

2007: DEVELOPMENT, IMPLEMENTATION, AND OUTCOMES OF INTERNATIONAL SERVICE LEARNING IN STRUCTURAL ENGINEERING

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Development, Implementation, and Outcomes of International Service Learning in Structural Engineering

Abstract

The primary role of a civil engineer is to serve the community; thus, it is essential that students understand the impact of engineering projects on, and the context of engineering projects within, society. One objective of an engineering capstone design course should be to mesh the technical knowledge of the discipline with an encompassing engineering problem that incorporates “real world” issues and challenges. With all of the aforementioned criteria in mind, the objective of Villanova University’s structural capstone course described herein is to tie together technical and non-technical issues through a challenging real world project. This paper presents the development, implementation, and outcomes of a unique structural engineering capstone course.

Introduction

Villanova University is an independent coeducational institution of higher learning founded by the Augustinian Order of the Roman Catholic Church. A medium-sized comprehensive university, Villanova emphasizes undergraduate instruction and is committed to a strong liberal arts component in each of its degree programs including engineering. The University is committed to the development of well-rounded students and has a strong service culture. Hundreds of students, faculty, and staff participate in extracurricular service activities including week-long mission trips over fall and spring breaks, and the University has a number of service learning opportunities embedded within its curricula.

This paper discusses the development, implementation, and outcomes of one of those opportunities — a service learning capstone course in structural engineering offered by the Department of Civil and Environmental Engineering. Civil Engineering Design Project II (CEE 4606) is a team-based design course that serves as the capstone course for the undergraduate curriculum. Students work on a comprehensive design project in one or more of the department’s five specialty areas: environmental, geotechnical, structural, transportation, and water resources. In the structural engineering specialty area, the design project has included a service learning component since 2000.

Development

One of the poorest countries in the Western Hemisphere, Honduras is a country still trying to recover from decades of guerilla warfare, and has an overwhelming number of children whose parents are unable to provide for them. Amigos de Jesus (Friends of Jesus) is a Catholic orphanage that offers a refuge for abandoned and abused boys in a remote area of Western Honduras. The orphanage was co-founded in 1997 by Sister Teresita, S.S.N.D., a Honduran nun, Reverend Dennis O’ Donnell, rector of the Malvern Retreat House in Malvern, PA, and Anthony and Christine Granese, a 1990 Villanova Civil Engineering alumnus and his wife. The mission of the orphanage is to provide boys the opportunity to grow up in a loving environment where they will receive a formal education and a lifelong skill such as farming, welding, or carpentry.

In late December 1999, Anthony Granese approached the College of Engineering with the idea of developing a relationship with the orphanage. At that time, work on a two-story reinforced concrete structure to house the six children and the two administrators was nearing completion, and construction of a dormitory structure had been initiated. The idea of building a reinforced concrete cross on a hill overlooking the orphanage was discussed. The cross would serve as a symbol of hope for the boys and the surrounding villages in the valley. The structural engineering capstone course seemed to be a natural fit for the scope of the design needs of Amigos de Jesus. Consequently, plans were made to focus the 2000 course around the design and construction of a 25-foot tall reinforced concrete cross. The selection of this project in a Third World country offered the students some interesting design challenges, tied directly to the University's Catholic mission, and provided the feasibility of being constructed in one week.

Student feedback regarding both the technical and non-technical learning from the cross project in 2000 was overwhelmingly positive; consequently, it was decided that the partnership between Villanova and Amigos de Jesus would continue. The 2001 through 2003 capstone projects focused on the design and construction of a split-level volunteer center and chapel. From 2004 through 2007 students surveyed a site, developed designs, and aided in the construction of an eight building elementary school complex. The cross, volunteer center/chapel and first classroom building are shown in Figure 1. Currently, all design work for the school complex has been completed and three buildings are under construction with a completion target of September 2007. The projects are being supervised by a 2006 Villanova Civil Engineering graduate who has volunteered for a one year service assignment. Amigos de Jesus has recently decided to open their doors to young girls; consequently, the 2008 project will be the design of a girls' dormitory.



Figure 1: Reinforced concrete cross, volunteer center/chapel, the first classroom building.

Implementation

The capstone course (CEE 4606) is structured to allow groups of three to five students to complete the design that solves a “real-world” engineering problem over one semester. Students begin by interacting with the client to define the design problem and by researching the site in Honduras to develop design criteria such as material properties, building loads, wind speeds, and seismic ground accelerations. They then develop a complete design for the structure. Halfway through the semester, at least one student from each design group travels to Honduras and spends a week at Amigos de Jesus as part of a week-long departmental mission trip. During this time, the site representatives gather additional information from the client to facilitate their design, and

participate in the construction of one of the structure's elements (or similar elements under construction on another structure at the site). Throughout the semester, students are required to provide oral and written progress reports. Final designs and drawings are then presented to faculty, parents, members of the departmental advisory committee, and fellow students at the end of the semester.

Historically the focus of the capstone projects has been on technical work. However, the nature of these service-oriented international design projects have always allowed for the added benefit of non-technical learning. In an effort to further formalize the link between education and service, a parallel one credit service learning course, CEE 4611 was introduced in 2003 for all students participating on the Honduras trip. The course meets one hour per week (in addition to the trip itself), and is structured around a simple pedagogy of service learning that includes four key elements: preparation, service, reflection, and celebration. Table 1 presents the methodology used in implementing these four elements of service learning in CEE 4611.

Table 2 presents the enrollment in the capstone course (CEE 4606) and affiliated service learning course (CEE 4611), between 2000 and 2006. The demographic of trip participants is also presented. A typical trip includes two faculty members, five seniors, and five underclassmen interested in structural engineering and/or service. Graduate students and alumni that have previously been to the site have served as mentors on trips as well. About 28% of students enrolled in CEE 4606 have elected to go to Honduras. Approximately half of the students who go on the trip and enroll in the CEE 4611 service learning course are also enrolled in the CEE 4606 capstone course, with the other half being other seniors, juniors, or sophomores.

Table 1: Implementation of service learning pedagogy in CEE 4611.

<i>Step 1: Preparation</i>
<ul style="list-style-type: none"> • Students conduct background research on Honduras and present it to the group. • Guest lecture from the Latin American studies department presents information on Honduras. • Students organize events to raise the funds necessary for traveling to Honduras.
<i>Step 2: Service</i>
<ul style="list-style-type: none"> • Students work on the design and the construction of an element of the infrastructure at the site over spring break. • Students interact with boys and staff at Amigos de Jesus and help with daily activities.
<i>Step 3: Reflection</i>
<ul style="list-style-type: none"> • Students keep a personal journal where specific questions are asked and entries are made (prior to the trip, during the trip, and after the trip). • Web site of the trip activities is maintained while in Honduras. Students leave daily messages to their family and friends reflecting on their experiences. Family and friends follow the groups' progress through the week and leave messages for the students. • Group prayer with the boys just prior to bedtime to thank God for the gifts we have received. • Groups of two students plan and lead a reflection at the end of each day while in Honduras.
<i>Step 4: Celebration</i>
<ul style="list-style-type: none"> • Students work in groups after the trip to develop two posters and one oral presentation focusing on their service work and trip outcomes. • Multiple group social events.

Table 2: Course enrollment and trip participant descriptions.

Semester	Seniors enrolled in CEE 4606	Students enrolled in CEE 4611	Went to Honduras							
			TOTAL	Faculty	Graduate Students	Seniors enrolled in CEE 4606	Other Seniors	Juniors	Sophomores	Alumni
Spring 2000	7	N/A	10	2	0	4	0	4	0	0
Spring 2001	18	N/A	11	2	0	6	1	2	0	0
Spring 2002	25	N/A	15	2	3	5	0	4	0	1
Spring 2003	25	10	13	2	0	7	0	3	0	1
Spring 2004	14	11	14	2	0	3	2	5	1	1
Spring 2005	15	10	15	4	1	5	0	5	0	0
Spring 2006	18	9	12	2	1	4	0	5	0	0

Outcomes

In order to focus the teaching strategies within the capstone (CEE 4606) course, a list of eight technical and eight non-technical objectives were developed in 2001. The objectives are listed in Table 3, and coincide with many of the attributes that are required for ABET and ASCE accreditation. A survey was developed and is given to all students enrolled in CEE 4606 in order to formally measure how well the course satisfies the outcomes of both the technical and non-technical elements of the course. The survey was adapted from Eyster et al., 1999.¹ To date six years of data has been generated and collected. The survey is administered as a requirement at the end of the course, thus the rate of return is extremely high. In all 94% (108 out of 115) of students enrolled in the course completed the survey. Note that the survey data does not include students such as juniors who only enrolled in the service learning course but were not part of the capstone design course.

The data is presented in Table 3, and is shown separately for students who went to Honduras and students who did not go to Honduras. The data strongly shows the technical objectives are being satisfied very well by all students participating in the capstone course. Evaluation scores for all technical objectives tend to be marginally higher for students that went to Honduras. This indicates that students who went to Honduras felt they learned technical skills better, perhaps as a result of the hands-on work on site and direct interaction with the clients while in Honduras.

It is also evident that while the non-technical objectives are being adequately satisfied by all students, the students that participate on the trip feel that these objectives are satisfied significantly more than do the students that do not participate on the trip. This would suggest that while there is a carry-over effect in which students that do not go to Honduras still see some non-technical development because of the nature of the project, the structured one-credit service learning course is vital in developing this non-technical learning to a significant degree. The one exception to this is that nearly all students leave the capstone experience feeling a sense of accomplishment as a result of applying their engineering education in a comprehensive project with a service element.

Table 3: Course objectives and post course survey results.

Course Objectives (T = Technical; N = Non-Technical)		All Students Surveyed (n = 108)	Students Who <u>Did Not</u> Go to Honduras (n = 80)	Students Who <u>Did</u> Go to Honduras (n = 28)
T1	In this course, I was able to synthesize and apply previous coursework in Structural Engineering.	4.35	4.30	4.50
T2	In this course, I developed a better understanding of how different components of a structure fit together.	4.40	4.38	4.46
T3	In this course, I developed a better understanding of how real world constraints (cost, scheduling, material availability, etc.) affect a structural design.	4.29	4.24	4.43
T4	In this course, I was able to develop a professional work ethic.	3.92	3.86	4.07
T5	In this course, I was able to practice technical presentation skills, including presentation of technical drawings, calculations, reports, and oral presentations.	4.56	4.55	4.57
T6	In this course, I was able to further my problem solving skills.	4.27	4.27	4.29
T7	In this course, I was able to function as part of a team and work on teamwork skills.	4.50	4.49	4.54
T8	After taking this course, I feel more competent entering the work force as a Structural Engineer.	4.15	4.09	4.33
N1	After taking this course, I am more aware of global issues.	3.56	3.39	4.04
N2	After taking this course, I am more likely to become involved in service-related activities.	3.37	3.10	4.14
N3	After taking this course, I feel that I am a more well-rounded individual.	3.68	3.46	4.29
N4	After taking this course, I feel better about myself.	3.70	3.51	4.25
N5	After taking this course, I have a better understanding of myself.	3.31	3.08	4.00
N6	After taking this course, I have a better understanding of others.	3.71	3.53	4.25
N7	After taking this course, I feel more spiritual.	2.64	2.30	3.61
N8	After taking this course, I feel a sense of accomplishment.	4.48	4.39	4.75
1 = Not Satisfied at All 2 = Satisfied Only a Little Bit 3 = Satisfied Adequately, But Room for Improvement 4 = Satisfied Reasonably Well 5 = Satisfied Very Well				

An additional outcome not captured by the data is that to date there have been four civil engineering graduates that have volunteered for long-term (one year or longer) work assignments at the site. These students supervise construction, teach English, coordinate ongoing student design efforts, while living in a volunteer center that they designed and built. Additionally, numerous other students have participated in long-term service activity immediately after graduation, many of which allowed them to apply their engineering skills to better serve society.

Conclusion

The stated mission of the Department of Civil and Environmental Engineering is to provide students with a high quality, contemporary, broad-based, civil engineering education within a Judeo-Christian, humanistic context. The unique structural engineering capstone course described in this paper builds on the inherent service-oriented nature of the civil engineering profession in a manner that is consistent with the Department and University's mission and culture of service. As demonstrated by the survey data collected over a six year period, this capstone course has fostered a learning environment where students are able to simultaneously apply their technical skills, directly serve others in need, and continue their own personal development and growth as members of a global community.

Acknowledgements

The authors thank Amigos de Jesus, our most gracious clients and hospitable friends from the beautiful country of Honduras. The authors also thank the many students that have elected to participate in the structural engineering capstone project with special thanks to those that have traveled with us to Honduras. Further thanks are given Villanova University, the College of Engineering, and the Department of Civil and Environmental Engineering for their incredible support of this work. The authors acknowledge the financial support of the Villanova Institute of Teaching And Learning for development of the course objectives and the surveys.

References

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