

## Effects of Pre-Freshman Program for Minority Students in Engineering

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### Abstract

The College of Engineering and Computer Science at the University of Michigan-Dearborn decided in early 1990s to increase, retain and graduate more minority students than in years before. A study was conducted to determine specific areas in engineering programs that impacted students' success; it revealed that students' performance in the first two calculus courses and physics were key to their subsequent success in engineering programs. To address this, a summer bridge in mathematics was developed and implemented. This was followed by academic year activities in tutoring and collaborative learning in key freshman and sophomore year courses. Most of these activities were initially funded through a NSF-AMP coalition grant but are now institutionalized through other sources. This report highlights the positive impact of the 4-week summer bridge program and academic year activities on the retention and graduation of minority students in engineering and computer science at the University of Michigan-Dearborn.

### Introduction

Since the early 1980s there have been significant interests and efforts to recruit underrepresented minority students in engineering and technology areas. These efforts were the results of several fundamental changes that occurred in the late 70s and 80s and policies that were enacted at the federal and state levels. Some of these were:

- Concerns about the demand for engineers in the U.S. to outpace their supply. There was also a need to maintain or increase enrollment in engineering and technology areas. These disciplines saw some of the largest drop in undergraduate enrollment; the total undergraduate enrollment of full-time and part-time students decreased by over 8% between 1988 and 1997 [1,2].
- Minorities and women would represent a significant portion of new workforce in the U.S. by early part of 21<sup>st</sup> century [3].
- The influx of large amount of federal and corporate funding that have supported students of diverse background to pursue technical higher education
- The social and ethical responsibilities of colleges and universities to provide access and support to students of color and diverse background.

Whatever the reasons, there have been an influx of new programs aimed at recruitment, retention and graduation of minority students in engineering, sciences and technology areas [4,5]

The College of Engineering and Computer Science (CECS) at the University of Michigan-Dearborn (UM-D) has had a very small percent of minority students enrolled in its undergraduate programs up until early part of 1990s. Although the campus is located within a close proximity of the city of Detroit, which produces the largest number of minority high school graduates in the state, the CECS did not have even a representative number of minority students in its program. A decision was made, supported by the Michigan Mandate, to increase, retain and graduate more minority students in engineering and very closely related disciplines. This paper discusses approaches used and the extent of their success or failures, and results of the College's attempts to increase retention and graduation of minority students in engineering.

### **Background Analysis and Support**

At around the time the College embarked on the plan, the University was invited to participate in a joint proposal to be submitted to the National Science Foundation for funding under the Alliance for Minority Participation (AMP, now called LSAMP) program. The focus of the AMP program was to increase and graduate more minority students in the SEM disciplines. The UM-D was one of six institutions in the coalition that participated in the program, which was funded for a period of 5 years beginning in 1995.

Prior to this funding and as part of the initiative to increase and retain minority students in engineering, the author of this paper conducted an in-depth investigation of engineering students' academic success. Since resources available for the initiative were very meager (except for funding from the AMP program) it was imperative that the investigation lead to specific areas in the process where we could focus our efforts and get the best return. The investigation focused on analyzing transcripts of several hundred students who entered as freshman over a three-year period beginning with the Fall 1992 cohorts. All entering freshman are required to take math and composition placement tests prior to their first enrollment. Students are then required to enroll in math (and composition) course depending on their placement level. Table 1 shows placement levels of minority and non-minority freshman students over the 3-year period.

**Table 1**  
**Math Placement Level of Freshman Cohorts**

Year of Entrance	Entering non-minority freshmen who placed at or above pre-calculus (Math 105), %	Entering minority freshmen who placed at or above pre-calculus (Math 105), %
1992	84	44
1993	80	38
1994	82	40

Although the absolute number of minority students in the sample was small compared to the other group, it became clear that a large percent of minority students were not prepared to enroll in pre-calculus and, hence, had to take a lower level math course in algebra (The Math department offers courses in algebra for students who are unprepared to enroll in pre-calculus.). Preparation of minority students for college level courses has been the subject of several reports [6-8]. A further analysis of students' performance data revealed that their success in the first two calculus courses and at least the first course in physics were almost essential to their retention and subsequent graduation.

Most of the students who were successful in Calculus I and II at their very first attempt were found to be in good academic standing (G.A.S., means they were not on any type of academic probation) a year later. This was the case for all students irrespective of their ethnicity, background or nationality. Even those who succeeded in Calculus I and II after two attempts were in a much stronger position academically a year later, as shown in Table 2.

**Table 2**  
**Students' Academic Standing after Calculus I and II at 1<sup>st</sup> and 2<sup>nd</sup> Attempts**

Year of Entrance	Students in G.A.S after passing Calculus I & II after 1 <sup>st</sup> attempt, %	Students in G. A. S. after passing Calculus I & II after 2 <sup>nd</sup> attempt, %
1991	85.0	73.5
1992	87.0	71.0
1993	86.5	74.0

Table 2 shows that a significant percent of students were in good academic standing even after passing calculus courses in two attempts. The corresponding numbers for students after the 3<sup>rd</sup> attempt were much lower. Interviews with then current students showed that success in the first two calculus courses was indeed important for the student's subsequent success in engineering programs.

### **The Summer and Academic Year Programs**

Based on the above analyses a summer bridge program in was designed. The major component of the program was an intensive course in mathematics designed for students who were placed at or below pre-calculus level during their math placement tests. The 4-week, daily classes included instruction in mathematics at algebra and pre-calculus levels, group learning activities, collaborative problem solving sessions, and periodic quizzes and tests. The bridge program was offered free to all newly admitted minority students. Incentives were offered to encourage the target group of students to participate and complete the program. These included

- Free tuition to eligible freshman students.
- Students were encouraged to retake the math placement test upon completion of the 4-week program.
- Those students who placed in a higher-level math course were allowed to enroll in that course commensurate with the placement test results.
- Those completing the program were offered academic scholarships, funded by AMP program. These students were called AMP scholars.

**Table 3**  
**Students' Performance in Math Placement Test after Summer Bridge**

Year of Entrance	No of AMP Scholars	% Students who improved by two levels on placement	% Students who improved by one level on placement	% Students who did not improve their math placement
1995	14	35.8	50.0	14.2
1996	13	30.8	53.8	15.4
1997	15	26.7	53.3	20.0
1998	13	23.1	53.8	23.1
1999	13	15.4	61.5	23.1

At the completion of the bridge all participants were strongly encouraged to take the math placement test over again. The implementation of the second placement test was to assess impact of the bridge program on students' learning. Table 3 shows participants' performance after completion of the bridge program. Most of the students who participated in the summer bridge program improved their math competence and strengthen their skill. However, not all students who placed in a higher math course elected to take the higher-level course in the semester. What was more important to bridge participants was the fact that the 4-week program and their subsequent performance on placement test gave them the confidence needed to tackle difficult courses in math, physics and engineering in subsequent semesters.

These students, along with other minority students in the College, were tracked as they progressed through the system. The students were classified into three groups: AMP scholars (defined earlier), AMP participants (those who did not participate in the bridge program but participated in academic and support services provided during academic year) and other minority students (O.M.S.) who were those students who did not participate in any of the activities offered by the program. All AMP participants were awarded some scholarship money to assist them in their academic expenses.

To assist students in their academics, the program offered tutoring and other support related assistance. These included:

- Group tutoring in key courses such as calculus I and II, physics and some of the freshman and sophomore level courses in engineering and computer science.
- Group meetings by AMP Program Director and Director of engineering advising office with all students at least twice during each semester.
- Academic evaluation of each student at the end of each semester during the first three semesters
- Assistance in getting co-op or internship positions during summer or academic terms.

Depending on their course selection all students receiving AMP scholarships (all AMP scholars and AMP participants) were required to seek tutoring and participate in at least some of the above activities. This was a requirement for scholarship eligibility during the first two years.

**Table 4  
Graduation or On-Track to Graduate Data**

Year of Entry	AMP scholars	AMP participants	O.M.S. participants	AMP scholars graduated or on-track to graduate, %	AMP participants graduated or on-track to graduate, %	O.M.S. participants graduated or on-track to graduate, %
1995	14*	10*	8	50	40	25
1996	13*	12*	10	53.8	41.7	20
1997	14*	10	10	50	40	30
1998	13*	11*	9	46.1	36.4	22.2
1999	13	10*	10	53.8	40	30

\* Some of the AMP scholars and participants changed their major (to business) after their freshman year.

Tracking of all minority students showed that the summer bridge program had the most positive impact, followed by the academic year support activities, as shown in Table 4. Even though the retention and graduation rates of minority students is still below those for the non-minority, it is much better than the corresponding numbers before the implementation of summer bridge and academic year activities. In fact, the University of Michigan-Dearborn was cited by NACME as one of the top 20 engineering schools in the country with high retention of minority students in

engineering [9]. Because of the success of the bridge program, the College has continued to offer it every summer even though the NSF funding for the AMP program ended several years ago. The current program is funded through corporate grants and support.

## Conclusions

The implementation of the summer bridge program in mathematics and other academic activities during the year, such as group tutoring and collaborative learning, had a very positive impact on the retention and graduation of minority students in engineering. The bridge program not only strengthened student' competence and skills in mathematics but also resulted in building confidence in students. Those students who successfully participated in the bridge had higher retention and graduation rates than those who did not participate in any of the activities offered by the program. We believe the summer bridge and academic year activities were key to the improvement in minority students' performance. For these reasons, the program is now institutionalized.

## References

1. Engineering Workforce Commission of AAES, "Engineering and Technology Enrollments", 1995, 1998.
2. Engineering Manpower Bulletin, Engineering Degree Trends, No 115, AAES, Washington, D.C., 1991.
3. Engineering Manpower Bulletin, Minorities in Engineering, No110, AAES, Washington D.D., 1991
4. Landis, R., Retention by Design: Achieving Excellence in Minority Engineering Education, NACME, Inc., New York, 1991
5. Campbell, G., et al., "Minority Graduation Rates," NACME Research Letter, Vo. 2 (2), 1991.
6. Snyder, N., and Bowman, B., "Improving the Pre-Engineering Education of Low-Income Minority Youth: Lessons from a Demonstration Project," ASME Tech. Soc. Publ., Vol. 2, 1-6, 1989.
7. Baker, G., "Pre-College Preparation of Minority Students for Careers in Engineering," Trans. of the American Nuclear Soc., Vol. 46, 35-36, 1984.
8. Das, M., "Novel Summer Camp for the Underrepresented Minority High School Students," Proc. ASEE Annual Conf., Washington, D.C., 1997.
9. Engineering Institutions Ranked by Minority Retention Rates and Relative Retention Index, NACME Research Letter, Vol. 4, 1997.
- 10.

## Bibliographical Information

Keshav S. Varde is a Professor of Mechanical Engineering and the Associate Dean of the College of Engineering and Computer Science at the University of Michigan-Dearborn. His area of expertise is in thermal sciences, more related to automotive power systems including combustion engines, exhaust emissions, alternate fuels and power systems. As the Associate Dean of the College he is responsible for the finance and management of several academic and research programs and operations in the College. He was the Principal Investigator on the NSF funded AMP Project and is the Principal Investigator on the NSF/DAPCEP ITEST Program for Pre-College students.