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A University-State College Collaborative Project for Hispanic Student Success in STEM

Dr. Ali Zilouchian, Florida Atlantic University

Ali Zilouchian is the founding of a $4.5 Million Dollars grant from DOE entitled: "An Articulated Community College-University Framework for Increasing Graduation Rate of Hispanic and Low-Income Students in Computer Science" to be completed by 2021. Professor Zilouchian was presented with 2017 FAU President's Leadership Service Award for his contributions in research and community engagement efforts at FAU. He has published more than 160 book, book chapters, scholarly journal papers, and refereed conference proceedings. He has supervised more than 20 Ph.D. and MS students to completion during his tenure, and taught more than thirty (30) different courses related to engineering technology. He has also received many other awards including 1998 outstanding leadership award (IEEE, membership development), best organizer award (World Automation Congress, 2002), best paper award (WAC, 2002), 2003 and 2004 College of Engineering Dean's awards. He has served as session chair and organizer of many sessions in the international conferences for the past 30 years. Professor Zilouchian is currently an associate editor of the International Journal of Electrical and Computer Engineering out of Oxford, UK. Professor Zilouchian is senior member of several professional societies including Tau Beta Pi, Sigma Xi, Phi Kappa Phi, ASEE and IEEE.

Dr. Nancy Romance , Florida Atlantic University

Dr. Romance is Professor of Science/Engineering Education and Director of FAU's STEM Collaborative. She is currently PI on the Title III Hispanic Serving Institution STEM Articulation grant and Co-PI on the College of Engineering and Computer Science's NSF S STEM grant guiding engineering majors toward completion of a MS degree in Artificial Intelligence. Her work is focused extensively on science and engineering activities to promote enhanced classroom engagement of students and increased discipline-based educational research. Her research interests address meaningful learning in complex STEM domains, coordinating learning communities, exploring options for reforming college mathematics curriculum which remains a serious barrier impacting student success and retention in undergraduate STEM programs.

Dr. Hanqi Zhuang, Florida Atlantic University

Dr. Hanqi Zhuang is a professor in Department of Computer and Electrical Engineering and Computer Science at Florida Atlantic University. His research interests are in Machine Learning, Robotics, Computer Vision, and their applications, as well as Engineering Education. He is a Co-Director of a DoE Title III HSI grant.

ABSTRACT

The session will report on the success of the last four years of implementing a collaborative DOE project between two state colleges and a Hispanic Serving Institution (HSI) university with a combined 140,000+ undergraduate students. The session will also report the revision of a Systemic, Evidenced-Based, and Student-Centered (SE-SC) framework as initially designed in the DOE project. The original SE-SC framework aims to maximize the number of academically-talented, Hispanic students who complete their AS degrees at State Colleges and transfer to a 4-year institution to complete their B.S. degree and are career-ready to enter engineering and computer science (ECS). The revised SE-SC framework addresses the fully on-line education challenge of undergraduate courses due to the current COVID-19 situation. In particular, the challenges and student outcomes of on-line lab participation are addressed.

In addition, the on-line revision of a course-specific mentoring Support Model to ensure student success in completing the Gateway Courses is reported. The overall objective of the mentoring component of the project has been to support students enrolled in gateway mathematics courses to ensure successful course completion. The on-line challenges of mentors and advisors due to the COVID-19 situation are reported in the paper. Data collected for the past four years (2016-2020) validate the proposed initiative's effectiveness. Besides, our innovative approaches to address education, advising, and mentoring challenges due to COVID-19 are presented in the paper. The collaborative model's effectiveness and significance could be replicated among other institutions interested in promoting engineering degrees among Hispanic and low-income students.

ACKNOWLEDGMENT

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INTRODUCTION

Achieving technological and scientific literacy is critical to ensuring America's competitiveness in the 21st century. We must educate and inspire our students in science, technology, engineering, and mathematics (STEM) at all levels, including the state colleges level, to maintain a broad pipeline of future engineers and computer scientists to ensure a highly advanced technological society. Computer Science's focus is particularly noteworthy given its dramatic impact on all segments of society, all industries, the economy, our national security, and the educational community. The growth in Information Technology (IT) and related computer industry is expected

to increase exponentially over the next decade. Given the fact that the medical and health care industries will require innovative software packages to manage health care, the exponential growth of 25.6 % in the IT sector is expected from 2018 to 2028[1], [2]-[5]. As a further indicator, the U.S. News and World Report have ranked software development jobs as number one among the best one hundred jobs in 2020 for the third year in a row [6]. It is anticipated that cybersecurity-related jobs will increase the fastest by 31.6% over the next decade. According to the new Pew Research Center analysis [7], employment in STEM occupations has increased 79% since 1990 from 9.7 million to 17.3 million, outpacing overall U.S. job growth. Additionally, over 99 percent of STEM employment was in occupations that typically require some type of post-secondary education for entry, compared with 36 percent of overall jobs [8].

For post-secondary institutions, specifically, the COVID pandemic has resulted in extensive alterations in terms of how instruction is being delivered to thousands of college students, how expansive the use of newer technologies is, their yet, unknown impact on student learning, and how we go about maximizing the career trajectories of HSI and Low-income students in emerging fields such as Artificial Intelligence, Autonomous Systems, Machine Learning, just to mention a few. At the same time, the demand for graduates with strong computer science backgrounds has grown tremendously especially among, including with the tech giants (e.g., Google, IBM, and Microsoft) and now with well as thousands of small start-up companies (e.g., Zoom) who's with its now ubiquitous presence can be found in almost every home and school. These trends require universities to accelerate their STEM production that meet the nation's expanding infrastructure and security needs. A second equally critical and related challenge is to increase the number of graduates from among the nation's growing diverse populations, such as low-income and underrepresented minority (URM) students (e.g., Hispanic) in engineering [4], [9]-[10]. It is believed that our focus on computer science, computer engineering, and electrical engineering will serve as a major contribution in addressing America's technological challenges and the need for a more diverse workforce [[3]-[4].

The DOE project aligns with evidence-based research and recommendations from the National Academy of Science, Engineering, and Medicine [9], the National Research Council [11]-[14], and the National Academy of Engineering [15]-[17]. In addition, higher educational institutions are confronted with students who, across various spectrum of ethnicities, struggle with many courses in mathematics and science ([18] – [20]) required for all STEM degrees. The DOE project builds upon a large body of research from a variety of disciplines such as the learning sciences[21]-[22].The project also draws upon principles and findings from related fields such as instructional design, cognitive science, and educational leadership[23]-[25], all of which serve as the basis for the SE-SC framework which guided our work with mentors and project participants as well as participating faculty across all three post-secondary institutions.

The present project and its research findings that are being reported on in this session align with the need to boost the nation's economic growth and competitiveness by not only expanding emphasis on STEM education but systemically addressing ways to expand the impact on the education of 'Hispanic' students, thus contributing to a growing, more diverse talent pool for STEM education and careers. In addressing the increased entry of Hispanic students into STEM fields, the paper will highlight the current education challenges due to the current COVID-19 situation.

UNIVERSITY-STATE COLLEGES COLLABORATION

Below is a brief description of the partnering institutions:

Florida Atlantic University (FAU) is a large, diverse, degree-granting institution (180 undergraduate and graduate degree programs) located in south Florida. It is designated as a "High Research Activity" university by the Carnegie Foundation for the Advancement for Teaching. FAU serves over 30,000 undergraduate and graduate students and ranks as the most racially, ethnically diverse institution in Florida. The College of Engineering and Computer Science and the Department of Computer & Electrical Engineering and Computer Science (CEECS) are located on the main campus. All the college undergraduate degree programs are accredited by the Accreditation Board of Engineering and Technology (ABET). The college offers a flexible schedule of courses delivered through various formats (e.g., e-learning, distance learning, daily-recorded live lectures, downloadable video streaming, podcasts, and interactive video courses broadcast to remote locations and featuring two-way audio and video). It also offers internships with over 30 business/industry partners and an Innovation Leadership Honors Program with training in innovation, entrepreneurship, leadership, and sustainability.

Broward College (B.C.) serves more than 67,000 students; 35% are identified as Hispanic. The percentage of enrolled students eligible for Pell grants is even higher-55%. Broward College students can choose from among 132 Bachelor's, Associate's, and certificate programs and classes offered on-line and on-campus. B.C. boasts a student body representing more than 175 countries, and 37% of B.C. student body was born outside of the United States. Broward College is one of the nation's largest institutions of its type and ranks fifth nationally among four-year institutions in awarding Associate degrees, according to *Community College Week*, and third in the country in awarding Associate's degrees to minority students.

Palm Beach State College (PBSC) serves more than 48,000 students, of which 27.5% are Hispanic, and 53% of the full-time students are eligible for need-based aid (as of 2014). PBSC offers 130-degree programs and 13 primary areas of study, of which two are focused on Computer Science & Information Technology and Science & Environment. PBSC is the 11th largest producer of Associate of Arts degrees (Community College Week). Its' two-year A.A. degree is a requirement for students to transfer seamlessly to the university and is a requirement for the present project.

OVERVIEW OF THE PROJECT

The primary goal of this Title III HSI project is to facilitate the completion of undergraduate degrees in computer science, computer engineering, and electrical engineering (referred to hereafter as "computer science") by students who first begin their undergraduate academic programs and complete their A.A. degree at B.C. and PBSC and then transfer, enroll and complete a B.S. degree Computer Science within the College of Engineering and Computer Science at FAU. Figure 1 overviews the major project components.

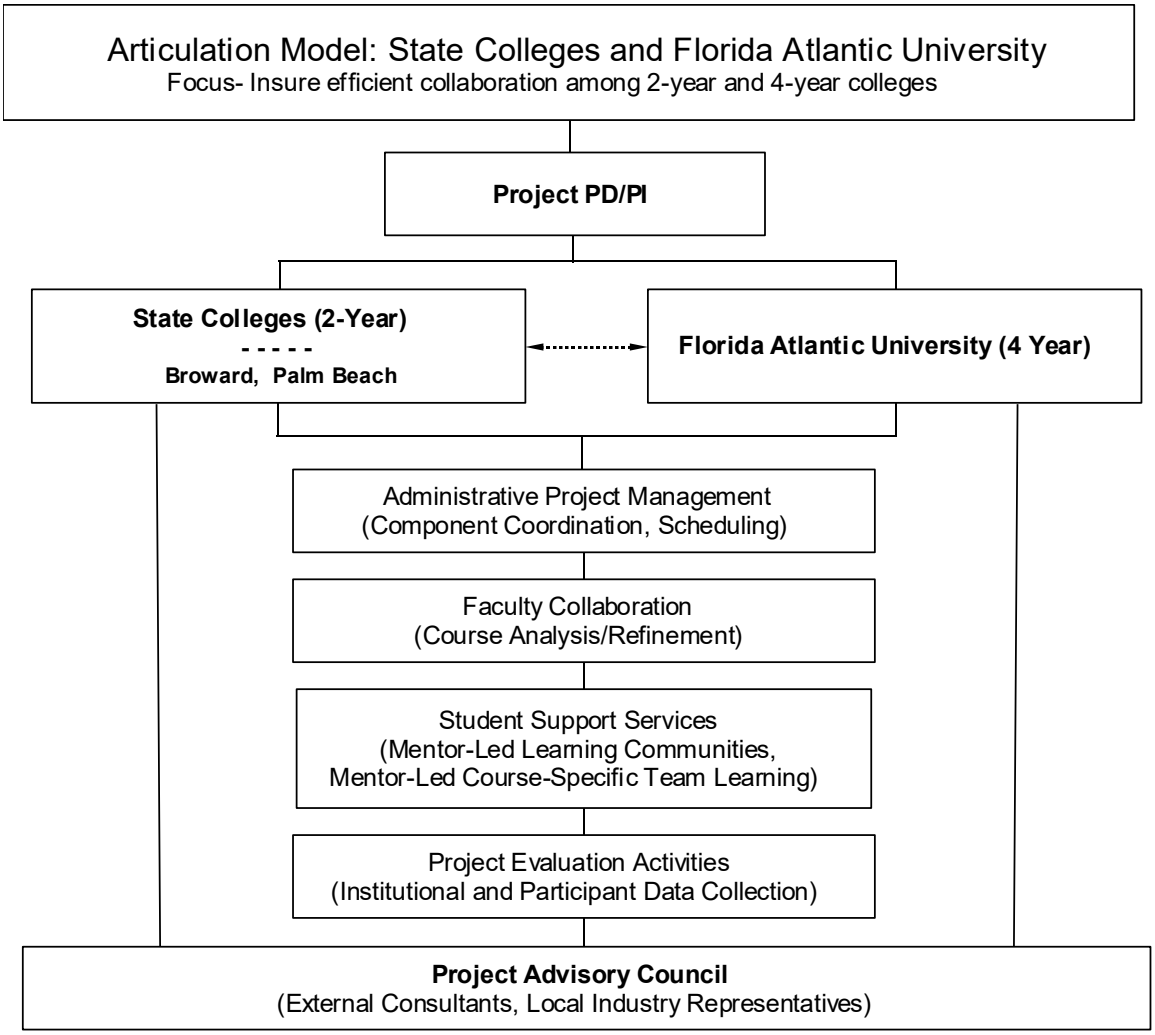

Figure 1- *Project Components*

In accomplishing project goals, the key elements were designed to provide academic and motivational support for student participants throughout their enrollment at the State Colleges and Florida Atlantic University. Although this paper's focus is on year 1-3 of the project activities, for clarity, some activities projected into year four are also noted.

The above Articulation Model (Figure 1) provides the framework for the extensive collaboration between the State Colleges (B.C., PBSC) and the upper-division CS/CE and E.E. degree programs at FAU. During Year 2 of the project, a series of key components were implemented. It is expected that the present Title III project will provide a national model due to the effectiveness of the project in increasing the graduation rates in CS/CE of Hispanic and low-income students. We have also expanded the scope of the program to include the Electrical Engineering program. In accomplishing the project goals, the key components were designed to provide academic and motivational support for student participants throughout their enrollment at the State Colleges and FAU.

IMPLEMENTATION OF MAJOR PROJECT COMPONENTS

In this section, the status and progress related to each of the major project components are reported.

a) Curricular refinement and analysis of courses in mathematics and computer science

On-going and dynamic conversations among mathematics and computer science faculty from the three post-secondary institutions have provided a professional forum to discuss course curriculum and student success and identify the critical learning issues that impact students in key gateway courses.

b) Development of a course-specific mentor support model

During years 1-3 of the project, Florida Atlantic University HSI project staff developed and iteratively refined a generic process through which project mentors, College of Engineering and Computer Science junior and senior honors' students, would provide instructional support to participating HSI students enrolled in the specific gateway mathematics sections taught by project-affiliated State College mathematics faculty. For 2020-2011, a digital platform model was developed for seamless communication between mentors and students. The detailed activities will be reported in the next section of the paper.

c) Student support Sevice

This component has been a major focus of the project in guiding/supporting the academic and personal success of the HSI participants in terms of their retention, graduation, and successful transfer to and graduation from the university with a most valuable degree, namely computer science and related fields (e.g., computer engineering, electrical engineering). More recently, Covid-19 has led to many innovations designed to (a) support faculty as they address these new challenges through new ways of teaching and considering student socio-psychological needs, and (b) to support students by reaching out to them to provide the motivational and academic support that keeps them in school, doing well, staying focused on their goals of completing their education, and graduating. The pandemic has resulted in implementing some new initiatives, which may need to continue foreseeable future.

d) ***Project multi-year longitudinal database***

The project multi-year database is designed to collect pertinent student data from each State College and provide accessibility for project-specific reporting functions across the 5-year project. Included as database support functions are: (a) the collection, filtering, and random selection of State College student applicants and of controls for each project cohort, (b) the tracking of the academic progress and performance of participating and control students in each project cohort, first at the State College and then, thereafter, when they transfer to FAU, and (c) support of the multi-year project evaluation and reporting process. A major focus of the longitudinal project database is the integration of student records as they complete their A.A. degree and continue on to the university where they will complete their Bachelor's degree in computer science.

The project created a web application that enabled students at B.C. and PBSC to enter their student information by themselves, and that was completed this year. Once an early release of the web application was completed, the web application was made available to students through the World Wide Web.

e) Project Advisory Council and External Evaluation.

Our project evaluator brings extensive knowledge and insights as to what constitutes HSI success and uses his evaluations and meetings to discuss best practices and successful trends, many of which we have integrated into our program. In addition, faculty members in engineering are providing us with resources (e.g., what's trending video segments) to support HSI students so that they keep informed about computer science activities, trends, and what they can expect when they transfer to FAU's College of Engineering and Computer Science. The faculty have served as a viable and internal advisory, really supporting students.

Project Mission and Reflection on the COVID-19 Impact on Project

The COVID-19 pandemic and its resultant impact across all sectors of the economy, education, and even people's daily lives have challenged us to embrace *system-wide digital transformation initiatives and rapid-cycle innovations*. Like many post-secondary institutions, FAU is reconfiguring itself and the education it is providing students in ways previously unexpected. The Title III Leadership Team has been working within our own College of Engineering and Computer Science as well as in close collaboration with our State College partners to maximize our strengths and resources in ways that enable us to more efficiently reach every student desiring to complete a quality post-secondary education in computer science, computer engineering. ALL of us have become problem solvers who must work together to safely, securely, and sustainably create an ecosystem of new applications and ideas to provide a safe and supportive environment for our HSI participants to stay the course and complete their education. For post-secondary students, particularly, the challenges of Covid-19 have been quite dramatic and have caused a major disruption in many of their plans for schooling!

Our three partnering Institutions have collaborated very closely, sharing successful strategies and activities to support students stay the course as we addressed some expected and some unexpected and daunting challenges.

1. We have adapted to remote work, as urgent issues around hardware, software, and support had to be resolved almost overnight.
2. We reconfigured all college classes to now be digital.
3. We adapted to teach from home and learn new modes of the meeting (Zoom, Webex, Teams, Google Class)
4. We figured out new ways of using technologies to make ourselves even more accessible to our students and colleagues.
5. We have, in the process, formed a tighter-knit community eager to address student needs in support of their retention and academic success. We believe that a recent article from Steven Mintz (University of Texas, Austin; 2020) summarizes our thinking as we go forward while still addressing the pandemic, namely: "*One of our principal tasks is to ensure that disruption advances our primary purpose: student learning. We must make sure that our innovations are purposeful, targeted, and mission-aligned."*

Sample Project Activities during the COVID-19

1. **Mentor Activities to Provide Seamless and Continuous Participant Support:**
    a. Mentors developed digital platforms to streamline contacts with participants.
    b. Participants across all 3 Institutions had access to any mentor, thus affording them access at almost any time/day and obviously making it more convenient for students.
    c. The project's mentors are majoring in computer science, computer engineering, or electrical engineering, so they can provide support for all courses offered at the State College or at the university in computer science.
    d. Mentors developed rich resources to motivate the state college participants to stay-the-course and complete their A.A. degree. Examples of resources include modules on financial literacy and what's trending in computer science.
    e.
2. **Mentors Supporting Participants using a Virtual Platform and Other Technologies.**
    a. Mentors provide course-specific academic tutoring, general guidance, and problem-solving support to the participants.
    b. Mentors moved to a virtual model. They accomplished this by using varied platforms. Mentors are taking advantage of features of the digital meeting technologies such as chat rooms, break-out rooms, whiteboarding, and resource identification. Interestingly, this newer technology clearly bridges the gap of having mentors and students at different locations and provides for a cross-cultural and inclusive on-line environment.

c. Mentors meet weekly with FAU Project Directors and engage in varied professional development opportunities designed to increase their proficiency in using key features of a virtual platform (e.g., group interaction; focused discussion with whiteboarding; simulated experiences) to work with and provide academic and motivational support for participants.

d. Mentors are being trained to become proficient in Cloud-Computing to support State-College Students who have transferred to FAU, BUT who have never even stepped a foot on campus. That is, they have had no direct interaction with peers, advisors, and faculty. This presents a serious new set of obstacles across almost all aspects of their academic world. Transfer students also face notable academic challenges due to course complexity and the requirement of project-oriented collaborative team-work commonplace within the computer science degree program. Not having academic and even social supports for these significant challenges in the present COVID-19 environment threatens their very success and retention. The issues/needs will be addressed in 3 ways: (a) use of cloud computing platforms, (b) instituting Bootcamps, and (c) virtual design groups. Fortunately, our mentors are knowledgeable about these technologies and activities and will be very helpful to the State College transfer students.

3. <u>Keeping State College Participants in the Know: Expansive Communication</u>

a. *Activities and Events*: All three partner institutions have proactively identified institutional activities/events/student opportunities (e.g., Virtual Career Fairs; Design Showcase; Meetings and Events being offered by FAU's Engineering student clubs) that would be of interest and potentially valuable/motivational to HSI participants at Broward and Palm Beach State Colleges as well as FAU. Expansive communication efforts have involved personal contacts, digital contacts, and posting on institutional websites as well as State College websites and social media.

b. *Bootcamps and Other Events*: The College of Engineering and Computer Science and more specifically the Department of Computer Science and Engineering (CSCE), under the chairmanship of Dr. Hanqi Zhuang, who is also the Co-Director of the Title III HSI Project, instituted two, 10-hour computer science-related Bootcamps as part of their continuing education initiative. While these were fee-based events, CSCE made these Bootcamps free-of-charge to HSI students at both State Colleges as well as to FAU HSI participants. The first two were supportive of the degree requirements for computer science (i.e., Introduction to Programming in C; Artificial Intelligence). The Bootcamps serve as *academically enriching experiences* that can increase students' subsequent success when enrolled in the course of that very same name.

c. *Financial Literacy. The goal here is to help students understand the financial consequences of dropping out of school and its long-term impact.* The Title III leadership team decided to address a key nationally identified barrier to college enrollment and completion for Hispanic and low-income students, namely developing participant financial literacy competencies known to be critically important during and after completion of their college degree program. Our work was based on the United States Government's summary document entitled: Opportunities to Improve Financial Capability and Financial Well-Being of Postsecondary Students prepared by the U.S. Government's Financial Literacy and Education Commission [27],[28].

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Also used was information from the Federal Deposit Insurance Corporation's (FDIC) Money Matters guidance. The mentors crafted and iteratively-refined an informative PowerPoint presentation that could be used with participants in an opened-ended discussion format about the importance of graduating from college in a timely fashion and the ramifications associated with not doing so.

4. <u>Collaborative Partnerships – Identifying Roadblocks during the Pandemic</u>.

Our multi-year collaboration, noted as exemplary by our Project Evaluator, enabled us to combine ideas as to the most effective new pathways to address student needs with the goals of helping them stay in school (retention), continue to do well in their course work (student self-determination and belongingness) and to help them understand the many benefits of *shortening their time to degree completion*.

a. State College and FAU leadership team meet bi-monthly using Zoom technology.
b. Meeting focus has shifted to institutional challenges, action steps to address those challenges, and what works for whom and why.
c. There has been cross-institutional sharing of best practices, new strategies, and lots of attention to how best to communicate with the students to ensure their success and their safety during this traumatic time for them.
d. Identifying resources that students can readily access is a priority.

D. <u>Communicating Careers in Computer Science</u>

a. The greater south Florida region has a fast-growing computer science industry, as noted by the graphic. The growth in this industry will only continue because of the favorable tax base in Florida and because the Covid_19 pandemic has magnified the need for and the actual emergency there is in filing high technology jobs in south Florida with the most qualified candidate from underrepresented groups.

b. Secondly, most of our students are "local.' They will not be leaving South Florida any time soon. All three collaborating institutions are Hispanic Serving Institutions, and growth in this population demographic will only continue.

Figure 2*- Technology Companies in South Florida*

STUDENT PARTICIPATION AND PERFORMANCE EVALUATION

This section presents findings describing the impact of the overall GPA of the HSI Project on participants at the two collaborating State Colleges. The data were drawn from the first two HSI cohort participant groups at each college. In evaluating the HSI achievement impact, demographically comparable control groups were randomly selected from each college for each of the four cohort groups.

Broward College				Palm Beach State College		
Cohorts	Initial Enrollment	Currently still Enrolled		Cohorts	Initial Enrollment	Currently still Enrolled
1	42	9		1	40	13
2	48	12		2	39	17
3	42	26		3	33	30
4	7	7		4	15	15

Table 1. *Number of HSI Participants in Each Cohort*

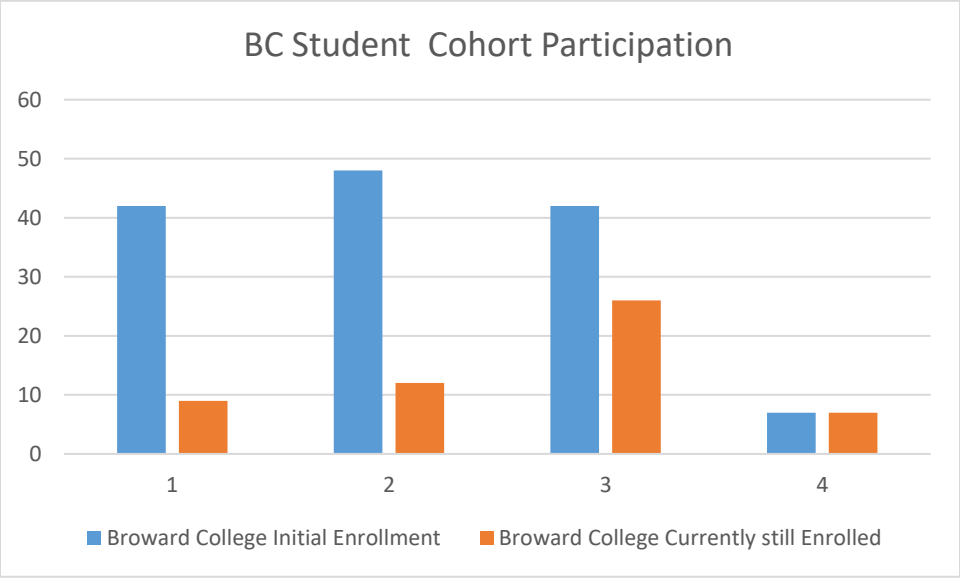

Figure 3- *Number of HSI student in BC*

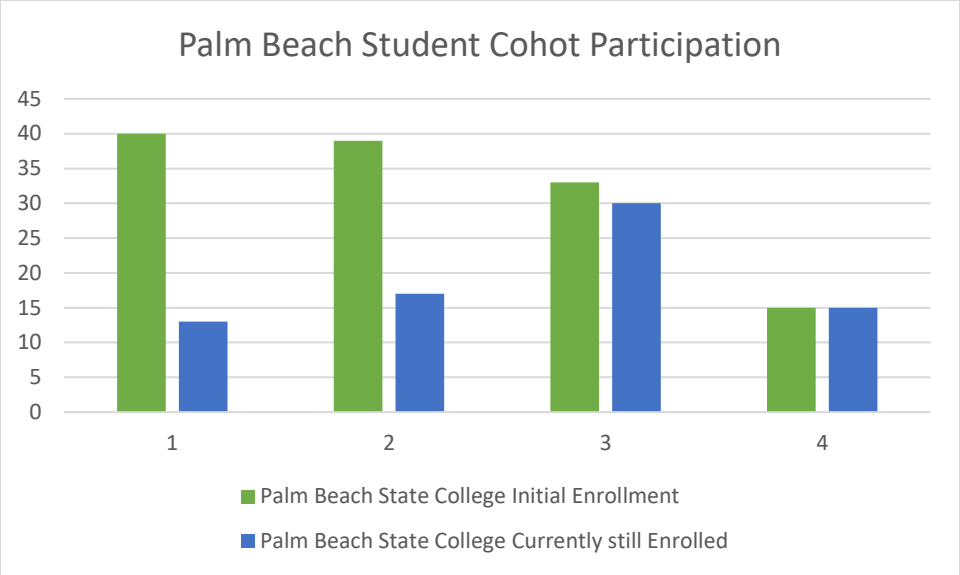

Figure 4- *Number HIS participant in PBSC*

Anticipated Number of Graduates Per Semester		
Semester/Year	Broward College	Palm Beach State College
Fall 2020	3	7
Spring 2021	24	15
Summer 2021	2	9
Fall 2021	10	12

Table 2. Anticipate *Number of HSI Graduate Each Semester*

Semester/Year	Broward College	Palm Beach State College	Total	Linear Plot
Fall 2020	3	7	10	
Spring 2021	24	15	39	
Summer 2021	2	9	11	
Fall 2021	10	12	22	
Total	39	43	82	
Graph				

Table 3. Anticipated *Number of HSI Graduates each Semester with the trend*

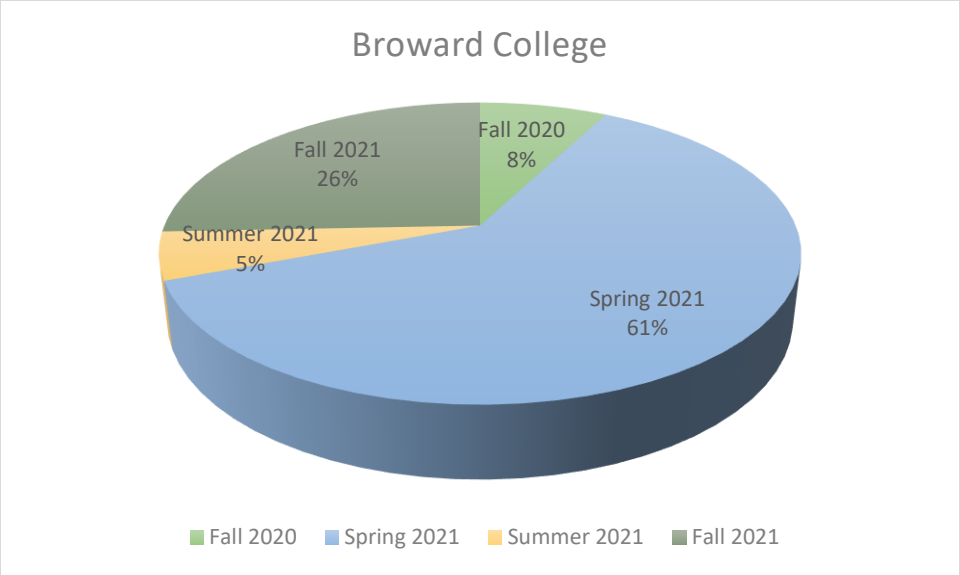

Figure 5- Anticipated *Number of HSI Graduates from BC*

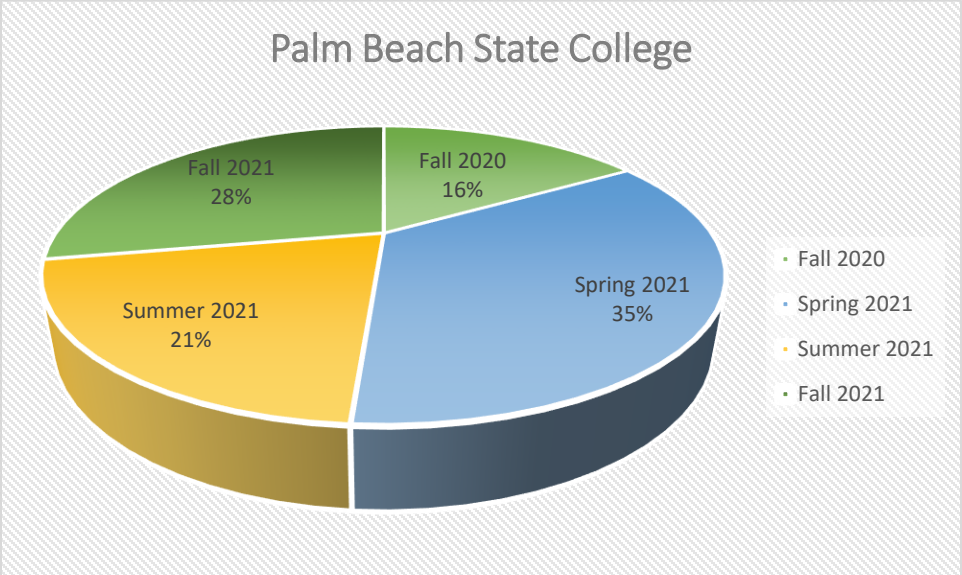

Figure 6- Anticipated *Number of HSI Graduates from PBSC.*

Students at FAU – Summary

State College Originally from	# of Students	Overall GPA
BC Grads at FAU	16	3.08
PBSC Grads at FAU	15	3.36
Average GPA		3.22

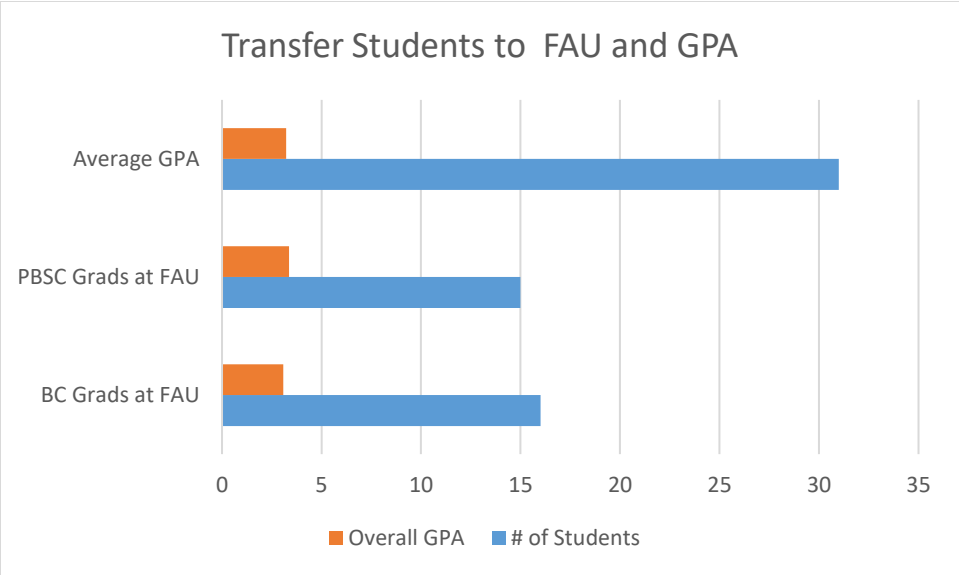

Figure 7- *Number HSI Graduates from FAU and Overall Student GPA*

SUMMARY

Overall, the project completed all major activities during the last four years. Covid-19 has led to many innovations designed to (a) support faculty and (b) support students. The pandemic has resulted in implementing new initiatives, which may last for several years. In addition, the implementation of the project for the last four years has deepened our understanding of the needs of transfer students from B.C. and PBSC who want to pursue Computer Science, Computer Engineering, and Electrical Engineering programs. It provides us with valuable lessons on how to better help students achieve timely graduations. In addition, the students attending the State Colleges (B.C. and PBSC) appreciate the accessibility of a personal advisor; someone to guide them through their academic plan of study, provide student success strategies with referrals to support services. Sharing resources among the campuses has proven to be of great value to both the students and the support staff at each college. Not only do the students benefit from the additional resources, but the staff also naturally share best practices and innovative teaching technologies.

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