AC 2005-676: ESTABLISHING EFFECTIVE STUDENT-LED OUTREACH WITHIN MULTI-UNIVERSITY, MULTI-DISCIPLINARY ENVIRONMENTS

Alene Harris,

Cordelia Brown, Purdue University

Danny Le,

Ellen Chen,

Johnathan King,

Monica Cox, Purdue University

Neha Goel,

Ragu Vijaykumar,

ESTABLISHING EFFECTIVE STUDENT-LED OUTREACH OPPORTUNITIES WITHIN A MULTI-DISCIPLINARY, MULTI-UNIVERSITY ENGINEERING RESEARCH CENTER

Monica Farmer Cox, Alene H. Harris, Ph.D., Neha Goel

Department of Leadership, Policy and Organizations, Peabody College at Vanderbilt University/ Department of Teaching and Learning, Peabody College at Vanderbilt University/ Department of Biomedical Engineering, Northwestern University

Introduction

In 1999, the VaNTH Engineering Research Center (ERC) for Bioengineering Educational Technologies became the first National Science Foundation (NSF)-funded Center solely devoted to bioengineering education research. Comprised of researchers from Vanderbilt University, Northwestern University, the University of Texas at Austin, and the Health Sciences & Technology of Harvard/ the Massachusetts Institute of Technology (HST/MIT), the VaNTH ERC was created to "unite educators and engineers, in industry and academia, to develop curricula and technologies that will educate future generations of bioengineers." [1] To help accomplish VaNTH's goals, students across VaNTH institutions established an outreach component for the ERC, the Student Leadership Council.

The Need for a Student Leadership Council

VaNTH SLC engineering outreach to K-12 students is needed for several reasons. First, many K-12 teachers have not studied engineering principles, and therefore do not teach these principles in their classrooms. [2] This means that most K-12 students are not exposed to engineering concepts until they enter undergraduate engineering programs. Outreach projects initiated by SLC students, however, can expose students to the field of bioengineering early. Second, the number of minorities graduating with engineering degrees is a small percentage of the overall number of minorities entering the United States labor force. [2] This means that most minority students are not pursuing degrees in engineering. Since the VaNTH ERC's SLC is comprised of a diverse group of students, however, K-12 minority students will be involved in outreach projects led by some minority engineering students. Third, engineering outreach allows VaNTH SLC engineering undergraduate and graduate students to teach K-12 students to apply engineering principles that they themselves are being taught in undergraduate engineering classes. [3] This not only reinforces their own education, it also allows SLC students to gain experience teaching engineering at an undergraduate level with a possibility of pursuing careers in academia.

Student Leadership Council Outreach Efforts

In an effort to provide bioengineering-related outreach opportunities to both K-12 and college students, education and engineering undergraduate and graduate students affiliated with the VaNTH ERC at the four VaNTH institutions formed a student-led outreach group called the Student Leadership Council (SLC). Specifically, the responsibilities of the SLC are (1) to disseminate bioengineering awareness to underrepresented groups, local communities, and pre-college and postsecondary students and teachers via outreach projects, (2) to establish an interdisciplinary forum for students to discuss VaNTH ERC outreach, "inreach," and research projects, and (3) to connect SLC students across the four VaNTH sites.[4]

Students within the VaNTH ERC have worked with K-12 and college students in metropolitan areas near the four VaNTH universities (Nashville, Tennessee; Chicago, Illinois; Austin, Texas; and Boston, Massachusetts), and they have also partnered with teachers in other parts of the United States. In Nashville, Vanderbilt's SLC members introduced undergraduate biology students and senior high school students to graduate and undergraduate opportunities in biomedical engineering, respectively. In Evanston, Illinois, Northwestern's SLC students worked closely with students in the Chicago and Evanston Public Schools. In Austin, the University of Texas's SLC partnered with the Austin Children's Museum to inform the local K-12 community about biomedical engineering through hands-on experiences. In Boston, Harvard/ MIT's SLC students worked closely with several schools and a Boys & Girls Club.[5]

In developing science and engineering-based workshops for students and teachers and in disseminating outreach through local agencies, the VaNTH SLC developed and implemented curriculum informed by the National Research Council's monograph, *How People Learn: Mind, Brain, Experience, and School*. Materials and learning activities were designed to be knowledge-centered, learner-centered, assessment-centered, and community-centered.[6] Many of these materials have been disseminated and continue to serve as models for current materials that are being developed by students across VaNTH ERC sites.

The majority of the outreach projects disseminated by SLC students were created by bioengineering students or students closely connected to bioengineering-related fields of study. For example, at Northwestern, under the direction of a biomedical engineering professor with a Partnerships in Education (PER) supplemental grant, undergraduate and graduate biomedical engineering students helped to develop an engineering design project piloted in Chicago Public Schools. Project "Get a Grip," co-sponsored by the Center for International Rehabilitation and the Rehabilitation Institute of Chicago, allows middle school students to apply math, science, and engineering principles in the design of a below-elbow prosthesis for a disabled person living in a third-world country. This two-week project is disseminated within Chicago Public Schools three times per year. [7, 8]

At HST/MIT, under the direction of a VaNTH ERC-funded staff member, undergraduate and graduate SLC students have developed three instructional units for use within local high schools. One project, "Spacercise," is co-sponsored by the National Space Biomedical Research Institute and is used as a model for teaching microgravity physiology and engineering design within high school anatomy and physiology classes. Other projects include an Egg Drop module

that introduces students to principles of physics and a Forensics DNA Fingerprinting module that provides in-depth information about DNA testing.

Although the content of SLC outreach is bioengineering, education students within the VaNTH ERC have also contributed to outreach efforts. For example, at Vanderbilt, education students have given presentations about bioengineering resources and opportunities available at Vanderbilt to K-12 students and to students at a neighboring college. In addition, SLC students have organized forums where professional bioengineers have presented information about their careers to current biomedical engineering students. Finally, education students have partnered with an on-campus science outreach office whose purpose is to increase awareness of science and engineering. Through this office, the SLC has exposed K-12 students across the country to biomedical engineering content.

To connect students across sites, SLC members are developing a "What is Biomedical Engineering?" CD for secondary students, to be disseminated to and through high school guidance counselors and science/math/technology teachers. The goal of the CD is to increase secondary students' understanding of bioengineering-related work, to inform and excite secondary students' about bioengineering-related work, and to increase students' matriculation into bioengineering fields. Specifically, the CD will explore the applicability of bioengineering to education, business, law, medicine, and government.

SLC Outreach Effectiveness

The effectiveness of VaNTH SLC outreach across sites is noted by the positive perceptions that secondary students have of SLC-led outreach activities, the influence of SLC activities upon the career choices that students are making, the diversity of the students who have been exposed to outreach activities, and the enjoyable teaching and learning experiences that are gained by SLC students. At HST/MIT, SLC students developed a survey to assess students' perceptions of the DNA Forensics Fingerprinting unit. Initial reports find that students enjoyed the activities that are presented by SLC students. At Vanderbilt, two undergraduate students who attended an SLC student-led presentation about bioengineering applied to and were accepted to a Research Experiences for Undergraduate (REU) summer enrichment program that exposed them to bioengineering educational technologies. In addition, two minority high school students who completed an engineering practicum with an SLC engineering graduate student applied to undergraduate biomedical engineering programs.

During the pilot year of the "Get a Grip" project, students interacted with three teachers and sixth-grade students in Chicago Public Schools. Fifty-two percent of the middle school students participating in the outreach were African-American, 35% of the students were Latino, 9.6% of the students were white, 3.2% were Asian-American, and 0.2% were Native American.[4] Through their participation in this K-12 outreach, SLC biomedical engineering students at Northwestern reported that they understood the engineering design process better, honed their communication, leadership, and management skills, peaked their interest in teaching, and interacted more collaboratively with their peers. [3]

Suggestions for Effective Collaboration

Coordinating student-led projects with local schools, museums, and organizations in cities where VaNTH ERC universities are located requires the cooperation of parties inside and outside of the ERC. Internally, faculty and staff familiar with the mission and the resources of VaNTH help students form partnerships with people who are external and internal to VaNTH. A partnership with both education and engineering faculty allows students to develop outreach materials that accurately represent disciplinary concepts, pedagogical knowledge, and K-12 science and engineering educational standards. In addition, VaNTH-funded researchers and K-12 teachers within VaNTH's Research Experiences for Teachers (RET) program provide mentorship to students who also want to develop HPL-based outreach materials. Staff members provide further support to students by passing along pertinent internal e-mail and telephone contact information that might be needed by new students who are asked to spearhead outreach projects.

Although faculty and staff help students administratively, students must organize their outreach projects and must initiate contact with their local community. In the case of the VaNTH ERC, no blueprint for outreach activities was given to students. Over time, students across sites took ownership of their respective SLC groups and developed projects that represented the strengths of their universities and student bodies and fulfilled educational needs within local communities. Realizing that each site's SLC population and outreach projects could differ increased the opportunities for the dissemination of activities that could most greatly benefit the local community. For example, SLC students at MIT and the University of Texas transformed their SLCs into chartered undergraduate organizations. In this way, their SLCs could receive funding from the student government organization and could increase their visibility to students at their universities.

One similarity across all SLCs is the necessity for organization among students. Clearly developing and presenting a project's goals to local interested parties and contacts increases the likelihood that a local school or community will embrace the presence of students within their environments. Documenting outreach activities and communicating these activities across sites also increases the number of possible projects that may be disseminated across the ERC.

Challenges Across Institutions

Since the creation of the VaNTH ERC, participation in the SLC has increased across all VaNTH sites (Table 1). Maintaining a "core" group of students who oversee the organizational and administrative responsibilities for each site, the SLC has grown to include student volunteers who have embraced the VaNTH vision, have developed high quality outreach projects, and have begun the development of a VaNTH-wide project that will introduce high school students to the field of bioengineering.

	Vanderbilt University	Northwestern University	University of Texas (Austin)	Harvard/ MIT
1999-2000	6 (3 core)	1	0	0
2000-2001	7 (3 core)	3 (1 core)	3 (1 core)	5 (1 core)
2001-2002	7 (3 core)	16 (2 core)	2 (2 core)	7 (3 core)
2002-2003	7 (3 core)	33 (4 core)	15 (5 core)	32 (8 core)
2003-2004	15 (5 core)	29 (2 core)	23 (4 core)	22 (4 core)

Table 1- SLC Membership from 1999 to 2003 [5]

Despite the growth of the VaNTH SLC, challenges remain across institutions. First, tracking SLC student volunteers across sites can be difficult because of transitions in student and staff leadership. Second, simultaneous communication across sites can also be challenging because of hectic student schedules. Third, presenting the goals of the VaNTH ERC and the SLC can be difficult when students are not actively involved in the Center. All of these limitations, however, can be addressed through communication among faculty, staff, and students across all VaNTH ERC sites.

Conclusions

Since its creation in 1999, hundreds of students have and are continuing to partner with the VaNTH ERC Student Leadership Council across four universities. Engineering students within the SLC are developing and implementing bioengineering-based and HPL-influenced materials for K-12 teachers, and in some cases assisting in the teaching of these to secondary students. In addition to helping these teachers, SLC students serve as mentors for a diverse group of students. To date, SLC students have impacted the local community by introducing children and adults to bioengineering, a field that some students might have never explored as a career option. For engineering outreach projects to succeed across multiple sites and disciplines, we recommend that student outreach leaders develop projects that support the goals of a Center, school, organization, discipline, etc., and that recruitment efforts start with students who are most likely to benefit from the advancement of the discipline that the outreach promotes.

References

1. Vanderbilt-Northwestern-Texas-Harvard/MIT Engineering Research Center for Bioengineering Educational Technologies (VaNTH). Website URL [http://www.vanth.org], site visited 12/29/04.

2. Jeffers, A.T., Safferman, A.G., and Safferman, T.I. "Understanding K-12 Engineering Outreach Programs." Journal of Professional Issues in Engineering Education and Practice, 130, 2, 95-108, 2004.

3. Olds, SA, Patel, CD, Yalvac, B, Kanter, DE and Goel, N. "Developing a Standards-Based K-12 Engineering Curricula through Partnerships with University Students and Industry." Proceedings of the American Society for Engineering Education. Session 2530: 6 pages, 2004.

4. Vanderbilt-Northwestern-Texas-Harvard/MIT Engineering Research Center Student Leadership Council (VaNTH SLC) Website. Website URL [http://www.vanth.org/slc], site visited 12/29/04.

5. Vanderbilt-Northwestern-Texas-Harvard/MIT Engineering Research Center for Bioengineering Educational Technologies (VaNTH)- Annual Report- Volume II: Project Descriptions and Curriculum Vitae. Website URL [http://www.vanth.org/docs/2004_Annual_Report_Vol_II.pdf], site visited 12/29/04.

6. Bransford, J.D., Brown, A.L., & Cocking, R.R. How People Learn: Brain, Mind, Experience, and School. Washington, D.C.: National Academy Press, 1999.

7. Olds, S.A., Kanter, D.E., Knudson, A., and Mehta, S.B. "Designing an Outreach Project that Trains Both Future Faculty and Future Engineers." Proceedings of the American Society for Engineering Education. (CD-ROM DEStech Publications) Session 1609: 5 pages, 2003.

8. Harris, AH and Klein, S. "Educational Outreach Using Learning-Theory-Informed Modules." Proceedings of the American Society for Engineering Education. 5 pages, 2004.

MONICA FARMER COX is a Higher Education Administration doctoral student in the Department of Leadership, Policy, and Organizations in Peabody College of Vanderbilt University and is a graduate student researcher in the Assessment & Evaluation thrust of the VaNTH ERC. Her research interests include teaching and learning in engineering education and the effects of faculty behaviors and pedagogy on engineering student outcomes.

ALENE H. HARRIS is a Research Assistant Professor of Education in Peabody College of Vanderbilt University. She serves as the Director of Education Programs for the VaNTH ERC.

NEHA GOEL is a senior biomedical engineering at Northwestern University who has been engaged in the Artificial Limb outreach project since its inception. She has received a Ford Grant to work on this project and manages the assessment portion of the module. She has also actively recruited new students. She plans to attend medical school after she graduates.