Community-Based Learning: Student Outcomes

Kurtis G. Paterson, Ph.D., P.E.
Michigan Technological University
Department of Civil and Environmental Engineering

Abstract

Initiated in Fall 2006 with the help of a NSF grant, this program engages engineering student teams in community-based learning (CBL) outside La Paz, Bolivia. CBL is defined as learning via working with and in a community in need of engineering (or other) services. This paper will present student participation, project results, and lessons learned to date.

The four main goals of this CBL experience are: (1) to produce engineers with a better sense of the societal and global interconnections of engineering works, (2) to provide engineering students experience working on diverse teams, (3) to enhance the real-world problem-solving and research capabilities of students, and (4) to work with developing communities on appropriate sustainable solutions to environmental problems.

Three student teams, each composed of two American engineering students (one undergraduate, and one mentoring graduate student) and two Bolivian engineering students, partner with a Bolivian NGO and Bolivian community members to assess, plan, design, execute, re-assess, and communicate a sustainable development project of need to the community. The American undergraduate engineering students are selected from a recently started Certificate in International Sustainable Development Engineering program, the doctoral students from a Graduate Certificate in Sustainability program. The Americans students spend one month in Bolivia working with the Bolivian students, NGO, and project community. During this phase, project re-design, implementation, and assessment takes place. Upon return to the home institution, final documentation is prepared for communication to the project community in Spanish, as well as university students and faculty in English.

Projects for the summer 2007 target the sustainability of wastewater treatment options at three small communities to the east of La Paz. The three student groups evaluated two existing treatment plants, using findings from these to make recommendations for best treatment plant design for the third community. Each group examined the interplay of two of the three facets of sustainability (environment and economics, economics and society, society and environment) at each of the plants. This sustainability interface research will result in more richly complex discoveries and require collaboration among groups.

1. Introduction

There has been increased recognition that the world faces serious challenges in terms of long-term economic growth, societal prosperity, and environmental protection. In particular, health problems resulting from environmental risks and a lack of economic resources in the developing world pose daunting challenges to the global scientific and engineering communities. Addressing these challenges through international research experiences integrated with sustainability and appropriate technology principles represents a significant and critical contribution to a more sustainable future. This has been called for both within and outside engineering education, starting at the undergraduate level.

Initiated in Fall 2006 with the help of a NSF grant, this program engages engineering student teams in community-based learning (CBL) outside La Paz, Bolivia. CBL is defined as learning via working with and in a community in need of engineering (or other) services. In this way, the student's research efforts in this program will be socially relevant and useful at the community level, and will foster two-way knowledge transfer between the economically developing world and the industrialized world. It also impacts students' understanding of appropriate technology, engineering equality, and social justice. This paper presents the program design, student participation, and lessons learned to date.

2. Program Design

The four main goals of this CBL experience are: (1) to provide engineering students experience working on diverse teams, (2) to produce engineers with a better sense of the societal and global interconnections of engineering works, (3) to enhance the real-world problem-solving and research capabilities of students, and (4) to work with developing communities on appropriate sustainable solutions to environmental problems.

Three student teams, each composed of two American engineering students (one undergraduate, and one mentoring Ph.D. student) and two Bolivian engineering students, partner with a Bolivian NGO and Bolivian community members to assess, plan, design, execute, re-assess, and communicate research related to a sustainable development project for the community. The American undergraduate engineering students are selected from a recently started Certificate in International Sustainable Development Engineering program, the doctoral students from a Graduate Certificate in Sustainability program. The Bolivian students will come from the engineering program at Universidad Tecnològica Boliviana in La Paz.

The program commenced with a campus-wide solicitation of participation. While this program is designed to draw students from two existing sustainable development programs, the undergraduate program was only recently approved by the University; hence for this first year, all undergraduates could apply. Six students were notified in mid-December, and had until mid-January to accept the offer.

The American student teams and one faculty member will reside in Bolivia for all of June 2007. Before then, teams and projects will be developed. To aid in the first, monthly meetings will be used to build team camaraderie, critical for getting through the occasionally stressful trials of work in developing communities. Once the teams are decided in early February, the American and Bolivian students will begin to share discussions on group readings to better prepare for sustainable development research. Readings will be assigned monthly and discussion of the readings will serve as a major component of the monthly meetings. The American students will also be encouraged to attend relative international development seminars on campus prior to departure.

In March, the Non-Governmental Organization (NGO) partner, ACDI/VOCA Bolivia, presented potential projects to the student teams, all involving recently completed wastewater facilities in the partner communities (Palos Blancos, Sapecho, and San Antonio). ACDI/VOCA works with the partner communities on development projects and served as the intermediary between American and Bolivian university students and the community prior to the team's arrival in Bolivia. The Mosetenes Indians are the most important population in the area, besides the Aymara and Quechua colonizers. The projects were defined by the team and modified upon arrival in the community. Table 1 illustrates how the wastewater development projects motivated these research projects, each looking at a different element of sustainability of wastewater development projects. Using the community interests communicated by the NGO, the student teams refined their research plan as much as possible in April and May. June was the in-country data collection and research execution phase. The month ended in preliminary report writing (in Spanish) for the community and ACDI/VOCA. July through September, the teams will analyze and interpret the data collected, and document findings. The program culminates in November with public presentations during our university's first annual D80 Conference. Summary documentation will then be delivered to all partners. Figure 1 illustrates the general steps in this program. This program flow will provide research experience for the undergraduates and invaluable mentoring experience for the doctoral students.

3. Student Participation

Table 2 shows the student demographics for the inaugural offering in summer 2007. The applicant pool consisted of six majors. Nearly two-thirds of all applicants and program participants are women. This proportion is slightly higher than the percentage of female students in our university's numerous international sustainable engineering programs (an average of about 50% women for those programs). Half of the student participants are active in other international sustainable engineering programs or organizations on campus. All of the students have some Spanish language competency, on average two years of classroom training. All of the students who applied envision doing engineering work in developing communities as their professional pursuit. The UTB students were all undergraduate environmental engineering students in their last year of study. Half the UTB participants are women. Due to the breadth of majors, bi-nationality of teams, and partnerships with NGO and community members, the student participants were ensured work on diverse teams.

4. Assessment

A two-pronged assessment strategy was used in the program: daily self-reflective metrics, and weekly narrative statements. Both instruments were used one week prior to and two months after the conclusion of the in-country portion of the program. The daily metrics include the following questions:

1. All things considered, how do you feel overall?
2. How do you feel physically?
3. How do you feel emotionally?
4. Regarding your understanding and contributions on the project, how do you feel technically?

These questions were self-scored on a scale of 1 (horrible) to 10 (fantastic). There were two primary purposes of the daily assessment: to engage the students in a summative self-reflection, essentially pausing to think about how things were going, and to provide nearly realtime feedback to the program mentors, signaling when further discussions were warranted in the demanding nature of such programs. The survey format allowed the data to be collected easily in the field, both from perspective of the subjects and interviewer. Example data for two students is provided in Figure 2. A comparison of the Michigan Tech students to UTB students is presented in Figure 3.

Narrative statements were analyzed for content and word count. Content analysis was emergent, not *a priori*. Example word count data is provided in Figure 4 and content analysis in Figure 5.

5. Lessons Learned

This program builds on many years of successful international sustainable engineering programs at Michigan Tech; as such, many issues have been dealt with before and such issues are expected for this program, notably minor health problems, homesickness, and language/culture frustrations. Issues always arise in-country, and program weaknesses and improvements will be evident after the first program year (of three) concludes in November. However a few lessons to date include:

• Many students are attracted to this type of program, notably women. Two-thirds of the program participants are women. The combination of international setting, service, and community-based learning are immensely appealing. The students selected for the program are uniformly ecstatic about the opportunity, both prior to and following the in-country assignment. Traditional academic programs should take note, should they hope to match the demographics and enthusiasm of this program.

• This type of engineering work is widely appealing. Among the seven Michigan Tech students, there are six different majors represented. The emotional connection to engineering in developing communities clearly resonates with many students (and clearly does not for others). Yet, it is the emergence of such emotion that makes the learning deep. These programs provide great lessons on how to fix most typical university curricula.

• An assessment protocol has been developed that extends beyond the typical cognitive domain that engineering programs focus on. The assessment protocol for this program focuses on cognitive, affective, and physical domains and is scaleable. The preliminary assessment has already produced unexpected insights, such as the consistently more upbeat view of the world from undergraduates compared to graduate students, or Bolivian to American students. Graduate students demonstrated their greater capacity to describe their experience and understanding of the project. The Bolivian students consistently reported higher satisfaction levels in all metrics than the Michigan Tech students. The Michigan Tech students go through more extreme peaks and valleys than the Bolivian students, a consequence of culture shock and discovery, physical stress, and work expectations.

• The in-country portion could be better placed, perhaps in May. However, its placement is strictly constrained by the partnership of two universities operating on different academic calendars. This year, due to the short notice between grant notification and program startup, the in-country phase was a compromise between the universities and NGO. However, for Michigan Tech, May would be a better month, as it would allow students participants to enroll in Track B summer classes or pursue a June-August summer internship. July would result in similar summer fragmentation as June. August is not possible for the Bolivian students as it is the start of their school year.

• Integrating the Bolivian students into the team was much less difficult than expected. While language issues afflicted all of the students (none were proficient in a second language) the multi-national teams were generally solid by the second week of the in-country assignment. The American and Bolivian students entered the program for different reasons; altruism and adventure were bigger factors for the Americans, professional development more for the Bolivians. Cultural challenges among the students were few, but community cultural challenges were great for the American students.

• Like most successful international programs, this one requires considerable faculty investment. Current university load and reward systems are inadequate to fully consider the effort. Faculty who engage in programs such as the one highlighted herein will need to sacrifice traditional work demands. Additionally, there is not an easy way to account for the emotional and physical demands of programs in developing communities; faculty need to be aware of their own limitations, yet be available for students in ways that tend not to be needed on campus.

Table 1. CBL research projects

Bolivian Communities	**Research Project**
Projects executed at all three of the following communities: • Palos Blancos • Sapecho • San Antonio	• The influence of community structure on the failure of wastewater treatment development projects • The influence of complexity on the failure of wastewater treatment development projects • The influence of engineering decision-making on the failure of wastewater treatment development projects.

Table 2. Student participant demographics

Students	**Majors**	**% Female**
Michigan Tech Undergraduate students	Environmental Engineering (2) Civil Engineering Electrical Engineering	75%
Michigan Tech Graduate students	Environmental Engineering Mechanical Engineering Environmental Policy	66%
Universidad Tecnologica Boliviana Undergraduate students	Environmental Engineering (6)	50%

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Figure 1. Program flow schematic

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Figure 2. Example daily assessment data for two students.
Note likelihood of physical “crashes” for participants.

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Figure 3. Overall self-assessment comparisons: Michigan Tech students versus UTB students.

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Figure 4. Weekly narrative statement word counts.

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Figure 5. Example narrative emergent content analysis via tag cloud.