

## **Providing a More Complete Preparation for Engineering Students in a Minority Hispanic Institution**

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### Abstract

It is necessary to help preserve standards of quality in our society through education to maintain safety and integrity. The University of Texas at El Paso (UTEP) is the second largest Hispanic institution in the United States. Over 67% of its approximate 15,000 students are underrepresented minorities and an estimated two-thirds are the first in their families to attend college. Because of the necessity to work to finance their college education, more than 70% of the students believe that it will take them six years to complete the bachelor degree. In this paper, the authors initially present and discuss data on educational trends in Hispanic society. Then, the authors present the University's Model Institution for Excellence (MIE) system, which has increased student retention rates in the science and engineering disciplines. The authors then propose to extend the Accreditation Board for Engineers and Technology outcome assessment process adopted by the University and the present MIE activities to include interaction with the K-12 community and UTEP faculty and administrators, in addition to UTEP students and their families. With these efforts, the authors believe that students will obtain a more complete preparation for the demands required by industry and graduate schools.

### I. Educational Trends in Hispanic Society

During the 1998-2008 period, employment in Science and Engineering (S&E) occupations is expected to increase at almost four times the rate. Within engineering, electrical engineering is projected to have the biggest absolute and relative employment gains up by 26%. Civil and mechanical engineers are also expected to experience above average employment gains, with projected increases of about 21% and 16%, respectively. Employment for all engineering occupations is expected to increase by an average of approximately 20% <sup>6</sup>.

The trend of increasing enrollment in undergraduate programs by underrepresented minorities (including black, Hispanic, and American Indian/Alaskan Native students) has persisted for more than a decade and continued in the 1990s. Black enrollment increased 3% annually from 1990 to 1996. In the same period, Hispanic enrollment in higher education increased at an even faster rate

(7.7% annually). The stronger growth has been among Asians/Pacific Islanders (8% annually)<sup>6</sup>. In the case of Hispanics, information presented by the National Science Board suggests that they are likely to earn engineering degrees from universities in regions of the country where they are most concentrated: Arizona, California, Florida, New Mexico, Texas, and Puerto Rico.

In general, the number of earned bachelor's degrees has been increasing in the social and natural sciences and decreasing in engineering, computer science, and mathematics. One of the specific concerns recently discussed in the "Women, Minorities, and Persons with Disabilities in Science and Engineering" report by the National Science Foundation is the declining numbers and percentages of minorities enrolled in engineering programs. Minority (Asian, black, Hispanic, and American Indian) full-time first-year undergraduate enrollment in engineering decreased 5 percent from 1992 to 1996. Furthermore, the study indicates that black and Hispanic students are less likely than white and Asian students to complete a bachelor's degree in any field within 5 years. For example, 48% of whites, 47% of Asians, 34% of blacks, and 32% of Hispanics who entered a bachelor's degree program in 1989 had earned their degree by spring 1994. Thirty-seven percent of both black and Hispanic students, compared with 27% of white students and 26% of Asian students, had earned no degree and were no longer enrolled toward a bachelor's degree after 5 years. Other research confirms that older students, working adults, part-time students, and minority students have higher dropout rates than other groups<sup>2</sup>. These studies affirm the importance of developing programs to retain freshmen and upperclassmen minority S&E students.

Underrepresented minorities have showed continual steady progress in increasing graduate enrollment. However, there has been limited progress for minorities in S&E graduate programs. In the case of the Hispanic population, there is a large amount of data that demonstrates underrepresentation by almost an order of magnitude of the people earning a doctoral degree. Figures 1 & 2 indicate the trend of the last 10 years of the ratio of Hispanics of those being granted Ph.D.'s in science and engineering and the resident Hispanic population in the U.S.<sup>7</sup>.

For instance, data indicates that only about 2% of Mechanical Engineering (M.E.) Ph.D. recipients (U.S. residents and citizens) in 1999 were Hispanics. The percentage of Hispanics with regard to total Ph.D.'s granted, which includes all foreign students, is only about 1%. Over the last 10 years, an average of 9.2 Ph.D. degrees were granted per year in M.E. to Hispanics who were either U.S. residents or citizens. Of this number, only 2.1 degrees were granted to Hispanics of Mexican descent. This data compares to an average number of 112.8 granted to resident and citizens of Asian descent and 22 to individuals of Afro-American descent<sup>7</sup>.

The University of Texas at El Paso (UTEP) is a national leader in science, engineering, and mathematics (SEM) education, providing instruction to approximately 2,000 minority SEM majors annually. Over the past five years, SEM minority enrollment and degree production at UTEP have grown by about 33% at the undergraduate level and 50% at the graduate level, at a time when national data indicate a continuous decline in total undergraduate SEM degree production. Since UTEP is one of the leading universities in the country producing Hispanic

engineering graduates, then UTEP must take a stronger role in providing a more complete academic preparation for the Hispanic community.

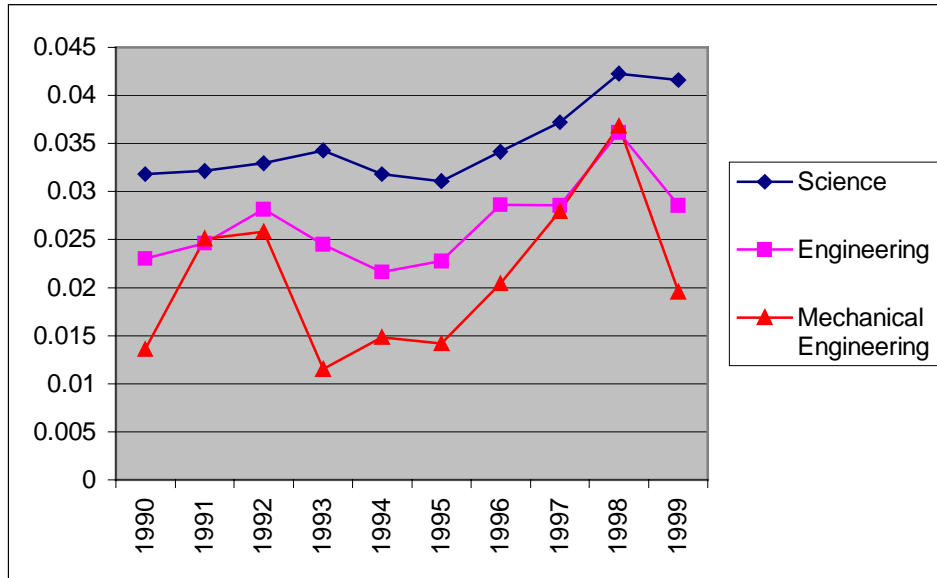


Figure 1. Ratio Between Hispanic and Total U.S. Resident Doctorates Awarded (1990-1999)

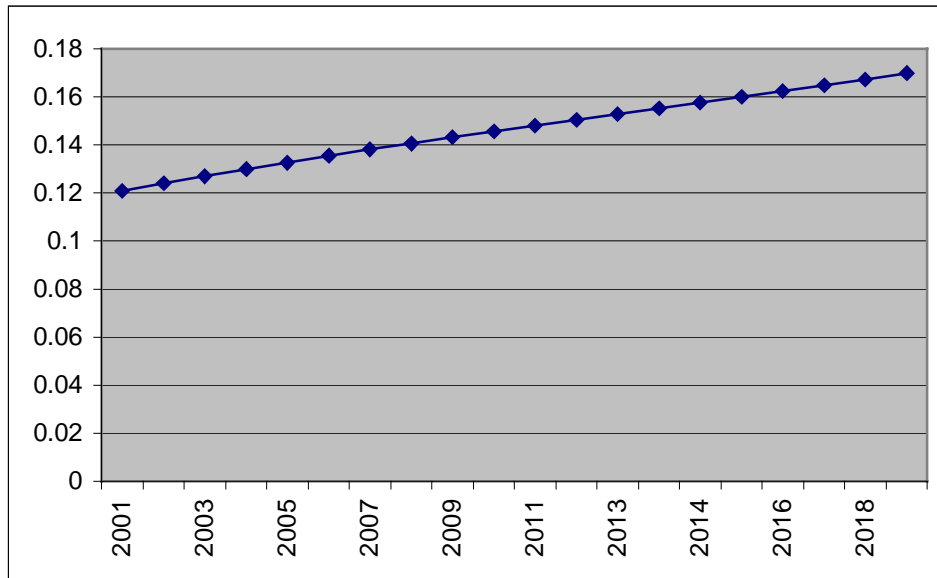


Figure 2. Projected Ratio of the Hispanic U.S. Resident Population to the U.S. Population

The University of Texas at El Paso is the second largest Hispanic educational institution in the United States. Over 67% of its approximate 15,000 students are underrepresented minorities, primarily Hispanic, and an estimated two-thirds are the first in their families to attend college. First-generation students are usually uncertain about their careers and university demands. Parents and family members may also be uncertain about university requirements. At UTEP, a significant proportion of minority and non-minority students arrive at the university inadequately prepared to do college-level work, particularly in mathematics. Because many UTEP students find it necessary to work to finance their college education, more than 70% of UTEP students believe that it will take them six years to complete the bachelor degree (72% of UTEP students responding to a campus-wide survey administered in Spring 1994 reported that they are employed, usually off-campus, with 42% reporting that they worked more than 19 hours per week)<sup>10</sup>.

## II. University's Model Institution for Excellence (MIE) System

The University of Texas at El Paso implemented the MIE program in 1995 to increase student success in science and engineering. Since its inception, student retention rates have increased in S&E. The principal current components of this program are<sup>10</sup>:

- The SMET Entering Student Program It is a mandatory orientation, advising, and first year academic program for all incoming students who have indicated an interest in pursuing a career in science, mathematics, engineering, or technology (SMET). The goal of the program is to increase the retention and success of all freshmen SMET students. It consists of an academic program that combines courses in English, mathematics, and critical inquiry. The Summer Transition Program also provides special programs for parents, familiarizing them with the University and the demands of college life.
- The Academic Center for Engineers and Scientists (ACES) It is a student support center which provides tutoring, study resources, general advising, and other key services for the academic success of a largely commuter SMET student population.
- The Center for Effective Teaching and Learning (CETaL) It is a faculty development center that promotes scholarly teaching and educational research across campus.
- The Research Experiences for Undergraduates (REU) Program It is a major component of an effort to track talented undergraduates into graduate school by encouraging them to pursue research opportunities and professional internships.
- SMET Curriculum Reform It is an effort that encourages faculty to adopt active learning strategies in the classroom, and revamp course content and student performance assessment techniques.

The MIE program is evaluated continuously to determine if the project's goals, objectives, and innovative activities are being met. If some of the proposed activities need adjustments, then evaluations show where the expected sequence of steps break down and suggestions are made to improve the program.

### III. Proposed Activities/Recommendations

The authors propose to extend the Accreditation Board for Engineers and Technology (ABET) outcome assessment process, adopted by the College of Engineering, to include interaction with K-12 faculty, students, and their families. The outcome assessment from a given course provides feedback to prerequisite courses. Most of the feedback comes from a pre-test administered in the first or second week of classes. The feedback helps faculty to emphasize certain material and/or focus on specific concepts that will later become the foundation for applications and/or for different courses. In the same way, we can provide K-12 administrators and faculty the results obtained from the outcome assessment process conducted in basic engineering and mathematics courses. This feedback can help the K-12 educational system to emphasize fundamental concepts and tools required for a higher education in engineering.

Furthermore, the authors strongly support the University's current MIE system programs. In order to provide a more complete preparation for engineering students and their families at UTEP, the authors propose two major complementary activities. The following interrelated activities are proposed to complement present MIE programs and are centered on the needs of the El Paso community, students, families, and faculty. We propose 1) the development of informational activities, such as, the development of websites and workshops to inform the community on college preparation and opportunities, and 2) the development of scholarship activities. These activities are illustrated in Figure 3.

#### a) General Informational Activities

Several studies conclude that the most common reasons for students to leave school are lack of pre-college academic preparation and financial aid<sup>1,2,3</sup>. Studies show that only 6% of minority students graduate from high school with a math-science sequence to enroll in engineering programs.<sup>4</sup> However, more high school minority students than nonminority students express an interest to seek careers in the science and engineering fields.<sup>4,9</sup> But many minority secondary schools do not offer mathematics and science classes that will prepare students for a higher education. The National Action Council for Minorities in Engineering (NACME) supports establishing national mathematics standards that will require schools to develop advanced placement mathematics courses.<sup>9</sup>

Research also shows that students who need to complete remedial courses prior to attending college may become discouraged, experience difficulty in academic courses, or drop out of college<sup>2</sup>. On the contrary, research studies support freshmen first-year programs to educate students on effective study skills and college expectations to increase student retention rates<sup>2</sup>.

Therefore, it is important to educate families and students on K-12 academic preparation for college. Many students arrive at UTEP ill-prepared to take mathematics classes such as calculus, a major course required by engineering and science departments. Also, many engineering students arrive at UTEP enrolling in pre-calculus classes, which adds at a minimum an extra semester to

their engineering degree program. As a result, we suggest early intervention in a student's primary and secondary education. We recommend developing workshops for the El Paso community to discuss students' K-12 academic preparation and university academic requirements, as well as, issues in retention for university students. Now more than ever, universities and K-12 schools need to work together to prepare students for higher education.<sup>12</sup> Many universities across the nation have partnered with primary and secondary schools to create summer bridge programs for teachers and students.

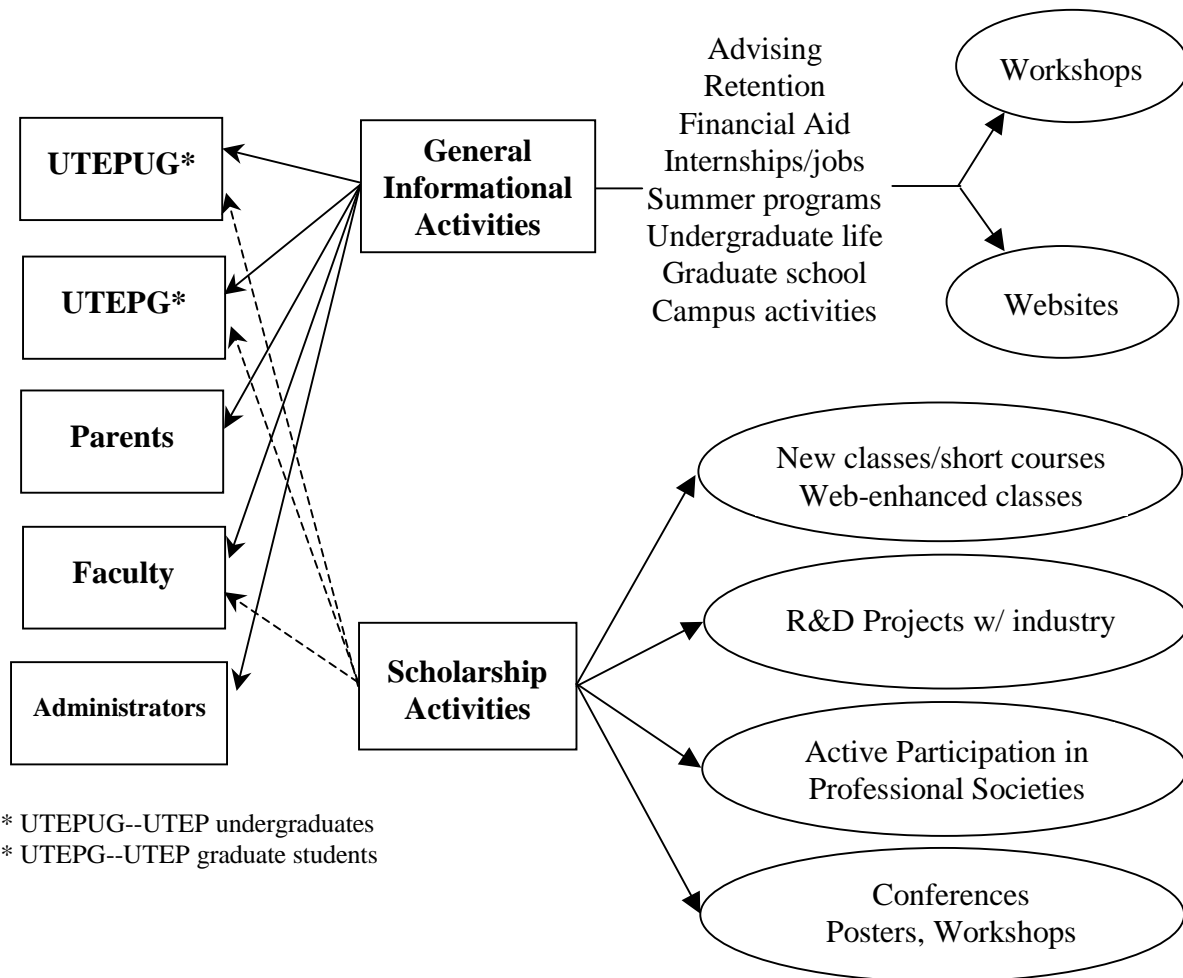


Figure 3. Proposed Complementary Activities and Participants

In addition, we propose to create workshops to inform the community about the opportunities offered by a college education and the demands required from a university. For example, Georgia Institute of Technology offers its pre-freshmen minority students a summer program where they discuss issues related to high academic achievement, job possibilities, and university and student expectations. Parents are also invited during the orientation process to learn about these expectations so that both parents and students are aware of the demands required by a university.<sup>5</sup>

NACME plans to develop a national public service advertising campaign to educate the public about issues related to a higher education.<sup>4</sup> Since many of UTEP's students are first-generation college students, parents may not fully appreciate the value of a higher education. These parents may be less informed about the process and be less able to guide and support their children during their college education. In fact, research shows that first-generation students have higher attrition rates, whereas students who have a parent who earned at a minimum a bachelor degree are more likely to complete college<sup>2</sup>.

Studies have shown that students employed full-time generally take fewer courses per semester, which leads to a greater probability to dropout of college<sup>2</sup>. As mentioned previously, many UTEP students are employed more than 19 hours/week and are full-time students. Many hold jobs to financially support their college education. Research shows that a varied financial aid package proves to be more effective than a high accumulation of loans<sup>2</sup>. As a second recommendation, we propose developing workshops to make families and students aware of the various types of financial assistance available to them, such as federal and state grants, privately funded scholarships from foundations, individuals, and corporations, work-study, subsidized loans, internships, and institutionally funded financial aid awards. In this manner, we hope fewer students will seek a part-time or full-time job off-campus and dedicate more time to their undergraduate career.

In parallel, we also propose developing workshops to inform students of the benefits of securing a summer internship or attending summer programs in their field of study. For many engineering students, summer employment in industry leads to many benefits, such as gaining practical experience, networking, and a probable job offer after graduation. Most importantly, students are incorporating their learned skills into a broader knowledge base and this application reinforces their experiences and studies in the classroom. Summer programs provide similar benefits and also add extra components to the student's career, among them, exposure to research and to a continuing education in graduate school.

Furthermore, we would also like to encourage faculty and administrators to increase the promotion and awareness of graduate school. Currently, the university holds a Graduate School day workshop to inform students of the opportunities offered through a graduate degree. We would like to encourage faculty to develop more research positions for undergraduates to enhance their undergraduate experience and to help them learn about conducting research in graduate school.

Most of the aforementioned activities should also be available to students from websites. We strongly suggest involving departments to develop websites containing information on upcoming conferences, scholarships, employment and graduate school opportunities, and on summer programs, to name a few. In this manner, students can access information more easily.

## b) Scholarship Activities

To provide a more complete college education for engineering students at UTEP, we also propose creating and supporting scholarship activities which include 1) developing short courses, web-enhanced classes, and new classes, 2) increasing research and development (R&D) projects with industry, 3) increasing and encouraging active student participation in professional societies, and 4) developing student conferences and workshops.

First of all, we suggest developing new classes and short courses in specialized areas to provide students with a more competitive edge in industry and/or with a better preparation for graduate school. The objective of these courses is to enhance students' skills and allow students to experience the latest tools and software. Such classes and short courses include programming classes and finite element analysis classes. Short courses will be created as demanded by classes. For example, if a certain application/software needs to be learned by students, then the short course will be offered. Consequently, professors may be able to spend more time on class material instead of teaching software usage to students. In addition, professors can introduce their students to more software applications since their students will now have the available resources to learn these tools. For example, Rice University offers short courses to learn about Matlab, Unix, and Windows, tools that students will use during the course of their undergraduate or graduate career.

We also propose increasing R&D projects with industry. In order to establish a research philosophy in local industry, we propose writing grants to match support for students acquiring projects from industry. In this manner, we plan to involve more students in research and in developing the needs of industry. Students will be able to apply their skills learned in school and obtain a more concrete representation and connection of material learned in school. Furthermore, these research projects may aid those students wishing to attend graduate school to learn more about conducting research.

An important aspect in a student's career is his/her involvement in professional societies. We recommend increasing the involvement of students in professional societies, and we encourage students to be active in activities such as industrial/plant tours and local and national competitions. These activities will help the student to learn more about his/her profession and become a leader in his/her career. Through industrial tours, students will become more aware of various applications in their field and technical problems industries face. This activity might lead to developing R&D projects with industry providing the student with experience. Competitions will foster a student's ability to work in a team, which is much a part of the real-world working experience, and will enhance his/her social skills.

Research studies confirm that involvement in campus communities strongly correlates with student retention and completion<sup>3</sup>. Therefore, we propose developing conferences, workshops, and poster presentations to attract more students to attend on-campus activities. We recommend having guest speakers from academia and industry to present talks in new areas of research or new



developments in software/instrumentation. Through poster presentations, students can present their research work and share their research experiences with the campus community and thus attract more students to be involved in research and to have more discipline in their studies. These activities will also directly help the student (the presenter) to develop more confidence in himself/herself and to enhance their presentation skills.

#### IV. Conclusions

The University of Texas at El Paso, among other institutions, has taken the lead to improve the existing gross under representation in leading roles of the community that it serves. It has created programs for faculty and freshmen engineering students through the MIE system. Now, we would like to expand this effort by proposing the development of several informational and scholarship activities for the El Paso community and for UTEP students and faculty with the goal of increasing the retention rate of engineering students at UTEP and producing leaders in industry and graduate school. The proposed and present programs not only provide a more complete preparation for engineering students but also can be extended to specific programs or to other minority institutions. In fact, most concepts can be adapted to target different student populations and can be introduced to existing programs. With the efforts presented in this paper, the authors believe that students will obtain a more complete preparation for the demands required by industry and graduate schools.

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