Strategies for Success: Enhancing Minority Student Success in Science, Engineering, and Technology (SET) Professions

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Abstract

Based on enrollment for the Fall 2003 semester, only 4% of the US citizens/permanent residents pursuing master's and doctoral degrees in the Lee College of Engineering at the University of North Carolina at Charlotte were African American, 0% were Native American, and less than 1% were Hispanic American. These enrollment demographics, which have remained consistent for many years, are distressing when one considers that 28% of the Charlotte population is African American[1], North Carolina is home to Cherokee and Lumbee Native Americans, and most recently there has been explosive growth in the Hispanic American population in the Charlotte metropolitan area.

Over the last few years, the College has developed a recruiting plan to attract qualified and talented undergraduate students, particularly underrepresented minorities. It has also implemented several programs which, according to assessment data, are having a positive impact on undergraduate retention. These programs are especially important for underrepresented minority engineering students as the graduation rate for students of color in engineering is half that of white students and those who do leave engineering eventually drop out of college altogether.[2] Therefore, the intent is to not only to retain these students through completion of their BS degrees but to also to fuel the graduate program pipeline with qualified and experienced undergraduate researchers from traditionally underrepresented populations.

Two years ago, the College implemented an innovative program called *Strategies for Success* (SFS), which is helping to improve retention and also bridge the undergraduate and graduate curricula for underrepresented minority students. In its first two years, 35 students have participated in the program and 60% of those who completed their BS degree successfully matriculated to graduate engineering programs. As a result of participating in SFS, students indicate a deeper appreciation of their own potential, increased technical competence, increased levels of self-confidence, self-esteem, interdependence, and a desire to pursue technical graduate degrees.

Introduction

Traditionally, recruiting efforts for the Lee College have focused on undergraduate students and resources dedicated to graduate student recruiting have been, and are still, severely limited. Very little is being done to specifically recruit underrepresented minorities into graduate engineering programs. The College recognized that it could work smarter, not harder, by targeting underrepresented minority students in its own back yard. Therefore, the Department of Electrical and Computer Engineering (ECE) pursued, and was awarded, a four-year, $544K US Congressional Appropriation to establish a unique inter-institutional partnership with Johnson C.

Smith University (JCSU), a four-year liberal arts institution located 10 miles from the UNC Charlotte campus. JCSU was the first HBCU* in the country to implement a computer engineering major. The primary purpose of the four-year program funded by the Congressional Appropriation, called *Strategies for Success* (SFS), is to expand the undergraduate research community of underrepresented minority students who successfully pursue graduate degrees in engineering by:

- Integrating the two campuses culturally and academically.
- Providing research opportunities and the support infrastructure necessary to ensure minority student success – *academically and professionally.*
- Stimulating inter-institutional projects dedicated to improving the scientific expertise and interest of undergraduate students from underrepresented groups.
- Facilitating an easy transition of these students to graduate school.

ECE and JCSU offer complimentary undergraduate engineering programs, thus providing the foundation for a strong, productive relationship between the students and faculty of both institutions. Program objectives are being accomplished by offering a variety of academic and professional experiences, described below, that challenge students to learn and grow in a mentored community. According to Astin[3], peer communities have the significant impact on whether or not college students are retained. Thus, it was important to the success of SFS to establish an integrated peer community of underrepresented minority student researchers from both institutions.

Year 1 of SFS

Initial program activities primarily focused on identifying qualified undergraduate students who had already expressed an interest in graduate school or who had the potential to succeed in graduate school based on their cumulative GPA. Students who had completed their freshman and sophomore year curriculum were especially recruited for the program. The purpose of engaging students in SFS early in their undergraduate career was to ensure that they had sufficient time prior to graduation to engage in relevant and challenging research, become comfortable with the College's procedures, and begin to define a focus of interest for their graduate studies.

Based on discussions with prospective participants, all of whom were underrepresented minority engineering students, most of them were not aware of the benefits and opportunities of a graduate degree. None of them were knowledgeable of the requirements and process for admission, including admission to the College's early-entry master's programs. Most students also were concerned that they did not have the level of experience and/or self-confidence to immediately begin conducting research. Consequently, the primary objective for Year 1 was to provide enriching opportunities for the first cohort of undergraduate students. These opportunities were designed to enhance their professional and technical skills, increase their self-confidence, and prepare them to do undergraduate research with the long-term goal of successfully matriculating to a graduate engineering program. In all cases, program participants

* Historically black colleges and universities

were paired with a faculty mentor who provided a challenging project, carefully monitored their performance, provided timely and relevant feedback, and encouraged them to pursue a graduate degree.

During the first year of SFS, 24 UNC Charlotte students were hired as peer mentors, Supplemental Instruction (SI) leaders, program assistants, and undergraduate or graduate research assistants, based on their personal preference and qualifications. Participants who chose to initially work in non-research positions in preparation for research experiences later were hired by the College of Engineering *MAPS (Maximizing Academic and Professional Success)* Program.[*] One PhD candidate and two early-entry master's students were also included in the first year cohort. By the end of the first semester of SFS, two undergraduate participants had accepted research positions within the College with funding provided by other external grants. During Year 1 students conducted research on a variety of topics including a gallium nitride based radiation detector for use in the x-ray spectrum and a timing analysis of built-in self-test for field programmable gate arrays for the National Security Agency.

Unlike the UNC Charlotte program, which operates year round, the JCSU program is restricted to summer undergraduate research experiences only since this format better meets the needs of their students and faculty. In Year 1, nine JCSU students (three teams) were supervised and mentored by a faculty advisor. The teams were introduced to undergraduate research when they designed a digital controller and developed various software tools.

Students from both campuses jointly participated in SFS summer workshops on the UNC Charlotte campus, where they learned about the opportunities and benefits of a graduate degree and the process for applying to graduate programs. In an effort to further acclimate JCSU students to the UNC Charlotte campus, SFS participants were given parking privileges, computer accounts, and library access. They also toured UNC Charlotte research facilities. One JCSU student conducted research on the UNC Charlotte campus as part of a senior project sponsored by faculty from both institutions.

Year 2 of SFS

Students who participated in the program during Year 1 were eligible to remain in the program if their cumulative GPA met the requirements for continuation. Therefore, Year 2 efforts were focused on attracting new students from both campuses into the program and expanding opportunities for existing participants. A total of 35 students participated in SFS: 23 from UNC Charlotte and 12 from JCSU. Some UNC Charlotte freshmen and sophomores were not prepared to do undergraduate research either because they did not possess the technical skills or, as was more likely the case with the first cohort, because they did not possess the self-confidence to feel comfortable in a research role. Therefore, as in Year 1, these students were hired as teaching assistants, program assistants, peer mentors, or Supplemental Instruction (SI) leaders through the Lee College of Engineering *MAPS* Program. Students from both institutions again participated in summer workshops on the UNC Charlotte campus. During Year 2, students

[*] *MAPS* is a nationally recognized engineering retention program that offers peer mentoring, Supplemental Instruction (SI), tutoring, academic and professional development workshops, experiential learning opportunities, and student organizations. Information on MAPS may be found at http://www.coe.uncc.edu/maps/.

conducted research on topics such as reactive ion etching, fluorinated fluxless soldering technology, and physical vapor deposition.

Other Professional Development Opportunities

SFS participants are encouraged to take advantage of other developmental opportunities that complement program activities and enhance their professional and academic skills. For example, during the first two years of the program, several students participated in local and international internships, with some funding for the latter provided by the College of Engineering. One student was awarded a graduate research fellowship with the National Institute of Standards and Testing in Washington, DC. Other students conducted research with the Ronald E. McNair Scholars Program and the National Science Foundation Research Experiences for Undergraduates Program. One student was a member of the NASA KC 135 Reduced Gravity Project and presented the team's research at an international conference in Germany. Several students were selected to participate in the College of Engineering Leadership Academy. Other students made presentations of their research projects, and their participation in SFS, at national and international conferences.

Marketing SFS

SFS is directly marketed to student members of the Society of Hispanic Engineers, the National Society of Black Engineers, and the Society of Women Engineers through presentations and discussions at each society's meetings. JCSU freshmen learn about SFS from UNC Charlotte faculty who guest lecture in their introduction to engineering course and who conduct workshops for their computing teaching assistants each summer. Program websites include student research projects and presentations.[4, 5] Targeted mass emails and bulletin board flyers also help market the program to prospective participants. However, it has been found that the most effective marketing technique has been by word of mouth. In the first two years of the program, it has self-advertised beyond available resources and further funding sources are being pursued.

Student and Faculty Feedback

The SFS program is continually evolutionary and is heavily dependent on input from all program stakeholders. Each academic year, and at the end of the summer session, quantitative and qualitative feedback is solicited from participants to determine if the program is meeting its objectives. Students are asked about their perceptions, experiences, and skills learned as a result of participating in the program and whether or not they are more interested in pursuing a graduate degree. Results for Years 1 and 2 are consistently positive. In fact, 100% of the students who participated in the first two years of the program indicate that they had a positive experience and that they would recommend SFS to their friends. Some of their written comments include:

- "This program offers a great opportunity for hands-on experience. I hope it sticks around!"
- "Talking with the graduate student about the process of applying and his actual experience in graduate school was very helpful."

- "I enjoyed working with graduate students and the professors. I learned more than I imagined I would. I enjoyed the time I spent working on this project."
- "This should be a requirement for all students for it gives an in-depth hands-on training in research and gets the student more into doing their own…research."

In addition, anecdotal feedback and survey results confirm that students who participated in the program as undergraduate researchers for the second year are much more comfortable with and confident in their role as a researcher and thus feel better prepared for graduate school.

Feedback from faculty who served as research advisors was also positive. As one advisor stated,

> "…involvement in this [program] appears to have given [the student] a new appreciation for research and graduate education, and he certainly realizes that this is indeed a viable career path."

Another faculty member indicated that he "would certainly like to see the program continue, especially in the [microelectronics] clean room, as it provides very valuable experience and hands on training." A third research advisor wrote:

> "The program offers a unique opportunity for these students to work with state-of-the-art equipment (including software and hardware) and new materials…. Their participation in conferences will provide an opportunity to network with their peers and fellow students from other universities, and to enhance their communication skills - an important, but often underestimated skill for engineers."

Thus, faculty feedback indicates that the students who participate in SFS are making valuable contributions to their research and that the students' technical and professional skills are being enhanced as a result of their participation in the program.

Program Support

An SFS Advisory Committee composed of faculty from both institutions, business and community leaders, and practicing engineers meets each fall and spring semester to discuss ideas for growing and improving the program. These meetings also provide an opportunity for students to present their research projects and hone their networking skills.

The project PI and co-PIs from both campuses meet at least once each semester and during the summer to discuss programming, review progress and results, and identify opportunities for improvement and expansion. These meetings have also been dedicated to other topics such as:

- Assessment strategies for ensuring accreditation of JCSU's computer engineering program by the Accreditation Board for Engineering and Technology (ABET).
- The impact of UNC Charlotte's College of Engineering *MAPS* Program, freshman residential learning community, and Supplemental Instruction program on retention and academic performance and how these programs could be adapted at JCSU.

- Advising and matriculation issues for JCSU students interested in pursuing an MSEE and/or PhD degree at UNC Charlotte.

Results of SFS

In the first two years of the program, 60% of the SFS participants from both institutions who graduated with their baccalaureate degrees successfully matriculated to graduate programs in the Lee College of Engineering* and at other institutions. Several other program participants are currently enrolled in the department's early-entry MSEE program and/or they have applied to graduate engineering programs at other institutions.

To date, seven of 12 (58%) UNC Charlotte underrepresented minority students have completed their BS degree and matriculated to graduate engineering programs at UNC Charlotte or other institutions. In addition, four students who are expected to graduate by May 2004 have either applied to or are enrolled in an early-entry MS engineering program at UNC Charlotte and one other student has applied to MS engineering programs at other institutions. Only one SFS participant from JCSU has graduated to date, and he is currently enrolled in UNC Charlotte's MSEE program. Another JCSU student is completing a senior design project that was originally a SFS summer research project sponsored by faculty from both campuses. He and 14 other SFS African-American participants from JCSU are planning to enroll in UNC Charlotte's MSEE program upon graduation in December 2003 or May 2004.

Institutionalizing SFS

In the past two years, the College of Engineering and the Department of Electrical and Computer Engineering at UNC Charlotte have committed $66K in matching funds to the SFS program to support student salaries. Faculty have eagerly assumed teaching and mentoring responsibilities and provided opportunities for undergraduate research to ensure student success and facilitate an easy transition to graduate school. The department has also provided support for internships in the microelectronics clean room and in research laboratories, thus incorporating SFS into its academic infrastructure and annual budgeting process. The program is now part of the College culture and this commitment will continue once external funding is no longer available. However, SFS has been so successful in attracting students to participate that the College is constantly pursuing funding to enhance and expand this program.

Conclusion

The performance and accomplishments of the first two years of the SFS program have exceeded expectations in terms of the number of interested students, number of students participating, quality and variety of research projects and developmental experiences, and impact on fueling the graduate pipeline with underrepresented minorities. In addition to electrical and computer engineering majors, the program has been expanded to include civil and mechanical engineering

* One student is pursuing an MS in physics at UNC Charlotte.

majors as well. In fact, demand for participation in the program continues to exceed availability of positions, which means that each semester students are put on a waiting list or turned away.

Feedback obtained from focus groups and surveys of SFS participants reveal that the students value the individual attention they receive from their faculty project advisors. They also enjoy working with and meeting graduate students and students from the other campus. They are also more interested in and feel better prepared for graduate school as a result of their participation in SFS. Feedback from faculty indicates that SFS is a success because of the developmental opportunities it provides students who might otherwise not have access and also because of the valuable contributions participants make to their research programs.

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