2006-2194: THE ENGINEERS IN TECHNICAL, HUMANITARIAN OPPORTUNITIES OF SERVICE-LEARNING (ETHOS) PROGRAM AT THE UNIVERSITY OF DAYTON AS AN INTEGRATED SERVICE-LEARNING PROGRAM MODEL

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The Engineers in Technical, Humanitarian Opportunities of Service-learning (ETHOS) program at the University of Dayton as an integrated service-learning program model

Abstract

The Engineers in Technical, Humanitarian Opportunities of Service-learning (ETHOS) program at the University of Dayton (Dayton, Ohio), designed by an interdisciplinary undergraduate engineering student team under faculty facilitation, incorporates educational philosophies guided by various diverse backgrounds. These guiding principles include appropriate technologies, sustainable development, the Catholic Marianist tradition, E.F. Schumacher's "Small is Beautiful", engineering ethics, service-learning principles, promotion of engineering vocation and other values consistent with appropriate application of humanitarian efforts. The ETHOS program seeks to provide opportunities where students gain understanding of technology's global linkage with values, culture, society, politics and economy.

The ETHOS program facilitates curriculum integrated service-learning programming, including international technical immersions, classroom projects, student organization activities, and independent/collaborative research. Such opportunities expose students to alternative, non-traditional technologies that are based on fundamental science and engineering principles; thus, allowing higher comprehension of curriculum material in a hands-on, practical and humanitarian manner. Further, these experiences support the facilitation of appropriate and sustainable technologies for the developing world, locally and globally.

This paper presents a detailed description of the ETHOS program's educational pedagogy in relation to facilitation of student learning and provision of unique learning opportunities. Specifically, this paper presents the ETHOS program's methodology and approach to integrated engineering service-learning and appropriate technology education.

Introduction and Background

Engineering service-learning programs have emerged from being small, select university entities into fully-integrated programs. The Engineering for Developing Communities and Engineers Without Borders (EWB) programs at the University of Colorado – Boulder[1,2], Engineering Projects in Community Service (EPICS) program at Purdue University[3], and the Edgerton Center at the Massachusetts Institute of Technology[4] are several examples. Such programs have paved new direction within each institution's engineering education; integrating engineering classroom education with real-world local and global challenges.

Definition of service-learning is wide-spread, but each definition resonates a similar theme. Most definitions agree that "service-learning can be characterized as a form of pedagogy."[5] More specifically, the ideology of service-learning is such that through service-learning opportunities, students are directly involved in a project that meets academic requirements, while providing a needed community service. Service-learning opportunities range in magnitude. For instance, opportunities can be included in a single course, be a multi-year community service project, or be a fully curriculum-integrated program. Engineering specific, service-learning has

been found to help students develop both technical and non-technical skills. For instance, participating students have shown to be able to make connections between class subjects, develop racial and cultural sensitivity, enhance their commitment to civic responsibility, increase their ethical awareness and awareness of the impact of professional decisions on society and the environment and see the human side of engineering. Through service-learning, students are able to develop learned classroom skills while serving the needs of a local or global community.[6-10]

The University of Dayton, rooted in Catholic-Marianist tradition, has guided student education since its 1850 founding. This educational guidance not only includes topics which are required for degree awarding, but also those which define and exemplify service-learning principles. The University of Dayton lists, as a core trait, it is "a diverse community committed to educating the whole person and to linking learning and scholarship with leadership and service."[11] In recent years, official programs have emerged at the University of Dayton which are dedicated to facilitating service-learning opportunities. The Fitz Center for Leadership in Community[12], the Office of Service-learning[13], and the Center for Social Concern[14] each facilitate opportunities to students which are seeking dedicated service-learning opportunities. While these programs exist, and are open to all University of Dayton students, the scope of their facilitation is not particularly directed at engineering education. Thus, a program was developed which directly integrated service-learning principles into the engineering curriculum.

The University of Dayton Engineers in Technical Humanitarian Opportunities of Service-learning (ETHOS) program is a School of Engineering integrated service-learning program founded on the belief that:

> *"Engineers are more apt and capable to serve our world more appropriately when they have experienced opportunities that increase their understanding of technology's global linkage with values, culture, society, politics and economy."* [15]

Developed in 2001, by a group of interdisciplinary undergraduate engineering students, the ETHOS program maintains several guiding principles. These principles include: appropriate technology, sustainable development, the Catholic-Marianist tradition, E.F. Schumacher's "Small is Beautiful", engineering ethics, service-learning principles, promotion of engineering vocation and other values consistent with appropriate application of humanitarian efforts. Further, the ETHOS program maintains educational objectives of challenging students to think creatively and independently, to work as a team, and communicate effectively.[15]

The following sections describe the ETHOS program's curriculum-integrated service-learning engineering education model.

Integrated Programs

ETHOS integrates engineering curriculum and service-learning through several mediums. Initiatives include: International Technical Immersions, classroom projects, on-campus student organization programming, and independent and collaborative research. To understand the primary focus of each initiative, the common theme of appropriate technology must be defined. Appropriate technology is defined as "any object, process, idea, or practice that enhances human

fulfillment through satisfaction of human needs."[16] Appropriate Technology typically involves solutions to problems using alternative, non-traditional technologies that are based on fundamental science and engineering principles. These technologies are culturally appropriate, facilitated and maintained by community members, environmentally conscious, energy efficient, sustainable, and promote community entrepreneurship.[17,18]

International Technical Immersion

The foundation of the ETHOS program is International Technical Immersions. These International Technical Immersions are eight to sixteen week experiences; whereby, students work with collaborating organizations and communities to assist in finding appropriate, sustainable and effective solutions to technical challenges. Technical challenges are identified as those which compromise a community's basic societal needs. Students facilitate use of learned fundamental engineering knowledge, addressing real world problems, while gaining better understanding of technology and society's global interface. Engineers are expected to play an important role in global society; thus, these opportunities are a valuable way of enhancing the skills, knowledge and values that engineers need to meet these challenges.[19]

Since inception, 31 students have worked with eight organizations and communities in six countries. In the summer 2006 semester, a further 15 students will work with a total of eleven organizations in eight countries. Countries include: Nicaragua, Honduras, Brazil, Mexico, Bolivia, Cameroon, Peru and Morocco. Student projects have included: biomass stove design, solar cookers design and production, photovoltaic system design and construction, solar pumping system design and analysis, light-emitting diode lighting design, biomass stove design and improvement, refractory brick design, well-field analysis and design, and bridge site evaluation, design and building,

To facilitate service-learning, where academic preparation is engaged with civic involvement, students participate in a three credit hour course EGR 330, Engineering Design and Appropriate Technology. This course, approved as an undergraduate technical elective, spans the winter semester prior to travels and includes the students' work with a collaborating organization and community during the summer semester. Through this technical elective course, students earn academic credit for preparation for and participation in an International Technical Immersion. EGR330 is facilitated to "provide undergraduate engineering students with an opportunity to prepare for, choose and then participate in an international technical service placement which will enable them to experience another culture, apply the knowledge gained in other courses to solve unique engineering problems, gain a greater understanding of appropriate technology and contemporary issues related to global development, engineering ethics, program management and written and oral communication, become more proficient at a second language and develop professional competencies (e.g. travel safety, use of public transportation, required international documentation, etc.)."[20]

EGR330 is co-facilitated by ETHOS administration, engineering faculty, Spanish Department faculty, and University of Dayton Center for Social Concern staff. Course structure is summarized in Table 1. Language sessions incorporate a "crash course" in Spanish, providing a review of, or introduction to, basic conversational Spanish skills. Most collaborating

organizations and communities are Spanish speaking; thus, the need of Spanish language instruction. For students traveling to countries where Spanish is not spoken, appropriate instruction is arranged. Appropriate Technology class sessions incorporate discussion and identification of Appropriate Technology principles. Further, these class sessions provide hands-on construction, modeling, analysis and testing of specific designs in which students may encounter. These class sessions take the theoretical discussion of Appropriate Technology and offer applied concepts for use in the field. Finally, Cultural Immersion course sessions incorporate topics of cultural integration, travel preparation and safety, and immersion reflection. When required, several seminars are administered to expand on the applied aspects of engineering and design to accommodate what students will encounter while working in the field.

Each class session is programmed by the associated facilitator and classroom work is assigned accordingly. Further readings and homework, directly relating to engineering, technology, and design, are assigned by ETHOS administration and engineering faculty to supplement each class session's topic.

Table 1: EGR330 Class Session Number, Topic and Facilitator

Class	Topic	Facilitator
1	Introduction and General Information	ETHOS Administration
2	Language Prep	Spanish Department
3	Language Prep	Spanish Department
4	Language Prep	Spanish Department
5	Language Prep	Spanish Department
6	Appropriate Technology	ETHOS Administration/Engineering Faculty
7	Appropriate Technology	ETHOS Administration/Engineering Faculty
8	Appropriate Technology	ETHOS Administration/Engineering Faculty
9	Cultural Immersion	Center For Social Concern
10	Cultural Immersion	Center For Social Concern
11	Cultural Immersion	Center For Social Concern
12	Cultural Immersion	Center For Social Concern
13	Cultural Immersion	Center For Social Concern
14	Cultural Immersion	Center For Social Concern
15	Final Trip Preparation	ETHOS Administration

Course requirements for EGR 330 include:

- attendance and participation in all class sessions,
- complete weekly readings and homework,
- weekly electronic status while traveling,
- written technical report upon return,
- written reflection paper on experience,
- submission of University expense report,
- two presentations to either a technical or non-technical audience, one of which must be given to an on-campus audience.

As set forth in the EGR syllabus, grades are issued according to the breakdown in Table 2.

Table 2: EGR330 Grading

Item	Weight (%)
Class attendance	**10**
Homework	**10**
Weekly Status Reports (6 – 12)	**10**
Reflection Paper	**20**
Technical Report	**30**
Expense Report	**10**
Presentations (at least two)	**10**
Total	**100**

The following reflections are taken from surveys conducted after student participation in International Technical Immersions. These quotes are a sampling of all quotes taken from students who not only participated in International Technical Immersions, but also in one-or-more other ETHOS facilitated programs. These other ETHOS facilitated programs will be discussed throughout this paper. These quotes reflect the enhanced quality of student education through such experiences.

— "The experience was extremely rewarding and has changed me as a person…I feel I can affect things globally now."

— "Not only did I get work experience in my specific career field, but I got to experience a different culture and interact with new and interesting people."

— "I learned so much about myself, another culture, and the world around me."

— "This experience has helped me develop as an engineer. I have gained real-world knowledge of how things work…I feel like I am better able to picture how things should look, rather than just being to plug numbers into the equations."

— "Engineering is such a useful knowledge in every aspect of life… Just a clever way of thinking to solve problems. An engineer is not only useful in designing a circuit…But also useful in coming up with a clever way to hoist a truck using limited resources."

— "Being immersed in another culture felt like being let out of a box and realizing for the first time, there is more out there…Seeing how other people perceive and approach problems was a valuable way to expand my knowledge and resources. And of course, I found the motivation and inspiration that I was looking for, as well as direction in my engineering career."

Classroom

ETHOS incorporates research projects into several undergraduate Mechanical and Aerospace Engineering courses. These courses include: MEE312L - Materials Laboratory, MEE410 – Heat Transfer, MEE431L – Multidisciplinary Engineering Design Laboratory I, and MEE432L – Multidisciplinary Engineering Design Laboratory II. To date, most classroom work has focused on the design and analysis of biomass cook stoves. Primarily, these course projects have focused on the design and analysis of insulative brick materials and the failure of chimney stacks used in construction of biomass cook stoves. Through these projects, students perform research benefiting collaborating organizations while being exposed to the associated social and cultural issues.

For example, the United Nations Development Program and World Health Organization lists indoor air pollution, as caused by the inefficient combustion of biomass materials and production of CO, CO_2 and carbon particulates, to be a leading cause of death for women and children in developing communities. Working with collaborating organizations identified in the International Technical Immersion section of this paper, classroom projects have been facilitated with regards to various components of biomass cookstoves. Students learn not only the engineering analysis of the biomass cook stove components, but further delve into the societal effects. Students undertaking the Materials Lab project learn about how biomass stoves are much safer then the ground fires they replace, significantly reduce smoke in the home, and require less biomass for fuel (which saves money and helps reduce deforestation.) Additionally, these projects provide students with the opportunity to develop course related skills and skills in project management, teamwork, communication and an understanding of sound and ethical business practices. Students are also provided with an opportunity to view engineering as a vocation and to consider the impact of engineering decisions on people and the environment.

Collaborative/Independent Research

An extension of the International Technical Immersions and classroom projects is collaborative and independent research. As students return from International Technical Immersions, many request to continue their respective projects. The ETHOS program works to facilitate student learning through self-guided research and experimentation. These projects lead to publishing of findings, which for any undergraduate student is of particular prestige.

Student Organization

ETHOS operates an on-campus student organization which maintains the objectives of providing local and domestic technical service-learning opportunities and promoting awareness of global technical issues and their effects on society. The ETHOS "club" meets these objectives through various club activities, including: club meetings, on-campus demonstrations, a guest lecture series, field trips, collaboration with community organizations, and local and state junior and senior high school high science fair award sponsorship. ETHOS "club" activities provide no academic credit; however, these opportunities combine learned classroom knowledge with direct action under the auspice of engineering faculty and staff. Some degree of discussion and

reflection is facilitated each activity, allowing students to disseminate their experiences and the relationship to technology and society.

Currently, the ETHOS club is working with a rural appropriate technology demonstration center to facilitate restoration and education of appropriate technologies. For instance, students are involved in the restoration of straw bale and cob buildings. These buildings are used to instruct students on alternative building techniques which are energy efficient and environmentally sustainable. Due to nature of its location, students and faculty visit the demonstration center two times per month. These visits are generally on weekends and last one to two days.

Collaborating with local organizations and University, local and state officials, the ETHOS club is helping facilitate weatherization initiatives for qualifying local families. This initiative will integrate students into the local community, providing a valuable community service, while enhancing engineers' technical capacity for community needs. This weatherization initiative provides students the opportunity to understand the major contributors to poor housing efficiency and address these problems appropriately. Students analyze each housing structure accordingly and provide technical solutions given the resources and materials made available through the weatherization initiative.

The ETHOS Guest Lecture Series has provided students with interesting and informative information regarding Appropriate Technologies in developing regions. The Guest Lecture Series provides about four lectures per year, which focus on technical issues directly concerning global technology and development issues. To date, lecturers have presented on rural water filtration methods, rural electrification and small scale photovoltaic systems, development of community recycling initiatives, and environmental concerns of international development efforts. Lectures have been presented by faculty members, returned Peace Corps volunteers, and collaborating organization personnel. Various courses, engineering and otherwise, incorporate the lectures as an extra-credit bearing exercises, encouraging students to become informed with, and engaged in, these contemporary global technical issues.

Students facilitate on-campus demonstrations of various appropriate technologies. For instance, students have held several "cookouts" using solar and biomass cookers. These "cookouts" have been held on campus areas where high student traffic occurs. While providing "snacks" while in passing to and from classes, students are also able to learn about these technologies and their global implications. ETHOS club students present on their knowledge of each technology and their direct implications to developing communities.

To promote and emphasize the importance of the engineering sciences amongst high school students, the University of Dayton is setting forth initiatives to provide pre-engineering workshops to those excelling in mathematics and the sciences. Through this initiative, ETHOS club members have designed and developed "modules", including a portable solar cooker design set, which allows high school students to build and test replica solar cookers. As part of these demonstration sessions, students not only provide a service to the university and high school, but also educate high school students in developing world issues and technologies.

ETHOS sponsors local and state science fair awards, given to junior or high school students which presents a project directly exemplifies the mission statement of the ETHOS program. In total, five awards have been given. ETHOS students attend the science fair, rate all projects and present the award to the winning student.

Conclusion and Remarks

The Engineers in Technical, Humanitarian Opportunities of Service-learning (ETHOS) program is an effective pedagogy for curriculum-integrated engineering service-learning at the University of Dayton School of Engineering. Reflection quotes, by participating students, exemplify the success of the ETHOS International Technical Immersions. These International Technical Immersions have qualitatively precipitated higher comprehension of curriculum material in a hands-on, practical and humanitarian manner. Integrating other programs, such as classroom projects, student organization activities, and independent and collaborative research into engineering curriculum have provided exciting opportunities for which a larger engineering population have become involved. Combined as a curriculum-integrated service-learning program, engineering students have been exposed to alternative, non-traditional technologies that are based on fundamental science and engineering principles; thus, allowing higher comprehension of curriculum material in a hands-on, practical and humanitarian manner.

For More Information

For more information regarding the University of Dayton Engineers in Technical, Humanitarian Opportunities of Service-learning (ETHOS) program, please visit http://www.udayton.edu/~ethos/.

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