A University-State College Collaborative Project to Advance Students' Degree Completion and Career Attainment in Engineering and Computer Science

Dr. Ali Zilouchian, Florida Atlantic University

Ali Zilouchian is currently a professor in the College of Engineering and Computer Science at Florida Atlantic University. He is also currently the Director of "CAPTURE" program which is related to increasing pipeline, graduation rate as well as future jobs in the State of Florida related to STEM graduates especially Computer Science and Engineering fields. His recent projects have been funded by DOE, Florida BOG, National Science Foundation, Florida Power and Lights (FPL), Broward County School district and several other sources. His recent research works related to alternative energy applications includes Maximum Power Point Tracking (MPPT) for Solar Systems, Proton Exchange Membrane Fuel Cell (PEMFC) and battery technology to transportation technology. In addition, he has conducted research on the applications of soft computing methodologies to industrial processes including, desalination processes, oil refineries, fuzzy control of jet engines, and fuzzy controllers for car engines. Dr. Zilouchian has published one book, and over 143 book chapters, scholarly journal papers, and refereed conference proceedings. He has supervised 20 Ph.D. and MS students to completion during his tenure at FAU. He has taught more than thirty (30) different courses related to engineering technology during his tenure at FAU. In 1996 and 2001, Dr. Zilouchian was awarded for the Excellence in Undergraduate Teaching at FAU. He has also received many 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 in recognition of his contributions toward achievement of the goals of College of Engineering and Computer Science at FAU. 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.

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Dr. Romance is Professor of Science Education in the College of Education at Florida Atlantic University (FAU) and a graduate faculty member in both the College of Engineering and Computer Science and the College of Science at FAU.Her research interests address meaningful learning in complex STEM domains, applying a learning sciences lens in addressing issues ranging from building elementary teachers knowledge and skill in teaching science to coordinating learning communities addressing mathematics curriculum as a persistent barrier impacting student success and retention in undergraduate STEM programs. She is currently OI on a NSF DR K-12, Co-PI on a USDOE Title III Hispanic Serving Institution, internal evaluator on FAU's NSF Advance early phase grant, and a member of the Advisory Board on the NSF STEM+C in Broward Schools and the NSF MSP at the University of Toledo.

Ms. Annie Laurie Myers, Broward College

Annie Myers - A dynamic, forthright leader who engages her employees in partnerships for success in process and performance, she exudes positive energy and has the ability to energize others. She is extroverted and optimistic and thrives on action, she relishes change, and has the ability to execute—to get the job done.

A hybrid leader, with 22 years of supervisory, management, and leadership experience from the newspaper industry, proficient in both operations and information systems.

Associate Dean at Broward College and teaching since 2002, providing leadership and policy advice on matters related to all teaching and academic support services which include courses within Baccalaureate degrees, Associate in arts, Associate in science, and Associate in Applied Science.

Ms. Dana Hamadeh, Palm Beach State College

Dana Hamadeh earned a Bachelor of Science in Computer Engineering and a Master of Education in Curriculum and Instruction with a minor in Mathematics. Some of her professional experiences include over ten years teaching college mathematics, supervising student learning center for physics and mathematics, managing multimillion dollar STEM grant programs, and serving as Associate Dean of STEM and Health Sciences Academic Affairs at Palm Beach State College. She continues to develop and present dynamic and interactive staff, faculty, and student workshops and seminars on various academic and professional related topics, and has been instrumental in the development of various STEM active learning spaces for students and faculty. She feels privileged and blessed to wake up every morning doing what she loves to do.

Michael Vitale, East Carolina University

DR. Vitale holds the Ph.D. in Educational Research and Instructional Psychology.

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ABSTRACT

The paper presents the summary of a successful five-year (2013-2018) collaboration among two state colleges and a recent Hispanic Serving Institution (HSI) university with a combined 140,000+ undergraduate students. The initial project entitled " Computer Accelerated Pipeline to Unlock Regional Excellence" (CAPTURE) sponsored by the Florida Board of Governors (BOG) has addressed curriculum mapping and articulation from two State Colleges to a 4 year institution to support student degree completion in computer science and engineering programs. In addition, this paper reports on the success of first two years of a United States DOE Title III project built upon the CAPUTURE initiative for Hispanics and low income students. The collected data for the past five years (2013-2018) validates the effectiveness of the proposed initiative in increasing both the student pipeline and graduation rates. The process has also deepened our understanding of the needs of students in terms of how to better align student career aspirations with industry workforce needs. The effectiveness of the collaborative model could be replicated among other institutions interested in promoting engineering degrees among Hispanic and low income students.

INTRODUCTION

Powerful indicators suggest that there may be more than 1 million new jobs in STEM fields by the year 2026, and, as a group, they will grow twice as fast as the average for all occupations in the economy, according to recent projections by the Department of Labor, Bureau of Labor Statistics [1]. Equally powerful indicators suggest that Hispanics are one of the fastest growing demographic groups in America, but one of the least represented in STEM post-secondary education and STEM careers [2]. The importance of these two indicators in terms of America's global competitiveness, national security, and economic growth cannot be underestimated.

The employment needs of software developers is projected to grow by 24% from 2016-2026 [1], [3]. Given the fact that the medical and health insurance industries will also need innovative software packages to manage the health care, the exponential growth of more than 25% in the Information Technology (IT) sector is expected within the next decade also [3]. Furthermore, the US News and World Report has ranked the software development jobs as the number one job among the best one hundred jobs in 2018[4]. According to the latest report by the Department of Labor, Bureau of Labor Statistics [1],[4] between May 2009 and May 2015, over 800,000 net STEM jobs were added to the U.S. economy with computer systems design increasing by over 300,000 jobs. Over 99 percent of STEM employment was in occupations that typically require some type of postsecondary education for entry, compared with 36 percent of overall employment [1]. In the same period, states that added the largest numbers of STEM jobs included California (160,950), Texas (102,190), New York (42,980), and Michigan (41,100). However, the State of Florida ranked 30th in the creation of new STEM jobs. According to the Florida Access and Educational Attainment Committee Report [5], the greatest demand for jobs in State of Florida, exceeding 2,000 projected positions, is in STEM. The Annual Projected Under-Supply in Florida in Occupations Requiring a Bachelor's Degree in Computer Occupations is 2,361. Computer Occupations include: Computer

Network Architects, Computer Systems Analysts, Computer Programmers, Software Developers and Graphic Designers. Based on regional workforce data from the Department of Economic Opportunity (DEO), 70% of the computer occupations identified by the Commission's gap analysis are found in four areas in the State of Florida which represent six DEO workforce regions and sixteen counties. An area of high unfilled demand is the tri-county region served in South Florida by Florida Atlantic University (FAU), Broward College (BC) and Palm Beach State College (PBSC).
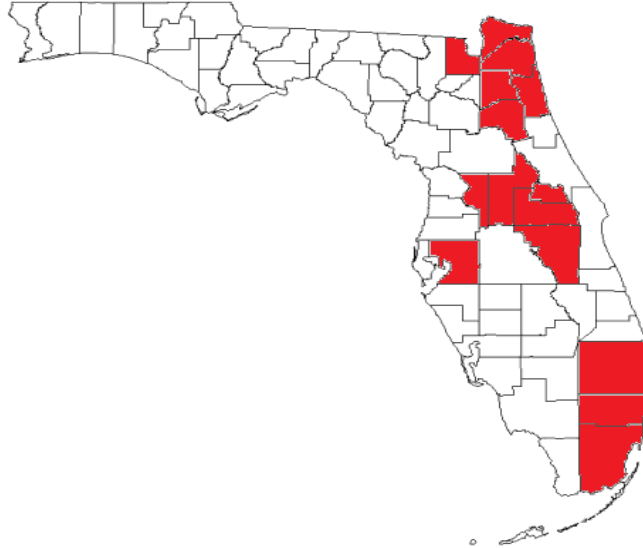

Figure 1-State of Florida Projected STEM related Jobs

Transitioning into college and successfully completing a STEM degree have been identified as key factors associated with and the pathway to economic success and preparation for STEM careers. As reported [6], more than 40% of the students entering 2- and 4-year postsecondary institutions indicated their intention to study in the STEM discipline. However, the national statistical data reveal that nearly half of the students with the intention to earn a STEM degree fail to earn these degrees in 6 years after their initial enrollment. Many of those who do obtain a degree take longer than the advertised length of the programs, thus raising the cost of students' education. In considering where to expand existing baccalaureate degree programs in support of computer occupations, BC and PBSC surveyed their students and found that the majority (86% PBSC and 77% BC) of them want to enroll in a program that guarantees admission to FAU. In addition, educational technology incorporated into program should allow students to access coursework and programs at times and locations that meet their needs—without regard to the location of the provider. Over 90% of our students are in-state students and so it's not anticipated the students enrolled relocate out-of-state. Given that many local industries employ more than 70% of FAU's graduates, it's obvious that many have chosen to remain in South Florida while some others were provided with assistance to relocate to other parts of Florida upon graduation.

In working to develop student career potential, this project also recognizes a complex array of barriers faced by students in progressing through the academic pipeline toward earning a CS degree. In considering these barriers as challenges to be overcome, this project aligns with evidenced-based recommendations from the National Research Council (NRC)[7]-[10], the National Academy of Science (NAS), the National Academies of Sciences, Engineering and

Medicine (NASEM)[11], National Academy of Engineering[12]-[14] as well as a large body of research from a variety of disciplines such as the learning sciences[15]-[20], instructional design, cognitive science, and educational leadership[21]-[23] .

UNIVERSITY-STATE COLLEGES COLLABORATION

In partnership with Broward College (BC) and Palm Beach State College (PBSC), the FAU CAPTURE program is designed to improve academic support services and to provide affect-informed tutorial scaffolding that will create a more nurturing, supportive experience for students. Because attrition is most likely in the first year of college, it is especially important that students' needs be met during this initial phase. A substantial body of research suggests that even students' earliest college experiences, as early as those first six weeks into the first semester, are critical predictors of academic performance and the likelihood of their graduation [17], [24]. Toward that end, the collaboration supports a living learning community that fosters and encourages new college students' sense of acceptance and confidence through peer mentoring. In addition, as community-based institutions, state colleges play a critical role in creating a dynamic academic environment that fosters the talent and education of an ethnically and racially diverse student body in a cost-effective, student-centered manner. Our program strategically builds on the critical role of state colleges in the educational pipeline by providing much needed faculty resources and student support services on BC and PBSC campuses. 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 and 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 undergraduate degree programs in the College are accredited by the Accreditation Board of Engineering and Technology (ABET). The College offers a flexible schedule of courses delivered through a variety of 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 (BC) serves more than 67,000 students annually of which 35% are identified as Hispanic in academic year 2015 – 2016. The percentage of enrolled students eligible for Pell grants in 2014 – 2015 was even higher—55%. BC has made its mission to serve students with limited means who can choose from among 132 Bachelor's, Associate's and certificate programs and classes offered online and on-campus. BC boasts a student body representing more than 175 countries and 37% of BC's student body was born outside of the United States. BC 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 nation in awarding Associate's degrees to minority students, according to *Diverse: Issues in Higher Education*.

Palm Beach State College (PBSC) serves more than 48,000 students of which 27.5% are Hispanic and 53% of full-time students eligible for need-based aid (as of 2014). PBSC offers 130 degree programs and 13 main 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 in the nation (Community College Week). Its two-year, AA university transfer degree is a requirement for the present project.

AN OVERVIEW OF CAPTURE PROJECT

The CAPTURE project was initiated to expand the STEM workforce in Computer Science and Engineering by creation of a multi-institutional infrastructure that involves collaboration between 2-year state colleges and a 4-year university that successfully transitions 2-year state college students pursuing CS degrees to the University for the Completion of the BS degree in CS. It addresses the curriculum mapping and articulation to support student degree completion in computer science and engineering programs. Specifically highlighted as part of the transfer model are curriculum alignment and mapping, degree-specific "_flight_" plans, and program-geared advising. Participating students must satisfy rigorous core requirements but they customize their track and their electives.

Figure 2-Overal Structure of the CAPTURE Program

The CAPTURE program has expanded computer science and computer engineering capacity as follows:

- FAU students and State College students with either an AA or AS will be qualified for admission to the program. Therefore, the program is designed with sufficient flexibility to accommodate students with different backgrounds.

- FAU and the State Colleges have developed a streamlined and seamless admission process established by articulation agreements within the first year of the grant.

- Many courses have been offered through cyber-learning platforms designed to build communities of inquiry with affect-informed tutorial scaffolding that can provide individualized and group feedback in real-time.

- The program has created common/shared advisors at the State Colleges and FAU. The students in the program will have the opportunity to take courses at the State colleges and/or FAU to speed progress.

- A Mathematics Boot Camp has been implemented to help students develop the necessary mathematics skills for success in computer science courses.

- The program created convenient class schedules with evening, weekend, and on-line formats for both traditional, full-time students, as well as part-time students who wish to maintain their professional employment while earning their degrees in computer related fields.

- The program has offered unique opportunities for problem-based learning through practical experiences with National Science Foundation (NSF) CAKE industry and community partners, i.e., Co-op/internships in the computer technology sector, government agency settings, etc.

- The program has utilized a critical resource for student engagement at FAU, the Office of Undergraduate Research and Inquiry (OURI). This is a distinct feature of FAU's undergraduate experience. The integration of research into FAU's undergraduate curriculum provided the students with unique and high impact educational practices in computer-related technologies.

- Peer Mentoring **-** The College of Engineering and Computer Science recently established an Innovation Leadership Honors Program (ILHP) supported by the College Executive Advisory Council comprised of some twenty-five top level engineering and business executives in Florida. At the beginning of each semester, the College recruits 30 top students from the junior' class cohort who have successfully completed general education courses and several fundamental classes in their majors. These students stay in the honors program until their graduation. As part of the leadership-skill development, selected IHLP students, working closely with faculty and advisors, will serve as mentors to students participating in the CAPTURE program. The IHLP mentors provided critical early support to targeted students in order to help them transit smoothly through computer science/computer engineering majors of their choice.

2018 CAPTURE PROGRAM-KEY ACTIVITIES

Activity 1. Completion and Implementation of Seamless Admission Process

The process of streamlined and seamless transfer and admission has been fully implemented with articulation agreements executed between FAU and Broward College and Palm Beach State College. Flight plans for the Associate in Arts in Computer Science (AACS) and the Associate in Arts in Computer Engineering (AACE) are posted on the PBSC and BC CAPTURE websites. Flight plans for the Bachelor of Science in Computer Engineering (BSCE) and Bachelor of Science in Computer Science (BSCS) are posted on the FAU CAPTURE website. More than 237 students from PBSC and BC adopted the proposed flight

plans this academic year (2017-2018) with the assistance of the shared advisors at the three institutions. The timeline to process and admit CAPTURE students is approximately 48 hours, assuming all required admissions documents have been received and the CAPTURE criteria have been met. All components to assure seamless admission to the CS/CE programs at FAU have been successfully completed and continue to provide a great benefit to students and the programs' expansion.

Activity 2. *CAPTURE Industry Advisory*
The CAPTURE Program was involved in two industry stakeholders' advisory meetings. The overall focus of these meetings was on economic development through mutually beneficial partnerships and expanding high-wage jobs. The first session, held by FAU Career Center concentrated on expanding industry liaisons in South Florida related to co-ops, internships, and job placement under the direction of FAU Career Center. The second meeting was held by FAU College of Engineering and Computer Science Deans Office with the CAPTURE Industry Advisory Board. The industry members included key South Florida industries including IBM, Motorola, Modernizing Medicine, and other well positioned stakeholders. The forum focus was to gather input and build common goals with respect to development of high-wage job opportunities, internships, and/or co-op opportunities. FAU received positive input and feedback pertaining to the program and our industry relation activities.

Activity 3. *FAU CAPTURE Scholarships to PBSC and BC Transfer Students with AA*

A total of 61 CAPTURE scholarships were awarded to PBSC and BC transfer students in the 2017-2018 academic year. In fall 2017, the average GPA of new scholarship recipients was 3.65. In spring 2018, the average GPA of new scholarship recipients was 3.55. Students apply for the CAPTURE Scholarship via a simple online form that is available on the CAPTURE scholarship page: http://fau.edu/capture-program/scholarships.php. Once the application period closes, student GPAs and AA completion are verified through transcripts. In sequel, the scholarships were awarded to highest ranking applicants from the qualified pool. A total of 171 scholarships were provided to AA students for the past three years due to funding availability through FAU Foundation matching for CAPTURE program. The scholarship will be given to qualified students for one more year (July 2019).

Activity 4. *Implementation of a Fully Online Computer Science Program*
One of the major successes of CAPTURE Program was the design, development and implementation of a fully online Computer Science program at FAU. Although, the development of such a fully online program was not part of the original team proposal, the creation and implementation of such a program has enhanced our pipeline and graduation. The program offers a complete set of CS courses to students who require more flexibility in their coursework through cyber-learning platforms.
The fully online Computer Science program was completed this spring 2018 semester. The CEECS Department has developed fourteen (14) online core courses on the cyber-learning platform with several of them certified for high quality by the Center of eLearning at FAU. In addition, nine (9) online elective courses are currently offered for the program. Please see the following link for more details: http://fauelearning.com/fauonline/portfolio-items/computer-science-bs-online

Activity 5. *Partnership with Palm Beach and Broward County School Districts*

Below is a summary of the expanding partnership activities with Palm Beach and Broward County Public Schools:

- The CAPTURE Program continues to work closely with both Palm Beach School District (PBSD) and Broward County School District (BCSD) to increase the pipeline of well-qualified students to computer science and computer engineering programs.
- The Engineering Scholars' Program (ESP) is a very successful and rigorous summer program that provides 3-credit dual-enrollment Engineering/Computer Science credits to high-achieving 10th, 11th, and 12th graders in Broward and Palm Beach counties. Both the School Board of Palm Beach County and School Board of Broward County have enthusiastically endorsed the ESP program. Because of the exceptional results achieved by their students in ESP, the counties continue to support the program and encourage qualified students to apply. The CAPTURE program utilizes of this program by attracting high-achieving students to CS/CE/EE program by offering several CSE courses including New Generation Web Technology (EGN 1935), Introduction to Bioengineering (EGN 1935) and Electronic Design with Operational Amplifiers (EEL1007). A total of 83 students enrolled in the program during the summer 2018 semester. Please see the following link for details: http://eng.fau.edu/esp.
- The COECS continues to offer dynamic Summer Youth Programs in Computer Science and Computer Engineering to expand the pipeline in these critical shortage areas. More than 122 students from Broward and Palm Beach counties took advantage of 9 different summer camps including: *Video Game Design, Girls exploring Engineering, Building Smart Cities, Exploring Electrical Engineering, Transportation System Engineering, and Fundamentals of Engineering.* Both Palm Beach and Broward County school administrators assisted FAU to publicize the program. They continue to provide opportunities for the College of Engineering and Computer Science to directly market the Summer Youth Program countywide. By marketing to the Magnet and Gifted Program offices, to middle schools, to high school mathematics and to science leadership meetings, and guidance directors' meetings, the college is able to effectively engage the target population. Please see the following link for more information: http://eng.fau.edu/set.
- The College of Engineering and Computer Science also works closely with the A.D. Henderson/FAU High School to include these highly talented students as part of the Capture Program through several curricular and co-curricular activities. The College provides two (2) dual enrollment engineering courses (*Introduction to Robotics, EGN 1935, and Fundamentals of Engineering, EGN 1002*) for freshmen (9th graders) at the FAU High School. The engaging curriculum designed for these two courses is intended to attract students to STEM careers, including Computer Engineering and/or Computer Science.

Activity 6. *Student Engagement Activities*

CAPTURE students volunteered and participated in the following College of Engineering and Computer Science events this academic year:

- CAPTURE Scholarship Luncheon (October 9, 2017)
- Undergraduate Admissions Open House (November 15, 2017)
- FAU Engineers Week (February 19-23, 2018)
- IBM Hardware Hackathon (February 21 and 22, 2018).

- Choose FAU Day (Formerly known as Campus Day) (March 23, 2018 and March 30, 2018)
- Explore FAU (Formerly known as FAU Open House) (April 7, 2018)
- Senior Design Project Showcase (December 13, 2017, May 2, 2018)
- Female Capture students participated in the Women in Engineering/Computer Science events that took place during AY 2017-2018.

Activity 7. *Orientation Sessions and Advising*
An orientation session for new students admitted into the FAU CAPTURE program for the spring 2018 semester was held. Students were introduced to the CAPTURE advisor, CS/CE advisors and the CAPTURE tutors and mentors. The CAPTURE mentees were assigned to mentors based on their major, common interests, and the courses (identified by students) where they may need help. Sustainability of these activities is indeed important.

Activity 8. *Mentoring and Tutorial Program*
The CAPTURE Mentoring Program started three years ago and continues to provide the talent pool needed to support the CAPTURE students. Several training sessions were provided to develop the mentors' leadership skills and ultimately benefit the CAPTURE mentees. Twenty two (22) mentors were selected and hired by FAU for mentoring at four campuses at PBSC and BC during 2017-2018 academic year. In addition, tutoring was offered by the CAPTURE mentors in all of the Gateway courses (Calculus, Intro to Programming, and other CS/CE courses). Again, sustainability of these activities is being maintained.

PROJECT PERFORMACE ANALYSIS

As the CAPTURE Program formally concludes this year, the execution of this student-centered project has served as a comprehensive research framework in our DOE project for investigating the effectiveness of academic/institutional/ mentoring support, early career activities and scholarships success. The current implementation of the CAPTURE Program demonstrated the significant impact of the project on transfer students' success and degree attainment in Computer Science and Computer Engineering programs. The following chart provides the number of students who have transferred from PBSC and BC to the two CE/CS programs at FAU during the last five years:
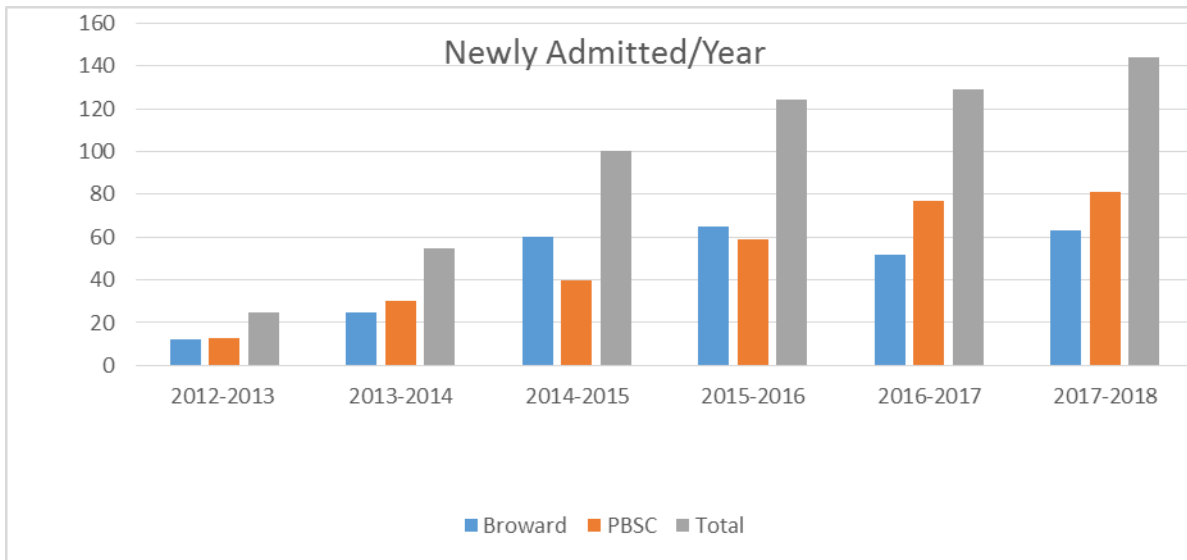
Figure 3 -Annual Student Pipeline from State Colleges to FAU (5 years)

As shown in figure 3 , the annual student pipeline from these two State Colleges has significantly increased from 25 students in the beginning of the project to 144 students this year (476% increase). We also had significant growth in the number of graduated students (66.4%). The CAPTURE Initiative has focused on specific performance data at the program level. First, data are presented for upper division enrollment in the funded academic programs. Second, data are presented for the number of bachelor's degrees earned in the funded academic programs.

Upper Division Enrollments

TABLE 1: Unduplicated Upper Division Headcount Enrollments in Targeted Programs							
Institution Name	Data Type	Academic Year					
		Current Year	Year 1	Year 2	Year 3	Year 4	Year 5
		(2012-13)	(2013-14)	(2014-15)	(2015-16)	(2016-17)	(2017-18)
Florida Atlantic University - Computer Science (11.0701), and Computer Engineering(14.0901)							
	Actual	463	433	617	689	743	848
	Projected	463	476	489	502	515	528
	Expected	463	522	570	677	740	810

Pipeline
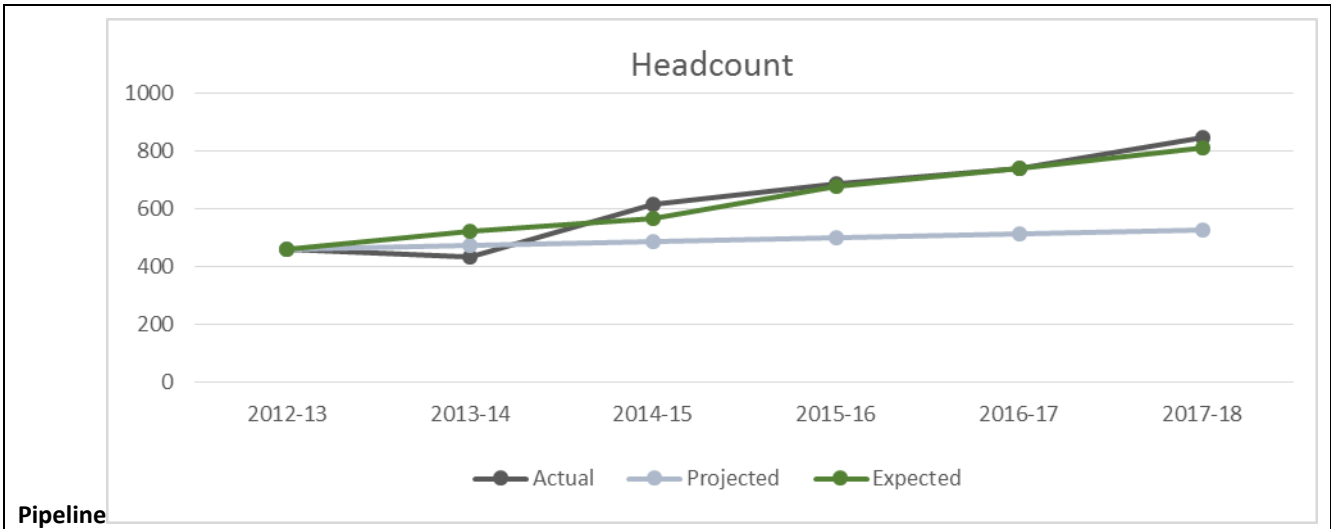
Figure 4-Upon Division Enrollment

As Table 1 shows, the number of upper division enrollments during the 2017-2018 academic year increased **14.13%** from the previous year, _exceeding_ the expected performance measure in our application proposal

Bachelor's Degrees Earned

TABLE 2: Unduplicated Upper Division Completers in Targeted Programs							
Institution Name	Data Type	Academic Year					
		Current Year	Year 1	Year 2	Year 3	Year 4	Year 5
		(2012-13)	(2013-14)	(2014-15)	(2015-16)	(2016-17)	(2017-18)
Florida Atlantic University - Computer Science (11.0701), and Computer Engineering(14.0901)							
	Actual	119	137	135	183	209	198
	Projected	119	126	133	140	147	154
	Expected	119	130	146	182	204	225

Figure 5- Bachelor Degree Awarded (CS and CE)

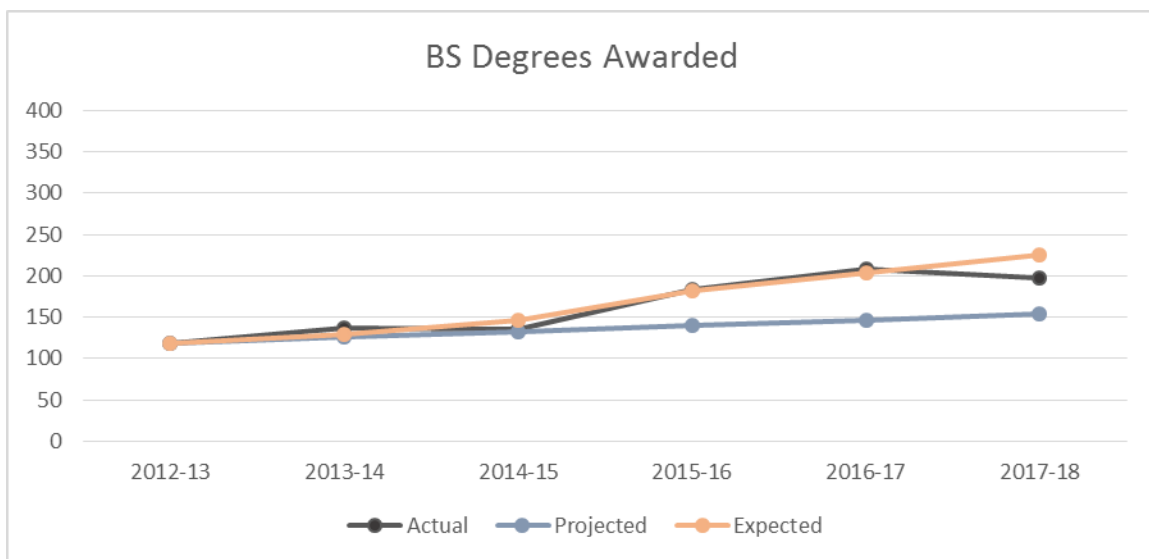As Table 2 shows, although, the number of degrees awarded during the 2017-2018 academic year increased by 28.57% as compared to the projected figure (row 2), the number of degrees awarded during this academic year decreased by 5.26% from the previous year and falls short of the expected performance measure in our application proposal.

The reason for such a short fall mainly is due to the change of CS curriculum last year with the addition of new senior projects I and II. This curriculum change was requested by faculty to bring consistency to all programs in the department. This change, however, resulted in a delay of student graduation this year. With a newly funded HSI title III grant from Department of Education for the next four years, commitment to the sustainability of the program by all three institutions, completion of the on-line course offerings this academic year, and the significant increase in the BC and PBSC student enrollment in CE/CS related AA programs, as well as the solidified partnership with BC and PBSC, the CAPTURE program is on course to significantly exceed the expected BS degrees earned in the targeted programs for the foreseeable future. The details and other relevant data   reported in [25]

PROGRAM ADVANCEMENT AND LESSONS LEARNED

The program has provided Palm Beach State College, Florida Atlantic University, and Broward College a great opportunity to collaborate effectively for academic and career success of students. The following is a summary of the lessons learned:

- Learning in an undergraduate CS/CE program requires, at a minimum, a programmatic sequence of required courses (some of which are the gateway courses) that reflect a focused and conceptually-coherent development of disciplinary principles and practices. In turn, conceptually coherent courses provide students with the prerequisite knowledge necessary for success in subsequent courses within the CS program. Many students lack adequate and relevant background knowledge necessary to successfully complete those gateway courses that are required prerequisites for entry into a degree program in CS. With such lessons learned from the CAPTURE program, the new DOE project   has focused specifically on the identified gateway courses that comprise part of the core curriculum content for the CS/CE degree programs and incorporate evidence-based ideas and recommendations from both discipline-specific education research as well as the broader ideas that drive instruction including the importance of aligning content, assessment and pedagogical practices. We expect to report on this transformative approach with new collected data in 2017-2018 AY report.

- The Articulation Agreements and Transfer Model have created a collaborative intervention and recruitment pathway between the three institutions. The Articulation Model is indeed a key component since the CAPTURE program has focused on facilitating the success of students who begin their CS degrees at 2-year state colleges (PBSC and BC) and then transfer as Juniors/Seniors to the 4-year university (FAU) where the CS/CE degree is offered. The CAPTURE Articulation Model is transportable to other settings in the State of Florida and beyond, and has been validated in its effectiveness in increasing the student pipeline and graduation rates in CS/CE.

- The students appreciate the accessibility of a personal BC CAPTURE advisor; someone to guide them through their flight plan, provide student success strategies with referrals to support services. Having an FAU CAPTURE Advisor on-site traveling to the various campuses was convenient for the students, since some students travel by bus. Understanding the needs of students who want to pursue Computer Science and Engineering programs and mapping those needs to Industry needs has been a valuable lesson.

- Hosting information sessions at the Broward College's five campuses, high school college fairs, community events, and open houses were effective in informing and recruiting students. In addition, presenting the information in the gateway courses proved effective in informing and encouraging students to join the CAPTURE Program. Sharing resources among the campuses turned out to be a 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 benefited by sharing best practices and innovative teaching technologies.

- Degree-specific flight plans and program-geared advising and tutoring have provided students with a kind of supplementary assistance that has proven to be highly contributory to their continued success. The scholarships they could receive through CAPTURE helped ease the financial burdens of their studies while also providing an incentive to achieve higher grades. Instead of coasting at the 2.5 GPA requirement for the program, many students worked even harder to meet the 3.0 requirement of the scholarship.

- Beyond the accomplishments in terms of GPA, there has also been a notable increase in student retention from semester to semester. The longer the program has been in existence, the more the students have strived to continually meet the requirements. The support that they have received from the CAPTURE advisors as well as the camaraderie they have felt by being part of something larger has also improved their drive and dedication, further advancing their achievements.

- The process has deepened our understanding of the needs of students who want to pursue Computer Science and Engineering programs, how to better help students achieve timely graduations, and better align student careers aspirations with industry workforce needs.

- 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.

- The Program created a strong communication pipeline between BC, PBSC and FAU, making the seamless transition of students possible, beneficial, and effective.

UNITED STATES DOE HISPANIC SERVING INSTITUTION TITLE-III PROJECT

The CAPTURE project provided a well-researched model which the researchers used in developing the USDOE Title III proposal as the means by which to expand educational opportunities for Hispanic and low income students within the computer science degree program. The CAPTURE team, in collaboration with the College of Education at FAU, proposed and was awarded a 4.45 million United States DOE grant to boost the number of computer science, computer engineering and electrical engineering degrees awarded to Hispanic and low-income students. The articulation model was a key component used by the DOE to provide the above prestigious federal grant to our three Institutions (FAU, PBSC and BC) for five years (2016-2021). While the CAPTURE program had focused on facilitating the transfer of students who began at 2-year state colleges (BC, PBSC) and transition to the 4-year university (FAU), the DOE Title III project provides a platform for an articulation model that can potentially can be replicated across and among HSI institutions. The articulation model addresses challenges which, for many in the past, were difficult to embrace. However, if the research-based findings hold up and enrollment increases within the state, then the model can potentially serve as a viable tool for other HSIs interested in implementing the model and learning about what it might take to serve as a national model.

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.

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│ Articulation Model: State Colleges and Florida Atlantic University    │
│ Focus- Insure efficient collaboration among 2-year and 4-year colleges│
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                   │   Project PD/PI   │
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┌────────────────────────┐           ┌──────────────────────────────────┐
│ State Colleges (2-Year) │ ◄ - - - ► │ Florida Atlantic University (4 Year)│
│      - - - - -          │           │                                  │
│  Broward,  Palm Beach   │           │                                  │
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         │  Administrative Project Management            │
         │  (Component Coordination, Scheduling)         │
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         ┌──────────────────────────────────────────────┐
         │  Faculty Collaboration                        │
         │  (Course Analysis/Refinement)                 │
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         │  Student Support Services                     │
         │  (Mentor-Led Learning Communities,            │
         │  Mentor-Led Course-Specific Team Learning)    │
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         │  Project Evaluation Activities                │
         │  (Institutional and Participant Data Collection)│
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│               Project Advisory Council                                │
│  (External Consultants, Local Industry Representatives)               │
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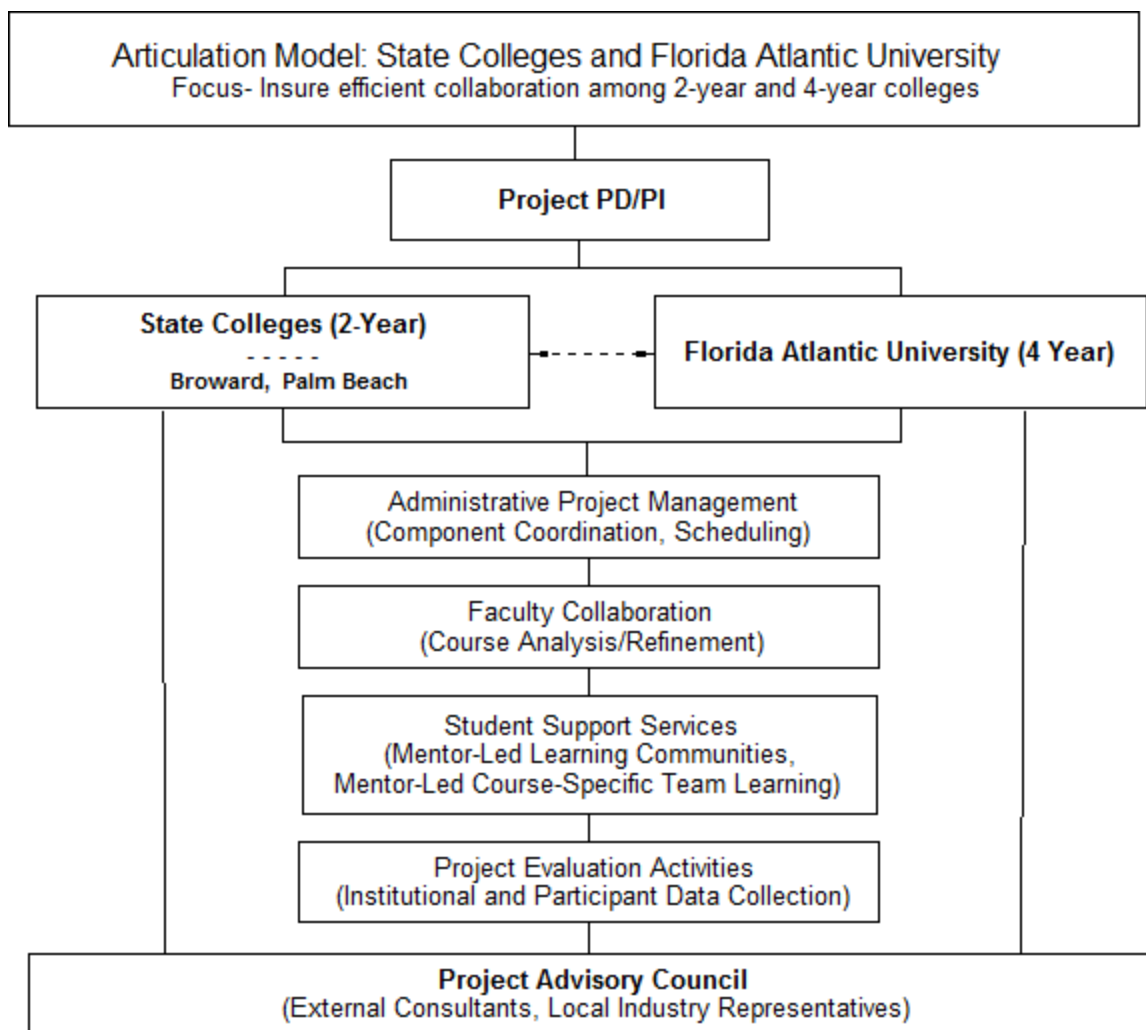
Figure 6- Overview of major project components.

The above Articulation Model (Figure 6) provides the framework for the extensive collaboration between the 2-year State Colleges (PBSC, BC) and the upper division CS/CE and EE programs at FAU. Within the scope of the model, various intervention components have been implemented in order to attract and support students. The specific key components in Year 2 were:

- Continued Articulation Agreement between State Colleges and FAU CS and CE.

As executed by the three institutions (FAU, Broward College and Palm Beach State College), this continuing agreement enabled the full implementation of a streamlined and seamless admission process from two State Collages to FAU. Students in the HSI program at both state colleges can develop appropriate programs of study with the help of their academic advisors. Such programs of study guide students in monitoring their progress toward specific degree programs in CS, CE and EE each semester. The individual programs of study are expected to be an important factor in increasing student retention and graduation rate as part of the student cohort transfer strategy from PBSC and BC to the College of Engineering and Computer Science at FAU.

- o Curricular Refinement of Key Mathematics Courses offered at the State Colleges.

  The following are the Gateway courses in mathematics (College Algebra, Trigonometry, Pre-Calculus, and Calculus I) offered at the State colleges and FAU.

  Because these courses have high DFW (i.e., failure and withdrawal) rates, they serve as barriers to students whose intent is to major in computer science. The objective of the project's curriculum refinement component was to improve the conceptual framework for each of these mathematics courses so that they are optimally effective for State College students in terms of course achievement outcomes and retention in a STEM education degree track. This curricular refinement objective which began in year 1 is now being completed in year 3. During year 3, the project will evaluate the curriculum framework for the Gateway courses by comparing their effectiveness to regular State College courses in (a) student academic success and (b) student success in follow-up courses (e.g., relative success of students in Calculus after taking the prerequisite Pre-Calculus course.

- o Introduction to Programming offered at State Colleges.

  Because this course also has a high DFW (i.e., failure and withdrawal) rate, it serves as a barrier to students whose intent is to major in computer science. The objective of this project curriculum refinement component is to improve the conceptual framework of this course so it is optimally effective for State College students in terms of course achievement outcomes and retention in a STEM education degree track. The course refinement process was initiated in year 2 of the project and will be completed in year 3. Once completed, the effectiveness of the refined course will be compared to regular versions of the course offered at the State Colleges.

- Development of a Course-Specific Mentoring Support Model to ensure Student Success in Completing the Gateway Mathematics Courses.

  The objective of this component is to maximize the conceptual learning support provided to students enrolled in gateway mathematics courses to ensure successful course completion and provide the necessary pre-requisite knowledge for success in subsequent mathematics and introductory programming courses. In addition to the course specific learning support, the mentors were also charged with providing complementary guidance in support of individual student development of self-regulated learning strategies to make them more effective learners.

  In year 2, while the project objectives of mentor support were continued, the arrangement of how mentors and students were connected changed from year 1 to year 3. In year 1, mentors were housed at specific locations at the State College sites and project students were to contact the mentors directly. In year 2, this process was modified to enhance mentor-student bonding by assigning a small number of project participants to each project mentor. The result of this refined process resulted in a personal linkage of students with their mentors and in an increased frequency of mentor-student support. This revised mentor contact process implemented in year 2 I being continued in year 3.

- Development of an Optimal Student Recruiting Model Leading to the Selection of Participating State College Students and Equivalent Controls.

  The objective of this project component is to implement a recruitment model for student participation at each State College that is feasible in terms of maximizing the number of recruits and that can be replicated by others interested in this model. Key components in year 1 were based on communication to students by State College Project Staff and State College

Faculty teaching the gateway mathematics courses regarding the opportunities for participating in the project. Gateway faculty were informed about the project, its broad goals, and then provided with a one-page flyer which was designed to be handed directly to interested students and that described the project goals and requirements as well as the Application Form and Student Consent Form. The second strategic recruitment strategy consisted of faculty announcements in which interested students were referred to the project web-based application site (www.fau.hsi). The overall objective of this project component was to establish an additional approach for enrolling student cohorts over the 5-year project.

In planning to improve the recruiting process during years 2-3, the project has made several significant revisions. Specifically, the year 2 revised model included implementation of a Computer-Oriented Learning Community component on (see following section) a pilot basis as the leading element of the student recruiting process rather than limiting it to only participating students.

First, in year 2, all students enrolled in the Introduction to Programming course were invited to participate in Learning Community Meetings as a means for facilitating their interest in participating in the project. Second, rather than focusing the student recruiting process on Math Gateway Courses, students were invited to apply for participation in the project through their Introduction to Programming course. The rationale for this focus was that students enrolled in an Introduction to Programming course were more likely to be interested in pursuing a computer science degree than students enrolled in Math Gateway courses. And third, the student application process was implemented through a project-developed web-based tool although a original paper-pencil application form continues to be available as informational to potential students and their faculty.

- Development of a Computer-Oriented Student Learning Community.

The objective of this project component is to provide participating students with future-oriented motivation to complete their State College AA degree and their BS degree in computer science at FAU. In the project, the learning community provided students with three key elements: (a) extended collegial connections with other student participants as well as opportunities for them to join a variety of student engineering clubs. (b) ongoing contact with regional high-tech corporate representatives outlining professional and career-related opportunities and eventual internships, and (c) knowledge of state-of-the-art ongoing technological developments in computer science presented by FAU computer science faculty and students. Considered together, the student learning community provides students with perspectives of possible career opportunities based upon their completing their undergraduate degrees in computer science.

As noted previously, in year 2 student learning community component was broadened to serve as a recruiting tool by inviting all students enrolled in the Introduction to Programming course. The intent of this enhancement was to provide students with exposure to the potential associated with having a computer science degree.

- Project Multi-Year Longitudinal Database. The objective of this project component is to store and provide accessibility of all student data over 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 project longitudinal database is the integration of student records as they complete their AA degree and matriculate from the State Colleges, transfer to and complete their BS degree at FAU.

CONCLUSIONS

As the CAPTURE program had focused on facilitating the transfer of students from State Colleges to FAU, the new DOE Title III   project provides a platform for a national model. It is expected that the new project will provide a national model 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. The DOE project has focused specifically on the identified gateway courses that comprise part of the core curriculum content for the CS/CE degree programs and incorporate evidence-based ideas and recommendations from both discipline-specific education research as well as the broader ideas that drive instruction including the importance of aligning content, assessment and pedagogical practices. We expect to report on this transformative approach with new collected data in the near future. Please see the following link for the detail of this transformative project: http://hsi.fau.edu.

ACKNOWLEDGMENT

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