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Research Experiences for Undergraduates (REU) in Pollution Prevention and Sustainability

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Abstract: - The College of Engineering at Rowan University has been hosting an NSF funded REU since 2001. The REU theme is focuses on Pollution Prevention and Sustainability. The project provides eleven undergraduates recruited from all over the USA to participate in a research project that focuses on engineering and science related to pollution prevention. REU activities are designed to stimulate students' interests in open-ended challenging engineering and science projects, which are mainly related to pollution prevention for a sustainable world. Key program features of the REU include individual research activities, strengthening of communication, leadership and social skills, educational fieldtrips and seminars. Research experiences expose undergraduate students to the creativity of the research process and enable them to apply their acquired knowledge from formal coursework. Active research experience is considered one of the most effective ways to attract talented undergraduates to and retain them in careers in science and engineering, including careers in teaching. Involving undergraduates in research also encourages them to pursue graduate education.

Key-Words: Pollution Prevention Sustainability Green Engineering

1 Introduction

The National Science Foundation (NSF) funds a large number of research opportunities for undergraduate students through its REU Sites program. REU stands for Research Experiences for Undergraduates. An REU Site consists of a group of ten or so undergraduates who work in the research programs of a host institution. Each student is associated with a specific research project, where he/she works closely with the faculty and other researchers. Students are granted stipends, assistance with housing and travel expenses. Undergraduate students supported with NSF funds must be citizens or permanent residents of the United States or its possessions. The major objectives of the REU program are

- *Generating* excitement among the undergraduate students by providing them with the opportunity to work on engineering issues of national and international significance,
- *Providing* undergraduate students with the opportunity to work on research projects that expose them to graduate students and graduate research,
- *Increasing* the participation in research of women, underrepresented minorities, and persons with disabilities,
- *Mentoring* undergraduate students by providing leadership roles by faculty and students,
- *Exposing* a broad and interdisciplinary group of undergraduate students to the scientific method used in creation, investigation, and documentation of a research project, and
- *Encouraging* undergraduates (especially those from underrepresented groups) to **pursue advanced degrees**.

The Rowan University College of Engineering has a brand new engineering building, including state-of-the-art equipment and computer resources, and a dedicated and extremely competent faculty. Facilities such as seminar and lecture rooms, laboratories, computer rooms, audiovisual equipment and study hall space are located in Rowan University's state-of the art $28M Henry M. Rowan Hall. This newly constructed home of the college of engineering has a 92,500 sq. ft. space with multifunctional state-of-the-art teaching and research laboratories. Founded in 1923 as Glassboro State Teachers College, Rowan University has evolved

into a comprehensive regional state university with six colleges. The College of Engineering was initiated as a result of a major donation in 1992 from the Rowan Foundation (Rowan and Smith, 1995). The engineering faculty use innovative methods of teaching and learning to better prepare students for entry into a rapidly changing and highly competitive marketplace. Key program features include: (a) creating inter- and multi-disciplinary experiences through collaborative laboratories and coursework; (b) stressing total quality management (TQM) as the necessary framework for solving complex problems; (c) incorporating state-of-the-art technologies throughout the curricula; (d) and creating continuous opportunities for technical writing and communication [1-6]. The College has four engineering programs of Chemical, Civil and Environmental, Electrical and Computer and Mechanical Engineering.

2 Rowan University REU Site

The College received NSF funding in 2001 to establish a three year REU site focusing on Pollution Prevention. A team of nine engineering faculty from various engineering disciplines participated in this REU. The faculty represented a strong diverse and multidisciplinary team. The grant allowed NSF funding of 7 students and Rowan funding for 2 students every summer with a total of 27 participating over three years. Every non Rowan REU participant was paired with a Rowan undergraduate and graduate student already working on research with REU professors through other funding sources such as industries, local and state government. This teaming helped the REU participants to have easy access to inquiries related to the campus, the campus town, sightseeing and laboratory procedures. Students stay on campus for an eight week duration.

An average of 80 applications per year was received from students both from science and engineering from all over the country. Recruitment activities included mailings (flyers, letters, emails to chairs, colleagues etc.) to all engineering universities, advertising in student newsletters, selected phone contact/visits, and a web site.

Fliers were also sent to appropriate professional organizations such as ASCE, the Society of Women Engineers (SWE), Women in Engineering Programs Advocate Network (WEPAN), the National Society of Black Engineers, the Society of Hispanic Professional Engineers, and the American Indian Science and Engineering Society. The Rowan University Educational Opportunity Fund/Minority Achievement Program (EOF/MAP) also assisted in recruitment activities by identifying institutions with a high minority enrollment. Participant selection was based on academic performance, recommendations, and research interests and goals. All application and recommendation forms were also posted on the website for easy access from the start of the REU. In 2003 we also posted an online application form on our website. *It was interesting to note that we consistently received more applications from female students. Informal discussions indicated that the theme of Pollution Prevention appealed to them and the fact that the REU had a number of female role models was encouraging. Three qualified Native American undergraduates were offered REU positions. However all were reluctant to move far from their hometowns.* Our REU was successful in attracting not only a diverse student body from reputable universities but also students from science and engineering from far away states such as California, New Mexico and Oklahoma.

3 Research Activities

Participating research faculty offer projects that focus on pollution prevention and sustainability. Typical project titles offered over the REU duration are presented in Table 1.

Table 1: REU Project Titles

Arsenic Removal in Drinking Water
BugPower: Fueling our Future with Microorganisms
Metal Removal from Industrial Wastewater
Developing "Green" Controlled Release Systems for Drug Delivery
Use of Jute in Strengthening Asphalt Mixtures
Stormwater Management in Chestnut Branch Watershed
Environmentally Conscious Disassembly of End-of-Life Computers
Chemical Kinetic Model Development and Flow Reactor Studies of Biodiesel Fuel Blends
Long-Life Smart Structures for Laser Data Transmission
Invertebrates as Bio-indicators of the Water Quality of the Maurice River
Design of Detoxifying Systems for Organo-nitriles Mediated by Cyanogenic Enzymes

Apart from participating in research activities the REU experience also provides opportunities for participants to strengthen their communication skills. Students are required to present their project results both formal oral presentations and in a written report format. Students are encouraged to present their findings at local, state and national conferences and participate in student paper/poster competitions.

4 Social Activities

Social activities are also an important part of the research experience. These activities allow the students to strengthen their social and team building skills. Activities include a picnic, trips to the Jersey Shore, New York City and Philadelphia Museum. Students are also required to watch movies that expose them to global environmental topics. Movies in 2004 included: The Whale Rider, Rabbit Proof Fence, Osama, Home and Abroad, The Bhopal Express, Mr. and Mrs. Ayyer, Erin Brokovich and a Civil Action.

5 Conclusions

The sustainability theme strengthens our REU site many ways. It has encouraged collaborative efforts between our College of Engineering and the College of Liberal Arts and Sciences. It also allows the students to perceive the multidisciplinary nature of pollution prevention research and sustainability concepts. Overall the program generates an appreciation for the need of engineering design and scientific inquiry to address sustainability for protection of the environment and future generations.

The Rowan University REU site has been highly successful in attracting a diverse undergraduate student body. REU impact and assessment indicate that undergraduate mentoring via faculty and graduate students can encourage students to pursue graduate studies. The high percentage of women applying for the REU experience is also extremely encouraging. The results indicate that institutions should integrate summer and academic research experiences for undergraduates that help them understand the importance of graduate studies and the workings of graduate school. This will help them have a more diverse graduate student body from the USA and relieve dependence on international students.

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