

2006-1359: SUCCESSFUL UNDERGRADUATE SUMMER RESEARCH EXPERIENCE FOR MINORITY STUDENTS

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Successful Undergraduate Summer Research Experience for Minority Students

Abstract

Minority student enrollment in engineering graduate programs continues to be a challenge especially among Hispanics. A relatively small number of Hispanics in undergraduate engineering programs decide to continue their education once they receive a bachelor degree. An array of factors affects each the student decision making process and commitment to pursue advanced degrees. Fortunately, many top ranked universities in the US have outreach summer programs to help guide undergraduate students through the unpredictable world of graduate studies. Unfortunately, many minority students do not know these programs exist nor know how to fully take advantage of the unique opportunities they offer. Outreach programs should have a strong marketing component to be completely successful.

One successful way to increase minority participation in undergraduate summer programs is by active participation and involvement of faculty members at both ends of the outreach program. In this paper, a successful approach used in the recruiting of minority students is presented. The approach consists in networking faculty members at top ranked universities with faculty at minority serving institutions, who can help identify potential students. Once minority students are invited to participate in a particular undergraduate research program, the designated faculty should closely monitors the students' performance. In a typical outreach program, students are quickly introduced to an interesting research project and asked to perform a variety of tasks and activities similar to the ones assigned to any regular graduate students. They include literature search and review, organization and selection of research ideas and results, and development and implementation of a research plan. Students are highly encouraged to be self-reliant, innovative, highly motivated, organized and methodical which are necessary characteristics of any successful graduate student in graduate school. In the paper, a specific case study is presented, which discusses the importance of assessing the students abilities and skills early in the program to ensure successful completion of the research program objectives. Finally, a list of successful outcomes and recommendations are presented.

Introduction

Recruiting and retention of minority students in engineering programs continues to be a major challenge in the US. According to the latest statistics, the percent of engineering graduate students who belong to underrepresented groups continues to be well below of the national average. As a result, aggressive outreach programs have been set up around the country to counteract this negative trend. One way to promote the recruiting and retention of underrepresented groups or minorities in engineering graduate programs is by engaging potential students early in their undergraduate education. Undergraduate research experience of short duration can certainly change the students' perception about graduate studies in a positive way.

In this paper, the results of a successful undergraduate summer research experience are presented and discussed. It includes one specific instance where a Hispanic student from a minority-serving institution was invited to participate in the Texas A&M University Undergraduate Summer Research Grant (USRG) program. As part of the program, the student had to undertake a new research project which he had to successfully complete in a period of ten weeks.

Background

Undergraduate research experience in engineering as a tool for promoting interest in graduate school has been discussed, proposed and used in the past rather successfully¹⁻³. Several major academic institutions in the United States have set up outreach programs to facilitate the student's transition to graduate school. Specific examples include the Women Engineering Program (WEP) at the University of Texas at Austin⁴, where female students successfully participate in an outreach program designed to encourage their eventual participation in graduate education. Other institutions encourage the participation of undergraduate students in research activities under the supervision of a faculty member⁵. Purdue University, on the other hand, has an outreach program that puts special emphasis on the students' ability to communicate technical information⁶. Others have even developed programs where students from different institutions collaborate on a common project⁷.

Other successful undergraduate research experiences have also been reported recently⁸. However, few examples of undergraduate research experiences or opportunities as mechanisms to attract, recruit or promote interest in graduate studies among minorities have been reported. This paper presents a successful approach which has been implemented to involve minority students in undergraduate research which promotes their interests in graduate education.

Description of Minority Outreach Program Approach

Texas A&M University every summer invites in-state and out-state engineering students to participate in the Undergraduate Summer Research Grant program (USRG). The program targets potential students including those who belong to underrepresented groups in engineering. The program pays for travel expenses and provides an allowance which can be used to offset room and board expenses. The program also brings together top-ranked researchers with minority students. This offers the students an unparalleled opportunity to experience first hand the "nuts and bolts" of ground-breaking and fascinating research projects.

Unfortunately, the USRG program is not very well known by many undergraduate students around the US and requires an active participation of faculty members as well as administrators. Regrettably, a significant number of faculty members at Texas A&M University are not fully aware of the program and its advantages. The College of Engineering at Texas A&M University is making a concerted effort to keep the

appropriate funding level to ensure sufficient faculty members participate in the program. On the other hand, the program has been successful in attracting minority students which have made up to 20% of all the participating students in the last few years. One way that the program can have a greater impact among minorities is by making sure that faculty members at Texas A&M University contact their colleagues at leading minority institutions to start the recruiting process. Figure 1 shows how the recruiting process was recently coordinated between a leading minority institution and Texas A&M University in 2005. The recruiting of an undergraduate student interested in undergraduate research activities was coordinated at the lowest level: faculty-to-faculty. This provided a unique opportunity to select a research topic of interest for both faculty members and the student well in advance.

As part of the coordination process, the faculty member at the leading minority institution agreed to let potential applicants know about the USRG program and discussed possible research topics before the students applied. From that point on, it was the sole responsibility of the applicant to apply, Figure 1, and to specify a potential faculty member and mentor at Texas A&M University. Given the nature of the faculty-to-faculty interaction, the applicant was informed of all the potential topics and available mentors before the application deadline. Once potential students applied, it was up to the administrators of the USRG program to grant admission to the program based on specific requirements. None of the faculty involved in the identification of potential minority students was involved in the admission process. Their only role was to encourage students to apply for the program. However, the faculty at the minority institution was actively involved in convincing students to participate in the program. The students who were encouraged to participate had shown enthusiasm, ability and dedication in their field of study.

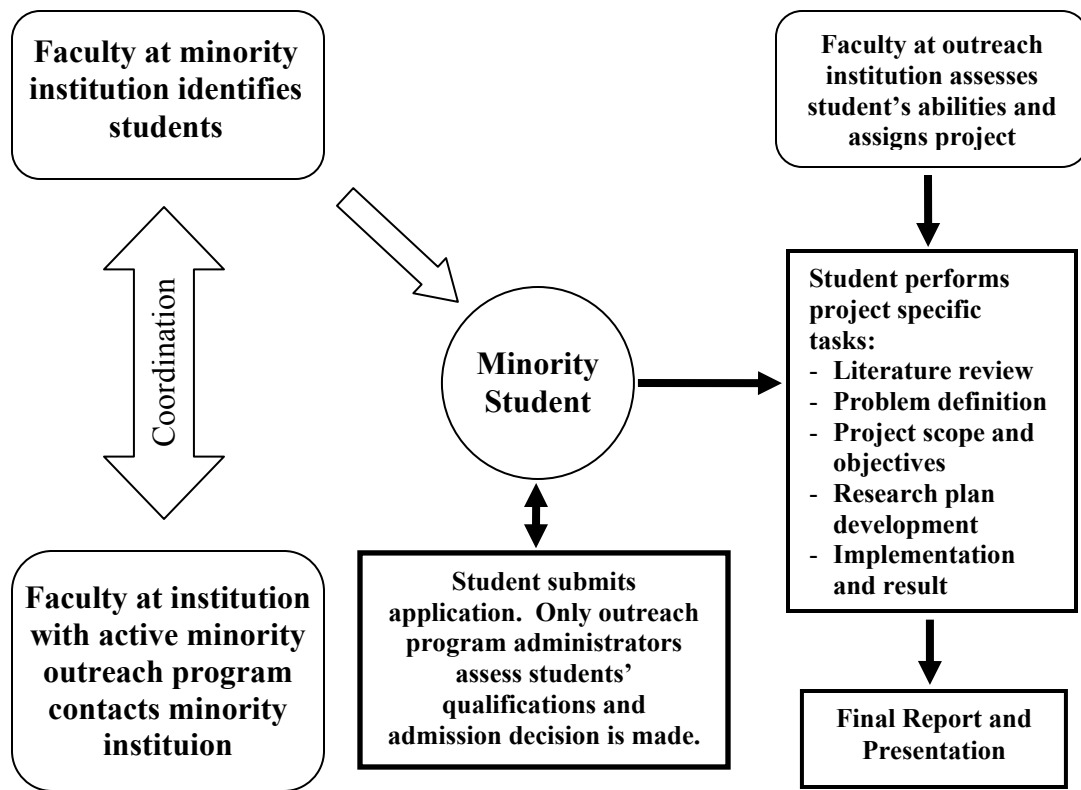


Figure 1. Faculty-to-faculty minority student recruitment process

Once the USRG administrators made their selections, the faculty member at Texas A&M was informed and asked to start developing appropriate research topics and tasks for the upcoming summer students. At this point, both faculty members brainstormed specific research ideas and tasks that could be handled almost independently by undergraduate students in a period of 10 weeks. Research project ideas were selected based on the following criteria:

- Level of difficulty
- Cost of components/equipment
- Availability of facilities
- Student expertise or knowledge in specific areas

Only research project ideas that met the above criteria were further refined and studied in more detail. Once the minority students arrive at Texas A&M University, they were presented with project ideas. At this point, the mentor had to gauge each student's ability to tackle the proposed project based on his or her level of expertise, and type and number of courses taken. Once a project idea was assigned to each student, the students had to perform the following tasks:

- Literature review of specific research idea
- Problem definition and significance of proposed research idea
- Project scope and objectives
- Development of detailed research plan
- Implementation and result

Each task is described below:

Literature review of specific research idea

Each student was asked to conduct a library-based literature review for the proposed research idea. The student was trained by a graduate student on how to use the university library resources to facilitate the review process. The student was also asked to write synopsis of each article of interest. This particular activity facilitated retention of new material, concepts, findings and results.

Problem definition and significance of proposed research idea

Once the student read all the important articles, he or she was asked to re-define the research idea or problem based on what he or she learned during the literature review process. The student was also required to clearly indicate the significance of the new idea and how it could be used to bring to light important benefits or even a better understanding of a specific phenomenon.

Project scope and objectives

Once the student understood the research idea and its ramifications, he or she was asked to propose and elaborate a project scope and a list of objectives. A graduate student assisted the student in the formulation of both items before making a formal presentation to the advisor (mentor).

Development of detailed research plan

The student developed a detailed research plan with the assistance of the advisor. The student had to make a concerted effort in planning the required activities to make sure that they were essential components of the overall effort. The student was asked to draw conclusions from previous studies too. However, the mentor also played a significant role in the development of the research plan to expedite the overall effort.

Implementation and result

Once a detailed research plan was at hand, the student quickly proceeded with the planned activities including construction, assembly or installation of laboratory equipment. A graduate student provided assistance when necessary but it was the sole responsibility of the undergraduate student to implement the research plan. The undergraduate student also ran the experiments, made findings, and reported on the experimental results.

The steps outlined above helped the undergraduate student fulfill the expectation of the program. They also fully exposed the student to the different facets of graduate school in a way that the student was able to grasp and enjoy.

Case study

Undergraduate summer student from the University of Puerto Rico

In the early spring of 2005, an assistant professor in the Department of Engineering Technology and Industrial Distribution at Texas A&M University contacted a professor at the University of Puerto Rico at Mayaguez (UPRM) with the purpose of identifying potential students for the USRG program. The professor at UPRM identified a mechanical engineering student interested in participating in USRG 2005 with the explicit desire to do research in the area of thermal sciences. The student was encouraged to submit an application.

The admission process was completely administered by the outreach program administrators and selection was based on established criteria. The student was admitted into the program which included paid travel expenses and a stipend.

Once the students arrived at Texas A&M, the mentor assigned an appropriate topic to the student after assessing the student's qualifications. The topic consisted in the evaluation of potential passive cooling strategies for residential use in tropical climates. The student, who was still a junior at the University of Puerto Rico at Mayagüez, was specifically asked to perform a literature review in the area of passive cooling for concrete roofs. Once the student gathered enough information, he created a database with all the appropriate technical data and findings. The next step consisted in contemplating variations of past technological breakthroughs. The students also reviewed publications in the area of solar cooking and drying since it involves common physical principles including solar irradiation, heat conduction, and convection. These areas were considered because they had opposite objectives and optimization goals and could illustrate the mechanisms involved in passive cooling. They proved to be instrumental in the development of a completely new idea for passive cooling of concrete roofs.

After brainstorming several ideas with the student mentor, the student wrote the problem definition and scope, and put together a detailed research plan. The research plan took

into account previous findings as well as the brainstormed ideas in a comprehensive manner.

Summer project implementation and outcomes

The student carefully followed each step of the proposed research plan and only deviated when experimental conditions or field findings indicated that corrections were necessary. The project implementation consisted in testing the thermal performance of two types of insulation systems. The student built two prototypes and measured their performances under simulated experimental conditions as shown in Figure 2. The student was responsible for fabricating the prototypes and connecting the data loggers to the different instruments.



Figure 2. Two insulation systems on top of identical structures under two 500-watt lamps

The student ran several experiments to determine the thermal performance of two insulation systems placed on scaled residential units. The result indicate that one of the proposed insulation system considerably improve the thermal performance of concrete roofs as illustrated in Figure 3.

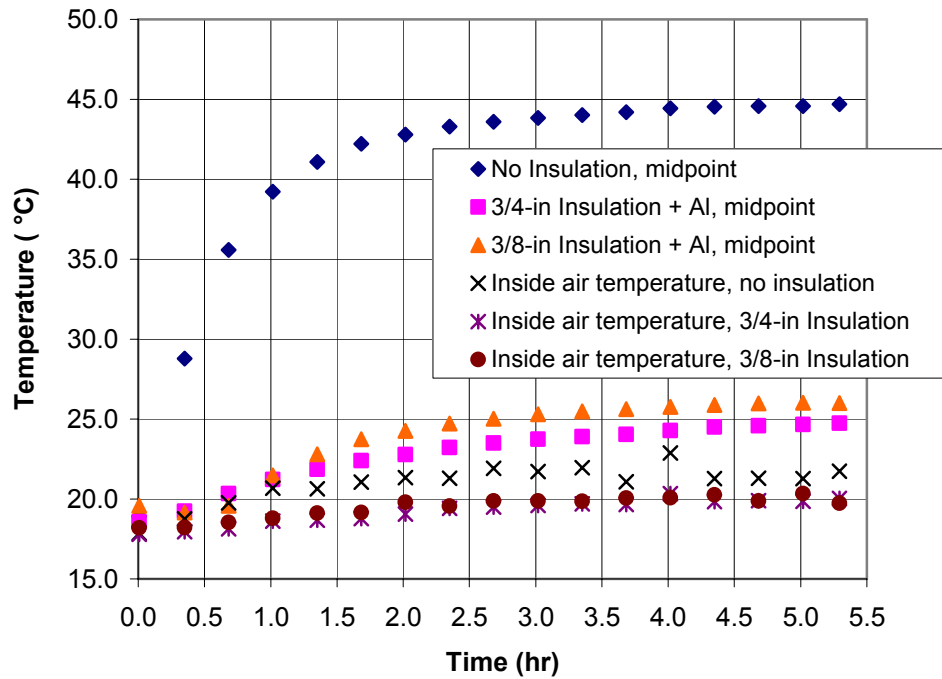


Figure 3. Concrete roof temperature with and without improved insulation system

At the end, the student learned and was able to run meaningful and intriguing experiments which he used to draw compelling conclusions. He also completed all the proposed tasks in a timely manner which was one of the main goals of the summer program. The successful project outcome gave the student a great sense of accomplishment despite his limited technical background at the time. As a result, the student is seriously thinking about applying to graduate school and taking on similar research projects. The case study also shows that undergraduate students can do meaningful research work with adequate preparation and a clear plan of action.

Minority Outreach Program Successes and Challenges

In general, Texas A&M University has been relatively successful in the recruitment of minority students. However, the percent of minority students enrolled at the university still need to increase to reflect the state demographic distribution. The USRG program has also been relatively successful from the students' perspective. Over 50% of minority students interviewed who participated in USRG 2005 has the desire or willingness to consider graduate studies in the next five years. This is indicative of the program's effectiveness in promoting greater participation among minority students. For the program to continue to be successful, more faculty members should become actively involved by networking with minority-serving institutions.

Conclusion

Recruiting and retention of minority students in engineering continues to be challenge for educators and administrators. Successful outreach programs need to continue to bring faculty members, students and other institutions together so that potential students can be informed about the different outreach opportunities and experience by themselves the meaning and purpose of graduate education. The case study presented in this paper clearly shows how faculty members can play a decisive role in the recruiting of potential students. Specifically, mentors should take an active role in the selection, training and academic goals of minority students in engineering.

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