

AC 2008-2525: RESULTS OF SEVEN YEAR COMMUNITY OUTREACH PROGRAM TO IMPROVE THE PIPELINE OF UNDERREPRESENTED MINORITIES STUDYING SCIENCE, ENGINEERING OR MATHEMATICS AT COLLEGE LEVEL

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Results of Seven Year Community Outreach Program to Improve the Pipeline of Underrepresented Minorities Studying Science, Engineering or Mathematics at College Level

Abstract

The Center for Student Success (CSS) at Loyola Marymount University has the goals of recruiting science and engineering students and improving the retention of SE students in general. But special attention is given to improving the recruitment and retention of women and underrepresented minorities in the Seaver College of Science and Engineering. Developing methods to recruit students normally falls under the auspice of the admissions office on a college campus but the admission office goal is to recruit students to apply to the university, not within targeted majors. In order for engineering departments to recruit the best and brightest students they must find innovative and efficient methods to reach out to the high school community.

The Seaver College of Science and Engineering at LMU wanted to do more to improve our chances of recruiting underrepresented students. To accomplish this goal we started a high school community outreach program known as The Science and Engineering Community Outreach Program (SECOP) in the summer of 2001. SECOP is a two-week residential pre-college summer school program with a focus on science and engineering. We created a partnership between our College and five different academic enrichment programs in Southern California. By working with community organizations we have reached highly motivated students who have a strong aptitude for science and mathematics. We found funding to support our partnership from private corporations and foundations with similar goals; to improve the representation of African American, Latino, Native American, and females in engineering majors. Since 2001, 154 students from 54 different high schools in the Greater Los Angeles Area have participated in SECOP and the results of the community outreach partnership have been outstanding. We have collected data on the SECOP alumni who have graduated high school. We contacted many of the students over the phone and searched for them on Face Book. Of the students who attended SECOP and now have graduated from high school, 100% have or are attending college. Sixty-seven percent have select Science, Engineering or Mathematics as majors in college. Of the 84 students interviewed, 38 have selected engineering as a major in college (45%). These statistics are over three times higher than the national percentage of underrepresented engineering students graduating with engineering degrees (12%). The first SECOP students (from SECOP 2001) have graduated from university or will be graduating in 2008. The graduation rate of students contacted is 100%. The percentage graduating in STEM majors is 58% (14 out of 24), including 43% graduating with engineering degrees (6 out of 14). This article discusses the methods the CSS Office used to develop a very valuable and meaningful community outreach program that supports our community, improves the pipeline of engineering students and benefits Loyola Marymount University.

I. Introduction

The **Science and Engineering Community Outreach Program (SECOP)** is a two-week residential summer school program for students entering their sophomore or junior year in high school who have a strong aptitude and desire to study science, engineering or mathematics. SECOP is a collaborative partnership between LMU and different academic enrichment programs in Southern California including: Young Black Scholars (YBS), College Bound (CB), Boyle Heights College Institute (BHCI), American Indian Clubhouse (AIC), and The Blazers. Since 2001, one hundred and fifty-four students from 54 high schools in the Greater Los Angeles Area have participated in SECOP. By working with community organizations we have reached highly motivated students who are close to Loyola Marymount geographically. These community organizations are valuable sources of inspired students who have family support to participate in a summer program for two weeks.

SECOP focuses on introducing students to science, technology, engineering, and mathematics (STEM) careers and improving students' content knowledge in these topic areas. The goal of SECOP is to address the shortage of African American, Latino and Native American and female students studying science, mathematics, engineering, and technology at college level by introducing students to pre-engineering and advanced mathematics classes early in their academic careers. The objectives of SECOP coincide with the objectives of American Society for Engineering Education (ASEE):

- increasing awareness of opportunities available in science, engineering and technical fields;
- increasing students' confidence to grasp mathematics, technology and science subjects;
- improving student achievement in mathematics, technology and science;
- mentoring students through the process of applying to college; and
- increasing the pipeline of underrepresented minorities in STEM majors.

The American Association for the Advancement of Science discusses the benefits of summer school programs for minority students and women in their study, "Investing in Human Potential: Science and Engineering at the Crossroads." The study recommends, "providing residential campus experiences such as overnights, summer programs, and bridge programs" (p.3) to help expand the base of participation in science, engineering and mathematics. None of the academic intervention programs listed above offer summer school classes to their participants. During SECOP, students take courses in pre-engineering, computer graphics, physics, chemistry, mathematics, and SAT Preparation.

Historically, America's racial and ethnic minorities have been underrepresented in higher education in the science and engineering fields. Technology-based industries such as biomedical engineering, aerospace and computers are the nation's fastest growing and make up one-sixth of the total United States economy (Barret, 1997). Today, the United States is the world leader in the global Science, Technology, Engineering and Mathematics (STEM) enterprise. While national engineering baccalaureate production

grew in 2003 by 9.3% from 68,053 to 75,031, the fractions of this total awarded to African Americans, Latinos, and American Indians, respectively, all declined. Degrees earned by these three historically underrepresented groups peaked in percentage terms in 1999-2000 (11.6%), and have drifted downward ever since, reports the National Action Council for Minorities in Engineering, Inc. (NACME). Currently, African American, Latino and American Indian only make up 11.3% of the engineering undergraduate degrees. These same race/ethnic groups are projected to make up 33.9% of the U.S. population graduating from high school in 2014. Engineering degrees awarded to women have followed a similar trajectory-growth through the 1990's with a percentage peak in 2000 at 20.6% of the total. In 2003, women represented 20.1% of the baccalaureates awarded in engineering (Society of Women Engineers).

According to *Science* (Culotta 1993), a publication of the American Association for the Advancement of Science, there are several reasons why African American, Latino, and Native American students remain underrepresented in science and technology fields. These reasons include:

- inadequate academic preparation;
- low expectations by teachers;
- image problems due to low minority representation at most universities; and
- limited knowledge of mathematics and science professions.

Loyola Marymount University seeks to help students overcome the barriers they encounter while trying to enter into science, engineering and technology fields by improving academic preparation and expanding students' knowledge of the myriad of opportunities available for science and engineering majors. The University has the resources and intent to help students clear these obstacles by providing supplemental education with experienced teachers, state-of-the-art classroom facilities and supportive college students who act as counselors and mentors. Additional attention in advanced math and science courses such as calculus and physics before students enter college is an effective means of ensuring preparedness for science and engineering degrees.

“SECOP has given me the opportunity to experience science and engineering on a first hand basis. I think it is a very challenging and rewarding career, and I feel that it is something I'd want to do.” Female Student from Class of 2003 Sacred Heart High School in Boyle Heights

II. Benefits to Working with Community Organizations

For the typical engineering department working with local high schools to improve the pipeline of females and minorities entering engineering and other technical fields can prove to be very challenging. Immediately many questions come to mind: Who do we speak with at the high school: the principal, counselors, or individual teachers? How do we recruit for students? Do we visit during science and mathematics classes, or have a school assembly or invite parents for a career night discussion? Most high schools do not have the infrastructure to support extra phone calls, or community

outreach partnerships. If you have tried to call a high school and reach the principal or faculty members, you are aware of how difficult it can be to develop a line of communication. Many times you will have to call a teacher at home in the evenings to discuss a project or program. The engineering faculty and staff within a university are already stretched between research and teaching and do not have the luxury of time for community outreach programs unless they can operate smoothly and efficiently. The barriers to working with several high schools in your community can be overwhelmingly complex and create a sense of frustration that will prevent an outreach project from ever getting off the ground.

One solution to improving your odds of reaching highly motivated students who have a strong aptitude for science and mathematics is to work with community organizations that provide academic enrichment to minority students. Many communities around the United States have church organizations, or high school outreach organizations such as Young Black Scholars or Upward Bound that work with minority students on Saturdays or after school during the academic school year. These organizations are valuable sources of inspired students who are tailor-made for recruitment into a science, engineering or mathematics department.

The benefits of working directly with community organizations include: saving time, consistency of access, inspired students, and dedicated families. All of the academic enrichment programs I have worked with over the past seven years have staff members that answer the phones. The organizations are easily accessible to anyone in an engineering department because they can be located in the phone book or on the web. One is able to work directly with the organization's president or the educational director in a timely fashion. I find working with community organizations much easier than trying to work with individual high schools.

Academic enrichment programs are very interested in creating a partnership with a university to help encourage and inspire their students. They want to use the partnership to help advertise their program to perspective families. The partnership creates a win-win situation. The partnership can develop rapidly and run smoothly over many years.

Families that drive their children to Saturday Programs are very motivated. They value the added academic and emotional support that community groups provide for their children. Since they are already sold on the benefits of enrichment programs, they are eager to find other supportive programs that will provide further enrichment. Parents that enroll their children in academic enrichment programs are often times willing to have their children attend programs at the local university such as a summer school program or an engineering career day event during Engineering Week.

A family's motivation, improving their child's chances of being accepted into college and receiving scholarships, is often the compelling force that drives parents to be a taxi driver on Saturday mornings. A university that is willing to provide focused enrichment in topic areas not traditionally discussed in the high school curriculum such

as engineering or computer science will be doing a service and recruiting students.

III. About the Science and Engineering Community Outreach Program

The Science and Engineering Community Outreach Program (SECOP) is a partnership between Loyola Marymount University and local academic enrichment programs including: Young Black Scholars, College Bound, Boyle Heights College Institute, American Indian Clubhouse and The Blazer. Loyola Marymount University works directly with each organization to choose the participants. Participants in SECOP are underrepresented minority students who have demonstrated an aptitude for mathematics, science, or engineering and wish to enhance and strengthen their academic abilities.

Four faculty members teach courses in pre-engineering, computer graphics (AUTO CAD), physics, chemistry, mathematics and SAT Prep. Nine minority Loyola Marymount University students studying science and engineering act as counselors during the Program. Their roles include being teachers' aids during classes, project leaders for each of the group projects, and resident assistants in the dormitories.

Parents visit SECOP on two occasions for Family Night Events. The events include dinner and discussions on important topics including financial aid and scholarships for college and future jobs in science, technology and engineering. Guest speakers from Jet Propulsion Laboratory, NASA, Boeing, Southland Industries and the Metropolitan Water District of Southern California discuss engineering with the students on Career Day. Different science and engineering-based field trips to the Petersen Automotive Museum, Disney's Imagineering, Ballona Wetlands and Northrop Grumman give students a first-hand look at the day-to-day work of engineers and scientists.

Students are housed on campus in Rains Dormitory and eat their meals in the Lair Dining Hall. In the evening and on weekends students utilize the Fritz Burns Recreation Center for basketball, working out, tennis and swimming.

The summer school program has five (5) components that enable young scholars (and their families) to visualize themselves as college students studying mathematics, science or engineering.

1) Academic Preparation for Engineering and Science Degrees Component

The results of the Third International Mathematics and Science Study (TIMSS) show that, as a nation, we are not adequately preparing our high school students for college science and math courses. High school seniors in the United States placed 28th in mathematics and 17th in science (Barrett 1997). During the SECOP, Loyola Marymount University focuses on giving the students in-depth learning experiences. Students work together in a team with the support of Loyola Marymount University engineering and science student mentors to design, and produce a project. During the summer of 2007, each student was assigned to a group project and had to design and build a robot using

LEGOS MINDSTORMS NXT Kits. The students present their projects the last day of the program. They share their results with the other students. Additional benefits of the group projects included improving team working skills and public speaking ability.

2) Career Component

Female and minority students tend to have limited knowledge of the array of career options in mathematics and science fields (Clewell, Anderson and Thorpe 1992). Malcolm, Hall, and Brown (1986) noted that the majority of the nation's Black scientists were first-generation scientists with very few role models to encourage them and to facilitate their success. During SECOP, students study different African American, Latino and female scientists, mathematicians and engineers. Their mathematics groups are named after Maria Agnesi, a famous female mathematician who wrote a textbook on calculus, *Instituzioni Analitiche* in 1750 and Lewis Howard Latimer, a famous African American electrical engineer who in 1882 made the electric light bulb marketable by creating a more efficient filament that would not burn out.

The program director, Dr. Barbara Christie, plans a Career Day during SECOP. The guest speakers work for engineering -based organizations and all are African American and Latino leaders in mechanical, civil and electrical engineering fields. Several field trips to different science and engineering-based companies exposed students to different career opportunities. In the past several years the field trips have included visiting Disney's Imagineering, Northrop Grumman Space Park, Collision Dynamics, and Ballona Wetlands.

“SECOP has definitely influenced my feelings on studying engineering. At one point in time I did not really know what engineering was. Now I feel a lot more aware of what engineering is all about.” Male Student Class of 2004 King Drew H.S.

3) Family and College Preparedness Component

The support and understanding of parents is very important to first-generation college students. Parents need information on ways to foster math and science interests and persistence in their children (Clewell, Anderson and Thorpe 1992). Once a week we invite the family members of participants to attend a College Life seminar and dinner. Each week we focus on a different aspect of college life. Week 1: “How to Prepare for College Financially”, (families will be given a list of foundations that offer scholarships such as the American Chemical Society or American Society of Mechanical Engineers). Week 2: “Benefits of College and the Success Rates of College Graduates in Science, Engineering and Technology Careers”.

“I'm so pleased my daughter had the opportunity to participate in the SECOP program. She needed the first hand experience to gain an understanding of the types of issues/problems she'll be asked to solve as an engineering student/engineer. She really enjoyed the friendships she made and worked very

hard to tackle the assignments. You are providing an invaluable service for both LMU and the underserved segments of the community.” Mother of SECOP participant

4) College Life Component

First-generation college students often do not have examples of what college life is and are more likely to be intimidated by a college or university campus and lifestyle than students from families who are second or third generation college graduates. Attending SECOP provides students insight into the college experience. Students have the benefit of computer equipment and other technology that their high schools cannot provide.

5) SAT Preparedness Component

The gap in performance on college entrance exams between African American and Latino students and their white counterparts continues to grow. During SECOP the students have an opportunity to take evening SAT Preparation Lessons once a week.

IV. Addressing the Needs of the Community

The YBS, CB, BHCI, AIC, and The Blazers programs do not offer any summer school classes for their participants. Although the overall percentage of YBS, CB, BHCI, CEA and AIC students who attend universities and colleges is high, all of the programs have a low percentage of students who seek degrees in the science or engineering fields (much like the statistics found across the country). Loyola Marymount University intends to continue to address the needs of the community by continuing to expand the Science and Engineering Community Outreach Program. During the summer of 2008, we will have our largest group yet. We expect to invite 35 students to participate in SECOP 2008.

SECOP benefit students by giving them access to information that will help them make an informed decision about technical courses, majors and career paths. SECOP student are selected from inner city high schools. Many of the participants attend Title I Schools including; Banning High School, Crenshaw High School Lynwood High School, San Fernando High School, Jordan High School, Roosevelt High School and Westchester High School.

V. Results of SECOP 2001-2005

The Director of SECOP tracks students four years after they have graduated from high school. Of the students who participated since the summer of 2001 who graduated from high school, 100% of the students contacted by our study have entered college (N=84). Fifty-six of the students have selected STEM majors (67%). We continue to monitor the progress of our SECOP alumni over several years and collect data on their choices of college majors upon their graduating from high school. During the spring, Dr.

Christie conducted telephone interviews of the SECOP students who participated between the summers of 2001-2005. Data requested from the SECOP Alumni included SAT Scores, where the student applied to college, where they were accepted, their major, scholarships received and their final decision as to where they will attend. The table below shows the results of majors selected from 5 years of SECOP participants.

Table 1: Student statistics from 2001-2005 SECOP high school graduates (N=84)

**56/84 Science, Technology, Engineering or Mathematics (STEM Degrees)
67%**

14/84 Science
17%

38/84 Engineering
45%

4/84 Mathematics
5%

**36/52 Females in STEM degrees (52 of the 84 respondent were female)
69%**

12/36 Females Science
33%

12/52 Female Science
23%

21/36 Female Engineering
58%

21/52 Female Engineering
40%

3/36 Female Mathematics
9%

3/52 Female Mathematics
6%

Of the SECOP 2001 participants who have graduated college the results have been excellent. There were 28 students who participated in SECOP 2001. Of these, 24 were contacted and the following are the results from the phone interviews:

- 14 of the 24 have graduated with STEM degrees (58%)
(6 in science (43%), 6 in engineering (43%), 2 in mathematics (14%))
- 16 started in STEM degrees as freshmen, 14 are graduating in STEM (87.5%)
- All 6 of the science students are female and 4 of the 6 engineers are female

The SECOP participants have an SAT overall average which is 170 points above the average for underrepresented minority students (1070 compared to 900). The Grade Point Averages of SECOP graduating seniors over the past has been a full point above the GPA average for African American high school graduates across the United States. The SECOP participants' average GPA was 3.6.

(According to The High School Transcript Study: A Decade of Change in Curricula and Achievement, 1990-2000 - a publication by the National Center for Education Statistics, the mean GPA of African American high school graduates on the graduation year of 2000 is 2.63. This publication can be accessed at <http://nces.ed.gov/>. Results from the 2003 College - Bound Seniors: A Profile of SAT Program Test Takers are below. This report

can be accessed from The College Board website.

Average Verbal SAT score for AA males: 430, Average Verbal SAT score for AA females: 432

Average Math SAT score for AA males: 436, Average Math SAT score for AA females: 420)

VI. Conclusion

SECOP has accomplished many of its objectives over the past seven years. Improving mathematics scores was measured through pre and post testing. The scores of the mathematics pre and post-tests showed that 65% of the students increased their scores by 10% or more. The other 35% of the participants were within 10% of their original pre-test scores. These scores are encouraging and indicate that SECOP helped improve the participants' mathematics achievement.

The following are four of the responses from the student evaluation:
(1 strongly disagree, 2 disagree, 3 average, 4 agree, 5 strongly agree)

	1	2	3	4	5
The instructors improved my understanding of what engineers do.	0%	0%	10%	34%	56%
SECOP helped improve my mathematics skills.	0%	0%	20%	56%	24%
I would recommend this Program to a friend.	0%	0%	6%	18%	76%
The computer class helped improve my understanding of computers and their capabilities.	0%	0	16%	36%	48%

The future success of Southern California relies on a well-prepared and highly trained population. Achieving the goal of improving the participation of underrepresented students in science, engineering, and mathematics degrees and careers is important to the future success of the United States also in a more and more globally competitive world and the writer hopes that this paper gives some insight into how to design and implement an outreach program at your institution.

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