

Enhancing Engineering and Computer Science Education for a Diverse Community

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ABSTRACT

With its prime location in Orange County, California State University, Fullerton is at the heart of diversity and multiculturalism. As a comprehensive university, it serves approximately 36,000 students from a variety of cultures and backgrounds, with the recent increases tied to the immigrant population from Mexico as well as Central and South American countries. The majority of this surge has been from first-generation college students. The College of Engineering and Computer Science enrollment also reflects the ethnic diversity that exists in the university. The College, in an attempt to reverse its historical legacy of high student attrition, provides support and services that will help its diverse student population succeed academically and socially while preparing them for the future. A variety of programs has been established in the College in order to fulfill this purpose. This paper will describe these programs in detail, their significance in retaining students, results to date and plans for the future.

Keywords: diversity, engineering education, student retention

1. INTRODUCTION

As the demographics of students entering four-year universities continue to shift, institutions of higher education are being faced with the task of educating a multicultural student body. During the period of 2004-2015, the National Center for Education Statistics predicts that degree-granting institutions will see an increase in total enrollment by 27% for Black students, 42% for Hispanic students, 28% for Asian American and Pacific Islander students, and 30% for Native American students (Hussar & Balley, 2006). Unfortunately, students of color are still not completing degrees at the same rate as their White, non-Hispanic counterparts. During the 2002-2003 academic year, 67% of all degrees conferred were to White, non-Hispanic students, while 22% were conferred to students of color including Black, Hispanic, Asian American, Pacific Islander, and Native American (U.S. Department of Education, 2005). The remainder was awarded to nonresident alien students and students who did not indicate ethnicity (U.S. Department of Education). The increasing diversity is important for institutions of

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*Fifth LACCEI International Latin American and Caribbean Conference for Engineering and Technology (LACCEI'2007)
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higher education because diversity benefits individual students, the institution, the economic and private sectors, and society in general (Milem, 2003). Within the field of engineering, increasing the diversity of engineers in terms of race, ethnicity, gender, and class is also important. According to the National Academy of Engineering (2005), changing demographics will mandate that the engineering profession develop methods for serving a diverse society as well as incorporate techniques for recruiting a diverse workforce. For this reason, engineering degree programs will also need to recruit and retain a more diverse student population. Milem argues that within a university, structural diversity, or the numerical representation of the student population, is important; however, diversity-related initiatives are also important for enhancing education. Several programs in the College of Engineering and Computer Science at Cal State Fullerton not only address the need for increased diversity within the fields of engineering and computer science, they also address the importance of fostering retention and student success in technical majors. This paper will review two major retention initiatives housed within the College of Engineering and Computer Science at Cal State Fullerton, including the Center for Academic Support in Engineering and Computer Science and Title V Retention Programs.

2. CENTER FOR ACADEMIC SUPPORT IN ENGINEERING AND COMPUTER SCIENCE

The Center for Academic Support in Engineering and Computer Science (CASECS) is an academic support program designed to recruit, retain and graduate students who are interested in pursuing careers in engineering and computer science. The program was originally founded in 1987 as the CSUF Minority Engineering Program (MEP) with the goal of enrolling, retaining, and graduating African American, Hispanic/Latino, Native American, women, and other underrepresented students in engineering programs. In 1996, the Minority Engineering Program changed its name to the MESA Engineering Program (MEP) at the request of the MESA (Mathematics, Engineering and Science Achievement) Statewide office, a state-funded umbrella organization housing a variety of programs under the direction of the University of California Office of the President. MESA Statewide is a pipeline program designed to assist and encourage educationally disadvantaged students to pursue and achieve success within the fields of engineering and technology (*About MESA*, 2006).

In 2006, MEP underwent another name change and became the Center for Academic Support in Engineering and Computer Science (CASECS). The Center now serves approximately 300 educationally disadvantaged students including first-generation students, students from low socioeconomic backgrounds, students of color, and students from groups with low eligibility rates for attending four-year colleges. The Center has a nine-point strategy for ensuring student success that begins with pre-matriculation activities and ends with graduation and career placement. The nine-point strategy includes the following service components: admissions and matriculation, summer orientation, study center, tutoring, academic counseling, student organizations, scholarships and grants, part-time employment, and professional development.

- *Admissions and Matriculation:* CASECS makes contact with prospective students upon admission to the university and introduces them to the program. Prospective students are provided with transitional support and introduced to current CASECS students who serve as mentors.
- *Summer Orientation:* CASECS provides a three-day summer orientation to new students where they are introduced to the fields of engineering and computer science. Students also learn study techniques and receive guidance in handling campus administrative procedures. A parent orientation is also provided.
- *Study Center:* The study center is a place for students to network, participate in tutoring sessions, utilize the computer facilities, or relax between classes.
- *Tutoring:* CASECS provides students with tutoring for lower-division technical courses including math and science courses.
- *Academic Counseling:* All CASECS students are required to meet with their CASECS academic counselor once per semester in addition to annual advisement meetings with faculty members within their computer science or engineering discipline. The CASECS academic counselor utilizes a holistic approach to advising that takes individual student needs into consideration.

- *Student Organizations:* CASECS provides support to student chapters of many professional engineering organizations, including four culturally-based student societies.
- *Scholarships and Grants:* CASECS provides scholarship, grant, and fellowship opportunities to CASECS students with support from industry and external entities.
- *Part-time Employment:* CASECS works with the Industry Advisory Board to maximize internship and career employment opportunities for students.
- *Professional Development:* CASECS offers continuous opportunities for students to gain invaluable practical and professional experience through internships, interdisciplinary team clinics, cooperative team projects and corporate-sponsored partnership programs.

Over the years, CASECS has received funding and support from a variety of entities including California MESA, industry partners, grants and alumni donations. In addition to industry and alumni support, CASECS is currently funded by the College of Engineering and Computer Science and the student affairs division at Cal State Fullerton, making it a model program for bridging the gap between student affairs and academic affairs. Since its inception in 1987, CASECS has successfully attained between 45%-67% six-year graduation rates for its students, depending on the annual cohort. This is in comparison to the 30.9% six-year graduation rate of the College of Engineering and Computer Science.

2.1 STUDENT ORGANIZATIONS

As noted, CASECS provides support to four culturally-based student organizations including the National Society of Black Engineers (NSBE), the Society for Hispanic Professional Engineers (SHPE), the Society of Mexican American Engineers and Scientists (MAES), and the Society of Women Engineers (SWE). The organizations are an important pillar of support for CASECS students as they provide students with professional affiliation, academic workshops, national conferences, mentoring, and cultural connections. Many CASECS students become involved in one or more organization in order to develop leadership, interpersonal, and professional skills for the future. Montelongo (2003) argues that for Latino students, involvement in a Latino-based student organization may increase the student's satisfaction with the campus environment and may enhance academic achievement. Additionally, Astin (1993) found that student-to-student interaction, including participating in a student organization, holding an officer position, working on a group project for class, tutoring other students, and participating in intramural sports, has a positive correlation with self-reported growth in leadership abilities, public speaking skills, interpersonal skills, analytical and problem-solving skills, and preparation for graduate school.

2.2 PARENT ORIENTATION

The overwhelming majority of students at Cal State Fullerton lives with their parents and commutes to school for a variety of reasons such as cultural expectations and prohibitive costs of living independently in Orange County. Such an arrangement does not create the traditional college separation, at least in proximity, between the parent and the child as the student enters college. Furthermore, living at home also poses challenges to the student as the demands of sharing household work or working part time to contribute to family needs continue to exist. These circumstances oblige the parents to remain involved in the details of the educational needs of the student attending college. The issues are exacerbated by the fact that many of the parents might not have attended college themselves.

During each summer, CASECS hosts a summer orientation for the parents of students enrolled in the CASECS program. The summer orientation provides parents with an overview of the CASECS program and informs them of what their son or daughter will be studying at Cal State Fullerton as an engineering or computer science major.

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The parents attend presentations made by representatives from the College as well as presentations made by student speakers and CASECS alumni about the rigor of the curriculum, the need for the student to work hard

and the services provided by CASECS in assisting them to succeed. Overall, the message sent to parents is that they should support their son or daughter in pursuing a college education, although it may be a significant challenge for many of them. Parents are also encouraged to do research to learn about the educational experience of the students when they find that the matters they are dealing with are unfamiliar to them. Other parent resources include the campus-wide Cal State Fullerton family orientation, which introduces parents to the campus and to college life and the Spanish language family orientation for Spanish-speaking parents of first-time freshmen.

2.3 THE DWIGHT D. EISENHOWER HISPANIC SERVING INSTITUTIONS (HSI) FELLOWSHIP

In 2006, CASECS established a fellowship program for students in the College of Engineering and Computer Science. The Dwight D. Eisenhower Hispanic Serving Institutions (HSI) Fellowship provides funding for students attending Hispanic Serving Institutions, or other Minority Serving Institutions, to help provide them with additional opportunities to enter careers in transportation. Fellowships are available to students pursuing a Bachelors, Masters or Doctorate degree in transportation related fields and are designed to attract qualified ethnic minority students to the fields of transportation education, research and workforce. The fellowship program was established in 1992 by the Federal Highway Administration's National Highway Institute.

In its inaugural year, fellowships were awarded to three Cal State Fullerton engineering and computer science students for the 2006-2007 academic year. Each student received a \$15,000 fellowship for study and research in the area of transportation. These students were the first Cal State Fullerton students to apply for and receive this prestigious award. In addition to funding received, each fellow attended a national transportation conference held in Washington, D.C. in January 2007 where one Cal State Fullerton fellow made a special presentation on his research project. His research investigates the possibility of designing a blind spot sensor for cars. Along with his faculty advisor, he is exploring possible approaches for "blind spot" detection and considering various methods to be used for alerting drivers of objects that may be interfering with the "blind spot." The inaugural year of the fellowship program has proven to be a success. The College of Engineering and Computer Science is dedicated to increasing the number of fellowship recipients each year as it encourages original research and application within the field of engineering and computer science.

3. TITLE V RETENTION PROGRAMS

In October 2004, Cal State Fullerton was awarded a Hispanic Serving Institution (HSI) Title V grant from the U.S. Department of Education. Title V is a five-year capacity building grant for institutions looking to increase programs and services for Latino students on campus. As noted by the Pew Hispanic Center, Latino students enroll in institutions of higher education at greater rates than any other ethnic groups but they are less likely to complete a degree program than other groups (Rooney, 2002). One goal of the Cal State Fullerton Title V grant is to increase retention of Latino students in math and science based majors. To address this goal, a full-time coordinator was hired to develop a variety of programs within the College of Natural Sciences and Mathematics (NSM) and the College of Engineering and Computer Science (ECS). Since the inception of the grant, several new programs have been implemented to help students become more successful in engineering and computer science: *Peer Advisor Program*, *Peer Group Program*, early academic alert, *ECS Scholars*, and ECS Tutoring Services. Each program is designed to foster both the academic and social integration of students, which, as argued by Tinto (1993), has the ability to increase overall retention of students. The primary focus of the grant's retention efforts are on first-time freshmen since the College traditionally sees a 50% departure rate by the end of students' second year.

The *Peer Advisor Program* is for all first-year Latino students enrolled in math, science, engineering, or computer science. Peer Advisors are upper-division students from similar cultural backgrounds and similar majors who serve as mentors and role models to incoming students. They support first-year students in their transition to campus by calling advisees regularly to check in and by meeting with advisees to assist them in a variety of ways. Torres (2006) argues that for Latino students, persistence is likely to increase when they are paired with mentors and advisors who help them develop the skills necessary to survive in college. Additionally, Torres contends that the intent to persist by Latino students is enhanced by cultural similarities between students and mentors.

The *Peer Group Program* is designed for first-year students searching for additional assistance and support on campus. One peer advisor serves as a mentor to peer group members and is responsible for facilitating weekly

Tampico, México
May 29-June 1, 2007

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group meetings. During group meetings, members discuss topics such as study skills, time management, campus resources, and career opportunities. Astin (1993) argues that connecting college students to their peers has the ability to influence substantial growth and development during undergraduate education, making the *Peer Group Program* an important aspect of retention for first-year students.

Early academic alert is designed to warn students who may be in danger of failing a course early in the semester. Mid-semester grade reports are sent to professors who complete the reports and then return them to the Title V retention coordinator. The coordinator then meets with students to provide necessary intervention and assistance. Early academic alert is suggested to foster retention and success of students (Tinto, 1993).

3.1 ECS SCHOLARS

The *ECS Scholars* program is a learning community established in collaboration with Title V Retention Programs, the University Learning Center and the Center for Academic Support in Engineering and Computer Science. Learning communities, as argued by Shapiro and Levine (1999), are an effective way to organize faculty and students into an intimate group of learners, to help students establish academic and social support groups, and to encourage integration of curriculum. With this in mind, the *ECS Scholars* program was launched in the fall 2006 semester with the goal of fostering academic success of first-time freshmen in engineering and computer science. In fall 2006, twenty-five engineering and computer science students were enrolled in their core classes together including math, English, and philosophy. In addition, a tutor attended class with the students and facilitated mandatory study sessions after each class session.

During the fall 2006 semester, the pre-calculus tutoring session for the *ECS Scholars* had 635 student visits and the calculus tutoring session had 206 student visits. Together, the two tutoring sessions represented approximately 19% of the total tutoring completed by the University Learning Center during the fall semester. Students in the *ECS Scholars* program also participated in the Peer Group Program in order to learn important skills for success. At the end of the program's inaugural semester, students in the *ECS Scholars* program were doing better than the comparison group of Latino first-year students in engineering and computer science. As indicated in Table 1, students in the *ECS Scholars* program passed their entry-level calculus courses at a 90% rate compared to approximately 50% pass rate for Latino first-year students not involved in the *ECS Scholars* program.

Table 1: Pre-Calculus and Calculus Pass Rates in Fall 2006

| Fall 2006 | First-year Latino Students in ECS | Students in <i>ECS Scholars</i> |
|-------------------------|-----------------------------------|---------------------------------|
| Pre-calculus (Math 125) | 49% pass rate (N=37) | 90% pass rate (N=10) |
| Calculus (Math 150A) | 50% pass rate (N=8) | 90% pass rate (N=10) |

Additionally, only 24% of the students in the *ECS Scholars* program were on academic probation at the end of the fall 2006 semester compared to 39% of the Latino first-year students in engineering and computer science.

3.2 ECS TUTORING SERVICES

The College of Engineering and Computer Science has increased its tutoring services in order to assist students academically. The Department of Computer Science, with assistance from Title V funding, is able to provide tutoring to students taking the entry-level computer science courses. Additionally, Title V Retention Programs has established a tutoring center in the Engineering Building, offering assistance in math, chemistry, and entry-level engineering courses. In its inaugural semester, the Engineering Tutoring Center had 187 student visits, making it the most visited satellite tutoring service offered by the University Learning Center.

3.3 RESULTS

Since the inception of the Title V grant in fall 2004, the College of Engineering and Computer Science has realized positive results. For the purpose of the grant, retention and success are measured by the percentage of students on academic probation or academically disqualified at the end of each semester. Since the primary focus of Title V Retention services is on first-year students, first-year probation and disqualification numbers are reported. Table 2 reveals that the percentage of Latino students on academic probation or academically disqualified after one semester has been decreasing since fall 2004.

Table 2: Percentage of First-time Freshmen on Academic Probation after One Semester on Campus

| Year | All First-time Freshmen in ECS | Latino First-time Freshmen in ECS |
|------------------|---------------------------------------|--|
| Fall 2004 Cohort | 34% | 45% |
| Fall 2005 Cohort | 40% | 42% |
| Fall 2006 Cohort | 34% | 39% |

4. CONCLUSIONS AND PLANS FOR THE FUTURE

Recruitment and retention are challenges faced by most engineering and computer science programs around the nation. These challenges are magnified when a college serves an increasing number of first generation college students from immigrant families. During the last decade of existence under different names but always having the same mission, CASECS has devised and deployed a nine-point strategy in ensuring success of undergraduates in engineering and computer science. CASECS services are available to all students, although the majority of students seeking its services are from underrepresented groups in the community. The success rate of these students is significantly higher than the general population of ECS students, thus affirming the effectiveness of the program. The CASECS program will continue to expand over the next few years but is limited by the case load capacity of one academic counselor. Additionally, CASECS plans to increase the number of Eisenhower Fellowships awarded each year.

The Title V grant has a larger scope of serving the math and science based programs at Cal State Fullerton, including natural sciences, math, physics, engineering, and computer science; however, it has an ethnic/racial focus on Latino students. Early indications are very encouraging and the results validate the tasks undertaken under the Title V grant. Work is under way to assess more quantitatively the effectiveness of the program. By the end of the fifth year, the grant is expected to have established a solid foundation for effective retention initiatives, at which point the hope is that the university will absorb the cost of funding the much needed programs. Over the next few years, the *ECS Scholars* program is expected to double in size and the ECS tutoring services will continue to expand in order to serve the demands of all students within the College.

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