

Engineers of the Future (EOF): Preparing Diverse Students for a Diverse Workforce

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Abstract - The purpose of the Educational Opportunity Fund (EOF) program at Rutgers School of Engineering is to support academically talented and economically disadvantaged students, including women and underrepresented groups. Since the early 1970's, engineering industry has strongly advocated for a large diverse workforce. In response, the educational research community examined the factors impacting recruitment, retention, and graduation rates for engineering students. Utilizing a theoretical framework grounded in the research findings, the EOF program has been designed to provide financial and academic support, as well as professional development and informal learning opportunities. The purpose of this paper is to describe the various components of the successful Rutgers engineering EOF program. The average retention and graduation rates for EOF students match those of non-EOF students. The success of the EOF program is contributed to the customized programming for students that assist them in adjusting to academic and social rigors of the university life.

Index Terms – Engineering Education, Low-Socioeconomic Status, Opportunity Program, Engineering Identity

INTRODUCTION

The latest technological revolution has brought with it a high global demand for technology based jobs, such as engineering, that require scientific and mathematical literacy that far exceed the number of qualified applicants in the United States [1]-[2]. In order to compete in the global economy, our nation's universities must attract, retain, and graduate qualified engineers, regardless of their gender, ethnicity, race, or financial need. Interestingly, traditionally underrepresented groups (women, racial/ethnic minorities, and low-income students) are entering institutes of higher education in larger numbers [3]-[4]. However, women, ethnic/racial minorities, and economically disadvantaged students remain underrepresented in engineering [5]-[6].

In President Obama's address to the National Academy of Sciences, he committed "to participate in a public awareness and outreach campaign to encourage students to consider careers in science and mathematics and engineering -- because our future depends on it" [7]. Furthermore, the

President stated, "women and minorities... too often have been underrepresented in scientific and technological fields, but are no less capable of inventing the solutions that will help us grow our economy and save our planet." Joining President Obama's campaign, the purpose of the Rutgers School of Engineering Educational Opportunity Fund (EOF) program is to support academically talented and economically disadvantaged students, including women and other underrepresented groups, as they pursue engineering as a profession.

Since the early 1970's, engineering industry has strongly advocated for a large diverse workforce. Thus, the research community focused on studies to examine the factors that impact recruitment, retention, and graduation rates for engineering students [8]-[12]. Researchers conclude that outreach activities starting as early as middle school have a positive impact on recruitment of students to institutions of higher learning. Also, participation in academic and social support programs increases persistence [13]-[17]. Even though minorities begin their college education with similar academic interest as non-minority students, they do not receive bachelor's degrees at the same rate often due to poor high school preparation, income disparities, and lack of a social support network. However, regardless of students' academic profiles prior to entering college, participation in academic and social support programs, such as tutoring, study skills workshops, student organizations, and mentoring, have a positive impact on their persistence and academic achievement [18]-[19]. Thus, the primary goal of EOF is to develop programs that support students financially and academically, as well as provide professional development and informal learning experiences.

EOF AT RUTGERS SCHOOL OF ENGINEERING

New Jersey is ranked in the first quartile for the number of individuals who are college educated and are employed in science and engineering jobs in the US workforce [20]. Consequently, New Jersey's economy has a high percentage of technical jobs in comparison to other states. Rutgers, The State University of New Jersey is home to over 50,000 students, where, more women (51%) are enrolled than men

(49%), and the ethnic/racial diversity of the student body is increasing. The number of baccalaureate degrees awarded to women and other underrepresented groups illustrates the diverse student population. In 2005, 37.5% of baccalaureates were awarded to minorities, ranking 7th among public Association of American University (AAU) institutions; 10.1% African Americans, ranking 2nd of public AAU institutions; 8.6% Latino, ranking 10th of public AAU institutions; and 56.2% women, ranking 5th of public AAU institutions.

While University-wide enrollment and graduation rates are impressive, the gaps at the School of Engineering (SoE) remain widely parted. The under-representation of women, minorities, and economically disadvantaged students in engineering fields is due, in part, to low enrollment at the undergraduate level and high attrition rates. As of fall 2012, SoE enrolled approximately 3300 undergraduate students. Of these students, 20%, 6%, 10%, and 8% were female, black/African-American, Latino/Hispanic, and economically disadvantaged students respectively.

Students who fall within state poverty guidelines set to identify students as “economically disadvantaged” qualify for the Educational Opportunity Fund (EOF) program, which is one of New Jersey’s most comprehensive and successful educational initiatives. The program provides educational access to students from low-income families who have the academic potential to succeed in college, but may not be prepared for the academic rigor. At Rutgers engineering, we have done a “play on letters” to rename the acronym as “Engineers Of the Future (EOF).” The engineering EOF population is more diverse than the general undergraduate engineering population. Specifically, it is comprised of 21%, 20%, and 33% female, black/African-American, and Latino/Hispanic students, respectively.

Annually, approximately 8% of the engineering freshmen class is admitted as part of the Educational Opportunity Fund (EOF) program. The average retention and graduation rates for several past freshmen classes were calculated and are presented in Tables 1 and 2. As shown in the tables, EOF students lag behind the general population in four-year graduation rates. While 32% of the total population graduates in 4 years, only 17.2% of EOF students complete the undergraduate program in that time. However, graduation rates are almost equivalent at the 6-year mark. EOF students tend to take five or six years to complete the baccalaureate. This is due in part to their need to work one or several, part- to full-time jobs while in school. These jobs are often menial and not related to engineering. Although the EOF program provides financial assistance to its participants, some students are still at an economic

disadvantage compared to their peers. Furthermore, many of these students require additional programming to adjust to academic and social rigors of the university life.

Year	Total Population (N = ~650)	EOF Population (N = ~55)
1-Year	70.3%	87.9%
2-Year	60%	75.1%
3-Year	52.9%	62.7%

Year	Total Population (N = ~650)	EOF Population (N = ~55)
4-Year	32%	17.2%
5-Year	48%	40.5%
6-Year	53%	51.1%

EOF PROGRAM COMPONENTS

Based on the theoretical framework that academic, social, and professional development initiatives increase retention, EOF offers a variety of student development activities. The following sections describe the main components.

I. Summer Program

Admission into the EOF program is processed during the regular first-year, first-time admission application into Rutgers. In other words, high school seniors applying for admission to Rutgers complete a financial questionnaire to assess EOF eligibility as part of their application for admission into Rutgers. The Rutgers admission application is an online process. One question asks students if they experience financial hardship. If student selects this option, they will be directed to complete an EOF application that requests data on family income and assets.

Once students prove a history of financial hardship, they are admitted into the University as an EOF student. They begin with a mandatory five-week summer bridge program prior to the start of their freshmen year. Students receive textbooks that they will need for their first year, school supplies, and a monetary stipend upon completion of the summer experience. The program is free-of-charge, including on-campus room and board for the summer.

The engineering EOF summer program offers a battery of courses that mirror the first-year engineering experience. The summer bridge provides an excellent opportunity for students to form a cohesive community and ease the transition from high school to college. EOF staff uses the summer program to diagnostically assess students’ academic standings in core classes (math, physics,

programming, and writing). Students receive credit for the “Engineering Orientation” required course if they successfully complete the summer program.

II. Cohort Advising

In the summer bridge described above, each student is assigned an Academic Advisor that serves as a University point-of-contact. This Advisor is knowledgeable about the various engineering disciplines’ curricula, general graduation requirements, University regulations, and personal counseling. Based on students’ performance during the summer program, the assigned Advisor prepares an individualized academic plan for each student.

Throughout students’ academic career, their EOF Advisor engages in proactive advising to ensure students’ success. In their first year, EOF students sign a contract with their Advisor which outlines the benefits of the EOF program and student responsibilities (i.e. meeting with Advisor regularly, attending professional development workshops, and mandated academic support as needed). At the start of each academic year, students are required to meet with their Advisor to assess previous year and outline academic and personal development plan for upcoming year.

III. Academic Support

The academic support provided to EOF students comes from a variety of university partners, a well as from the Office of Student Development, which coordinates the engineering EOF program. The resources include tutoring, study groups, a Methods of Inquiry course, academic coaching, and study skills workshops. In leveraging university resources, EOF students take advantage of the services provided by the Rutgers Learning Resource Centers. These resources include tutoring, study groups, and academic coaching (i.e. customized learning plans and study skills to match individual learning styles). Depending on students’ academic performance, they are either encouraged or mandated to take advantage of these services. If students are mandated, they must turn in attendance forms to their Advisor on a regular basis.

In the first-year, the Rutgers Learning Resource Centers provide tutoring for all the first-year engineering courses. As students progress in their academic career, the Office of Student Development (office that houses the EOF program), provides tutoring and study groups for second-year and upper-level engineering courses. The Office of Student Development also coordinates the Methods of Inquiry Course. This course is designed on the Learning-to-Learn theoretical framework. In other words, the course engages students in learning and applying study skill techniques. For example, students learn proper outline techniques, then develop outlines for the math course in which they are simultaneously enrolled, and submit outline for review in the Methods of Inquiry course.

IV. Financial Assistance

EOF students receive grants and loans from state and federal agencies. The EOF grant is supported by the State of New Jersey. Additional financial support is provided through scholarships made available by the EOF program. These funds secured through fundraising efforts. EOF staff support students as they apply for external scholarships and fellowships.

In addition to grants, loans, scholarships, and fellowships, EOF students may take advantage of a textbook lending library. Students may borrow a textbook from the program. Students continue to return their old textbooks to replenish stock. Various grants have also supported the stocking of the lending library.

V. Professional Development

In preparing the next generation, ABET recommends educating a diverse community of engineers who have a “solid educational foundation and are capable of leading the way in innovation, emerging technologies, and in anticipating the welfare and safety needs of the public”[21]. In achieving the ABET recommendation, a growing body of engineering education research advocates for providing various curricular and extracurricular activities to prepare the next generation of ethical innovators [22]-[25]. These types of activities include involvement in student organizations, participating in engineering research and design in- and out- of the classroom, as well as engaging in professional development courses and workshops.

The EOF program has offers a set of professional development workshops throughout the academic year. The topics include understanding the various disciplines, exploring job opportunities, industry and research center tours, networking sessions with practicing engineers, and mentoring. We also partner with other university units offering relevant workshops.

VI. Informal Learning Experiences

Aligned with research on informal learning experiences [18], we provide opportunities for students to extend their learning beyond the classroom. First, students may engage in research or design projects with faculty. Because Rutgers School of Engineering is a leader in innovation, our faculty engage in cutting-edge research that is supported by various funding agencies. To assist faculty with their educational outreach initiatives, we place EOF students in research and design projects in various engineering departments and centers. We work with faculty and students to ensure success. For example, we discuss mentoring techniques with faculty and responsible work ethic with students.

Second, we provide opportunities for students to develop their engineering identities through outreach activities. In our effort to infuse engineering at the pre-college level, the Office of Student Development coordinates summer and

academic year programs for precollege students and educators. The EOF students are trained to facilitate hands-on, engineering workshops. We find that this connection to the community is rewarding to the EOF students and provides them with an altruistic outlet.

SUMMARY AND FUTURE WORK

The overarching goal of the Educational Opportunity Fund (EOF) is to provide educational access to students from low-income families who have the academic potential to succeed in college, but may not be prepared for the academic rigor. The comprehensive program not only provides access, but supports students throughout their academic career to ensure their success. At Rutgers engineering, the diverse EOF population is provided financial and academic support, as well as professional development and informal learning experiences.

Quantitative data has shown positive results. EOF students are retained and graduate at nearly the same rate of non-EOF students. To compliment the quantitative data, the EOF program is developing a research project focused on hearing the voice of EOF students through the collection, analysis and dissemination of qualitative data.

Because EOF students are among the poorest in the State, it is critical to look at the greater implications of the EOF program. For example, the engineering EOF program has a documented history of successfully graduating students for over thirty years. Because engineering is a lucrative and influential profession, it is necessary to understand the potential of the engineering EOF program to break the cycle of poverty. In other words, we have seen generations of students who rise out of poverty because they have completed an engineering degree and changed the economic status of their families. An interesting branch of future work is to understand the dynamic changes that occur in EOF families once students have completed their engineering degrees.

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