

A Model for Underrepresented Minority Students' Success in Engineering: The PREF Summer Bridge Program

Anita Persaud, Amy L. Freeman

College of Engineering, The Pennsylvania State University

Introduction

It is important to create opportunities outside of the classroom where minority students can gather for academic workshops, and social and cultural events due to the isolation feelings many face on predominantly white campuses. Research shows that African-American and Hispanic/Latino American college students have a higher attrition rate than Asian American and European-American students⁴. According to the National Institute of Education Report, when faculty, administrators, and students are involved in learning, there is greater student achievement and retention within that college environment^{1, 6, 8, 10, 2, 3}.

College students experience three major stages in their acclimation to college: separation, transition, and incorporation or integration⁹. Academic and student support services need to be front-loaded because the research demonstrates a high attrition rate during the first year of college. In order for students to be retained, they need to develop their skill competencies and confidence in their ability to perform well academically. This can be done by: a) increasing the number of minority faculty members; b) establishing mentoring programs; c) assigning academic advisers and support services counselors; d) arranging for consistent financial aid presentations; e) gaining access to tutorial services focusing on mathematics and the sciences; f) implementing first-year seminars for incoming first year students and transfer students; g) instituting communities of learning such as special housing options; h) arranging for book and tuition scholarship programs; i) clustering of core engineering courses taught by selected faculty members; j) working in conjunction with internship or cooperative education programs; and k) establishing pre-college programs and college-summer-bridge programs^{11, 7, 10, 5}. The following recommendations have been shown to improve the retention and graduation rates of underrepresented minority students in higher education and are adhered to within the College of Engineering at The Pennsylvania State University. Further, the summer bridge program, Pre-First Year Engineering & Science Program (PREF) has been designed to embrace these principles and has been remarkably successful in doing so over its 14 year history at the university.

PREF is a summer bridge program specially designed for underrepresented first-year students of color in engineering or science-based curriculums. It is well equipped with intensive academic preparatory courses for entry-level Calculus, Physics, Chemistry and English writing courses. In addition, time management and study skills seminars are offered in a college survival skills series to ensure academic success. Experienced university engineering and science faculty and

staff oversee the program. The overall objective of the PREF program is to maximize the retention and graduation of underrepresented minority first-year students in engineering and science majors at The Pennsylvania State University. In the process, students would also be prepared for internships and cooperative educational experiences as well as exposure to the engineering industry through interaction with sponsoring corporations.

Program Description

The PREF program is held at The Pennsylvania State University, University Park (main) campus. This residential, six-week, rigorous academic summer program typically spans from late-June to early August. Accommodations for participants are made available through on-campus student residence and dining halls. PREF participants enroll in six-credit hours of course work that will prepare them for their first semester. University and corporate funding offsets the cost of their first summer tuition, fees, room and board. There is no cost to the student, most of whom are university scholars.

Selection Process

Selection of PREF participants is based on quantitative as well as qualitative criteria. Potential PREF students are identified from a group that has many of the following traits:

- Applied and accepted to Penn State's main campus (University Park)
- Currently at the Calculus level in High School
- Currently taking Physics, Chemistry or other science courses
- SAT Math score typically at 550 or higher
- High school GPA well above 3.0
- College science predicted gpa of 2.75 or above
- Identified Engineering or Science as an intended Major
- Large scholarship recipients with renewal contingent upon annual GPA
- Essay discussing students' engineering aspirations

This group is invited to apply to the program. Of those applying to the program, 15-18 are currently selected per summer. The limited number of participants is based upon the significantly high cost to run this program.

Components of PREF

PREF is comprised of three program components: social/cultural, academic, and professional development. The social/cultural component addresses family interaction and the transition from high school to college and includes on-campus residential living and daily interaction with other students and staff. The academic component includes those elements that affect students' present and future academic performance. Academic advising provides information and resources that assist students in making productive choices as they attempt to fulfill their course requirements for the first two years of engineering at Penn State. Professional development includes workshops that provide information about how to become professionally prepared for future employment, as well as a corporate visit.

The Social/Cultural Component

The social/cultural component is structured to ease the transition from high school and home to college and independence. Students arrive with their families to an orientation that reviews the program expectations of the students and families. This is a successful strategy in leveraging early support from the families. Students are introduced to staff and the rules and expectations of the program. Participants are full time summer admitted students at Penn State. Consequently, they are required to know the rules and policies of the university. They receive student identification cards, computer lab and library access and every other privilege and responsibility of all Penn State college students. PREF participants are assigned to live in the same residence hall and are in proximity to each other. Although there is a Residence Advisor (RA) who provides services for all students in a given residence hall, PREF students are also assigned to two Program Assistants (engineering upper-class male and female student) who live with them and provide specialized information to assist them successfully through the program. The Program Assistants participate a brief training session, attend two designated courses with the students, serve as their tutor at mandatory study sessions, assist in arranging field trips and are available to answer questions participants may be uncomfortable asking in a public forum.

The Academic Component

In the first week of PREF, students take a proficiency exam administered by the Freshman Testing, Counseling & Advising Program (FTCAP). FTCAP placement tests identify the performance level and course placement for Math, Chemistry and English. The participants' first semester schedules are determined by placement test results. After the PREF program, students can choose to retake particular components of the FTCAP placement exam and possibly improve their placement level in the above courses.

The academic component begins with four introductory courses that participants are required to take. These include Calculus, Chemistry, Physics and English and a special study skills seminar series. It is clear that high school course work is not uniform across the nation. As a result, the knowledge base of each student varies widely even though students appear to have taken identical courses such as calculus and physics. Students have no way to measure this phenomenon prior to taking a college-level calculus or physics course and typically arrive believing they are ready for college level work. The courses required for PREF are an introduction to Calculus, Physics, Chemistry and English. Their texts are the same as will be used in their upcoming fall semester. Participants receive an intensive review of the first four to five chapters for each course. Because the participants have the freedom to change or alter their schedules based on their own beliefs about their past academic abilities, regardless of advising, these courses assist in confirming to the participant his/her actual performance level that can be expected in the fall semester. They attend courses daily with most time committed to Calculus. Participants are also required to attend evening study sessions to complete homework and assignments. They are encouraged to work in groups where appropriate and assist each other. This early practice ensures that study groups may form more easily in the fall. Students receive six college credits for this six-week session with a final grade that counts towards their cumulative gpa.

The Professional Development Component

Professional development is emphasized upon their arrival. Participants are expected to complete a resume, a light research paper and presentation implementing library resources, and create an electronic portfolio showcasing themselves and their work. They receive information on business etiquette and are taken to visit their corporate sponsor in business attire. They are coached on questions to ask and must research the corporation prior to their visit. The corporate visit includes a tour of various industrial venues, an overview of the corporation's products and activities, and opportunities to meet corporate engineering interns. These visitations have proven to be quite effective in helping the PREF participants to see the value of their classroom lessons and how learning math and science are directly used in their future careers.

Continued Retention Strategies

Upon the completion of the PREF program, there are several vehicles designed to monitor the program participants throughout their years in the college of engineering. These include a mentoring program, assignment into an engineering living option, a first-year seminar, "cluster" course scheduling, and free tutoring. To assist in the social adjustment, all first-year students, including PREF participants, are assigned a mentor who contacts the students throughout their first year. In the fall, PREF participants are assigned to Freshmen in Science and Engineering (FISE) House, a living option that includes residential tutoring services for Calculus, Physics and Chemistry, and other resource workshops that residents are required to attend. For academic continuity, PREF participants are scheduled in "clusters" of six or eight for designated sections of Math, Chemistry, and/or a first year engineering seminar taught by the Director of Multicultural Engineering Program. The purpose of this is to encourage students to continue the relationship building throughout the academic year. Every student then has at least one course with someone familiar and is more likely to initiate collaborative relationships throughout the academic year. Finally, MEP offers free tutoring in core engineering courses such as Calculus, Chemistry, Physics, Engineering Design and Graphics, and Engineering Mechanics are just a few. The tutoring center, (Academic Excellence Center) is opened six days per week for approximately 50 hours per week. Students are encouraged to attend tutoring sessions with incentives such as the EATT card (Educational Advancement Through Tutoring) where students earn \$10 to their meal points for every five sessions of tutoring attended. Also, book scholarships are awarded to students based on improved grade point averages per semester.

Data Collection

Data were collected by means of a university database (Data Warehouse) as well as Microsoft Access to pool and track the science predicted GPA, first semester cumulative GPA and five-year graduation rates. This data were meticulously tracked over the program's 14 year history. Data for PREF participants were compared to underrepresented engineering students who did not participate in PREF as well as minority and non-minority engineering students who were not a part of the PREF program.

Results

The 14-year program included a total of 269 students from the three colleges (Engineering, Science and Earth and Mineral Sciences). Of the 269 participants, 170 were from the College of Engineering. Gender and ethnicity breakdowns are in Tables I & II.

Table I
Gender and Ethnic Data for 14-Year Program

Year	Total Participants	Male	Female	African American	Hispanic American	Native American
1991	25	11	14	12	12	0
1992	19	7	12	4	13	0
1993	28	15	13	16	11	0
1994	40	17	23	27	13	0
1995	23	9	14	19	4	0
1996	15	9	6	14	1	0
1997	17	10	7	12	5	0
1998	16	7	9	13	3	0
1999	17	8	9	12	4	0
2000	13	4	9	11	2	0
2001	9	4	5	8	1	0
2002	16	11	5	9	6	1
2003	16	14	2	9	6	1
2004	15	13	2	9	5	1
Total	269	139	130	175	86	3

Table II
*Comparison of Five-Year Graduation Rates for all PREF Participants
& Engineering PREF Participants*

Year	Total Participants	Total Graduates	% Graduated	BS or BA	B S EN	% B S EN
1991	25	20	80%	20	6	30%
1992	19	12	63.1%	12	7	58.3%
1993	28	21	75%	21	10	47.6%
1994	40	29	72.5%	28	11	39.3%
1995	23	15	65.2%	15	7	46.6%
1996	15	10	66.7%	10	4	40%
1997	17	12	70.6%	12	6	50%
1998	16	14	87.5%	14	6	42.9%
1999	17	15	88.2%	15	6	40%
Total	213	154	74.3%	153	64	43.9%

During this demanding academic program, students adjust to academic expectations of a university setting as well as social and cultural transitions. When they return in the fall, PREF students have proven to be better prepared for success in engineering and have higher academic performance rates than underrepresented minority engineering first-year students without such a summer bridge preparation program (see Table III). Although the average first-semester GPA is not significantly different for PREF participants compared to non-PREF participants (2.89 vs. 2.57) the 5-year graduation rate is explicitly different (see Table III).

Table III
Comparative Table of PREF Academic Performance & Five-Year Graduation Rates

Cohort Year	PREF Average Science Predicted GPA	Average 1 st Fall Sem. Actual GPA(ENGR)		5-Year Graduation Rate
		PREF	NON-PREF	
1991	2.91	2.92	2.53	80%
1992	2.92	2.73	2.60	63%
1993	2.96	3.06	2.77	75%
1994	2.89	2.80	2.55	73%
1995	2.91	3.19	2.32	65%
1996	2.81	2.82	2.64	67%
1997	2.86	3.17	2.51	71%
1998	2.90	2.99	2.64	88%
1999	2.94	2.83	2.77	88%
2000	2.91	3.09	2.64	NA
2001	2.71	2.44	2.49	NA
2002	2.98	2.74	2.48	NA
2003	2.91	2.76	2.44	NA
2004	2.90	NA	NA	NA
Average	2.89	2.89	2.57	74%

Note: Average 1st fall semester GPA for PREF 2004 engineering students & five-year graduation rate for the years 2000 to 2004 were not available at the time of this submission.

Based on this data, it is clear that the PREF program has strong long term benefits. PREF participants demonstrate a higher 5-year graduation rate (74%) when compared to non-PREF engineering students. The 5-year graduation rate for minority engineering students is 38.4% compared to the 5-year graduation rate for non-minority engineering students of 55.7%. Minority refers to American Indian, African American/Black and Hispanic and non-minority refers to White, Asian-American/Pacific Islanders and International students. This intensive academic support system continues as first-year PREF students have access to free tutoring and

they are mentored by upper-class students, many who have also completed the PREF program, and are headed towards graduation.

Unequivocally, participants performed better academically after the PREF program. We can clearly say that the program was successful in preparing these students for the academic rigor of their first academic semester in the college of engineering.

Notably the average predicted GPA is amazingly the same as the average first fall semester GPA (2.89) for PREF participants. This information indicates that the college science predictor is an accurate indicator of first semester academic performance. The program provides intensive academic preparation to bring first year students up to their expected academic performance level.

The five year graduation rate has ranged from a low of 63% to a high of 88%. Incredibly, even the low end of this range is extremely higher than the 5-year graduation rate for non-minority students (55.7%). In the 14 years of the PREF program, there has been 154 Baccalaureate degrees awarded to underrepresented minority students from the college of engineering. This results in an average of 10 PREF graduates per year, which results in approximately 16 PREF graduates per year if the five-year graduation timeline is taken into consideration. These extremely high graduation rates indicate that the PREF program is successful in attaining its goal of retaining and graduating underrepresented minority engineering students. In the college of engineering, attrition tends to be high, especially for underrepresented minority students. The 5-year attrition rate for underrepresented minority students is 56.5% compared to 42.7% for the non-minority engineering student population (College of Engineering Retention Rates by Race/Ethnic Status for University Park Campus from 1991-1999).

Conclusion

The PREF program has been established as a retention program at The Pennsylvania State University within the College of Engineering through the Multicultural Engineering Program. This program is a direct pipeline of underrepresented minority engineering graduates who are not only technically competent but also world-class engineers. Specifically, students enrolled in this program develop core competencies that extend beyond technical ability which include effective communication skills, planning and prioritization, time management ability, engaging team players, and success in competing globally.

In its 14 year history at The Pennsylvania State University, 269 students (170 students from engineering) have completed the PREF program. This support service, created to improve the retention and graduation of underrepresented minority engineering students, continues to diversify the university and the field of engineering by helping to ensure success of these students.

The PREF program serves as a strong retention mechanism which safeguards students' first semester transition and leads to ultimate success. Its extremely high five-year graduation rate of 74% is the highest for any student population within the college. The PREF program may be the

key to successfully retaining and graduating all underrepresented groups and implementing it for all engineering students can only secure their future academic and career success.

In conclusion, of the 896 underrepresented engineering alumni who have graduated in Penn State's College of Engineering 110 year history, 725 or 81% of these engineers graduated in the last 20 years, *after* the establishment of The Multicultural Engineering Program. This is clear evidence of the significant effectiveness and success of the continued need for Multicultural Engineering Programs and Women in Engineering Programs on university campuses nationwide.

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Biographical Information

ANITA PERSAUD earned her doctorate in Counselor Education from The Pennsylvania State University and has been the Associate Director of MEP for four years. Dr. Persaud currently serves on an NSF panel review; she is on

the Research Committee for WEPAN and serves as an affiliate member of the Penn State Commission for Women Faculty Issues Committee.

AMY L. FREEMAN earned her Masters of Science in Architectural Engineering from the Pennsylvania State University and has been the Director of MEP for the past five years. She is currently Director of Engineering Diversity (MEP & WEP) and is pursuing her doctorate in Work Force Education. Ms. Freeman is a published poet and a highly successful motivational speaker.