International Journal for Service Learning in Engineering
Vol. 2, No. 1, pp. 44-63, Spring 2007
ISSN 1555-9033

INTEGRATING SERVICE-LEARNING PROJECTS INTO CIVIL ENGINEERING COURSES

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Abstract **- Three service-learning projects of various content, workload, and community partnering were identified and implemented in two core and one elective undergraduate courses in the Department of Civil & Environmental Engineering at the University of Massachusetts Lowell in 2005. This paper presents how these service learning projects were seamlessly integrated into existing courses without removing pertinent course materials and without a significant increase in time commitment. Details on the course contents, course structure, projects implemented, and how each project was used to address certain course objectives were presented as well. The selected projects were as follows: (1) Davidson Street Parking Lot Redesign for the City of Lowell; (2) Intersection Analysis – Traffic Signal Control for the City of Lowell; and (3) Preliminary Building Structural Evaluation for the Architectural Heritage Foundation in Lowell, MA. Over 80 undergraduate students ranging from freshmen to seniors participated in these community-based projects. Course objectives and ABET program outcomes were evaluated by a course-specific survey questionnaire. Students' experience on the S-L project was assessed by a newly developed survey instrument. The survey demonstrated that service learning had several positive impacts on the students.**

Index Terms – service-learning, civil engineering, community partners, assessment

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INTRODUCTION

The Accreditation Board for Engineering and Technology (ABET) has a relatively new set of criteria, ABET EC 2000, for engineering programs.[i] In addition to achieving the more traditional technical objectives, these criteria require that graduates demonstrate:

- an ability to function on multi-disciplinary teams
- an understanding of professional and ethical responsibility
- the broad education necessary to understand the impact of engineering solutions in a global and societal context
- a knowledge of contemporary issues.[i]

Service-learning is the integration of academic subject matter with service to the community in credit-bearing courses, with key elements including reciprocity, reflection, coaching, and community voice in projects.[ii] Service-learning team projects have the potential to ensure students learn and satisfy these objectives in addition to applying engineering to the design of systems and experiments. Service-learning offers a way to integrate instructional methods designed to enhance student learning of technical subject matter with that of activities designed to address these above mentioned objectives. Research indicates that the S-L approach motivates students to work harder, be more curious, connect learning to personal experience, and demonstrate deeper understanding of subject matter.[iii]

While service-learning has been well established in many disciplines in higher education, engineering has been slow to adopt the pedagogy.[iv, v] Recently, efforts have been made to implement S-L in engineering contexts. Examples include civil and environmental engineering courses;[vi] first-year introductory courses;[vii, viii] capstone senior design courses;[viiii] multidisciplinary approaches;[x, xi] and the Engineering Projects in Community Service (EPICS) program at Purdue University.[viiii, xii] However, it appears no program in engineering has service-learning spread throughout the curriculum in required mainstream courses.

At the University of Massachusetts Lowell (UML), the goal in the Francis College of Engineering (CoE) is to integrate service-learning into a broad array of courses so that students will be exposed to service-learning every semester in the core curriculum in every program in the entire CoE. This initiative was supported by NSF through the Department Level Reform Program. However, how to add new material into an already packed curriculum remains a challenge and more strategies and examples on how to integrate new material into an already packed curriculum are critically needed. The objective of this study was to present how three service-learning projects were seamlessly integrated into three courses in civil engineering curriculum without eliminating pertinent course materials and without a significant increase in time commitment as a first step towards undergraduate curriculum reform in the Department of Civil & Environmental Engineering (CEE). Details on the course contents, course structure, projects implemented, and how each project was used to address certain course objectives were presented as well. Course objectives and ABET program outcomes were evaluated by a course-specific survey questionnaire. Students' experience on the S-L project was assessed by a unique survey instrument developed by Duffy and Brandis University.[xiii]

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PROJECT IMPLEMENTATIONS

Three S-L projects with two community partners were identified through a S-L workshop held at UML. The associated community partners were: City of Lowell and Architectural Heritage Foundation (AHF) in Lowell. Three faculty members from CEE department worked with each of the community partners in detailing the project descriptions and integrating the project into the curriculum. Over 80 undergraduate students ranging from freshmen to seniors participated in these community-based projects. See Table I for more detailed information on the courses and the corresponding S-L projects.

TABLE I
S-L PROJECTS INTEGRATED INTO CEE COURSES

Course Title	Projects	Community Partners	Number of students participated
Intro. to Engineering (II) (Freshmen-level, Core)	Davidson Street Parking Lot Re-design	City of Lowell- Traffic Department	40
Transportation Engineering (Junior-level, Core)	Intersection Analysis – Traffic Signal Control	City of Lowell – Traffic Department	42
Design of Masonry Structures (Senior-level, Elective)	Preliminary Building Structural Evaluation	Architectural Heritage Foundation (AHF)	3

Freshmen-level Introduction to Engineering (II) (Spring 2005)
Project 1: Davidson Street Parking Lot Re-design

Introduction to Engineering (II) is a required course for all freshmen in CEE. This course is intended to train future civil and environmental engineers with communication (both verbal and written) and computer skills. This course covers a variety of topics, including: public speaking, PowerPoint presentation, technical writing, resume writing, engineering ethics, and AutoCAD. This course has a final project to evaluate students' ability to integrate all the essential skills learned in class (i.e. public speaking, PowerPoint presentation, writing and AutoCAD).

Traditionally, the final project has been to ask each student take one of their labs from Physics or Chemistry, draw their lab apparatus in AutoCAD, make an oral presentation using PowerPoint to explain their lab - underlying theory, what they measured & how, summary & conclusions. In Spring 2005, a service-learning parking lot re-design project was identified and used to replace the traditional project as a final project. The community partner for this project, the City of Lowell, was considering putting a 10-12' wide bike trail and eliminating some of the fences within an exiting parking lot on Davidson Street. The objectives of this S-L project were to (1) re-design and maximize the number of parking spaces, (2) allocate a 10'– 12' wide bike trail along the Concord River to provide sufficient room for the development of a neighborhood bike trail. This project met three course objectives: (1) able to make 2D line and dimensioned engineering drawings using AutoCAD; (2) able to communicate technical information to an audience in written form; (3) able to function effectively in groups.

One class period (2 hours) was used for the site visit (5-minute drive from campus). Two school buses were provided to transport 40 students to the site. The project was technically challenging due to the irregular shape and the large size of the parking lot. The students were assigned into groups with each group having 3 or 4 students to work on a section of the parking lot. They measured the parking lot with RollaTapes (Figure 1), and produced dimensioned drawings of the new parking lot design with the AutoCAD program they learned in this course. A total of 221 parking spots were designed, with an individual number of 65, 121, and 35 for each section.

FIGURE 1
FRESHMEN WERE BUSED TO THE PARKING LOT TO DO ON-SITE MEASUREMENTS

The City of Lowell's planners received 10 AutoCAD-generated parking lot re-designs and written reports on the designs (a design example is shown in Figure 2). They are currently determining which design will be used when the parking is redone. The students enjoyed doing a community-based project and the fact that one of the designs would actually be used by the City.

This S-L project was used as a tool to evaluate the ability of the students to use AutoCAD, create a Power Point presentation, make an effective oral presentation, work in a team and their ability to write a technical report. This project met several course objectives, ABET program outcomes (see Appendix A), and community objectives simultaneously.

Junior-level Transportation Engineering/Lab (Fall 2005)
Project 2: Intersection Analysis/Traffic Signal Control

Transportation Engineering (Course No. 14.340) is a required course for all junior students. It consists of 3 recitation lectures per week and is accompanied by a 3-hour laboratory (Course No. 14.341). Generally, lab assignments are coordinated with lecture materials in such a way that students have the opportunity to practice what they learn in theory in a subsequent lab. The following are the course descriptions from online university catalog.

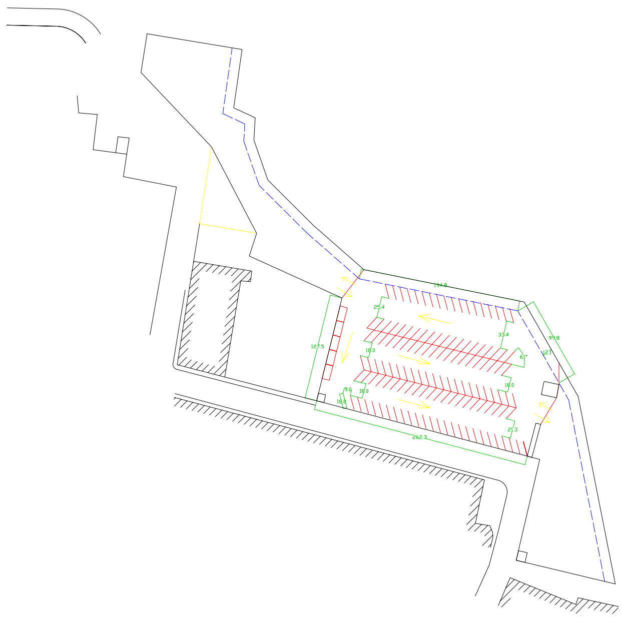

FIGURE 2
EXAMPLE DESIGN FOR DAVIDSON STREET PARKING LOT RE-DESIGN PROJECT

14.340: Transportation Engineering (3 credits): Development of the basic principles pertaining to the movement of people and goods by modern transportation systems. Techno-economic characteristics of various transportation modes. Aspects of planning, design and operation of land, air and water transportation facilities. Development, structure and function of the U.S. transportation system.

14.341: Transportation Engineering Laboratory (1 credit): Practice techniques of data collection, analysis and presentation that are commonly used in the planning, design and operation of transportation facilities with primary emphasis on highway systems.

Course 14.341 includes a two-lab sequence on Intersection Analysis: Part 1 consists of Volume Study and Analysis and Part 2 involves Traffic Signal Control. The data collected during the first part of this sequence are used to generate signal timings in the second part. The students submit a separate report after each lab. Traditionally, this exercise was merely a computational study in which students calculated hypothetical signal timings. This S-L project involved a practical analysis and design of the intersection signal timings using professional software tools. The implementation of this S-L project only required little additional time commitments in obtaining the current data and conveying the results and without taking out any course materials.

Project description: The objectives of this project were two fold: (1) to assess the performance of the existing signal control at the intersection of University Avenue and Riverside Street, located in Lowell, MA, and (2) to optimize the signal settings with existing traffic operations software, reassess the performance, and make recommendations to the City. This project met two course objectives, including being able to conduct an intersection volume study and calculate traffic signal timings at an intersection.

An hour-long volume study was performed by the students at the intersection (see Figure 3). Working in groups of four, they collected arrival information in 1-minute intervals for all approaches, including vehicle classification and turning movements. They also measured the signal timings activated at the time of the volume study. The data was input into Synchro 6[xiiii], a software package for modeling and optimizing traffic signal timings. The package includes Sim Traffic model for microscopic simulation analysis.[xv] Microscopic simulation models consist basically of two main components. First component includes a description of the road network geometry including traffic facilities as traffic lights, traffic detectors, variable message sign panels, etc. In the second part detailed modeling of traffic behavior is carried out which reproduces the dynamics of each individual vehicle, distinguishing between different types of vehicles, offering the possibility of taking into account behavioral aspects of vehicle's drivers. Sim Traffic analysis provides measure of effectiveness such as delay/vehicle, fuel efficiency, speeds, and exhaust emissions as output. Sim Traffic can model networks of signalized and unsignalized intersections, including roundabouts. In addition to calculating capacity, Synchro allows the user to quickly generate optimum timing plans by optimizing the splits, cycle length, and offsets to reduce delays and stops. Tables II and III show the results generated by these tools.

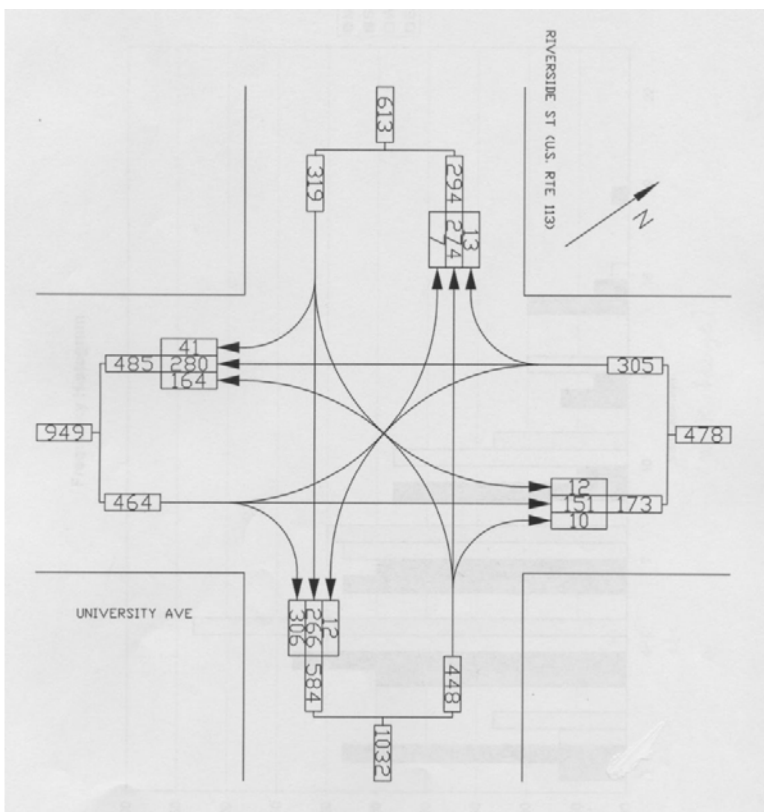

FIGURE 3
VOLUME STUDY AT THE INTERSECTION (OCTOBER 2005, WEDNESDAY, 4-5PM)

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TABLE II
TRAFFIC OPTIMIZATION CONDITION REPORTS GENERATED BY SYNCHRO 6

MOE*	Existing Conditions	After Optimization	Improvement (%)
HCM* Average Control Delay for Intersection (sec)	27.3	18.2	33
HCM Level of Service for Intersection	C	B	C->B

*MOE- Measures of Effectiveness
*HCM-Highway Capacity Manual

TABLE III
PERFORMANCE RESULTS GENERATED BY SIM TRAFFIC

MOE	Existing Condition	After Optimization	Improvement (%)
Total Delay (hr)	5.5	3.5	36
Delay/vehicle (sec)	42.8	31.9	25
Average Speed (mph)	17	19	12
Fuel Efficiency (mpg)	13.3	15.2	14
HC* Emission (g)	80	39	51
CO* Emission (g)	2622	1304	50

*HC-Hydro Carbon
*CO-Carbon Monoxide

The existing cycle length for the intersection was 90.5 seconds, with a green time of 45.4 seconds for Riverside Street and a green time of 45.1 seconds for University Ave. After the optimization with the measured volume data, the optimal cycle length for the intersection was found to be 55 seconds, green time of 31 seconds for Riverside Street, and 24 seconds for University Ave. The HCM level of service for the intersection was improved from C to B after the optimization.

As a result of the optimization, the software calculated that the HCM average control delay for the intersection would be cut by 33%. The microscopic simulation SimTraffic indicated that the total delay of the intersection and the delay per vehicle would be reduced by 36% and 25%, respectively. Both HC emission and CO emissions would be cut by 50%. In addition, the average speed and fuel efficiency would be improved by 12% and 14%, respectively. Thus, the results clearly indicate a significant improvement in terms of MOE after optimization of the signal settings.

Recommendations made to the City of Lowell were: to use during the study time period a cycle length of 55 seconds for the intersection, green time of 31 seconds for Riverside Street, and green time of 24 seconds for University Ave to improve the operational efficiency and effectiveness of this intersection control.

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Senior-level Design of Masonry Structures (Spring 2005)
Project 3: Preliminary Building Structural Evaluation

Design of Masonry Structures is a senior-elective course. It covers the fundamental characteristics of masonry construction, the nomenclature, properties, and material specifications associated with basic components of masonry, the behavior of masonry assemblages subjected to stresses and deformations, and the design of un-reinforced and reinforced masonry structures in accordance with current codes. Traditionally the students were given a final exam to evaluate their performance in class. In Fall 2005, a S-L project was identified and provided to the students as an option to replace their final exam. The time demand of the project was reported approximately 20 hours spent for site visits and report preparation.

Project description: The Cambodian Mutual Assistance Association (CMMA) owned a large masonry mill building built in 1825. CMMA cooperated with the Architectural Heritage Foundation (AHF) to look into the possibility of renovating this building to house a medical center, a shopping area, and residential units. The students were asked to perform a preliminary structural evaluation of this mill building. The project met several course objectives: (1) understanding the structural behavior of masonry structures, (2) functions of structural components made of different material systems and their interaction, (3) mechanisms of degradation and failure, (4) their impact on the service life, and (5) the structural implications of re-development and renovation actions. A team of three students (two undergraduate and one graduate) participated in this project.

The project implementation started with planning meetings to determine the project stages, identification and acquiring of national and local masonry codes and other useful resources, and purchasing of necessary equipment such as a laser range meter to minimize the risk of accidents during field measurements. Two site visits were conducted (see Figure 4) and on-site measurements and visual inspection were performed. The students examined the foundations, floors, and clay brick walls. Inspections revealed the following: some foundation is submerged under water and signs of previous movement (Figure 5); visible cracking and signs of deterioration in the basement; and consistent inclined cracking of the clay walls (Figure 6).

FIGURE 4
STUDENTS EXAMINING THE CMAA BUILDING

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FIGURE 5
FOUNDATION SUBMERGED UNDER WATER

FIGURE 6
VISIBLE CRACKING.

Written reports with recommendations were submitted to the community partners CMAA and AHF. The students' recommendations, with supporting pictures and calculations, were to perform: (1) foundation repair and lateral load analysis, (2) add properly designed steel column supports after foundation rehabilitation, and (3) new masonry repairs.

Student surveys before and after the project implementation showed that all three students found the project educating, rewarding, and worth including this experience in their resume. It was the opinion of the instructor and students alike that this S-L project better served the course objectives and ABET program outcomes than the final exam it replaced.

ABET PROGRAM OUTCOMES MET

ABET Program Outcomes describe what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that students acquire in their matriculation through the program. The following are the ABET Program Outcomes for CEE Department:[xvi]

A. an ability to apply knowledge of mathematics, science and engineering;
B. an ability to design and conduct experiments, as well as analyze and interpret data;
C. an ability to design a system, component, or process to meet desired needs within realistic constraints;
D. an ability to function on multi-disciplinary teams;
E. an ability to identify, formulate, and solve engineering problems;
F. an understanding of professional and ethical responsibility;
G. an ability to communicate effectively;
H. the broad education necessary to understand the impact of engineering solutions in a global and societal context;
I. a recognition of the need for and an ability to engage in life-long learning;
J. a knowledge of contemporary issues;
K. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

The S-L projects implemented in these three courses all addressed in a substantial way several of the ABET program outcomes by the activities listed in Table IV.

ASSESSMENT

Each course was evaluated by a course-specific survey. Due to space limitation, only the course survey results collected from Introduction to Engineering (II) Spring 2005 (Table V) was presented in this paper as an example (see Appendix A for the full survey). The difference among the course surveys is the course specific objectives; the other sections are the same for all the courses taught in CEE. Student course surveys in all three courses showed that both course specific objectives and ABET program outcomes were met.

Students' experience on the S-L project was assessed by a newly developed survey instrument (see Appendix B).[xiii] The same survey was given to the students to fill out before and after they have conducted the S-L projects. The pre-survey was conducted on all the freshmen in CoE and juniors from CEE in Fall 2005 (n=218). The post-survey was conducted on the same population after their completing the S-L projects in spring 2006 (n=145, noticing that some freshmen didn't move up to Spring 2006). In the first part of the survey, the students were asked to rank five attributes representing their career values chosen from challenge/helping/independent/income/outdoors/physical/prestige/public/security/creativity/variety/team based on their S-L experience. However, this part of the survey results was not conclusive.

TABLE IV. ABET PROGRAM OUTCOMES MET BY THE ASPECTS IN S-L PROJECTS

ABET program outcomes	S-L Projects		
	Davidson Street Parking Lot Re-design	Intersection Analysis – Traffic Signal Control	Preliminary Building Structural Evaluation
A	the application of their knowledge in solving a poorly designed parking lot problem	the application of mathematics for data analysis and signal timing design	the application of their knowledge of masonry analysis and design
B		the design and conduct of a intersection study, the analysis and interpretation of traffic data	a site visit where they made measurements and input the relevant measurement data in their structural analysis
C	the design of a new better parking lot	the design of a new traffic signal control plan	
D	worked in a team	worked in a team	worked in a team
E		identified, formulated, and solved a traffic control problem	performed a preliminary structural evaluation of the building
F	gained a better understanding of how their engineering solutions could improve people's life		gained a better understanding of the responsibilities of a professional engineer and the impact of their ethics and competence on vital decisions
G	communicated with their teammates, advisor, and client	communicated with their teammates, advisor, and client	communicated with their teammates, advisor, and client
H	gained a better understanding of how their engineering solutions could improve people's life		experienced first hand the significance of their engineering work on the community that it serves
I	recognized that a lot more considerations should be given when designing a parking lot		recognized the need for life-long learning and development through this simple engineering project
J	a knowledge of contemporary issues, such as difficulty of maneuvering in a parking lot	a knowledge of contemporary issues, such as energy consumption and pollutant emissions	a knowledge of contemporary issue that involves rehabilitation of historic masonry structures in Lowell area to serve new functions
K	the use of modern tools, i.e., AutoCAD, for engineering practice	the use of modern engineering tools necessary for engineering practice, such as the Synchro design software and the SimTraffic simulation software	the use of their knowledge, skills and related engineering analysis tools to perform the evaluation

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TABLE V. SAMPLE COURSE SURVEY RESULTS FROM INTRODUCTION TO ENGINEERING (II) SPRING 2005

To what degree are the following course outcomes achieved? 0=never confident, 1=sometimes confident, 2= fairly confident, 3=confident, 4=very confident	
1.1 I can *create* a presentation using PowerPoint.	3.80
1.2 I can *communicate* technical information both orally and in a written format.	3.00
1.3 I can *make* 2D dimensioned engineering drawings using AutoCAD.	3.21
1.4 I can *make* 2D layered engineering drawings using AutoCAD.	3.15
1.5 I *understand* the complexity of ethical issues in Engineering.	3.50
1.6 I *learned* about the different specialties within Civil & Environmental Engineering.	3.39
1.7 I enjoyed the nanoiron synthesis lab.	2.70
1.8 I enjoyed doing the service-learning project.	3.45
1.9 The final project was a good way to incorporate the major skills we learned in this class (i.e. AutoCAD, PowerPoint, oral presentation and teamwork).	3.80
1.10 I feel I have improved my presentation skills and computer skills.	3.40
Did this course help you better achieve the following ABET Program Outcomes? (0 = not at all; 1 helped somewhat; 2 helped; 3 helped a lot; 4 helped tremendously)	
3(a) ability to apply knowledge of math, science & engineering	3.30
3(b) ability to design experiments, & analyze & interpret data	3.10
3(c) ability to design a system, component or process to meet desired needs	3.25
3(d) ability to function on multidisciplinary teams	3.40
3(e) ability to identify, formulate & solve engineering problems	3.25
3(f) understanding of professional & ethical responsibility	3.45
3(g) ability to communicate effectively	3.30
3(h) understand global & societal impact	3.20
3(i) recognition for need to & ability to engage in life-long learning	3.20
3(j) knowledge of contemporary issues	3.25
3(k) ability to use techniques, skills & modern engineering tools	3.32

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In the second part of the survey, the students were asked to answer twelve questions. The central limit theorem[xvii] was used to obtain the standardized sample mean (Z) whose values are given by the difference between the sample mean and population mean divided by the standard error of the mean. For a sample size of 145, one can conveniently and accurately assume that the distribution of the standardized sample mean is normal. Setting the statistical significance criteria at the 95% confidence level, in other words, that $1\text{-}F(Z) > 0.95$, one can determine the statistical significance of the responses to each question in Table VI. As can be seen from the last column of the table, responses to questions 1, 2, 7, 8, 10, and 12 are the questions that display a statistical significance in the post-survey responses with respect to the pre-survey responses. An examination of the statistically significant responses shows that the implementation of service learning may have had an impact on the students from the following perspectives:

(a) Students have reinforced their belief that service and academic coursework should be integrated.
(b) Students developed a better sense that engineers should use their skills to solve social problems facing their local community as well as communities internationally.
(c) They have become more interested in pursuing a career that involves helping people.
(d) They have become more comfortable working with people from different race and backgrounds.
(e) They have developed better relations with the faculty members.

DISCUSSIONS

How to fit more material into an already packed curriculum is a continuing challenge to engineering educators and students. From our experiences, it was found that a S-L project can be seamlessly integrated into a course without taking out course materials and huge time commitment. Careful planning is definitely needed, i.e., a parking lot re-design project was a good replacement for a lab presentation, traffic signal study was a good replacement for a similar study using historical data, and building preliminary assessment was a good replacement for a final number-crunching exam. The extra time associated with each project was the site visit. From the students' perspective, it seems like that students spent more time (+ 0.7 hours) on the S-L projects (as indicated by the students' survey in Table VI) as opposed to regular projects. This is expected when a social dimension is added to a project; which typically requires more time for the students to think through all unforeseeable issues and incorporate their thinking into design or analysis. With careful planning, we were able to cover all the subjects that we can normally cover.

Finding the right project for the community and students can be challenging. The project has to be the "right size" and "right topic" so that it is feasible for the students to accomplish within class time and be able to deliver the product to the community partner. Therefore, adequate planning and detailed coordination with the community are both critical to the success of each project.

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TABLE VI
STATISTICAL SIGNIFICANCE OF POST S-L EXPERIENCE SURVEY RESULTS

Other survey questions (1-9, 9=strongly agree)	Pre-survey (n=218)		Post-survey (n=145)		1-F(Z)	Statistical Significance
	Mean	Std. Dev.	Mean	Std. Dev.		
a. The amount of effort I put into the service-learning project was greater than what I would have put in for an equivalent project not involving service.	-	-	5.7	2.1	-	-
b. In the service project, I learned how to apply concepts learned in class to real problems.	-	-	6.4	1.6	-	-
c. In the service project, I learned how to work with others effectively.	-	-	5.9	2.0	-	-
1. Service and academic coursework should be integrated.	5.6	2.0	6.2	1.8	1.00	√
2. Engineers should use their skills to solve social problems.	6.1	2.2	6.7	1.8	1.00	√
3. I feel that social problems are not my concern.	3.9	2.3	3.6	1.9	0.10	x
4. People who receive social services largely have only themselves to blame for needing services.	4.2	2.1	3.9	2.0	0.05	x
5. Social problems are more difficult to solve than I used to think.	5.5	1.9	5.5	1.8	0.33	x
6. The problems of unemployment and poverty are largely the fault of society rather than of individuals.	4.9	2.1	5.1	1.8	0.82	x
7. I feel that I can have an impact on solving problems that face my local community.	5.9	1.9	6.3	1.4	0.97	√
8. I feel that I can have an impact on solving problems that face under-served communities internationally.	5.4	1.9	5.7	1.7	0.99	√
9. It is important to me personally to influence the political structure.	4.7	2.0	4.9	1.9	0.82	x
10. It is important to me personally to have a career that involves helping people.	5.8	2.1	6.2	1.8	0.99	√
11. I feel uncomfortable working with people who are different from me in such things as race, wealth, and life experiences.	3.1	2.8	3.0	2.5	0.46	x
12. I have developed a close personal relationship with at least one faculty member at this institution.	4.4	2.3	5.2	2.3	1.00	√

CONCLUSIONS

The integration of service-learning has been demonstrated in three courses within the civil and environmental engineering undergraduate curriculum at UML. Community partners were identified and actively involved during the completion of these projects. Quantitative deliverables were presented to the community partners. At the completion of these service-learning projects, the students not only accomplished the specific community objectives but also important technical objectives for the courses. These projects also helped to meet several ABET program outcomes. A unique assessment instrument was used and demonstrated that service learning had several positive impacts on the students.

The integration of service learning into the curriculum is a first step towards undergraduate curriculum reform in the Department of Civil & Environmental Engineering at the University of Massachusetts Lowell. This process added breadth to the course content and made a positive contribution to the curriculum development.

ACKNOWLEDGEMENT

The authors would like to thank the National Science Foundation for the financial support, and the City of Lowell, Architectural Heritage Foundation in Lowell for their assistance in the projects presented in this paper.

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Appendix A: Course Survey of "Introduction of Engineering II" - Spring 2005

0 = no success 1 = limited success 2 = moderate success 3 = mostly successful 4 = complete success

To what degree are the following course outcomes achieved? 0=never confident, 1=sometimes confident, 2= fairly confident, 3=confident, 4=very confident	0	1	2	3	4
1.1 I can *create* a presentation using PowerPoint.					
1.2 I can *communicate* technical information both orally and in a written format.					
1.3 I can *make* 2D dimensioned engineering drawings using AutoCAD.					
1.4 I can *make* 2D layered engineering drawings using AutoCAD.					
1.5 I *understand* the complexity of ethical issues in Engineering.					
1.6 I *learned* about the different specialties within Civil & Environmental Engineering.					
1.7 I enjoyed the nanoiron synthesis lab.					
1.8 I enjoyed doing the service-learning project.					
1.9 The final project was a good way to incorporate the major skills we learned in this class (i.e. AutoCAD, PowerPoint, oral presentation and teamwork).					
1.10 I feel I have improved my presentation skills and computer skills.					
Did this course help you better achieve the CEE Program Educational Objectives? 0 = not at all; 1 helped somewhat; 2 helped; 3 helped a lot; 4 helped tremendously	**0**	**1**	**2**	**3**	**4**
2.1. understanding of math & eng. science as it relates to engineering practice					
2.2. knowledge & ability to apply engineering & critical thinking skills to engineering analysis in Civil Engineering					
2.3. knowledge & skills to design, conduct, evaluate experiments & work in teams					
2.4. ability to communicate technical & professional information in written & oral forms					
2.5. understand need for life-long learning & moral, ethical & professional obligations					
Did this course help you better achieve the following ABET Program Outcomes? (0 = not at all; 1 helped somewhat; 2 helped; 3 helped a lot; 4 helped tremendously)	**0**	**1**	**2**	**3**	**4**
3(a) ability to apply knowledge of math, science & engineering					
3(b) ability to design experiments, & analyze & interpret data					
3(c) ability to design a system, component or process to meet desired needs					
3(d) ability to function on multidisciplinary teams					
3(e) ability to identify, formulate & solve engineering problems					

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3(f) understanding of professional & ethical responsibility					
3(g) ability to communicate effectively					
3(h) understand global & societal impact					
3(i) recognition for need to & ability to engage in life-long learning					
3(j) knowledge of contemporary issues					
3(k) ability to use techniques, skills & modern engineering tools					
Overall, what is your assessment of the following? 0 = very poor, 1 = poor, 2 = OK, 3 = good, 4 = great	0	1	2	3	4
4.1 Lab Exercises					
4.2 Public speaking sessions					
4.3 Lectures					
4.4 Examples					
4.5 Field trip					
4.6 Teaching Assistant					
For the following, use 0 = definitely no, 1 = not really, 2 = so-so, 3 yes, 4 = definitely yes	0	1	2	3	4
5.1 Was the instructor knowledgeable about the course material?					
5.2 Did the instructor foster and maintain a learning environment in the class?					
5.3 Did the instructor explain the course material clearly?					
5.4 Did the instructor do a good job of helping you learn the material in the course?					
5.5 Did you find the pace of the course appropriate?					
5.6 Do you feel that you have been fairly assessed in this course?					
5.7 Are you satisfied with your performance in this class?					
5.8 Do you feel the material in this course is important to your engineering career?					
5.9 Would you recommend this course to other students in engineering?					

Appendix B: S-L Project Student Survey[xiii]

UML Student ID (ISIS No.) ___________________
Today's Date: ___________________ Course Number: _________________
Questions for students ("post")

i. Did you participate in a service-learning project in this course? __ Yes __ No
A. Gender: __ Male __ Female
B. Are you an international student: __ Yes __ No

C. Ethnicity: __ Asian __ Black __ Caucasian __ Hispanic
__ Native American __ Other:_________________

D. Have you voted in a previous election? __ Yes __ No

E. How far do you live right now from campus? ____ miles (If you live on campus, put zero.)

F. Age: _____
G. Have you ever been involved in community service activities before? Check all that apply:
__No __ Yes, during high school __ Yes, during college

H. How many hours per week do you work at a paid job? _____

I. How many credit-hours of courses are you taking this semester? ________

J. Please rank your five (and only five) most important career values (1 = highest):
___ Challenge: Learning new skills or information, self-development
___ Creativity: Doing things in a new way or inventing things
___ Helping: Doing things for others, building a better world
___ Income: Making a high salary
___ Independence: Being our own boss, deciding how and when to do your work
___ Outdoors: Working outside, in different types of weather
___ Physical: Being physically active at work, or being physically inactive
___ Prestige: Doing work that is seen as important, and for which people respect you
___ Public: Providing information to, and interacting with the public
___ Security: Having stable employment and income, not worrying about lay-offs
___ Variety: Doing many different activities, not doing the same things all the time
___ Team: Being cooperative, getting to know co-workers

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Please respond based on your honest reaction to each item below. Please choose the answer that makes sense to YOU; not what you think others would say.

[*1= Strongly Disagree, 5=Neutral, 9=Strongly Agree*]

a. The amount of effort I put into the service-learning project was greater than what I would have put in for an equivalent project not involving service.	1	2	3	4	5	6	7	8	9
b. In the service project, I learned how to apply concepts learned in class to real problems.	1	2	3	4	5	6	7	8	9
c. In the service project, I learned how to work with others effectively.	1	2	3	4	5	6	7	8	9
1. Service and academic coursework should be integrated.	1	2	3	4	5	6	7	8	9
2. Engineers should use their skills to solve social problems.	1	2	3	4	5	6	7	8	9
3. I feel that social problems are not my concern.	1	2	3	4	5	6	7	8	9
4. People who receive social services largely have only themselves to blame for needing services.	1	2	3	4	5	6	7	8	9
5. Social problems are more difficult to solve than I used to think.	1	2	3	4	5	6	7	8	9
6. The problems of unemployment and poverty are largely the fault of society rather than of individuals.	1	2	3	4	5	6	7	8	9
7. I feel that I can have an impact on solving problems that face my local community.	1	2	3	4	5	6	7	8	9
8. I feel that I can have an impact on solving problems that face under-served communities internationally.	1	2	3	4	5	6	7	8	9
9. It is important to me personally to influence the political structure.	1	2	3	4	5	6	7	8	9
10. It is important to me personally to have a career that involves helping people.	1	2	3	4	5	6	7	8	9
11. I feel uncomfortable working with people who are different from me in such things as race, wealth, and life experiences.	1	2	3	4	5	6	7	8	9
12. I have developed a close personal relationship with at least one faculty member at this institution.	1	2	3	4	5	6	7	8	9