
AC 2012-5562: INTERNATIONAL SERVICE AS A MEANS OF IMPROVING RETENTION OF ENGINEERING STUDENTS

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International Service as a Means of Improving Retention of Engineering Students

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Abstract

One of the most significant challenges facing engineering education is the chronic problem of inclusion and retention of underrepresented minority (URM) groups. One group requiring unique retention efforts is students who are making satisfactory grades when they decide to withdraw. Many of these students have a difficult time connecting the work of introductory engineering classes with the local, national and international societal issues that they value. Service learning has been integrated into many non-engineering curricula with success in developing skills and promoting social engagement. In engineering settings it can also be used to highlight the link between engineering and society at moments when students seek such a connection.

The authors have established an international service club with activities developing in Peru. The paper presents an overview of some of the international service activities currently underway which have resulted in good participation, and exceptionally strong interest by URM students. Students will be surveyed as to their desire to integrate service in their careers and ways that involvement in the club has fulfilled these desires. An outline of such a survey instrument is presented.

Introduction

Engineering student retention represents a significant challenge in engineering education. Only about one half of students who enroll in engineering will actually earn an engineering degree¹. This challenge is further exacerbated by the chronic problem of inclusion and retention of underrepresented minority (URM) groups. An interesting nuance is the loss of students who are making satisfactory grades at the moment they withdraw. In fact, research from the US Department of Education² has indicated that fewer than 10% of students who leave engineering are motivated to do so because of low grades. While many students enter engineering with a desire to make a difference in the world³, they have a difficult time maintaining this motivation and connecting the work of introductory engineering classes with local, national and international societal issues.

In this paper, we present a brief review of existing research literature which suggests that while general participation in extracurricular activities does not appear to make a significant contribution to retention of engineering students, service opportunities in particular may be an important factor in sustaining student interest and persistence in engineering education. Next, we present an overview of international service club activities currently underway at our institution which have resulted in good participation and exceptionally strong interest among undergraduate engineering students. We outline our assessment plan of the impact of club activities on student attitudes and intentions to incorporate service in their studies and careers, including questionnaires, interviews, journals, and focus group protocols.

Role of extracurricular participation in engineering retention

Prevailing theoretical models of college student retention emphasize the importance of involvement or engagement in the institution^{4,5}. Astin's⁴ theory asserted that the peer group is

the most important factor in college student development, while Tinto's ⁵ model suggested that social and academic integration in the freshman year is vital to student persistence. Some studies have found that out-of-class involvement is important for the success of underrepresented groups, including women ⁶ and African American students ⁷. However, engineering education research during the past decade has de-emphasized the importance of extracurricular participation for engineering student retention and success, and there is an overall sense that the factors that ensure engineering student success are different than for non-engineering majors ^{8,9,10}.

One study that illustrates this finding was conducted by Lichtenstein and colleagues ⁸ utilizing a national data set from the National Survey of Student Engagement (NSSE). While the data indicated that engineering students spent a similar amount of time engaging in co-curricular activities and volunteer work as their non-engineering peers, the time spent was not a statistically significant predictor in engineering student persistence. Similarly, a study by Veenstra and colleagues ^{9,10} using data from a single institution (the University of Michigan) found that volunteering and participation in clubs was not a statistically significant predictor of retention or academic success for engineering students; however, this type of involvement was significant for predicting first year GPA among pre-Med and non-STEM students ⁹. Based on this research, Veenstra et al. ¹⁰ proposed a retention model for freshman engineering students, emphasizing the importance of pre-college predictors and commitment to career goals versus commitment to the institution and social involvement.

A recent study by Brint, Cantwell and Hanneman ¹¹ further supports the idea of differences in engagement between engineering and other majors. Utilizing data from their institution's undergraduate survey, the authors conducted factor analyses to find empirical support for two cultures of engagement – arts, social sciences, and humanities, and natural

sciences and engineering. The authors noted that while interaction, participation, and idea exchange characterized the first group, a focus on improving quantitative skills, collaborative study, and anticipation of labor market rewards characterized the second group. The authors caution against specifying normative good educational practices, as the practices that ensure student success differ based on major.

A noteworthy limitation of the studies reviewed above is related to the measurement of student social involvement, which is often assessed with a single item referring to general participation or has a restricted scale of measurement (e.g., always, often, sometimes, never). Thus, while more recent evidence certainly suggests that social involvement plays a minimal role in engineering student persistence and success, research on involvement in service learning and community service suggests that there are types of involvement that may encourage students to continue engineering studies.

Service learning in engineering education

Engineering education researchers have increasingly acknowledged that active pedagogies, including service learning, contribute to greater student learning and engagement¹², development of professional or “soft” skills emphasized by accrediting agencies¹³, and hence, greater persistence and success. In engineering settings, service learning provides experiential learning to help students appreciate the non-engineering related aspects to problem solving, develop practical skills, and illuminate the link between engineering and the amelioration of societal issues and problems. The application of engineering skills to community service projects distinguishes service learning from the typical internships, co-ops and fellowships that students frequently seek. In these experiences, students would likely work on projects of commercial importance to the sponsoring agency. Service learning may be integrated into the

existing coursework of the engineering curriculum. When used as a course component, service learning differs from hypothetical design problems and case studies because the deliverable is necessarily intended for presentation to a beneficiary or implementation in the community. Various service learning initiatives have been highlighted as models for good practice by Shuman and colleagues¹³, including Engineers Without Borders¹⁴ and Engineers for a Sustainable World¹⁵, humanitarian engineering programs¹⁶, and other projects in which students conduct design research focused on helping improve the capacity of citizens in the globe's most disadvantaged areas to meet their basic needs^{17,18,19}.

There is ample anecdotal evidence of improvement in student attitudes and awareness based on participation in service learning projects as part of courses or clubs. For example, mechanical engineering students who helped install insulated doors and windows in low-income housing indicated greater sensitivity and awareness after participating in the project²⁰. As a result of participation in an international service learning project²¹, engineering students reported improvements in technical skills as well as broader understanding of social and economic realities in Guatemala. While it is difficult to link student success to these types of experiences, they foster commitment to engineering studies, which is a key precursor to retention.

International service club at southeast research institution

The development and coordination of an engineering international service club at the authors' institution is designed to encourage several of the forms of student involvement described by Astin⁴. The International Service Club (ISC) was established in 2008 and is similar to Engineers Without Borders groups present at other universities. The club has established a range of short-term, local activities as well as a long-term, flagship project in an Andean community near Cuzco, Peru.

The ISC provides a unique opportunity to engineering students through participation in multi-year projects that require and promote frequent, intense interaction with other students as well as faculty members in various engineering disciplines. Additionally, the club has inspired interdisciplinary course offerings related to international service that directly link engineering to broader, societal and global issues. The ways in which the club management has encouraged these aspects of involvement are described below.

Publicity and recruitment

Club members actively seek opportunities to talk about their work in the ISC. Students have prepared presentations that enable them to easily deploy to other student groups, invited class presentations and student orientation activities to discuss the various projects that are currently underway. Some of these presentations have been specially targeted to attract underrepresented minority (URM) students; for example, a recent presentation to the Multicultural Academic Services – January Academic Bridge Program for STEM students. Club members have also made presentations to the freshman engineering courses as well as to broader audiences during open presentations in the evening. The effect of these presentations has been to grow club membership substantially during the past year. However, additional benefit is expected for students who see the presentations even if they do not become active members because it helps build awareness about the connection between engineering and societal issues.

Opportunities for interaction with peers, faculty and community members

Each of the activities undertaken by ISC requires intense interaction and collaboration among peers, faculty and community members. The club's faculty advisors often initiate contact with off-campus entities, however communication responsibilities are quickly distributed to the club leadership. The project planning and implementation has resulted in increased interaction

amongst students involved in the club as well as increased amounts of time spent in the College of Engineering facilities. Study abroad and travel programs provide extended opportunities to interact with faculty in ways that are not typical of the lecture/office hour format that is otherwise available. This leads to more thorough communication of individual professional experiences and establishment of mentoring relationships. Insight into the life of an academic and engineer seems to help students establish their own professional goals for graduate school and career.

Multi-year nature of activities

Students in earlier phases of their university studies are important to club operations due to the necessity of competent succession as older students graduate. However, a primary motivation of the club advisors for attracting freshmen and sophomores lies in the hope that club activities can satisfy the student desire for socially relevant engagement during the first few semesters when basic science and engineering coursework lacks an explicit connection. The long-term, multi-year nature of projects that ISC undertakes is hoped to encourage retention of students in the club as well as in their engineering study career. This is by helping students to establish school-related goals, other than classroom accomplishment, with milestones located in future semesters. We anticipate that this will improve student commitment to remain in their engineering programs.

The club has succeeded in attracting freshmen and sophomores to meetings and finding pathways for them to be significantly involved in club activities. While the design tasks associated with flagship projects require the more advanced skills of upperclassmen, the variety of projects that have been undertaken by the group have a range of knowledge requirements. For instance, one design project undertaken locally for international deployment involved

redesigning a shade structure for growing leafy greens in climates that are typically too hot for these plants. The ISC was approached by an agency that installs the units in Southern Africa and the Caribbean for assistance with improving their design. The club met for a half-day, “charrette”-style activity and presented three alternatives to the current design. This activity was entirely appropriate for undergraduates because it required no specialized engineering knowledge. It did, however, introduce the notion of appropriate technology via the selection of materials and joinery techniques.

Direct linkage with societal and global issues

During the summer of 2010, three student members of the ISC made an initial trip with the first two authors to Peru. The bulk of the time in-country was spent performing a needs assessment and preliminary evaluation of conditions in the village, Paru Paru, which was selected as a project site. While students felt competent with the engineering measurements required for the needs assessment, they were impressed with the complexity of issues related to how potential projects would positively or adversely impact the community. The experience of completing the needs assessment provided many opportunities to discuss matters of engineering ethics and to demonstrate the necessity of creating multidisciplinary teams. Students returned from the trip with a heightened interest in the historical, sociological and anthropological details surrounding the project.

Civil and Environmental Engineering faculty have organized to offer a for-credit summer design studio with the title “Engineering for Development Workers.” The course will be instructed within the context of a development scenario in an Andean village in Peru. While the engineering content is coordinated to parallel Structural Materials Laboratory and Geotechnical Engineering Laboratory, additional lecture material is scheduled for the general development

topics as described in Table 1. Each of these topics makes a direct link between societal issues and the role engineers play in ameliorating the human condition.

Table 1: Learning objectives for a development engineering course

Topic	Description
Participants, Objectives and Mechanisms of Development	International development patterns: origins of uneven development and distribution of resources; consequences of underdevelopment: health, safety, access to livelihood opportunities, standard of living; objectives and intents of development agencies; players in development: World Bank, NGOs, USAID, UN, Donors
Appropriate Technology for Development	Features of systems, infrastructure and devices that make them culturally, economically and technically acceptable in the environment where they are designed to function; examples of appropriate technology deployed in other development projects
Needs Assessment and Project Planning	Collection and interpretation of information that is required for project design and project planning; interfacing with non-engineering stakeholders and project personnel; communicating with community and end-users
Implementation	Management skills for construction in under-resourced areas

Assessment plan

The club is in its second year, and thus we are in the design phase of developing appropriate assessment tools for our local and international activities. We are currently in the process of designing instruments to assess the impact of club activities on student attitudes and intentions to incorporate service in their studies and careers. We will use questionnaires to assess club participants' attitudes and intentions at the end of each academic year, along with short, focused evaluations for club activities. Overall, we will assess whether students feel their participation in the club enhances their abilities and knowledge related to the ABET a to k objectives (e.g., ability to function on multidisciplinary teams; understanding of professional and ethical responsibility; ability to understand impact of engineering solutions in global and societal

context; recognition of need for lifelong learning) as well as specific intention to engage in service work (e.g., intend to incorporate service into my studies at UNC Charlotte; intend to incorporate service in my engineering career). Focus groups with club members will allow us to facilitate student conversations about their attitudes, intentions, and understandings to contextualize and deepen the results from the questionnaires.

To assess the impact of participation in the service project/study abroad components, students will complete readings, participate in daily group discussions, and respond to short, open-ended journal questionnaires every other day, following the approach used by Borg and Zitomer²¹. The journal questionnaire approach will allow us to document how student understanding of international service learning changes during the experience. In addition, students will complete a pre-post trip questionnaire to assess learning objectives, motivation, and commitment to engineering. These assessments will be implemented during our upcoming summer design experience in Peru (June/July 2012).

Summary and conclusions

This paper presented a brief review of literature related to the role of involvement and engagement through extra-curricular and co-curricular activities to the success and persistence of engineering students. Recently published studies have not found correlation between the level of involvement of engineering students in extra-curricular and co-curricular activities and their academic outcomes. However, there seem to be benefits from students participating in coursework specific activities. These are described as extra-curricular activities that are related to engineering. While such activities are not required for a specific class, thus extra-curricular, they may be more akin to service learning as a result of their focus paralleling important contents of the curriculum along with service to a community. The authors assert that a service oriented

club is distinctly different from a science or engineering oriented club that does not feature a service component. This is due to the link that service oriented clubs provide between engineering professions and the work of bettering the human condition locally, nationally and internationally. Such connection is sought by many early engineering majors and is known to be especially important for women and URM students^{6,7}.

The development and management of an International Service Club at the authors' institution was described to anecdotally present the anticipated benefits to students. Finally, an assessment plan was summarized that can be used to determine the local benefit that the club provides to its members. Results of the assessment will help the ISC advisors improve the management of the club to benefit student satisfaction, performance and persistence.

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