Institutionalizing a student-cantered community-based service learning engineering education experience

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ABSTRACT

*Service learning (SL) has been formally defined as engagement of students in course-based, credit-bearing educational experiences in which students' participate in a service activity **and** are provided a framework and context to engage in guided reflection on the service activity. In this paper, SL is examined in the context of Engineers Without Borders (EWB) site and project assessment visit to a rural location in western Kenya. Although not part of a formal credit bearing course, the multidisciplinary team of students, along with their faculty advisor, engaged in local and rural community-based service activities as part of an EWB project. The EWB project process provided students with guidelines to participate in group reflection, assessment and evaluation. The absence of a course structure and an academic credit vehicle did not prevent the students from engaging in substantive and community-inclusive reflection that included various multi-disciplinary perspectives as well as the inclusion of community members in assessment, evaluation and strategic project planning. Nevertheless, incorporation of academic credit through institutionalization of this course for service activities would significantly enhance the learning component, including through more rigorous expectations, both before and after the service, providing the necessary reflection component to be a true service-learning experience. This paper argues for the institutionalization of SL to meet quality assurance guidelines for outcome-based engineering education.*

Keywords: *Service Learning, Project Based, Engineering, Education*

INTRODUCTION

Service Learning, or SL, has been formally defined as academic and/or curricular activities that are course based and credit-bearing, and have two major components – (1) engagement of students in a (usually) self-selected, planned and driven, but professionally supervised and advised, service activity, and (2) an opportunity and requirement to engage in reflection and writing on the service activity (Bringle et al, 2004). The value of service learning has been anecdotally championed and trumpeted across diverse stakeholder groups, including students, faculty, community partners, the University, society in general and employers. Over two decades of research demonstrate that high quality service-learning experiences enhance student learning outcomes and engage students more deeply

in the educational experiences, providing for independent thinking, self-development of resources and general enhancement of educational outcomes (Eyler & Giles, 1999, 2001).

Virtually all definitions of service-learning refer to an organized educational experience that both meets needs of the community and fulfils learning objectives of the educational program. However, for the purposes of this paper, service-learning also incorporates credit-bearing courses that include reflection activities that connect the student's experience with course content and the wider discipline (Bringle & Hatcher, 1995).

Engineers without Borders[1] is a national and international service-based organization with multiple roots, focused on improving the quality of life by providing focused and team based community development projects incorporating sustainable and appropriate technologies. Numerous professional chapters of EWB now operate in countries and cities around the globe, and scores of chapters have sprouted up in college campuses across the world. These campus chapters are harnessing the millennial generations expressed need to be part of the solution to the basic problems and issues facing developing communities. With their understanding of technology capabilities and their awareness of development issues, students can focus on addressing critical energy, environmental and developmental needs of less-developed communities around the world. These campus chapters have the support of dedicated faculty advisors and university administrations eager to demonstrate their responsiveness to student-expressed interest in such educational projects. This has enabled the synergistic combination of service with education to leverage student classroom training into community-based and service-driven actions with the potential for positive results for the community.

Service Learning Experiences at Howard University

Students at Howard University do not have a formal service-learning curricular option. Student organizations, such as EWB-HU, have however, through their faculty advisors and the support of university administrations, been able to take teams of students on several service activities that have been combined with informal and formal learning activities. In 2008, one group of students travelled to Senegal to construct and install a photovoltaic solar system in a previously non-electrified remote rural community under the guidance of two faculty members (Tharakan et al, 2008). A second team began a project with an underserved community in Bahia, Brazil, to help design, develop and construct a performance space for a community theatre group in a *favela* (slum). A third group travelled to the Nandi Hills community in the Choimim region of western Kenya, to assist a community based educational institution that supported both an orphanage for HIV-afflicted orphans and an elementary school improve their facilities. On these visits, service learning took place on a broad scale that was student driven and community based while being professionally mentored and academically advised.

[1] http://www.ewb-usa.org

These three projects provided sufficient educational and field experiences for the engineering student participants to become engaged in the community development process, beginning with problem selection, community interaction, project conceptualization, community feedback and engagement, responsiveness to community concerns, project design and eventually in project development and finally implementation. The challenge for the educator and the academic is to evaluate these projects and develop models for the institutionalization of such experiences so that the opportunity for participation is available to all students, not just those in a special membership based extra-curricular student organizations such as EWB-HU.

This paper begins with an exploration of teaching and learning and then seeks to utilize the experiences of the EWB-HU project teams to develop a model for an academic and curricular based service learning experience. The proposed curricular change seeks to incorporate an SL experience into standard engineering curricula. This would provide all students in an engineering program with the benefit of these mind-broadening types of educational and practical experiences.

TEACHING AND LEARNING

We learn through our senses and our capacity to reason. We look, we hear, we touch, we feel, we taste and we bring whatever information, knowledge, and experience we have at the time to bear on that which we sense. That is how we process information. Different sorts of learning and teaching occur at different points and in different parts of our lives, and in different contexts. As newborns and infants, we learn through imitation and mimicry and our learning is, hopefully, guided and reinforced by the loving and caring hands and minds of our care providers and nurturer's. Because without care and nurture, none of us would have learned, let alone learned to survive and prevail. This initial early learning is, by its very nature, random and chaotic. The flotsam and jetsam of information in the pre-school mind would most likely be unfathomable, confusing, and likely terrifying to any rational human or even an educational psychologist.

As we grow into our pre-school years, learning becomes differently organized, as does the teaching. Information begins to become categorized even as those very categories are being formed. Bits and pieces of data and random facts begin to align themselves into various structures; it seems like suddenly one is introduced to the idea of knowledge. Anybody who has been around children would be familiar with that transition from random data to information progressing eventually to knowledge. In our pre-school years, learning happens in many ways – and rote recitation and straight memorization are important components of early elementary school pedagogy. The more enlightened of the pre-schools do incorporate sufficient free un-structured and protected learning typical, say, of a Montessori pre-school. There must also be experience and interaction and this must be connected to exploration and enquiry. But in many parts of the world, where half the worlds children likely sit in a one-room schoolhouse or in a classroom under a tree, that element of rote recitation and memorization has been

a constant part of those children's learning, and will unfortunately be the only formal teaching they will have the opportunity to have.

The organization of the information, and the learning of that information, becomes more focused and disciplined as we move up the K–12 ladder. Science becomes chemistry, physics and biology; Arithmetic morphs hydra like into algebra, geometry, trig, and calculus; Social Studies becoming geography, US History, and World Religions; English and literature expand and multiply into a diverse spectrum of humanities courses. Once we reach college we are supposed to use all of what we learnt as the basic foundation upon which to build a specific disciplinary career. This broad exposure, if done right, will engender in the student the necessary understanding and appreciation for a diverse array of subjects that's can form a strong foundation with depth and breadth, upon which disciplinary concentrations of study can be built. This is what differentiates *education* from *training.*

How we do that, grow those scientists, engineers, mathematicians, architects, psychologists, historians, sociologists and so on, is critical. It is important to examine our pedagogy and ensure the effectiveness of our teaching. This can only be done if there is a continuous and rigorous evaluation and assessment of student learning. The standard university model of teaching of "chalk and talk" is no longer sufficient. University educators have long understood the weaknesses and insufficiency of the "chalk and talk" model. Our academic degree programs have progressed to now incorporate, at least in the better curricula, programs and schools, interactive learning as a core pedagogical tool. Here students participate in their own education, learning by asking questions and exploring issues interactively with a knowledge provider, whether that knowledge provider is a screen or professor. Our pedagogy has progressed even further. It is now routine to see, as part of every teacher's pedagogical repertoire, the problem-based or project-based learning exercise. Further, we know that when we place students in co-operative groups, learning is enhanced and students are more engaged and motivated, sensing the control they have over their own education.

REGULARIZING SERVICE LEARNING

Service learning takes the problem-based and project-based educational model and develops and extends it further. SL takes learning outside the sterile confines of the classroom and moves it into the field and the community. Problem-based learning in the field can then occur in a real context. It is in this real context that group effort and team participation become important. It is in real world problems that the need for multidisciplinary solutions to complex global problems, in whatever field, becomes clearly evident and necessary.

It is important for our pedagogy to require our students to engage with their critical thinking and analytical skills, with quantitative rigor and scientific rationality, and with their disciplinary strengths and their team player skills, **to** work together in multidisciplinary teams, **developing and implementing** real solutions that address needs within communities across the globe.

Service learning is certainly not new. It has arguably been around since our rural forebears had their children doing chores to learn skills necessary to carry on society, ensuring the survival of the community. What this paper suggests is that the current educational paradigms and models need to be expanded to incorporate service based learning opportunities into regular academic curricula and programs that substantively and rigorously tie these experiences directly to regular degree program requirements.

An example of formalized service learning that has been around for a long time can be found in Cuba, specifically at the Cuban equivalent of MIT, known by its acronym, *CUJAE*. On a study tour to Cuba, lead by the Howard University Project on Appropriate Technology in March 2003, students and faculty were exposed to curricula with a formal service-learning component. During this educational visit, three faculties and a group of fifteen students from Howard University participated in a study tour that included numerous site visits and meetings with individuals in government, education and the community. There, the students learnt that in the Institut Superior Polytechnica, Arcitectura, Y Ingineera/CUJAE, which is Cuba's equivalent of MIT, a senior design project is a requirement not unlike at MIT and almost all engineering programs. However, the big difference is that the CUJAE senior project must be conducted **outside** the university in a **community based setting** and **address** a community problem, with the design project being the **development and recommendation, with possible implementation, of a real solution**.

The way the EWB chapters, both professional and campus based, initiate and develop projects is through a partnership between the chapter and a community that has an expressed need. Communities across the world seek assistance from EWB by posting or listing community needs or problems with the national organization. Chapters then seek out a problem from the listings that the Chapter's leadership and membership may have an interest in, and then partner with the community to develop a project that will address a specific need. The chapter works closely with the community and proposes possible solutions that the community reviews and evaluates, specifically to make sure that specific needs that the community has prioritized are being addressed. In the case of the EWB projects, partnerships are usually multi-year engagements that begin with an assessment visit and proceed from there through solution conceptualization, project design and development and end with implementation, all done through engagement, interaction and feedback with and from the community. A guiding imperative is the avoidance of top-down solutions and handouts, but engagement of the community in addressing their own needs and "buying-in" to the proposed solutions.

It is clear that it would extremely difficult to incorporate a multi-year team based project into the regular engineering curriculum. However, following the model that has been developed and implemented at *CUJAE*, final year design projects in engineering curricula can be moved in the direction of community-based problem selection. The entire EWB process, from project selection to solution development and implementation need not be required. The senior design project

can be focused on community problem selection and then the development of proposals and models for solution. This truncated and abbreviated EWB project model can be the basis for enhancing current engineering curricula with real-world problems of critical environmental and social significance with sustainability as a core under-girding theme.

EDUCATIONAL OBJECTIVES AND OUTCOMES

It is important clearly articulate the educational objectives and expected educational outcomes from an institutionalized service learning component to any program's curriculum. Considering that, as per ABET (Accreditation Board of Engineering and Technology) guidelines and requirements, each accredited undergraduate degree program must clearly outline the programs educational objectives which must set about to meet the educational outcomes listed by ABET (a – k), as well as any specific additional educational outcomes a particular program seeks to see in its students. Hence, at Howard University's department of Chemical Engineering, in addition to the standard educational outcomes as listed by ABET, we have added three others that the department faculty felt were unique to our program.

To institutionalize a service learning course within a degree granting program, the educational objectives for the SL course as well as the expected educational outcomes should both mesh into the programs educational objectives and outcomes. More specifically, if an SL course is to be established as a required part of a program's curricula, the educational objectives and outcomes for the SL course would include those program objectives and outcomes that the course could be tailored to satisfy.

As a possible case study, it is helpful to consider a situation where the SL course is incorporated into, for instance, the senior design course. In this case, it would be important to ensure that the original senior design course's objectives and outcomes are maintained, although there are likely expanded outcomes from transforming the senior design course from a sterile industrial case study to a community-based service oriented course to be conducted half in the classroom and half in the field.

CONCLUSION

It is imperative that we move our pedagogy, and more importantly our curricula, in the direction of student-engaged, participatory, service oriented projects to enhance teaching and learning in a meaningful direction and towards application-oriented real-world problem solving. Numerous surveys of current college age students both informally and formally have always demonstrated the need the college generation has to be able to engage in service to the community. In high schools, it is often part of the graduation requirement that students engage in a minimum number of hours of community service. The one thing we know about our students is that most of them want to make a difference in their world,

especially those in the millennial and following generations, be they generation X, Y or later.

It is time to build on the high school experience and extend and deepen it into one that is more mature and rigorous and addresses the educational and growth needs of today's college students. This is how we can engage them and help them achieve the goal of engagement in service, and contributing in the process both to student development, community development, improvements in the quality of life, and enhancing the sustainability of communities as they seek to improve their standard of living. This is an invaluable contribution to the education of a student and connects their academic world to the real community in a positive and inclusive manner. Institutionalizing a service learning experience into formal undergraduate engineering curricula will address these needs and go a long way towards making an engineering education a more attractive and rewarding one.

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