community services at the universities (Boatman & Long, 2016). These impacts are considered necessary conditions for academic success and development of self-esteem that in turn will lead to better job prospects upon graduation (Cheung, Cheung, & Hue, 2015).

Financial assistance is a form of providing money to help students cover the cost of education while in college (Powell, 2018). The money can be delivered in the form of a grant, work study program, loan, or scholarship. According to the National Center for Education Statistics (NCES), 82% of Hispanic students, slightly above the national average of 77%, as shown in Figure 1(a), received grants for the 2015-16 academic year. Similarly, Figure 1(b) shows that on the average, Hispanic students received $11,090 per person in 2015-16.



(a) percentage

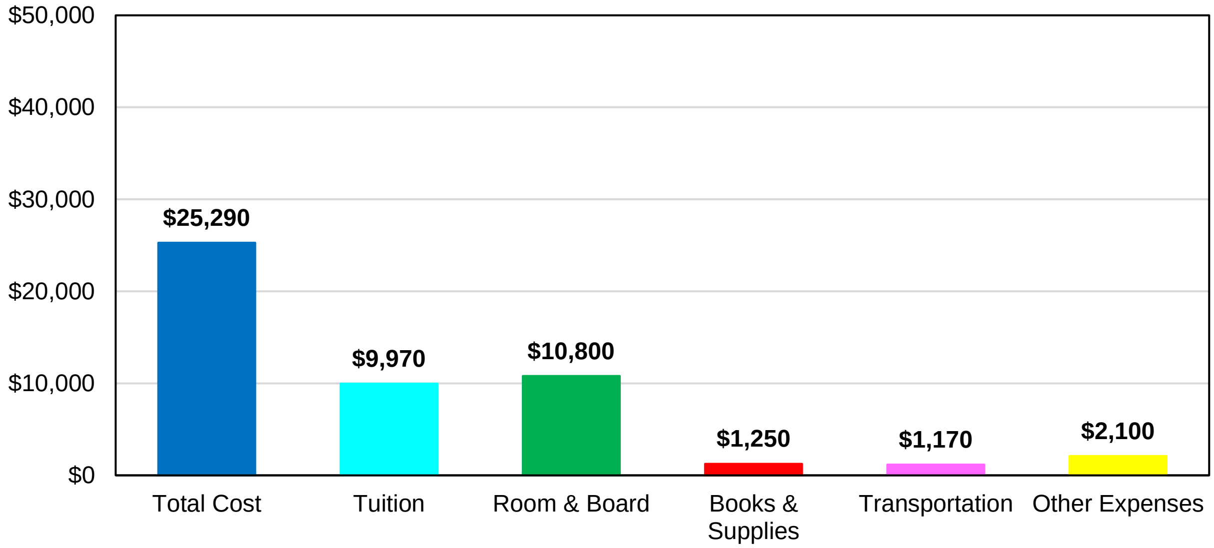


(b) average amount per student

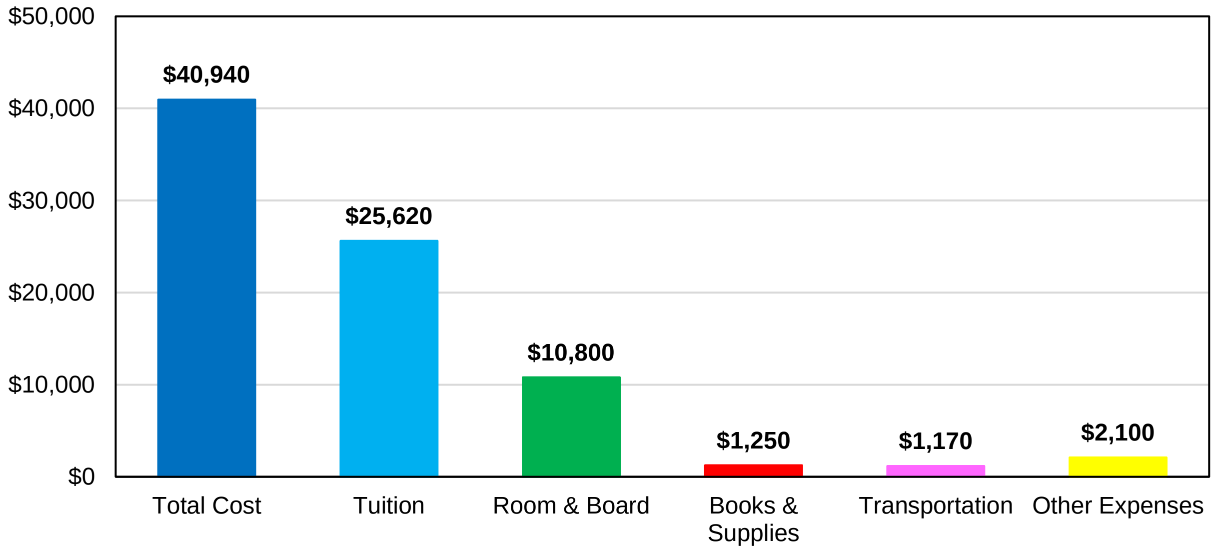
*source: National Center for Education Statistics https://nces.ed.gov/programs/raceindicators/indicator_REC.asp

Figure 1
Financial Assistance
These figures illustrate data of full-time undergraduates who received financial aid in the form of grants, organized by race/ethnicity, for the academic year 2015–16

However, the average cost of college is about $25,000 at public institutions for students who live in state, and about $41,000 for students who come from out of state, as shown in Figure 2. This amount leaves an average Hispanic student who receives $11,000 in grants to need an additional amount of $14,000 to attend public institutions at the in-state rate, or an additional $30,000 at the out-of-state rate.



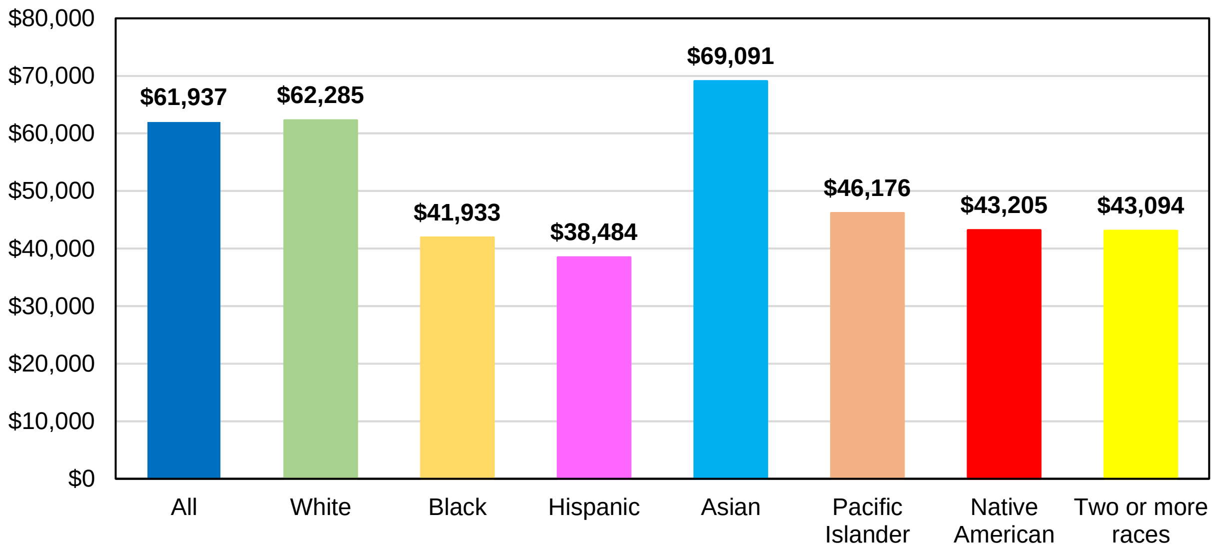
(a) average cost of college at a public 4-year institutions (instate cost)



(b) average cost of college at a public 4-year institutions (outstate cost)

*source: ValuePenguin https://www.valuepenguin.com/student-loans/average-cost-of-college

Figure 2
Cost of College.
These figures illustrate the average in state and outstate cost of college for the academic year 2017–2018.



*source: DQYDY https://dqydj.com/income-by-race/

Figure 3
Average Household Income.
This figure illustrates the average income per household for 2018.

For a Hispanic family with an average household income of $38,484, shown in Figure 3, paying the difference of $14,000 for the in-state rate or $30,000 for the out-of-state rate would put a serious financial stress on their budget. Regardless of in-state or out-of-state rate, after paying the difference, an average Hispanic family would be placed below the poverty line of $25,100 defined by the Federal Guidelines (Sraders, 2018). Thus, despite the good intention of financial assistance programs, Hispanic students still face the pressure to work even after receiving assistance in the form of grants.

Research assistantships and internships are financial assistance programs that offer students some working opportunities in their field of study while earning money to support their academic endeavors (Ocean, Tigertail, Keller, & Woods, 2018). For some students, these programs provide a sense of self-sufficiency in addition to the opportunity to increase their academic focus (Hemmerich, Hoepner, & Samelson, 2015). For others who have limited financial support, the research stipends and paid internships may be a key factor in whether continuing college and graduating are feasible (Pierce, 2016; Adams, Meyers, & Beidas, 2016).

Research assistantships are paid work oriented toward research projects where the students are exposed to academic research directed by the professors at the university (Kuther, 2017). In this line of work, students are hired to help with some aspect of the project like organizing literature for review, data collecting, conducting time-consuming experiments, running software to analyze data, and other associated tasks (Kuther, 2017). This experience allows students to have direct contact with the research process and allows them to network within their field (Springer et al., 2018). For Hispanic undergraduate students, it was found that the quality of the professor who guides the research project is a positive influence on the students' academic and professional development (Daniels, Grineski, Collins, & Morales, 2017). Furthermore, the logical working mode, critical thinking habits, and effective communicating style are the instruments that students learn from their mentoring professor, and are what will prepare them for graduate school (Alcocer & Martinez, 2017). For Hispanic students, the mentorship that the professors provided also serve as an introduction to the research process that attracts them toward, and mentally prepares them for, life in graduate schools (Willis, Schall, & Piazza, 2018). Given the significantly low rate of Hispanic representation in graduate schools in STEM areas, mentioned in Chapter 1 (i.e., 8.7% of master's degrees, 7% of doctoral degrees), research assistantships seem like an effective long-term investment for the research professors while providing an effective short-term financial relief for financially disadvantaged Hispanic students (Morales, Grineski, & Collins, 2017; Nuñez & Sansone, 2016).

Internships are paid work oriented toward professional projects where the students are exposed to real professional environments in the industry that they expect to work in after graduation (Bloom, 2018). In this line of work, students are hired to help or participate in a project where they can contribute according to their capability, while at the same time they can gain industrial experience that enables them to find jobs after graduation (Parker, Kilgo, Sheets, & Pascarella, 2016). For Hispanic students, an internship is an important feature to have in their resume to find jobs after graduation, but it is also difficult to obtain: only 57% of graduating Hispanic students had internship experience compared with the national average of 64% (Merino, 2015). In the same report, it is assessed that students without internship experiences are 14% less likely to receive a job offer than those with internship experience. Thus, offering internships for Hispanic students at Hispanic Serving Institutions (HSI) can be seen as an important action to recruit them (Meador, 2018). Furthermore, internships are seen by Hispanic students as an environment for developing leadership (Garcia, Huerta, Ramirez, & Patrón, 2017).

Learning Communities

Learning communities are groups of students in a common major or in similar courses who rely on each other's knowledge and strengths to overcome their challenges that they encounter in class (Lippincott, 2019). All members in these communities contribute by sharing their knowledge, informing each other of external resources on campus, and socially bonding with each other (Beachboard et al., 2011; Lenning et al., 2013). Members in a learning community should ideally share the same heritage and cultural background so that they have a sense of belonging to support each other, thus allowing them to develop trust to solve common college-related problems (Beachboard et al., 2011; Bowman, Park, & Denson, 2015).

The Hispanic communities of practice have positive effects on the members, especially for members who are first-generation college students or who lack a college-educated role model in their life (Nora, Carales, & Bledsoe, 2018). For Hispanic students, the participation of the faculty members in the Hispanic learning communities is important because they look up to the participating professors as their role models (Tova, 2014). For this reason, it is implicitly suggested that the participating professors must assume the expected role that their Hispanic students in the learning communities are missing in their personal lives (Rodriguez, Massey, & Sáenz, 2016). Additionally, in this segment of first-generation college students, if the students speak Spanish as their first language, learning communities that use the Spanish language are even more essential for enhancing their classroom performance (Pascual y Cabo, Prada, & Lowther-Pereira, 2017). However, in the emerging STEM fields, many technical vocabularies originate from the English language, and therefore might not have equivalent translation into the Spanish language (Levine & Lateef-Jan, 2017). Even in the best-case scenario when there are Spanish equivalent words, the Spanish vocabularies are not uniformly used and this lack of unified vocabularies might not serve the purpose of socially bonding members together (Pulinx & Van Avermaet, 2017; Stavans, 2017). Thus, the use of Spanish might be an attractive factor at the beginning to draw Hispanic students together in learning communities, but can be a hindrance later on when technical vocabularies are not uniform (Aichhorn & Puck, 2017).

Emotional bonding, a necessary characteristic for members of learning communities, is a sense of attachment to a certain entity that permits sharing of personal feelings, interests, and excitement with other members of that entity (Grande, 2017). Developing emotional bonding is considered an interactive, mutual, and continual process where the bonding gradually builds up between individuals through daily interactions (Sanz-Blas, Bigné-Alcañiz, & Buzova, 2019). Elements that can trigger emotional bonding in learning communities include common needs, interests, cultural values or cultural identity, and political ideologies (Parson, 2015). For first-generation Hispanic college students, it is also that they share the common need for a role model to guide them through life in college (Nora, Carales, & Bledsoe, 2018), and therefore they can develop a quasi-familial atmosphere that bonds them together in their mutual goal for success in learning (Benoit, Olson, & Johnson, 2018). While the triggering mechanism can draw Hispanic students together, especially in the Hispanic Serving Institutions, their continual participation is the key for them to develop a bond to the learning communities (Sanz-Blas et al., 2019). In this aspect, the learning communities must be perceived as helping with academic success in order to sustain continual participation (Serrat, 2017).

Even though the scope of learning communities focuses on helping students in working toward academic success, emotional bonding implicitly requires social interaction and emotional support between students (Bayer, Ellison, Schoenebeck, & Falk, 2016). In order to promote social interaction among Hispanic students, social settings with common themes of Hispanic heritage that they can relate to are used as a conduit for pleasant social interactions (Brown, McDonald, & Mitchell, 2015). However, some Hispanic students come from low-income families which tend to be absent in social settings (Quaye & Harper, 2014). For this reason, it is suggested that online social networks may be an effective alternative for promoting social interaction among low-income Hispanic students (Greenhow & Robelia, 2009). Thus, the learning communities, when facilitated by an online platform, provide ubiquitous participation from the students (Porwol, Ojo, & Breslin, 2018) and this addresses the issue of low social interaction among low-income Hispanic students. With the participation that builds up emotional bonding, students can reach a point of trusting each other enough to share personal issues that can be resolved through emotional support (Huurne, Ronteltap, Corten, & Buskens, 2017). In this exercise of building trust, it is difficult to promote the use of an online platform alone because of precautions surrounding interacting with strangers met online (He & Zhang, 2019). Thus, classroom attendance and additional tutoring sessions where the students meet face-to-face should associate classmates and consequently resolve this impediment of security associated with online platforms (Hill, Bartol, Tesluk, & Langa, 2009; Nilsson & Mattes, 2015).

It is important to note that the facilitators play an important role for the success of the learning communities (Margalef & Roblin, 2016). Normally, a facilitator of a learning community can be a professor, a professional specialized in academic guidance, or an upperclassman who already participated in the learning communities as a student in the past (Dimino, Taylor, & Morris, 2015). The role of a facilitator is to maintain focus in the discussion, to foster collaboration, to pique interest, to encourage participation, and to moderate the social interaction between the participating students (Hung & Chou, 2015). Additionally, it was observed that Hispanic students look to the facilitator as a role model in their personal life, and therefore it is important that the facilitator comes from the same Hispanic heritage, speaks the same Spanish language, and understands the perspective of an average Hispanic family (Mintrop & Charles, 2017).

Peer Tutoring

Peer tutoring is a program in which upperclassmen are hired to support students in difficult subjects (Capp, Benbenishty, Aster, & Pineda, 2018; Pan, Guo, Alikonis, & Bai, 2008). Typically, when students are struggling academically, professors organize remedial sessions to help students with the individual class (Siddiqui & Alghamdi, 2017). In addition, administrators petition the universities for more resources to organize remedial programs to aid students on a broader scale across the university (Jimenez, Sargrad, Morales, & Thompson, 2016). However, a generically designed intervention might not tailor specifically to fit the background of ethnic groups such as Hispanic students. As the result, these students might choose to not use these services (Giraldo-García, Galletta, & Bagaka, 2019). Therefore, Hispanic tutors should be used to accommodate Hispanic students' language and cultures to achieve expected results (Zamora, Curtis, & Lancaster, 2019).

Peer tutoring, when conducted at a residential hall, is often considered part of the learning communities (Kim, 2015). In this aspect, a tutor is not just a person helping the students with a difficult problem in a specific subject, but also a person who must play the role of a facilitator of the group (Hung & Chou, 2015). Thus, a tutor for a group of Hispanic students should speak Spanish and understand the Hispanic culture (Mintrop & Charles, 2017; Pascual y Cabo, Prada, & Lowther-Pereira, 2017). Furthermore, for bonding with the students, it is suggested that the tutor comes from the same residential hall as the students for development of common identity and friendship (Yung, 2016). However, it is always important to understand from the perspective of the students that a tutor must be knowledgeable in the subject the students need help with (Nimir, Hamid, Saliem, Hossain, & Kadir, 2018). For Hispanic students who culturally look up to the tutor with respect, this expectation of knowledge in a tutor is even more prevalent (Yale, 2019). This high expectation places tremendous pressure on a Hispanic tutor, who must have the requisite knowledge and act in a specific manner so as to display an air of authority in the subject so that the students are assured that their respect is well invested (Chng, Yew, & Schmidt, 2015).

Using Spanish language is a common practice to build bonds with Hispanic students, especially first-generation students who attend college (Li & Liu, 2017). However, for a tutor to use Spanish to help the students in STEM subjects, it can be a difficult scenario because there might not be a directly equivalent vocabulary for words originating from English (de Ramírez & Shapiro, 2007), or because there is no standardized equivalent vocabulary due to the divergence of the Spanish language (Lipski, 2008). These two scenarios were already mentioned as difficulties for facilitators in learning communities consisting of Hispanic students in the earlier section of this chapter. While a tutor can speak Spanish in common conversation to bond with the students, it was noted that some students actually prefer the tutor to use English when helping them in the STEM subjects (Babino & Stewart, 2017). This preference is understandable because the textbooks that they use in the class are written in English, and having to learn another set of Spanish vocabulary can be a burden to the students who are already struggling with the class (Cho, 2015).

Tutoring can have positive effects on the tutors, such as developing self-esteem, understanding the teaching process to prepare for graduate school, having an alternative to internships to earn money, and acquiring a deeper understanding of subjects (Imtiaz, 2018). For this reason, it is preferred to hire students participating in the SCS Program as tutors so that they can enrich themselves with these positive effects while helping other younger Hispanic students participating in the project. Self-esteem is the confidence in one's ability and worth, and gaining self-esteem is particularly important to first-generation Hispanic students so that they are motivated to explore their full potential and meaningfully contribute to society (Cvencek, Fryberg, Covarrubias, & Melzoff, 2017). Gaining an understanding of the teaching process is an educational experience that explains the academic environment at the university level, and having this experience can motivate Hispanic students to aspire to study toward a doctoral degree where they are significantly underrepresented (Kobayashi, 2018). Having an alternate means to earn money is a flexibility that some Hispanic students might prefer due to familial situations, specific career goals, and lack of transportation (Baeza, Gonzalez, & Wang, 2018).

Peer Mentoring

The peer mentoring process often utilizes students in the upper classes or recent graduates to help undergraduate students getting familiarized with adapting to the university environment, getting to know the expectation or customization of a degree plan, understanding the recruitment process, and selecting classes and professors (Ockene et al., 2017). The objective of this process is to broaden the perspective of the students (who receive the mentoring), to identify a sense of purpose, and to gain confidence and emotional strength while working toward graduation (Morales, Ambrose-Roman, & Perez-Maldonado, 2015). Since the students often connect their feeling with their cultural identity, it might be a good idea to recruit mentors who share the same cultural values with the students so that they can connect together to achieve the objectives of the mentoring process (Crooks et al., 2015). Research has shown that Hispanic mentors have profound effects on students who share their cultural identity in peer mentoring programs customized to Hispanic heritage and culture (Moschetti, Plunkett, Efrat, & Yomtov, 2017).

Peer mentoring can cover a wide range of subjects: university life, career opportunities, life skills, and crisis resolution (Knouse, 2013). Hispanic students receiving peer mentoring often see the benefits as social capital during their integration into the university (Moschetti, Plunkett, Efrat, & Yomtov, 2017). Most first-year students have to adjust from high school to college and may find mentoring about university life useful for them (Alcocer & Martinez, 2017). Students who are near graduation find that getting the first job offer is an important issue in their mind and will find mentoring on career opportunities a necessity: coaching for interview, presentation of current job market, and geographical job concentration (Bozioonelos et al., 2015). It is commonly recognized that success in life requires a certain set of life skills such as interpersonal relationship interactions, effective communication, balancing work with personal life, and stress management. Students will find mentoring in these life skills a practical inclusion in their college experience (Bose, Ancin, Frank, & Malik, 2017).

The roles of a peer mentor are different from the roles of a faculty mentor; whereas Hispanic students look at a faculty mentor as a parental figure, they can potentially look to a peer mentor as a friend who has practical advice (Hojjat & Moyer, 2016). In this informal setting between friends, advice is much better received and taken when given in a casual conversation instead of in a formal lecturing format (Placencia, 2012). Since advice is considered more effective between friends, it was noted that peer mentoring in colleges has positive effects on the rate of graduation for students in the mentoring program (Kobulnicky & Dale, 2016). Because of this success, peer mentoring has also been used in learning communities and its effectiveness has been observed (Rieske & Benjamin, 2015). Instead of covering a wide range of subjects, peer mentoring in learning communities focuses on motivation and support for a student's studying efforts, occasionally wandering into peer tutoring that results positively in the measurable GPA of the students (Zaniewski & Reinholz, 2016). When a peer mentor inadvertently becomes a peer tutor or a peer tutor comes a peer mentor, the observed positive results are probably due to the existing knowledge that triggers the volunteer to assume the other role (Benson & Gurney, 2019).

Peer mentoring can have positive effects on self-esteem for the mentors in the same manner that peer tutoring has on the tutors (Karcher, 2018). For this reason, it is preferred to hire students participating in the SCS Program as peer mentors so that they can enrich themselves with the positive effects while helping other younger Hispanic students participating in the project. Self-esteem is defined as the confidence in one's own abilities and worth. Developing self-esteem is particularly important to first-generation Hispanic students so that they can be motivated to explore their full potential and meaningfully contribute to the needs of society (Cvencek, Fryberg, Covarrubias, & Melzoff, 2017). By serving as a peer mentor and implicitly assuming the role of an expert, a student can see their practical potential beyond the role of an entry-level job that they typically find upon graduation (Lin et al., 2016). Furthermore, by putting themselves in the role of helping others, a peer mentor can potentially find personal satisfaction in being able to contribute to society and develop a sense of responsibility and professionalism (Haber-Curran, Everman, & Martinez, 2017).

Summer Orientation and Bridge Programs

Summer orientation or Bridge programs are programs that provide high school students or college students with the initial training necessary for transitioning to institutions of higher learning (Ashley et al., 2017). Summer orientation programs are important for first-generation students, especially for the Hispanic population, because they may not be able rely on their parents for advice or guidance concerning classes or life in college (Wibrowski, Matthews, & Kitsantas, 2017). Additionally, Bridge programs are important to improve students' learning proficiency in their field of study. Both of these programs provide students an opportunity to interact and develop a connection with members of the faculty and with other students in their field of study (Tomasko et al., 2016). This connection helps increase students' sense of relatedness with the college, the faculty and staff, and the learning community, which their family would not be able to help them develop (Strayhorn, 2018). However, most of these students are from low-income families and have to work during summers, and therefore they find it difficult to attend these programs.

In general, summer orientation programs present an introduction to life in college, with both parents and students attending (Lissner, n.d.). Typically, an orientation session will last between one to two days. The introduction consists of three targeted audiences: students, parents, and combination of students and parents (Shaffer, 2015). In addition to covering the topics of life in college, the students will be introduced to the professors and the classes that they will be taking in their first year (A Student Guide, n.d.). Some orientation programs can include a seminar about learning how to learn where the students are taught about the process of acquiring knowledge (Moniz, 2017), whereas others are about time and priority management where the students are taught about how to use time effectively and efficiently in the learning process (Ghiasvand et al., 2017). After the orientation sessions, both students and parents are often introduced to the sport facility that the university is offering as an introduction to using physical exercises for stress management (van der Zwan et al., 2015). This introduction to sport is an indirect teaching to the students on how to study efficiently based on the concept that the mind is functioning much better when there is no stress, and especially after a certain hormone is released to aid the thinking and memorizing (Firth et al., 2016; van Dongen et al., 2017).

Summer Bridge programs are programs that help the students build up a certain foundation so that they can take the regular classes without difficulty (Nelson, 2011). Most of the Bridge programs focus on STEM subjects because the subjects require a thorough preparation to build a solid foundation that STEM classes require (Witt, 2015). In the past, the Bridge programs were delegated to preparation classes taught at the community colleges, and students were required to pass some proficiency exams before being permitted to the regular STEM classes offered at the university (Dove, 2018). However, when students are required to attend additional classes at a nearby community college, they may feel inadequate and can easily lose their self-esteem (Koebler, 2011). Therefore, recent trends show that these preparation classes are now incorporated into a Bridge program to make sure the entering students meet the minimum requirements at a specific university (Rosenbaum et al., 2017) while eliminating the potential loss of self-esteem of the incoming students. The Bridge program can be implemented at the university where the students are accepted, or at a nearby college that works in collaboration with the university (Wilson & Lowry, 2016).

Hispanic Learners

Hispanic learners (Valenzuela, 2020) are the recipients of the culturally responsive teaching (Gay, 2018; Ladson-Billings, 1994) that is customized with specific consideration to the Hispanic heritage (McFarland, 2004). Even though the Hispanic heritage can be diverse (García, 2020), a common trait often observed across the spectrum of the Hispanic heritage is the strong family ties (Cross, 2018) that can often affect the learning style of the Hispanic learners (Griggs & Dunn, 1996). For this reason, planning for culturally responsive teaching (Gay, 2002; Valenzuela, Nieto, & Steeter, 2016) must consider specific characteristics of the Hispanic learners (Nieto, 2013) in order to achieve the intended effects (Gay, 2014).

The scope of the family ties in the Hispanic culture lies with the definition of a family that extends beyond a basic household unit of parents and children (Vogt, 2020). Additionally, the family hierarchical structure (Heard, 2007) in the Hispanic culture dictates the downward flow of influence across these ties (Baer & Schmitz, 2007). In this extended family setting, an older person of higher rank in the family hierarchical structure has a tendency of giving unsolicited advices to younger family members of lower rank (Feng & Magen, 2015). The scope of the advice can be wide and diverse, ranging from interpersonal relationship, to educational goals, to philosophy of life (Zayas & Solari, 1994). One common practice of giving out advice is that the person giving the advice does not need to be an expert in the scope of the advice (Motley, 2008), and yet his counsel still carries some weight, perhaps due to his higher rank in the family hierarchy (Ruiz, 2008).

The tendency to respect a person of higher rank in the family hierarchical structure of the Hispanic culture preconditions a young Hispanic learner to look up to the teacher in a classroom setting as a person of authority (Bulterman-Bos, 2020). As the result, Hispanic learners often approach their learning environment with devoted discipline and take instructions from the teachers with seriousness that can parallel military settings (Osiel, 2017). This disciplined attitude can give the Hispanic learners an advantage in sciences and mathematics classes, where they can rigidly apply the basic theories to support transitional steps in solving a problem that often has a unique solution (Backhouse, 2011; Zingaro, 2020). However, this same disciplined attitude can accustom Hispanic learners to take clear and explicitly detailed instructions from authority figures while dulling their creativity and critical thinking in the direction of mental atrophy (Bouygues, 2019). This phenomenon can pose some disadvantage to Hispanic learners in engineering classes, where there is no rigid approach to solve a problem that might not have a scientific solution and therefore requires creative thinking (Griffiths & Costi, 2019) to find and implement a practical solution that works somewhat "satisfactorily" (Dym, 2013).

With the understanding of the Hispanic family ties and the respect for people with higher rank in the family hierarchical structure, a professor should plan to change the teaching style (Gay, 2002; Valenzuela, Nieto, & Steeter, 2016) to gradually wean the Hispanic learners off of expecting specific and detailed instructions to more general ones, and fewer instructions in the advanced classes of engineering design (Chua & Iyengar, 2011). This process of fostering independent thinking (Tsui, 2002) perhaps cannot be done in just the span of a semester, the duration of a typical class, and therefore requires coordination of many classes, which in turn requires the strategic collaboration of many professors teaching these classes to have the desired effects (Gunasekara, 2008).

Culturally Responsive Teaching

Culturally responsive teaching is a teaching pedagogy that includes students' culture in every aspect of learning (Gay, 2018; Ladson-Billings, 1994; Valenzuela, Nieto, & Steeter, 2016). Since learning styles are culturally dependent, this teaching pedagogy is important when working with a multicultural student body, especially among Hispanic students, who are still strongly bonded to their heritage (López, 2016). The primary purpose of this concept is to gain cooperation from the students through the teacher's efforts to address their cultural and ethnic needs (Woodley et al., 2017). Thus, teachers must be trained on how to refocus their lessons through deeper global perspectives as well as with culturally enhanced activities (Ebersole, Kanahele-Mossman, & Kawakami, 2016). This requirement represents an economic trade-off between cost and students' success for administrators to consider at the implementation level (Brown & Crippen, 2016).

For classes in STEM subjects, the fundamental principles of sciences, technology, engineering, and mathematics are thought to be independent of culture (Davison, 2007); therefore, it can be difficult to adapt to a culturally responsive teaching style. However, as STEM classes begin to adapt project-based learning where real-life projects are assigned to the students to allow them to see the application of science and technology principles into their daily lives, the projects can be designed to be oriented to the Hispanic culture that the students can relate to (Bryan, Moore, Johnson, & Roehrig, 2015). In this respect, the summer internship programs mentioned earlier can partner with organizations that have projects in Central and South America such as the Engineers without Borders (Engineers without Borders USA, 2019), or Doctors without Borders

(Medecins Sans Frontieres, n.d.) to provide real-life projects to STEM Hispanic students so that they can enjoy the project-based learning while immersing in the Hispanic culture that the location where the projects are implemented is providing (Ford, 2018).

A common strategy for implementing culturally responsive teaching is to use reciprocal teaching. With reciprocal teaching, students and professors take turns in leading discussions in the class (Zendler & Reile, 2018). Recognizing that the students might not be ready to teach the fundamental concepts of STEM subjects, the reciprocal teaching often uses cases so that the discussion can be led by anybody with common sense (Penn, Currie, Hoad, & O'Brien, 2016). This method of case studies places the emphasis on the professor to select appropriate cases so that the students can relate them to the classroom materials (George & Bennett, 2005). Thus, the students can concentrate on presenting the cases from their cultural perspective without losing focus on the relevant topic of the class (Walsh & Sattes, 2015). In the context of culturally responsive teaching of STEM subjects, the selected cases should provoke profound thinking of the students who were shaped by the Hispanic culture while maintaining focus on the principles of the STEM subjects (Babaci-Wilhite, 2016). In this context, the Summer internship programs in Central and South America mentioned earlier seem to provide this connection between the culturally dependent way of thinking and the understanding of the STEM subjects (Batey & Lupi, 2012).

Conclusion

This chapter identified the relevant topics related to the purpose of this study and reviewed the literatures covering these topics. Key issues such as the financial assistance, learning communities, peer tutoring, peer mentoring, Summer orientation and Bridge programs, and culturally responsive teaching were discussed in the context of applying to Hispanic students. In the next chapter, an overview of the research problem, theoretical construct, research questions, research design, procedures, and analysis for this study are discussed. There, the scope and limitation of the study are also identified and clearly defined.

CHAPTER III:

METHODOLOGY

The purpose of this study was to identify positive effects of the intervention program implemented for Hispanic students in STEM majors. The study was conducted at a large public university in Texas. In this study, quantitative analysis was used to track the performance of the SCS Program. Students' academic performance numerical data (GPA) was analyzed in a cross-sectional study to identify the difference between the participating Hispanic students and the non-participating Hispanic students with similar academic majors and socioeconomic profiles. This cross-sectional study was used to identify influencing factors that affect the effectiveness of the SCS Program. Furthermore, numerical data of the academic performance of the participating students was analyzed in a traversal study to identify the yearly rate of improvement and to project the saturation point of performance. This traversal study was used to establish a realistic expectation of improvement that the SCS Program can deliver over a course of time.

Overview of the Research Problem

The general research problem of identifying positive effects of intervention programs has been an ongoing topic for managing the performance of sponsored intervention Programs (Vedung, 2017). To measure positive effects of the programs implemented for Hispanic students in STEM majors such as SCS Program, the academic performance of each student who participated in the program was tracked and compared with a non-participating Hispanic student who has similar study major and socioeconomic profile. Figure 4 graphically illustrates the population and sample in this study.

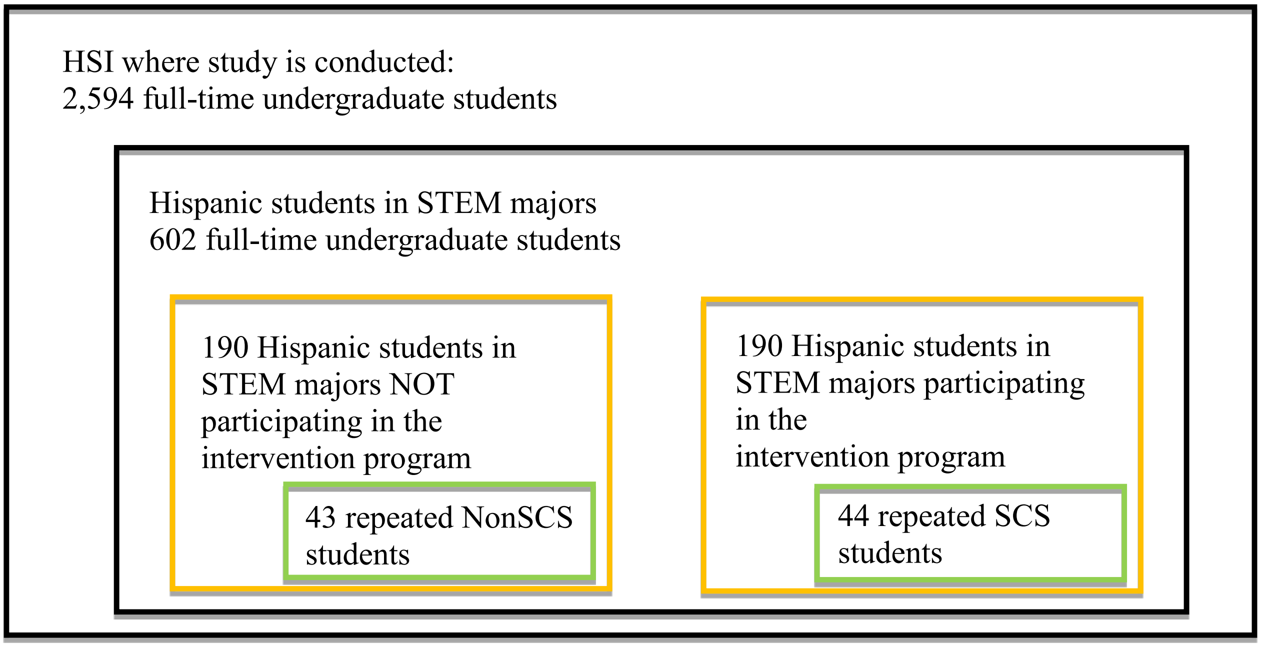


Figure 4
Diagram of Population and Sample.
This figures graphically illustrates the population and sample in this study

The positive effects of the SCS Program was also studied in a traversal study (Shumway & Stoffer, 2017) along a timeline to establish and manage realistic expectations of the year-to-year improvement of the program (Munson & Pierce, 2015). In this aspect, the improvement was anticipated to be significant at the beginning and to eventually reach a ceiling (Nelson, 2016). At this point of saturation, additional improvement required a tremendous effort that significantly outweighs the benefits (Saunders et al., 2018). Therefore, it is acceptable to see significant improvement in the first year after the implementation of the program. However, significant improvement at the outset leaves the program with less room for improvement in later years. Figure 3.2 graphically illustrates the concept of improving a situation in a traversal course of time. With the performance data available, a mathematical model as a function of time can be established and the point of saturation can be determined.

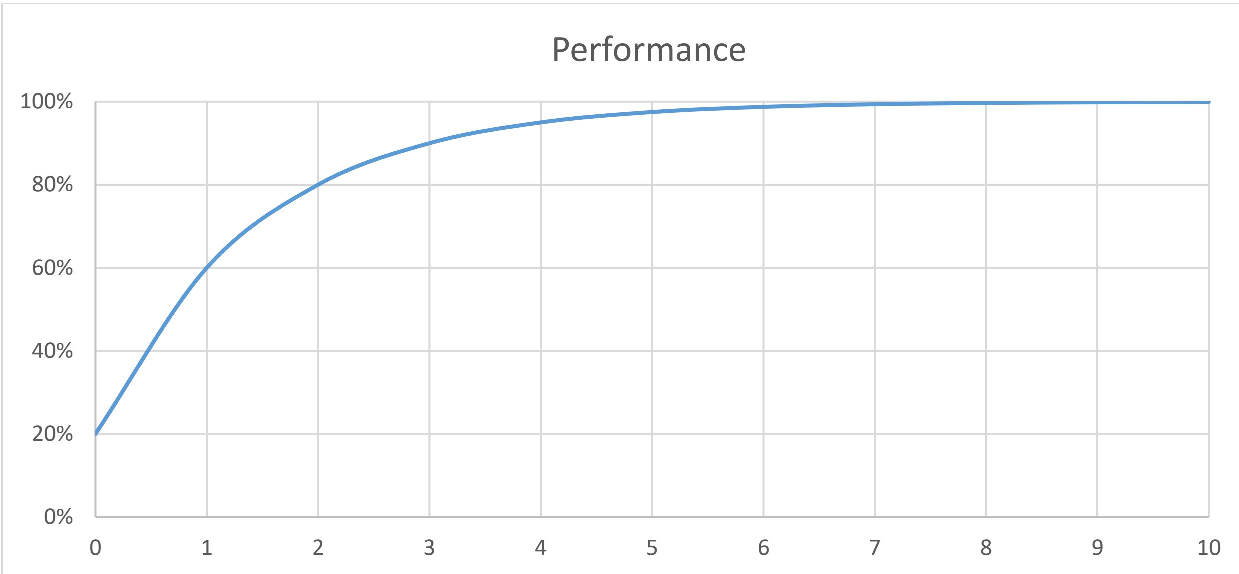


Figure 5
Performance Tracking.
An example of performance tracking of a program along a timeline in a traversal study

Operationalization of Theoretical Constructs

The study consisted of three constructs: (a) current learning results of the students, (b) demographic profile of the students, and (c) academic progress of the students.

Learning results were defined as the level of mastery of a subject, measurable from the standardized grading scale adapted nationally (O'Connor, 2017). Students are assigned a numerical grading level by a professor according to how well they perform in each class, ranging from 4.0 (or A) as mastery to 0.0 (or F) as failing. Students with an overall academic performance (GPA) of 2.0 (or C) or above are classified as having a good academic standing. The net positive effect of the SCS Program was measured based on the GPA increase after a student participated in the intervention program.

Demographic profile was defined as a set of students' characteristics that the university maintains, normally for the purpose of reporting in terms of racial and gender equality, studying in terms of effective marketing, and addressing specific needs of individual groups (Johnson, 2015). Demographic profile, which included students' gender, age, ethnicity, and major, was required by the university when they applied for admission. Other demographic information such as socioeconomic conditions were available when students apply for financial aid.

Academic progress was defined in terms of how much achievement a student has accomplished with respect to the studying plan designed for the selected major (Schudde & Scott-Clayton, 2016). This academic progress often includes general classification (freshman, sophomore, junior, and senior), number of academic credits achieved, participation in certain academic programs and honor societies, and recognition for achieving exemplary academic performance and delivering distinguished services. The university maintains this academic progress information for each student in a registrar database and normally use it for managing the academic success of the students dictated by the requirements for accreditation (Ahrens & Khalifa, 2015).

Research Purpose, Questions, and Hypothesis

The purpose of the study was to identify positive effects of the intervention program SCS implemented for Hispanic students in STEM majors. The following research questions were posed to guide the study:

1. Is there a difference in the academic performance of the Hispanic STEM students participating in the SCS Program?

   H_o: There is no difference in the academic performance of the Hispanic STEM students participating in the SCS Program and those not participating.

   H_a: There is a difference in the academic performance of the Hispanic STEM students participating in the SCS Program and those not participating.

2. Is there a year-to-year improvement for the SCS Program in terms of the number of the participating Hispanic STEM students maintaining good academic standing?

   H_o: There is no year-to-year improvement for the SCS Program in terms of the number of the participating Hispanic STEM students maintaining good academic standing.

   H_a: There is a year-to-year improvement for the SCS Program in terms of the number of the participating Hispanic STEM students maintaining good academic standing.

3. Is it possible to mathematically model the year-to-year improvement to project a saturation point (or a point of diminishing returns) for establishing long-term realistic expectations?

   H_o: It is not possible to mathematically model the year-to-year improvement to project a saturation point (or a point of diminishing returns) for establishing long-term realistic expectations.

   H_a: It is possible to mathematically model the year-to-year improvement to project a saturation point (or a point of diminishing returns) for establishing long-term realistic expectations.

Research Design

For this study, a quantitative retrospective causal-comparative analysis was used to find the difference in academic performance between students who participated in the SCS Program and students who did not. Their academic performance numerical data were used to calculate the mean difference for the two groups. These three steps were repeated for various pairs of the control group and test group, both in a cross-sectional study and in a traversal study. Furthermore, data from the traversal study were used to find a mathematical model representing the performance function so that expectation of year-to-year improvement of the SCS Program can be realistically managed.

Population and Sample

The university where the SCS Program was conducted has a population of 6,488 undergraduate students, consisting of 3,151 full-time students and 3,337 part-time students in the Fall Semester of 2018, according to the latest statistics released by the University. Table 2 displays the student demographics of the university where the SCS Program was conducted during the school year of 2018. Of this population, 2,445 (38%) were males and 4,043 (62%) were females. Ethnically, the student body consisted of 2,594 (40.0%) Hispanics, 2,567 (39.6%) Whites, 511 (7.9%) African Americans, 443 (6.8%) Asians, 19 (0.3%) Native Americans, 81 (1.2%) International students, 74 (1.1%) students of unknown origin, 196 (3%) students of multi-racial origins, and 3 (0.05%) Native Hawaiians.

Table 2

Student Demographics Data for Undergraduate Level (2018)

	Population (N)	Percentage %
Gender		
Female	4043	62.0
Male	2445	38.0
Status		
Full-time	3151	49.0
Part-time	3337	51.0
Race / Ethnicity		
African American	511	7.9
Asians	443	6.8
Hispanics	2594	40.0
International	81	1.2
Multi-racial	196	3.0
Native American	19	0.3
Native Hawaiians	3	0.05
Unknown	74	1.1
White	2567	39.6

The Hispanic undergraduate student body at this university had a total population of 2,594 students, of which 876 (34%) were males and 1,718 (66%) were females. Of this group, 1,181 (46%) were full-time students and 1,413 (54%) were part-time students. Table 3 displays the Hispanic student demographics of the university where the SCS Program was conducted during the school year of 2018. According to general areas of studies, 602 (23%) were in STEM and 1,992 (77%) were not in STEM. Of the 602 students in STEM, 336 (56%) were males and 266 (44%) were females. Similarly, the Hispanic graduate student body had a total population of 538 students, of which 157 (29%) were males and 381 (71%) were females. Of this group, 140 (26%) were full-time students and 398 (74%) were part-time students. According to major selected, 60 (11%) were in STEM and 478 (89%) were not in STEM. Of these 60 students in STEM, 31 (52%) were males and 29 (48%) were females.

Table 3

Hispanic Students Demographics Data in College of Science and Computer Engineering (2018)

Student	Population (N)	Percentage
Undergraduate	2594	100%
Female	1,718	66%
Male	876	34%
Full-time	1,181	46%
Part-time	1,413	54%
Non-STEM Majors	1992	77%
STEM Majors	602	23%
Female	266	44%
Male	336	56%
Graduate	538	100%
Female	381	71%
Male	157	29%
Full-time	140	26%
Part-time	398	74%
Non-STEM Majors	478	89%
STEM Majors	60	11%
Female	29	48%
Male	31	52%

Variables

For the dependent variable, data for students' GPA were collected from the university's College of Science and Computer Engineering. For the independent variables, data for students' demographic profile and SCS Program's participation were collected from the university's College of Science and Computer Engineering.

Data Collection Procedure

The researcher obtained permission to conduct the study from the University of Houston-Clear Lake (UHCL) Committee for the Protection of Human Subjects (CPHS) and the SCS grant's Institutional Review Board (IRB) before retrieving students' academic performance numerical data from the College of Science and Computer Engineering and demographic data from the university's registrar office.

Data Analysis

Following data retrieving from the College of Science and Computer Engineering, the data was imported from Microsoft Excel into an IBM SPSS statistics spreadsheet for further analysis. The Shapiro-Wilk test was performed to ensure that data were normally distributed.

To answer research question one, *Is there a difference in the academic performance of the Hispanic STEM students participating in the SCS Program?*, independent samples t-test and factorial analysis of variance (ANOVA) were used to examine and compare students' GPA in both groups in the criteria of participation, gender, classification, and by college, to identify where the program had the most positive effect on students.

To answer research question two, *Is there a year-to-year improvement for the SCS Program in terms of the number of the participating Hispanic STEM students maintaining good academic standing?*, a repeated measures ANOVA with a Greenhouse-Geisser correction was used to examine and compare the GPA of students in both groups that participated in SCS Program consistently over the four years of investigation.

To answer research question three, *Is it possible to mathematically model the year-to-year improvement to project a saturation point (or a point of diminishing returns) for establishing long term realistic expectations?*, the data results from both Research

Question 1 and Research Question 2 were used in the regression of the exponential function to predict the saturation point of the program estimation.

Privacy and Ethical Considerations

The researcher obtained permission to conduct the study from the university's CPHS before collecting data. Only participants' numeric ID was retrieved and used in the study. The data collected remain securely locked in a cabinet and pen drive in the office of the supervising professor of this study. The researcher will maintain the data for five years, as common practice, for further investigation. After the deadline has passed the researcher will destroy all data files associated with the study.

Research Design Limitations

The research design consisted of some limitations. First of all, due to the availability of data within only one university, the scope of the study and the findings were limited to the Hispanic population sample size of the university at the time of the study. Furthermore, the study was based on the first four years of the program with only 19 participating students in the first year, 39 on the second year, 56 on the third year, and 76 on the fourth year. Finally, all findings were based only on students' GPA, no other indicator was used in conjunction for this study, and GPA is not always the best measure of success once students have graduated.

Conclusion

The purpose of this study was to use quantitative analysis to identify positive effects of the intervention program implemented for Hispanic students in STEM majors. This chapter identified the steps to establish various pairs of the control group and test group of Hispanic students at the university where the SCS Program is implemented, and the steps to measure the effect that the participated students can experience from this program. The chapter also outlined a cross-sectional study so that affecting factors can be identified, and a traversal study so that a model for the performance could be established to realistically manage the SCS Program.

CHAPTER IV:

RESULTS

The purpose of this study was to identify positive effects of the intervention program SCS implemented for Hispanic students in STEM majors. This chapter begins with a detailed description of the demographic characteristics of participants at the University under the study, followed by the numerical results of the statistical analysis of the data relevant to Research Questions 1, 2, and 3. The chapter concludes with a summary of the study's findings.

Participant Demographics

This study was conducted for a group of Hispanic students who enrolled in the STEM majors at the University conducting the SCS Program. In this matched group of 380 students, 190 of them participated in the SCS Program and 190 did not. The group was first created by identifying all the Hispanic students who participated in the SCS Program from 2016 through 2019. There was a total of 190 students: 19 in 2016, 39 in 2017, 56 in 2018, and 76 in 2019. For every student who participates in the SCS Program, a matched student who did not participate in the SCS Program was carefully selected, using primarily the commonality in major, classification, and age, respectively. If there was more than one match for an SCS student, other criteria were used to narrow down the selection of the NonSCS students such as first-generation in college, SAT or ACT score, graduated high school or transferred from another institution, and gender so that the database would be composed of 190 pairs of matched students. Table 4 shows the composition of the sample from 2016 to 2019. Table 5 shows the participant demographics categorized by gender. Table 6 shows the participant demographics categorized by classification.

Table 4

Participant Demographics

Students	2016	2017	2018	2019	Total
SCS	19	39	56	76	190
NonSCS	19	39	56	76	190
Total	38	78	112	152	380

Table 5

Participants Categorized by Gender

		Gender				
		Female		Male		Total
		N	%	N	%	
2016	SCS	13	34.21	6	15.79	19
	NonSCS	7	18.42	12	31.58	19
	Total	20	52.63	18	47.37	38
2017	SCS	24	30.77	15	19.23	39
	NonSCS	16	20.51	23	29.49	39
	Total	40	51.28	38	48.72	78
2018	SCS	32	28.57	24	21.43	56
	NonSCS	27	24.11	29	25.89	56
	Total	59	52.68	53	47.32	112
2019	SCS	40	25.97	36	24.00	76
	NonSCS	37	24.03	39	26.00	76
	Total	77	50.00	75	50.00	152
Total		196	51.58	184	48.42	380

Table 6

Participants Categorized by Classification

		Classification										
		Freshman		Sophomore		Junior		Senior		Grad/PB		
		N	%	N	%	N	%	N	%	N	%	Total
2016	SCS	2	5.26	0	0.00	11	28.95	6	15.79	0	0.00	19
	NonSCS	3	7.89	0	0.00	10	26.32	6	15.79	0	0.00	19
	Total	5	13.16	0	0.00	21	55.26	12	31.58	0	0.00	38
2017	SCS	2	2.56	5	6.41	16	20.51	15	19.23	1	1.28	39
	NonSCS	2	2.56	5	6.41	16	20.51	15	19.23	1	1.28	39
	Total	4	5.13	10	12.82	32	41.03	30	38.46	2	2.56	78
2018	SCS	2	1.79	9	8.04	16	14.29	27	24.11	2	1.79	56
	NonSCS	1	0.89	10	8.93	16	14.29	27	24.11	2	1.79	56
	Total	3	2.68	19	16.96	32	28.57	54	48.21	4	3.57	112
2019	SCS	4	2.63	3	1.97	31	20.39	36	23.68	2	1.32	76
	NonSCS	4	2.63	2	1.32	34	22.37	34	22.37	2	1.32	76
	Total	8	5.26	5	3.29	65	42.76	70	46.05	4	2.63	152
Total		20	5.26	34	8.95	150	39.47	166	43.68	10	2.63	380

Research Question One

Research Question One, *Is there a difference in the academic performance of the Hispanic STEM students participating in the SCS Program*?, is answered with an independent t test using the GPA between two groups, 190 SCS participating Hispanic STEM students and 190 general Hispanic STEM students not participating in the SCS Program, as the independent variables. The result of Research Question One's analysis is presented in four sub-questions:

1. *Is there a difference in the academic performance of the Hispanic STEM students participating in the SCS Program by participation?*
2. *Is there a difference in the academic performance of the Hispanic STEM students participating in the SCS Program by gender?*
3. *Is there a difference in the academic performance of the Hispanic STEM students participating in the SCS Program by classification?*
4. *Is there a difference in the academic performance of the Hispanic STEM students participating in the SCS Program by college?*

The first sub-question, Is there a difference in the academic performance of the Hispanic STEM students participating in the SCS Program by classification?, was answered using results from the independent samples t test on the GPA means of the SCS and NonSCS students.

Descriptively, the SCS groups did consistently better than the NonSCS group over the four years. At a glance, Table 7 summarizes the GPA mean difference between the SCS and NonSCS students for the years from 2016 to 2019. The result from the t test also shows that the statistical difference is significant and this significant difference is consistent throughout the four years.

Table 7

GPA Mean Difference of SCS and NonSCS Students in Participation Category

Academic Year	Student	GPA Mean	Standard Deviation	t value	df
2016	SCS	3.35	0.37		
	NonSCS	2.74	0.87	2.81	36
2017	SCS	3.34	0.41		
	NonSCS	2.81	0.75	3.84	76
2018	SCS	3.14	0.52		
	NonSCS	2.60	0.73	4.50	110
2019	SCS	3.06	0.57		
	NonSCS	2.46	0.76	5.44	150

Note. All t values were significant at $p < .05$.

The second sub-question, *Is there a difference in the academic performance of the Hispanic STEM students participating in the SCS Program by gender?*, was answered using results from the independent samples *t* test on the GPA means of the SCS and NonSCS students.

Descriptively, both female and male students in the SCS groups did consistently better than the NonSCS group over the four years. However, there are two out of eight results from the *t* tests that show the difference was not significant, and these two results are both in the female category of the two earlier years. The Table 8 below shows statistical data for the GPA mean in gender category years of the program where the number of students was smaller.

Table 8

GPA Mean Difference of SCS and NonSCS Students in the Gender Category

Academic Year	Gender	Student	GPA Mean	Standard Deviation	N	t-test	df
2016	Female	SCS	3.28	0.39	13		
		NonSCS	2.97	0.74	7	1.24^	18
	Male	SCS	3.50	0.30	6		
		NonSCS	2.61	0.94	12	2.25	16
2017	Female	SCS	3.30	0.35	24		
		NonSCS	2.92	0.98	16	1.77^	38
	Male	SCS	3.41	0.51	15		
		NonSCS	2.74	0.56	23	3.71	36
2018	Female	SCS	3.16	0.42	32		
		NonSCS	2.82	0.64	27	2.46	57
	Male	SCS	3.12	0.64	24		
		NonSCS	2.41	0.76	29	3.65	51
2019	Female	SCS	3.08	0.52	40		
		NonSCS	2.50	0.73	37	3.72	75
	Male	SCS	3.03	0.54	36		
		NonSCS	2.43	0.81	39	3.9	73

Note. ^ t value not significant.

The third sub-question, Is there a difference in the academic performance of the Hispanic STEM students participating in the SCS Program by classification?, was answered using results from the factorial ANOVA on the GPA means of the SCS and NonSCS students.

For 2016, the descriptive result showed that the SCS group consistently outperformed the NonSCS group in Freshman, Junior, and Senior classifications. There were no students in Sophomore and Graduate/Post. Table 9 below shows descriptive statistical data for the GPA mean in classification category for 2016.

Table 9

GPA Mean by Classification for the Year 2016

Academic Year	Classification	Student	Mean	N
2016	Freshman	SCS	3.12	2
		NonSCS	1.58	3
	Junior	SCS	3.31	11
		NonSCS	2.91	10
	Senior	SCS	3.50	6
		NonSCS	3.03	6

A factorial ANOVA was conducted to examine the effects of participation in SCS and classification on GPA. Residual analysis was performed to test for the assumptions of the two-way ANOVA. The data were normally distributed and there was homogeneity of variances (p = .006).

The interaction effect between SCS participation and classification on GPA mean was not statistically significant, $F(2, 32) = 1.92$, $p = 0.16$, partial $\eta^2 = 0.11$. Therefore, the main effects for Participating and Classification were examined. The main effect for Participating was statistically significant, $F(1, 32) = 12.4$, $p = 0.001$ and the main effect for Classification was also statistically significant, $F(2, 32) = 4.37$, $p = 0.02$, partial η^2 =0 .21. *Post hoc comparisons using the Bonferroni correction indicated that the mean score for the Freshmen was significantly different than the GPA for the Juniors (M = 0.92, SD*

= 0.29) and Seniors (M = 1.07, SD =0.31). However, the Juniors were not significantly different than the Seniors.

For the year 2017, the descriptive result showed that the SCS group consistently outperformed the NonSCS group in all classifications, except for Freshman. Table 10 below shows descriptive statistical data for the GPA mean in classification category for 2017.

Table 10

GPA Mean by Student Classification for the Year 2017

Academic Year	Classification	Student	Mean	N
2017	Freshman	SCS	2.50	2
		NonSCS	3.22	2
	Sophomore	SCS	3.31	5
		NonSCS	2.85	5
	Junior	SCS	3.32	16
		NonSCS	2.62	16
	Senior	SCS	3.46	15
		NonSCS	2.90	15
	Post Bac	SCS	3.70	1
		NonSCS	3.62	1

A factorial ANOVA was conducted to examine the effects of participation in SCS and classification on GPA. Residual analysis was performed to test for the assumptions of the two-way ANOVA. The data were normally distributed and there was not homogeneity of variances ($p = 0.14$).

The interaction effect between SCS participation and classification on GPA was not statistically significant, $F(1, 68) = 1.32$, $p = 0.27$, partial $\eta^2 = 0.07$. Therefore, the main effects for Participating and Classification were also examined. The main effect for Participating was not statistically significant, $F(1, 68) = 0.90$ $p = 0.35$, and the main effect for Classification was not statistically significant, $F(4, 68) = 1.06$, $p = 0.38$, partial η^2 =0 .06. *Post hoc comparisons were not evaluated because the omnibus test was not significant.*

For the year 2018, the descriptive result showed that the SCS group consistently outperformed the NonSCS group in all classifications. Table 11 below shows descriptive statistical data for the GPA mean in classification category for 2018.

Table 11

GPA Mean by Student Classification for the Year 2018

Academic Year	Classification	Student	Mean	N
2018	Freshman	SCS	2.37	2
		NonSCS	2.29	1
	Sophomore	SCS	3.14	9
		NonSCS	2.16	10
	Junior	SCS	2.97	16
		NonSCS	2.53	16
	Senior	SCS	3.29	27
		NonSCS	2.81	27
	Post Bac	SCS	3.34	2
		NonSCS	2.82	2

A factorial ANOVA was conducted to examine the effects of participation in SCS and classification on GPA. Residual analysis was performed to test for the assumptions of the two-way ANOVA. The data were normally distributed and there was homogeneity of variances (p = .008).

The interaction effect between SCS participation and classification on GPA was not statistically significant, $F(4, 102) = 0.78$, $p = 0.54$, partial η^2 =0 .03. Therefore, the main effects for Participating and Classification were examined. The main effect for Participating was statistically significant, $F(1, 102) = 5.66$ $p = 0.02$ as well as the main effect for Classification $F(4, 102) = 2.74$, p = 0.03, partial η^2 =0 .10. *Post hoc comparisons using the Bonferroni correction indicated that the mean score for classification showed no significant differences because the omnibus test was only marginally significant.*

For the year 2019, the descriptive result showed that the SCS group consistently outperformed the NonSCS group in all classifications. Table 12 below shows descriptive statistical data for the GPA mean in classification category for 2019.

Table 12

GPA Mean by Student Classification for the Year 2019

Academic Year	Classification	Student	Mean	N
2019	Freshman	SCS	3.12	4
		NonSCS	1.96	4
	Sophomore	SCS	2.93	3
		NonSCS	2.82	2
	Junior	SCS	2.91	31
		NonSCS	2.26	34
	Senior	SCS	3.17	36
		NonSCS	2.67	34
	Post Bac	SCS	3.35	2
		NonSCS	3.01	2

A factorial ANOVA was conducted to examine the effects of participation in SCS and classification on GPA. Residual analysis was performed to test for the assumptions of the two-way ANOVA. The data were normally distributed and there was homogeneity of variances (p = 0.17).

The interaction effect between SCS participation and classification on GPA was not statistically significant, $F(4, 142) = 0.68$, $p = 0.61$, partial $\eta^2 = 0.02$. Therefore, the main effects for Participating and Classification were examined. The main effect for Participating was statistically significant, $F(1, 142) = 7.13$, $p = .008$ as well as the main effect for Classification $F(4, 142) = 2.94$, p = 0.02, partial η^2 =0 .76. *Post hoc comparisons using the Bonferroni correction indicated that the mean score for the Juniors (M = 0.36, SD = 0.11) were significantly different than the GPA for the Seniors. Other comparisons were not significant.*

The fourth sub-question, *Is there a difference in the academic performance of the Hispanic STEM students participating in the SCS Program in college?,* was answered using results from the factorial ANOVA on the GPA means of the SCS and NonSCS students for six colleges, Biological Sciences, Computer Engineering, Computer Science, School of Education, Engineering, and Natural Sciences.

For the year of 2016, the descriptive result showed that the SCS group consistently outperformed the NonSCS group in all colleges. Table 13 below shows descriptive statistical data for the GPA mean in college category for 2016.

Table 13

GPA Mean for SCS and NonSCS Students in the Category of College for 2016

Academic Year	College	Student	Mean	Standard Deviation	N
2016	Biological Sciences	SCS	3.38	0.47	5
		NonSCS	2.45	0.44	5
	Computer Engineering	SCS	3.20	0.39	5
		NonSCS	2.88	0.54	5
	Computer Science	SCS	3.38	0.43	5
		NonSCS	2.27	1.34	5
	Education	SCS	3.45	0.21	4
		NonSCS	3.52	0.28	4

A factorial ANOVA was conducted to examine the effects of participation in SCS and college on GPA. Residual analysis was performed to test for the assumptions of the two-way ANOVA. The data were normally distributed and there was not homogeneity of variances ($p = 0.14$).

The interaction effect between SCS participation and college on GPA was not statistically significant, $F(3, 30) = 1.71$, $p = 0.19$, partial $\eta^2 = 0.15$. Therefore, the main effects for Participating and college were examined. The main effect for Participating was statistically not significant, $F(3, 30) = 1.91$ $p = 0.15$, partial $\eta^2 = 0.16$. The main effect for college $F(1, 30) = 7.89$, p = 0.09, partial η^2 =0 .21. *Post hoc comparisons using the Bonferroni correction indicated that the mean score for majors showed no significant differences in 2016.*

For the year 2017, the descriptive result showed that the SCS group consistently outperformed the NonSCS group in all colleges. Table 14 below shows descriptive statistical data for the GPA mean in college category for 2017.

Table 14

GPA Mean by College for 2017

Academic Yr.	College	Student	Mean	Standard Deviation	N
2017	Biological Sciences	SCS	3.40	0.51	9
		NonSCS	2.89	0.37	9
	Computer Engineering	SCS	3.34	0.34	7
		NonSCS	2.64	0.60	7
	Computer Science	SCS	3.40	0.37	9
		NonSCS	2.34	0.95	9
	Education	SCS	3.45	0.25	8
		NonSCS	3.43	0.74	8
	Engineering	SCS	2.83	N/A	1
		NonSCS	3.40	N/A	1
	Natural Science	SCS	3.05	0.57	5
		NonSCS	2.66	0.61	5

A factorial ANOVA was conducted to examine the effects of participation in SCS and college on GPA. Residual analysis was performed to test for the assumptions of the two-way ANOVA. The data were normally distributed and there was homogeneity of variances ($p < 0.001$).

The interaction effect between SCS participation and college on GPA was not statistically significant, $F(5, 66) = 1.86$, $p = 0.11$, partial $\eta^2 = 0.12$. Therefore, the main effects for Participating and college were examined. The main effect for Participating was statistically significant, $F(1, 66) = 4.09$, $p < 0.05$ (p = 0.047), partial $\eta^2 = 0.058$. The main effect for college was not statistically significant, $F(5, 66) = 2.19$, $p = 0.6$, partial η^2 =0 .14. *Post hoc comparisons using the Bonferroni correction indicated that the mean score for classification showed no significant differences in 2017.*

For the year 2018, the descriptive result showed that the SCS group consistently outperformed the NonSCS group in all colleges. Table 15 below shows descriptive statistical data for the GPA mean in classification category for 2018.

Table 15

GPA Mean by College for 2018

Academic Year	College	Student	Mean	Standard Deviation	N
2018	Biological Sciences	SCS	3.14	0.52	16
		Non	2.51	0.59	16
	Computer Engineering	SCS	3.15	0.67	16
		Non	2.23	0.89	16
	Computer Science	SCS	3.04	0.17	6
		Non	2.58	0.42	6
	Education	SCS	3.45	0.31	10
		Non	3.30	0.64	10
	Engineering	SCS	2.52	0.40	3
		Non	2.56	0.24	3
	Natural Science	SCS	3.03	0.30	5
		Non	2.80	0.24	5

A factorial ANOVA was conducted to examine the effects of participation in SCS and college on GPA. Residual analysis was performed to test for the assumptions of the two-way ANOVA. The data were normally distributed and there was homogeneity of variances (p = 0.02).

The interaction effect between SCS participation and college on GPA was not statistically significant, $F(5, 100) = 1.62$, $p = 0.16$, partial $\eta^2 = 0.07$. Therefore, the main effects for Participating and college were also examined. The main effect for Participating was statistically significant, $F(1, 100) = 8.62$, $p = 0.004$, partial $\eta^2 = 0.08$. The main effect for college was also statistically significant, $F(5, 100) = 3.94$, $p = 0.03$, partial η^2 =0 .16. *Post hoc comparisons using the Bonferroni correction indicated that the mean score between Education and Biological Sciences (M = 0.55, SD = 0.17), Education and Computer Engineering (M = 0.68, SD = 0.17), and Education and Engineering (M = 0.83, SD = 0.27) were significantly different.*

For the year 2019, the descriptive result showed that the SCS group consistently outperformed the NonSCS group in all classifications. Table 16 below shows descriptive statistical data for the GPA mean in classification category for 2019.

Table 16

GPA Mean by College for 2019

Academic Year	College	Student	Mean	Standard Deviation	N
2019	Biological Sciences	SCS	2.97	0.66	28
		Non	2.44	0.57	28
	Computer Engineering	SCS	3.14	0.42	17
		Non	2.33	0.97	17
	Computer Science	SCS	2.97	0.60	10
		Non	2.51	0.49	10
	Education	SCS	3.33	0.42	10
		Non	2.90	0.71	10
	Engineering	SCS	2.94	0.74	7
		Non	2.11	1.20	7
	Natural Science	SCS	3.07	0.33	4
		Non	2.63	0.48	4

A factorial ANOVA was conducted to examine the effects of participation in SCS and college on GPA. Residual analysis was performed to test for the assumptions of the two-way ANOVA. The data were normally distributed and there was homogeneity of variances ($p = 0.09$).

The interaction effect between SCS participation and college on GPA was not statistically significant, $F(5, 140) = 0.42$, $p = 0.84$, partial $\eta^2 = 0.01$. The main effects for Participating and college were also examined. The main effect for Participating was statistically significant, $F(1, 140) = 19.81$, $p < 0.001$, partial $\eta^2 = 0.12$, and the main effect for college was not statistically significant, $F(5, 140) = 1.57$, $p = 0.17$, partial η^2 =0 .05. *Post hoc comparisons using the Bonferroni correction indicated that the mean score for showed no significant differences among colleges in 2019.*

Research Question Two

Research Question Two, Is there a year-to-year improvement for the SCS Program in terms of the number of the participating Hispanic STEM students maintaining good academic standing?, was answered using a repeated-measures ANOVA. Out of l90 SCS participated and 190 NonSCS participated students in Research Question 1, there were the same 44 SCS participated students and the same 43 NonSCS participated students who repeatedly attended the university from 2016 through 2019. A total of 87 students were selected for this repeated measure analysis.

Descriptively, the SCS groups did consistently better than the NonSCS group over the four years. At a glance, Table 17 summarizes the GPA means for repeated SCS and NonSCS students for the years from 2016 to 2019.

Table 17

GPA Mean for 44 Repeated SCS and 43 Repeated NonSCS Students 2016-2019

Academic Year	Student	GPA Mean	Standard Deviation
2016	SCS	3.28	0.37
	NonSCS	2.85	0.50
2017	SCS	3.22	0.31
	Non SCS	2.79	0.51
2018	SCS	3.16	0.34
	Non SCS	2.78	0.50
2019	SCS	3.19	0.31
	Non	2.81	0.52

A repeated-measures ANOVA with a Greenhouse-Geisser correction showed that the GPA mean difference between SCS and NonSCS students was significant between time points from 2016 to 2019 with $F(1.74, 147.54) = 5.27$, $p < 0.001$. Examining the profile plot in Figure 6, it is clear that the SCS group consistently outperformed the NonSCS group over the four years.

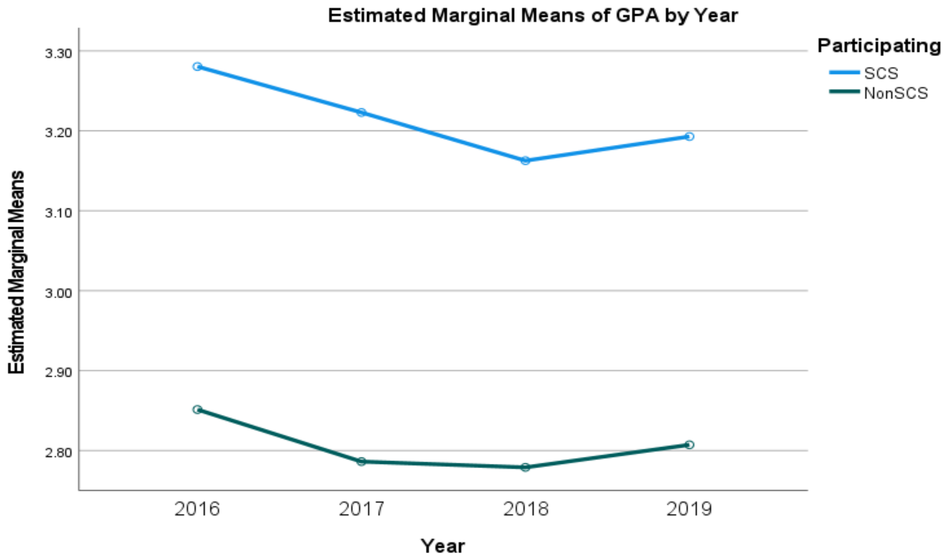


Figure 6
GPA Mean Difference.
This figure illustrates the GPA mean difference between repeated SCS and repeated NonSCS students

Research Question Three

Research Question Three, Is it possible to mathematically model the year-to-year improvement to project a saturation point (or a point of diminishing returns) for establishing long-term realistic expectations?, is answered with the exponential regression analysis of the GPA mean between students who participated in the SCS Program and students who did not. In this analysis, the parameters of the performance curve $\gamma(t) = \alpha e^{-\beta t}$ are calculated, with α being the intercept value at $t = 0$ to represent the SCS Program's first year at 2016 and β being the slope value of the curve. In addition, the difference in students' GPA mean between the two groups were calculated as improvement and this improvement is normalized using the following formula:

$$\gamma(t) = \frac{GPA\ Mean\ of\ SCS\ participated\ students(t) - GPA\ Mean\ of\ NonSCS\ students(t)}{4 - GPA\ Mean\ of\ NonSCS\ students(t)}$$

where the difference in the GPA mean of SCS participated students and the NonSCS participated students represents the improvement of the SCS group, and the value 4 – GPA Mean of NonSCS participated students is the scaling factor representing the maximum improvement possible. The result of Research Question Three's analysis will be presented in two sub-questions:

1. *Is it possible to mathematically model the year-to-year improvement to project a saturation point (or a point of diminishing returns) for establishing long-term realistic expectations of all 190 Hispanic STEM students participating in the SCS Program?*
2. *Is it possible to mathematically model the year-to-year improvement to project a saturation point (or a point of diminishing returns) for establishing long-term realistic expectations of the 44 repeated Hispanic STEM students participating in the SCS Program?*

For the first sub-question, Is it possible to mathematically model the year-to-year improvement to project a saturation point (or a point of diminishing returns) for establishing long-term realistic expectations of all 190 Hispanic STEM students participating in the SCS Program?, the result parameters of this model are: $\alpha = 0.48$ and $\beta = 0.08$, making the estimation of the program's saturation point in 19.67 years later, approximately at the year 2036 when the improvement is less than 10%. At a glance, Table 18 summarizes the GPA means for SCS and NonSCS students for the years from 2016 to 2019 and Figure 7 shows the estimation of the program's saturation point.

Table 18

GPA Mean of SCS and NonSCS Students 2016-2019

Academic Year	Student	GPA Mean
2016	SCS	3.35
	NonSCS	2.74
2017	SCS	3.34
	NonSCS	2.81
2018	SCS	3.14
	NonSCS	2.60
2019	SCS	3.06
	NonSCS	2.46

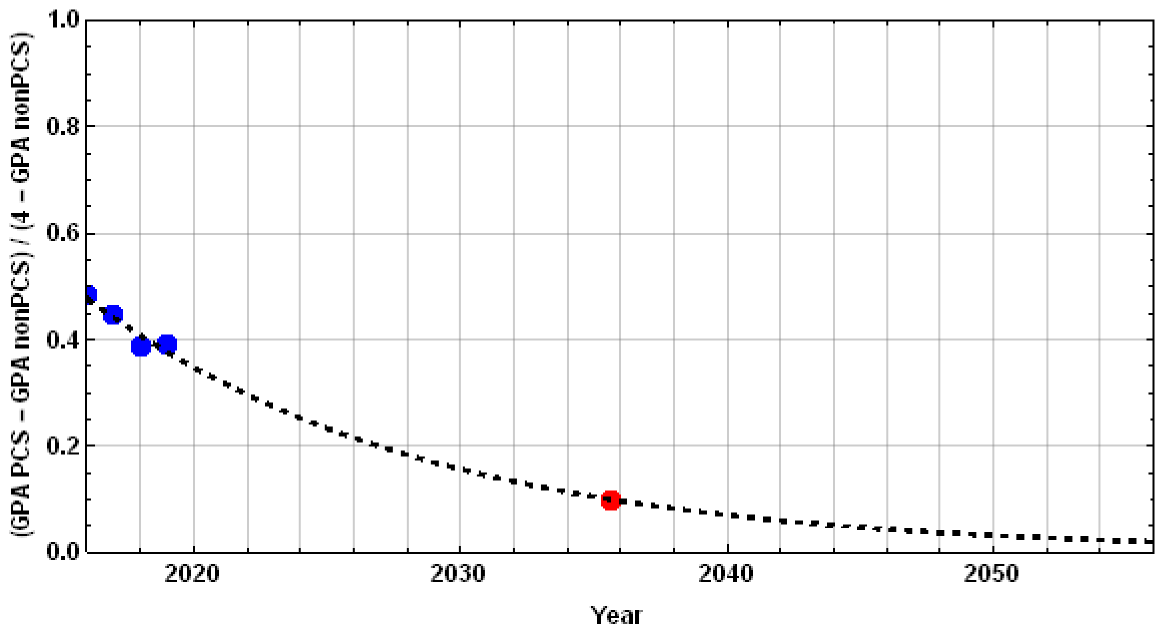


Figure 7
Estimated Saturation Point for SCS students.

This figure illustrates the SCS Program's performance curve for all 190 SCS students with estimated saturation point at 2036.

For the second sub-question, Is it possible to mathematically model the year-to-year improvement to project a saturation point (or a point of diminishing returns) for establishing long-term realistic expectations of the 44 repeated Hispanic STEM students participating in the SCS Program?, the result parameters of this model are: $\alpha = 0.37$ and $\beta = 0.06$, making the estimation of the program's saturation point in 21.67 years later, approximately at the year of 2038 when the improvement is less than 10%. At a glance, Table 19 summarizes the GPA means for 44 repeated SCS and 44 repeated NonSCS students for the years from 2016 to 2019 and Figure 8 shows the estimation of the program's saturation point.

Table 19

GPA Mean of Repeated SCS and Repeated NonSCS Students 2016-2019

Academic Year		GPA Mean	Standard Deviation
2016	SCS	3.28	0.37
	Non	2.85	0.50
2017	SCS	3.22	0.31
	Non	2.79	0.51
2018	SCS	3.16	0.34
	Non	2.78	0.50
2019	SCS	3.19	0.31
	Non	2.81	0.52

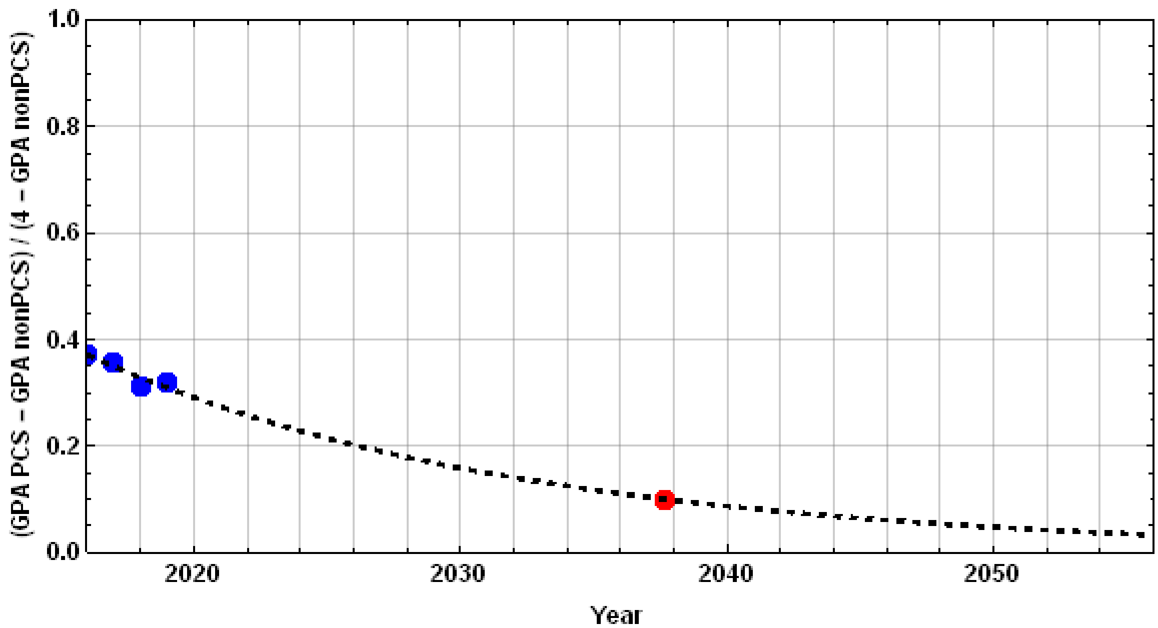


Figure 8
Estimated Saturation Point for repeated SCS students.
This figure illustrates the SCS Program's performance curve for 44 repeated SCS students with estimated saturation point at 2038.

Summary of Findings

The overall means of the GPA of the participating students were compared with those of the non-participating students using independent samples *t* tests. Results showed a statistically significant difference between the two groups, with the participating students performing better than the non-participating students, generally in the four-year duration spanning from 2016 to 2019 as well as specifically in each of these years. Furthermore, in each of the demographic subgroups such as gender, classification, and college, the students who participated in the SCS Program also performed better than the non-participating students with a positive statistically significant difference.

The year-to-year GPA comparison between the participating group and the non-participating group was done through a repeated measure analysis. The net positive difference in GPA of the participating students over the non-participating students was statistically significant in each of the years, even though it was noticed that the performance in both groups was slightly lower as the difficulty level in courses during upper classification increases. However, there is no statistically significant improvement in this net positive difference over the four-year span of the study.

The difference in GPA improvement of the participating students over the non-participating students for each year was normalized to the same percentage scale and then modeled with the exponential regression analysis. The model showed that the program will reach a saturation point in about 15 years when it will not be economically feasible to expect significant improvement. However, this model assumes that every factor affecting the program will remain the same. This assumption implies that it is still possible to improve the program if these factors can be adjusted correctly.

Conclusion

This chapter presented the numerical results of the statistical analyses and the discussion of these numerical results. Over the duration of 2016 to 2019, the statistical results of the analysis using GPA mean of 190 students who participated in the SCS Program and 190 students who did not showed a significant difference in performance in favor of the students who participated. This significant difference was found consistent when comparing the two groups overall and also in sub-categories such as gender, classification, and college. The analysis using GPA mean of 44 SCS students and 43 Non SCS students who repeatedly attended the University, also showed a significant difference in performance in favor of the SCS students. These analyses also suggested that the performance of the SCS program will reach the saturation in 15 years. In the next chapter, the researcher presents the implication of this study and discusses recommendations for future studies.

CHAPTER V:

SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS

The purpose of this study was to identify positive effects of the intervention program SCS implemented for Hispanic students in STEM majors at a four-year Hispanic serving university in Texas. In order to accurately assess the effects of the program, the study was done in two stages. First, GPA means comparison between the group of students who participated in the intervention program and the matched group of students, who have very similar profile in major, classification, age, and other background's criteria, who did not participate for each year in the period of 2016 to 2019. The comparison was done in different sub-categories, such as participants versus non-participants, between genders, and among classifications and colleges to reflect in details where the intervention program benefits students most. After that, a repeated measure analysis was done only for students who participated in the program for four consecutive years, from 2016 to 2019, with a matched group of students who also attended the University but did not participate in the program to measure the increase of the positive effects when students consistently participated in the program. Finally, the GPA means from both of these analyses were used to project the program saturation point, where student achievement's improvement reaches 95%. This chapter presents the summary of findings, implications, and recommendations for further research in the immediate future.

Summary of Results

Research Question 1, regarding the effect of the SCS Program on the participating Hispanic students, was answered through the mean difference analysis of two matched groups with identical backgrounds and academic profiles, where one group participated in the SCS Program while the other group did not. The general results show that for the period from 2016 through 2019, the Hispanic students enrolled in the SCS Program outperformed the Hispanic students who did not enroll in the SCS Program by a net difference of 0.56 in GPA that is on the scale of zero to four. In addition to the obvious significance in the magnitude of the difference, this difference is shown to be statistically significant through the rejection of the null hypothesis that the performance of the two groups are the same.

Research Question 2, regarding the effects of the SCS Program from one year to the next, was answered through the repeated-measure analysis of the same two matched groups who enrolled in every year of the duration of the study from 2016 through 2019. The results show a healthy improvement of about 23% after the first year, followed by a small dip to about 19% improvement after the second year, and a steady increase in improvement to about 22% after the third year and 24% after the fourth year. These differences were shown to be statistically significant through the rejection of the null hypothesis that the yearly performances are the same from one year to the next.

Research Question 3, regarding the modeling of the performance of the SCS Program so that the point of saturation can be identified, was answered through the exponential regression analysis of the yearly improvement of the participating Hispanic students when compared with the matched group of the non-participating Hispanic students. The modeling is inconclusive because there were only four data points for the four calendar years from 2016 to 2019, when the SCS Program began to operate.

Learning Community

Learning communities can have a profound positive effect on students who share learning experience while bonding with each other through the common interest of taking the same classes, thus leading to much better academic performance (Nora, Carales, & Bledsoe, 2018). Specifically, for Hispanic students whose culture depends heavily on family ties supporting their endeavor, the Hispanic learning communities offer an alternative connection where the participating professors and mentors can play the role models that these Hispanic students are missing at home (Tova, 2014). Additionally, when Hispanic students speak Spanish as their first language, learning communities that use the Spanish language are even more essential for enhancing their classroom performance (Pascual y Cabo, Prada, & Lowther-Pereira, 2017).

The SCS Program took advantage of the understanding of cultural conditions as well as the academic challenges that Hispanic students in STEM areas are facing while setting up the learning community with Spanish-speaking tutors and mentors to accommodate them in their learning quest. Furthermore, this learning community is also facilitated an online platform (Porwol, Ojo, & Breslin, 2018) that could be accessed from any at any time. With the participation that builds up emotional bonding, participating students can reach a point of trusting each other enough to share personal issues that can be resolved through emotional support (Huurne, Ronteltap, Corten, & Buskens, 2017).

It is important to note that the facilitators of the learning community play an important role for the academic success of the participating students (Margalef & Roblin, 2016). Normally, a facilitator of a learning community can be a professor, a professional specialized in academic guidance, or an upperclassman who already participated in the learning communities as a student in the past (Dimino, Taylor, & Morris, 2015). Additionally, it was noted that Hispanic students look to the facilitator as a role model in their personal life, and this is the reason why the SCS Program utilized the tutors who speak the same Spanish language and who understand the plight of an average Hispanic family (Mintrop & Charles, 2017). These tutors were upperclassmen who participated in the SCS Program and therefore also understand how the program is conducted. Thus, the participating Hispanic students in the SCS Program had all the necessary conditions for academic success.

First-Generation College Students

First-generation Hispanic college students are the first in their family to ever attend universities and often are facing additional challenges of not knowing what to expect (Tello & Lonn, 2017) while having stronger motivation to succeed (Ballysingh, 2019). In addition, first-generation Hispanic college students were observed to enter college with less academic readiness (Latino et al., 2020), more financial stress (Cadaret & Bennett, 2019), and inadequate learning skill (Antonelli, Jones, Backscheider Burridge, & Hawkins, 2020) when compared with other students in the general population. The result was that first-generation Hispanic college students recorded low academic performance in their first year of college and tended to drop out afterward (House, Neal, & Kolb, 2019). The difficulties that these first-generation college Hispanic students are facing cannot be resolved with personal motivation alone (Gaudier-Diaz, Sinisterra, & Muscatell, 2019).

The SCS Program, anticipating many first-generation Hispanic college students entering the university with commonly known challenges, set up their work components specifically to alleviate the anxiety (Badiee & Andrade, 2019) associated with these challenges in hopes of avoiding the academic pitfalls (Hatch & Garcia, 2017) that first-generation Hispanic college students can get into in their first year in college. These work components include financial assistance (Powell, 2018) in the form of scholarships, grants, and work study funding to relieve finance stress; summer Bridge programs (Ashley et al., 2017; Nelson, 2011) to increase the academic preparedness, peer tutoring programs (Capp, Benbenishty, Aster, & Pineda, 2018; Pan, Guo, Alikonis, & Bai, 2008) to respond to academic needs in real time, and mentoring programs (Ockene et al., 2017) to fill in the missing academic leadership that might not exist at home.

It is important to observe that the majority of Hispanic students participating in the SCS Program are first-generation college students, and their high level of motivation can be carefully facilitated to spread out in a contagious manner (Law, Geng, & Li, 2019) in a learning community. In this aspect, the motivational influence they bring to the learning community can positively affect other non-first-generation college students (Breugst, Patzelt, & Shepherd, 2020) while at the same time absorbing the emotional confidence that these non-first-generation college students exude (King, 2019). Thus, the carefully planned facilitation process (Odena & Burgess, 2017) of the PCS Program can be considered a contributing factor (Thomas, Cassady, & Heller, 2017) to the positive effect of the participating students.

Culturally Responsive Teaching

The strategy of implementing culturally responsive teaching (Ladson-Billings, 1994; Gay, 2018) to Hispanic college students has been seen with positive effects (Bai, 2018) though costing an additional amount of resources from the sponsoring institution (Franco & Hernández, 2018). In this endeavor, the teaching staff must be trained to understand the culture of the students represented at the university (Szlachta & Champion, 2020), and perhaps to speak the same language (Chalupa & Hoecherl, Alden, 2019; Kennedy, 2001) that is considered part of the culture. It is important to clarify that the teaching staffs, in addition to professors, also include teaching assistants, tutors, and facilitators of learning communities. While it might be difficult to train professors at research institutions (McLeod & Urquiola, 2021) for the additional burdens of managing Hispanic students with the understanding of Hispanic culture, because they (the professors) are required to conduct scholarly research in their subject matter of expertise (Burke-Smalley, Rau, Neely, & Evans, 2017), it is probably easier to recruit tutors and facilitators with Hispanic background and ability to speak Spanish (Back & Dean, 2020; Diaz-Rico & Smith, 1994) without loss of focus.

When the SCS Program was initially implemented, the idea of hiring participating Hispanic upperclassmen as tutors was utilized to satisfy two specific objectives: to provide financial assistantship (Scott-Clayton, 2015) to the students and to help implementing the culturally responsive teaching (Woodley et al., 2017) in the learning community (Lippincott, 2019) at the peer-to-peer level (Lipsky, 2010). This strategy was aimed at achieving the positive results in terms of better academic performance (Boatman & Long, 2016) commonly seen at the secondary school level (Mitchell & Stewart, 2012). In addition, the learning community was implemented in an online platform (Palloff & Pratt, 2007) to further promote the cultural aspect of learning through the direct interaction between participating students (Beachboard et al., 2011; Lenning et al., 2013). While the direct teaching might not be culturally based due to the nature of STEM subjects, it was noted that there are opportunities in the practice for culturally based projects (Engineers without Borders USA, 2019; Medecins Sans Frontieres, n.d.) that participating students can engage in during summer internship (Bloom, 2018).

The initial success of the SCS Program, measured through the improvement in academic performance of the participating Hispanic students in comparison to their non-participating counterparts, brings up an interesting point about implementing the culturally responsive teaching at levels higher than the peer-to-peer tutoring. While this question is a strategic decision (Kirkwood, 1996; Thompsen, 2016), it is imperative to project the expected sustainable success so that the cost and effort can be estimated (Rad, 2001) and justified (Boardman, Greenberg, Vining, & Weimer, 2017). This is the reason that the academic performance of the participating students is modeled in some regression manner (Harrell, 2015), so that a projection can be made in preparation for the strategic expansion that requires additional resources from the institutional level (Fabozzi & Fabozzi, 2020).

Comparison to Other Students

One important aspect of studying the effect of a treatment program is the comparison between two matched groups (Schulz & Grimes, 2019; Rosenbaum, 2010) of identical demographic characteristics (Renn & Reason, 2012), with the only difference being one group was receiving the treatment while the other group did not. In order to make a direct comparison of the outcome, the measurement of the performance of the two groups must be calibrated to the same scale (Gupta, 2012). Thus, if there is any difference in the performance, the only explanation available is the treatment that one group was receiving (Morgan & Winship, 2014). When the analysis is conducted over a period of time in a longitudinal study, the measurement of performance can be done for the two matched groups at intervals of time for a repeated measure analysis (Hickey, Mokhles, Chambers, & Kolamunnage-Dona, 2018).

The SCS Program, receiving funding from the federal government to improve the disproportional participation of Hispanics (Pew Research Center, 2018) in the workforce in the STEM area, has to practice accountability (Hutt & Polikoff, 2020) in terms of reporting results (Hillman & Corral, 2017) to the sponsoring agency. These results must be in the form that is verifiable (Smith, 2020) and comparable (John & Eeckhout, 2005) against a pre-defined goal that was typically estimated in the proposal and finalized upon the formal acceptance of the funding (Hall, 2009). The management of the funding from the sponsoring agency includes frequently monitoring the performance in progress (Robinson & Song, 2019) to determine if the fund-receiving institution is on track of achieving its final goal or if corrective measure (Meredith, Shafer, Mantel, & Sutton, 2020) must be taken to ensure the success expected at the end of the funding period. For this reason, the standardization of the performance measurement must be calibrated on the same GPA scale (Arco-Tirado et al., 2018) for direct comparison between the participating students and their non-participating counterparts.

While it is obvious to see the need for calibration of observed data in a cross-sectional study (Sedgwick, 2014) that requires comparing data of the participating students against that of the non-participating students, it is equally important and perhaps more complex to calibrate the data in a longitudinal study (Dabholkar, Shepherd, & Thorpe, 2000) that involves comparing the performance data from one year to the next. For this type of study, even though the GPA scale is the same, the level of difficulty or the mapping (Vanhatalo, Li, & Sillanpää, 2019) transformation of the students' competency to the GPA scale might be different each year. For this reason, the improvement of the participating students over the non-participating students is measured in terms of percentage to reflect that the baseline is always the same, and the scale from zero to 100% is uniform.

Implications

One important aspect of managing a public institution is to maintain the readiness of the academic staff according to the enrollment size. In light of the initial success of the PCS Program, it is likely that the enrollment will increase (Chiteng Kot, 2014; Kiser & Hammer, 2015) because of the availability of scholarships (Bozick, Gonzalez, & Engberg, 2015; Cornwell, Mustard, & Sridhar, 2006), word-of-mouth about good reputation (Nisar, Prabhakar, Ilavarasan, & Baabdullah, 2020), better relationships with parents (Levens, Elrahal & Sagui, 2016; Schiffrin et al., 2014), and better retention rates (Ryan & Glenn, 2002; Fowler & Boylan, 2010). While it is a fairly straightforward recruiting process to ramp up the academic staff when there is a demand, the decision to ramp up the academic staff is difficult to make because of the uncertainty about the sustainability of the demand (Chien, Dou, & Fu, 2018; Pak, Pornsalnuwat, & Ryan, 2010).

An informed decision (Harrington, 2014; Peterson, 2017) is a rational decision made based on hard evidence (Barends & Rousseau, 2018; Sullivan, 2016). For a strategic decision (Judge & Talaulicar, 2017; Puranam, 2016) to increase the academic staffing, especially with full-time tenured or tenure track positions that require long-term commitment from the university (Diversi, 2019; Loomes, Owens, & McCarthy, 2019), it is important to establish sustainability (Huang & Hsieh, 2020; Supplee, 2014) in enrollment in order to justify this commitment. In this endeavor, enrollment can be measured directly with headcount of full-time equivalence (Bowen & Sosa, 2016), and its stability is measured indirectly with the sustainable success (Lau, 2003) of programs such as the SCS Program that boosts its reputation and attractiveness to prospective students.

For an academic institution that engages in research or aspires to engage in nationally funded research, the recruitment of new faculty members must align (Jimenez, 2020) with the strategic plan (Ololube et al., 2016; Rashid et al., 2016) toward achieve the goal of engaging in research. This effort must balance between satisfying the teaching need and the research alignment with the academic programs (Mbaye, 2020). This alignment will foster the creation of relevant research assistantship and internship positions (Ocean, Tigertail, Keller, & Woods, 2018) for students in various intervention programs such as the SCS Program, designed to take advantage of these positions to stimulate interest and push academic success (Landrum & Nelsen, 2002).

Intervention programs such as the SCS Program for Hispanic students are financed by federal grants (Dayton, Gonzalez-Vasquez, Martinez, & Plum, 2004; Vargas, 2018; Vargas & Villa-Palomino, 2018). The grants are often seen as an initial investment to help solve an immediate situation of disparity between an ethnic representation in the population and its corresponding representation in the professional workforce (Pew Research Center, 2018). However, these grants will not provide the financing forever (O'Neal-McElrath, Kanter, & English, 2019), and therefore the grant-receiving institutions must learn how to maintain the intervention program after the grant money runs out (Smirnov, 2020) or to solve the problem for good (Vandekinderen, Roets, Van Keer, & Roose, 2017). In this respect, solving this problem of social inequity with a permanent solution in a short period of time is often seen as extremely difficult (Boliver, 2017; Teranishi et al., 2020), leaving the option of maintaining the intervention program a viable direction that can be managed. In order to justify maintaining the intervention program, it is important to evaluate the success that the program delivers, and the consistent manner that it delivers. Furthermore, if the success of the program can be positively correlated with the increase in enrollment of the institution, it will help justify the expansion of the faculty staff to an equitable student-to-professor ratio, where a better ratio will improve the ranking and profile of the university, which in turn will improve its reputation to attract even more students.

Recommendations for Future Research

There are three recommendations based on the results of this study: first to correlate the success of the SCS Program with the increase in enrollment of the university hosting the program, second to identify the specific characteristics of the SCS Program that the participated students found most beneficial to them, and third, to conduct a long-term study to establish the sustainability of the success of the SCS Program.

Conclusion

The growing Hispanic population in the United States highlights an important source of human resource that can play an important role in the national economy. As the national economy is shifting to the areas of STEM (sciences, technologies, engineering, and mathematics), the shortage of expertise in these areas has prompted changes in immigration laws permitting the hiring of foreign experts to work in the United States. This dependence on foreign experts can be a disadvantage for the United States in the intertwined global market.

The disparity of Hispanic representation in the STEM workforce is a numerically contributing factor to the shortage of expertise in the STEM areas. Given sufficient resources for corrective measures, it can be an opportunity to convert the untapped human resource from this ethnic group into the STEM workforce to alleviate the shortage of STEM expertise and to offset the current disadvantage of depending on the foreign experts. For this reason, federal programs were established to help Hispanic Serving Institutions to assist Hispanic students majoring in STEM areas in various aspects so that they can stay in the STEM majors and graduate into the STEM workforce.

The SCS Program in Texas where this study was conducted was established under the federal grant for the purpose of increasing Hispanic representation in the STEM workforce in the region. Under this program, Hispanic students in STEM majors are enrolled in summer bridge programs, need-based scholarships, tutoring sessions, mentoring sessions, research assistantships, summer internships, etc., to maintain their interest and commitment to the selected major while improving their academic performance so that they can graduate and join the STEM workforce. Their academic performance was measured with the cumulative grade point average (GPA).

The SCS Program is evaluated with the comparative performance of the participating Hispanic students over a counterpart group of Hispanic students with similar profiles but who chose not to participate in the program. Over the span of four years since its inception in 2016, the Hispanic students participating in the PCS Program outperformed their counterparts who did not participate in the program, in every category of the analysis. Furthermore, the improvement was consistent each year in the year-to-year analysis. An early exponential regression analysis of the yearly performance data suggests that the PCS Program can maintain this performance for about 15 more years before reaching its saturation point.

The statistical analyses in this study evidently support the conclusion that the SCS Program has been successful in its goals and objectives of graduating more Hispanic students in STEM majors to solve the disparity in the Hispanic representation in the STEM workforce.

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APPENDIX A:

RESUME

PHUONGDIEU JENNIFER NGUYEN

EDUCATION & CERTIFICATION

2021 – Education Doctor in Curriculum and Instruction with focus on STEM - specialization in Mathematics
University of Houston – Clear Lake

2021 – Texas Certified Teaching Certification for Computer Science Grades 8-12
The University of Texas at Austin – Texas Advanced Computing Center
The 2021 Computing Educator Diversity Initiative (CEDI) program, sponsored by Microsoft

2019 – Texas Certified Teaching Certification for English as Second Language (ESL) Grades 8-12
Deer Park Independent School District

2014 – Master of Science in Instructional Design and Technology
University of Houston – Clear Lake

2010 – Texas Certified Teaching Certification for Mathematics Grades 8-12
Houston Community College – Accelerated Teacher Certification Program

1987 – Bachelor of Science in Computer Science with Minor in Mathematics
University of Houston – Central Campus

WORK EXPERIENCE:

ACADEMIC EDUCATION (2010 – Present)

Deer Park Independent School District – Secondary Mathematics Teacher (2010 – Present)
Teach one-to-one using iPad (face-to-face, online, and combination) Geometry, Algebra II, Algebraic Reasoning, Advanced Quantitative Reasoning, Pre-Calculus, Gifted and Talented Mathematics Summer Bridge, Student Success Initiative in Mathematics

The University of Texas Health Science Center at Houston – School of Biomedical Informatics - Summer 2013
Rehost all modules of the Orientation Course for new students to an online version using online learning development tools such as Articulate, Adobe Captive, and Storyline

Lee College – Summer 2013
Create activities for courses in the Science, Technology, Engineering, and Mathematics (STEM) fields per professors' requests, including activities using graphing calculators

The Universidad de Talca, Chile – Summer 2014
Setup the electronic gradebook for professors and their teaching assistants using in-house software for Education Management

AEROSPACE ENGINEERING – NASA JOHNSON SPACE CENTER (1987 - 2010)

2004 – 2010 - Mission Operation Division (MOD)
International Space Station (ISS) Trajectory Operations and Planning (TOPO) Group

Programmer Analyst: support flight simulation for flight controllers' training.

Certified ISS Trajectory Analyst: with Secret Clearance status and in training for front room ISS TOPO Flight Controller. Responsible for planning, calculating, and generating ISS trajectory data products for both short term (weekly) and long-range (18-month), performing trajectory analyses for Satellite Breakup, Re-entry and Jettison, performing analytical studies for ISS Best Estimated Trajectory, State Vector Prediction Accuracy, Debris Avoidance Maneuver Threshold Limit, Probability of Collision Behavior for ISS Conjunction, and ISS Coefficient of Drag

1993 – 2004 – Engineering Division (ER)
Systems Engineering Simulation (SES) Group

Project Lead: Responsible for daily operational performance (software) and maintenance (hardware) of the Shuttle Forward Crewstation Ascent/Entry Simulation to provide a 3-D environment training for astronauts for every mission

System Analyst: Responsible for creating, maintaining, and upgrading the software to support:

- the Shuttle Aft Crewstation Simulation
- the ISS Centerline/External Berthing Camera Systems (CBCS and EBCS)
- the Ascent/Entry Trainer (AET) and Shuttle Abort Flight Management (SFAM)

1987–1993 – Man-System Division (EG)
Graphics and Simulation Group

Senior Programmer III: Responsible for engineering assessments, analyses and studies for each and every Shuttle flight configuration and Station assembly sequence under various lighting conditions including to create, maintain and update a 3-D complex graphics models with life-like textures database