AC 2007-2639: SERVICE-LEARNING INTEGRATED INTO EXISTING CORE COURSES THROUGHOUT A COLLEGE OF ENGINEERING

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Service-Learning Integrated into Existing Core Courses throughout a College of Engineering

Abstract

Service-Learning (S-L) and engineering education share the common goals of relating theory to practice and of civic engagement ("public problem solving"). In the current effort, service-learning is being integrated into a broad array of courses so that students will be exposed to S-L in ***every*** semester in the core curriculum in ***each*** of the five engineering departments at University of Massachusetts Lowell. The focus here is on the learning of traditional engineering content by engaging diverse learners in solving authentic problems in the community and in the process achieving ABET criteria and attracting underrepresented groups into engineering. Thirty-three faculty members out of 75 in the college integrated S-L into 52 different courses in 2005-06. Readers will find a wide array of projects and examples that can be adapted to their own courses.

Introduction

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 (Jacoby, 1996)[2]. Service-learning (S-L) has been shown to be effective in a large number of cognitive and affective measures, including critical thinking and tolerance for diversity, and leads to better knowledge of course subject matter, cooperative learning, recruitment of under-represented groups in engineering, retention of students, and citizenship, as well as helping meet the well-known ABET EC2000 criteria (a)-(k) (ABET, 2005)[1].

Service-learning team projects have the potential to ensure students learn and demonstrate these qualities in addition to the ability to apply engineering to the design and analysis of systems and experiments. Instead of adding more courses to satisfy ABET requirements, these criteria are met by S-L projects in existing core courses. For example, having community partners on S-L projects essentially guarantees that students will work on multidisciplinary teams. With the correct structure of S-L projects, the students will examine the impacts of engineering solutions in a societal context. Also, if S-L projects replace traditional analytical exercises in courses, the overall workload will typically not increase for the students. If students are motivated to spend more time on S-L projects, they are free to do so and should learn more in the process.

The approach of S-L, with its root in experiential learning, is consistent with the theories and empirical research of a number of leading educators and developmental psychologists, as documented by Brandenberger [3] and Jacoby[2]. The approach is also consistent with the recent change in paradigm in education from a focus on teaching to a focus on learning[3,4]. Astin et al[5]. found with longitudinal data of 22,000 students that service participation had significant positive effects on 11 outcome measures: academic performance (GPA, writing skills, critical thinking skills), values (commitment to activism and to promoting racial understanding), self-efficacy, leadership (leadership activities, self-rated leadership ability, interpersonal skills), choice of a service career, and plans to participate in service after college. "These findings directly replicate a number of recent studies using different samples and methodologies."(p.i) [7] They found that S-L to be significantly better in 8 out of 11 measures than just service without the course integration and discovered "strong support for the notion that service learning should be included in the student's major field."(p.ii) [8]

Eyler and Giles[9] in a classic study included 1500 students from 20 colleges/universities in a study of the effect of S-L. Service-learning was found to impact positively: tolerance for diversity, personal development, interpersonal development, and community-to-college connections. Students reported working harder, being more curious, connecting learning to personal experience, and demonstrated deeper understanding subject matter. The quality of placements in the community and the degree of structured reflection were found to be important in enhancing the positive effects, significantly so for critical thinking increases. They found that the "students who participated in service-learning differed significantly from those who did not participate on almost every outcome we measured."(p.182) [10] They summed up effective S-L principles in: connection (students, peers, community, faculty; experience and analysis); continuity (all four years; reflection before, during, after service); context (messiness of community setting is integral to learning); challenge (to current perspectives; not overwhelming); and coaching (opportunity for interaction; emotional, intellectual support).

There are varied opinions in the literature regarding whether S-L projects should be required or not. Eyler and Giles[10] state: "Service-learning is often better academic learning and thus a legitimate requirement of an academic program…Students who are most in need of the developmental opportunities afforded by service-learning may be less likely to choose such course options voluntarily" (p. 182). In contrast, Clary, Snyder, and Stukas[11] and Werner[12] argue for voluntary S-L, based on research showing a required activity reduces intrinsic motivation. In addition, S-L appears to have the potential to attract and retain underrepresented populations in engineering through meaningful and experiential applications. Recent experience at Purdue indicates that voluntary S-L courses attract twice the percentage of women engineering students compared to the student engineering population[14]. Our own experience with voluntary capstone courses also indicates a similar overrepresentation of women (in one course 4 to 1 over 6 years) and older and more diverse students.

In questionnaires prepared by Duffy[13], only approximately 20% of 260 student responses in his courses from 1997 to 2004 disagreed with the statement that service and academic coursework should be combined. Responses were correlated with age and gender, with older students and women more positive about the integration of service with learning. Eyler and Giles[9] had a similar percentage with their 1500 students in many disciplines.

Service-learning itself is certainly not new, and S-L in engineering is not new. Oakes (2004)[14] has a list of 33 universities that have S-L in engineering and describes a number of examples of S-L. In 2004-05 the National Science Foundation (NSF) funded ten programs to introduce S-L into engineering, which would add about 8 more universities to the previous list of 33. Perhaps best known is EPICS (Engineering Projects in Community Service), which started at Purdue and now includes 17 universities. The program involves elective interdisciplinary S-L courses that students can take from first year to senior year[15]. Tsang (2000)[16] and Lima and Oakes (2006)[17] describe more examples of S-L in engineering courses. Most of these S-L courses are capstone or elective courses with some first-year introduction to engineering courses.

In short, S-L and engineering education share the common goals of relating theory to practice and of civic engagement ("public problem solving"). In the current effort, service-learning is being integrated into a broad array of courses so that students will be exposed to S-L in every semester in the core curriculum in each of the five engineering departments at University of Massachusetts Lowell (UML). The focus here is on the learning of traditional engineering content in core required courses by engaging diverse learners in solving authentic problems in the community and in the process achieving ABET criteria and attracting underrepresented groups into engineering. The aim is more effective learning in core courses with possibly less coursework time overall than traditional programs satisfying ABET EC2000 criteria. The program is called SLICE, Service-Learning Integrated throughout a College of Engineering. The approach contains a mixture of required and elective S-L projects, depending on the wishes of the instructors. This project builds on a long history of a variety of core courses with S-L by three faculty members within the EE and ME Departments at UML, particularly through projects in assistive technology and global sustainable infrastructure development[13].
Given this effort's large scale, a number of questions needed to be addressed:

1. Can enough faculty members be recruited who are willing to offer service-learning in their required courses to meet the goal of one S-L course every semester for every student?
2. Will a significant number of students be open to doing S-L projects?
3. Will this program attract underrepresented groups into engineering?

The SLICE program is a work in progress; however, there are results so far to address these questions.

Approaches, Methods, and Results

The approaches and methods to develop the project and answer these questions are described below.

Faculty Engagement and Response

Faculty were recruited via personal contacts and through workshops offered in the summer and fall of 2004. All engineering faculty were invited. The summer workshop was an all day affair with presentations by Dwight Giles as well as community partners and breakout discussions; Dwight Giles is a well-known researcher in service-learning[9] and was a consultant on the project. A second workshop was about 3 hours and focused on assessment, and again Dwight Giles presented. A planning grant from NSF allowed faculty to develop S-L courses through minigrants and graduate student support, and a part-time S-L coordinator was hired to provide an easier link to community partners for faculty new to S-L. The authors of this paper provided additional help voluntarily. A motto for the faculty has been: "**Start small rather than not at all**." Courses were offered in the academic year 2004-05 by twenty-five different faculty members. The courses and their S-L projects are listed in Table A1 in Appendix A. The majority of the projects represent about 10-15% of the course, while some like capstone design were 100% S-L driven, and others provided S-L extra credit worth only a few percent.

Most of the same courses were offered in the fall of 2005 with some additions, as shown in Table A2, also in Appendix A. Five faculty members tried S-L for the first time in fall 2005. An implementation grant from NSF in early fall 2005 allowed the continuation of minigrants, more graduate student assistants, and the hiring of a full-time S-L coordinator. Concurrently, the university matched resources to provide course release time for faculty members who serve as department coordinators as well as a course release for one faculty member in each department to develop significant, high quality S-L projects in a course or courses. Over the course of the first year of SLICE implementation, more than **30 community partners** were engaged in anywhere from 1 to 9 S-L courses each; more than **32 faculty and 5 teaching staff participated** in the project and about **721 undergraduate students** and over **58 graduate students** were involved with S-L projects of the 2005-2006 academic year, for a total of **52 courses** (35 required undergraduate courses and 17 graduate /elective or related courses). Most faculty who are repeating their courses plan to engage in S-L projects again, and a number of faculty new to S-L are looking at ways to incorporate S-L into their classes in the future.

We are presently having biweekly community of practice meetings of faculty with a few invited students and occasional outside presenters and community partners to discuss objectives, techniques, problems, solutions with improving the S-L projects in our courses. It appears that our motto of "Start small rather than not at all" is working. We are targeting small but likely successful projects. We now need to focus on better delivery of projects to community partners and of analysis by students on the significance of their projects to the community and to society at large.

A description of a sampling of S-L projects from Tables A1 and A2 follows.

- In the Introduction to Engineering Course, nearly 300 students for two years in a row have split into teams to design and build working exhibits for the Tsongas Industrial History Center, part of the National Park Service[18]. More than 50,000 middle school children a year now interact with one dozen displays chosen by the museum out of the 120 exhibits built by the students. The design project constituted 25% of the course.

- For more than nine years, the UML Village Empowerment Project team has worked together in a large number of S-L projects with residents of remote Peruvian mountain villages, many lacking electricity, running water, and space heat. Students have designed and helped install in 35 villages with the local indigenous folks over 75 systems, many solar powered, to meet their basic material needs, such as water supply and purification, transceiver communication, vaccine refrigeration, and lighting in medical clinics, laptop computers in schools, and prosthetic limbs. A group of students along with other volunteers travel twice a year to these villages. In all fifteen courses have S-L activities stemming from this project. One example includes the Engineering Ethics course in which students were assigned: ***Village Empowerment and the Role of Television: A Position Paper.*** The objective of this project was to investigate the ethics of technology[*] with students: (1) carrying out a thorough search of the addressing the provision of television, especially in developing countries, and (2) writing a position paper based on best available evidence that the Peru team respond to the Peruvian village request.

- Another example involves a playground design for children with disabilities and a safety analysis of local existing playgrounds for a sophomore dynamics course. In the spring of 2005, over fifty students split into teams of two or three and chose different playgrounds in the surrounding area. Safety reports (requiring calculations with dynamics principles and including recommendations for improvements) that meet quality standards are sent out to those responsible for the playgrounds.
- A fourth example involves the soldering of voice recorder circuits by 70 first year electrical engineering students in the second semester of the introduction to engineering course. The voice boxes are for children who cannot speak but are able to push the bottom on the voice box to play a prerecorded message, such as, "Please give me some water." Each of several boxes for an individual has a different message.

The chart below (Table 1) indicates how the courses with S-L fit into curriculum by semester in 2004-05 and in which the S-L projects are required (☻) and which are elective (☺).

Table 1. Distribution of courses with S-L by semester in each program 2004-05.

Year	**ChE**	**CE**	**EE**	**ME**	**PE**	**Other**
FR 1	☻	☻	☻	☻	☻	
FR 2	☻	☻	☻	☺	☻	
SO 1		☻			☻	
SO 2		☻		☻ ☻	☻	
JR 1			☻ ☻			☻ **Ethics**
JR 2		☻	☻	☻		☻ **Ethics**
SR 1		☻	☻	☺	☻	
SR 2		☻	☻	☺		☻ **Writing**
Tech.Electives		☻		☻ ☻ ☻	☻	

The chart below (Table 2) indicates how the courses with S-L fit into curriculum by semester in 2005-06 and in which the S-L projects are required (☻) and which are elective (☺).

Table 2. Distribution of courses with S-L by semester in each program 2005-06.

Year	**ChE**	**CE**	**EE**	**ME**	**PE**	**Other**
FR 1	☻	☻	☻	☻	☻	
FR 2	☻	☻	☻	☺	☻	
SO 1		☺		☻ ☺	☻ ☺	
SO 2				☻ ☻	☻ ☻	
JR 1		☻	☻	☻		☻ **Ethics**
JR 2	☻ ☻	☻ ☻		☻ ☻	☻	☻ **Ethics**
SR 1			☻	☺ ☺ ☻		
SR 2			☻	☺ ☺	☺	
Tech.Electives	☻	☻ ☻	☻	☻ ☻ ☻ ☻		

So even during the planning year, 24 required undergraduate courses had service-learning projects with almost 700 students each semester being reached. In addition, 23 faculty tried the service-learning approach. We had 24 courses out of 36 needed, or two-thirds of the way to achieve our goal of at least one course available each semester with S-L. For implementation, we need to have 12 more courses and in addition to improve the quality of all the S-L projects.

Independent analysis by Dwight Giles and colleagues of additional initial assessment information (i.e., select interviews with 7 faculty in the summer of 2005 and written feedback by 8 faculty with about 50% overlap in the two groups) led to the following initial conclusions about faculty involvement:

- Faculty members are experiencing increased sensitivity to the social, cultural, and environmental consequences of engineering decision making.
- Faculty members are experiencing high levels of satisfaction in teaching and service.

A survey was distributed to faculty members after a fifteen-minute presentation by the first author on S-L during a faculty retreat in December 2004. With 70% of the 68 faculty responding, the survey results indicated that almost two-thirds agreed to the goal of this project, with only about 15 percent indicating they were not planning to incorporate S-L into any of their courses. Faculty ranked time as the biggest barrier to trying S-L followed by issues related to liability, lack of financial and staff support, and lack of information about S-L tied for second place. Interestingly enough, the lowest ranking barrier was lack of clear policy of the place of S-L in promotion and tenure.

Despite the perceived barriers, 23 faculty members actually implemented S-L into at least one of their courses during the 2004-‘05 academic year. In the next academic year, the number grew to 33 full-time and 5 part-time, representing about half the faculty. Virtually all those who tried S-

L are continuing to use it. While some of the S-L projects represented only a small part of the course, we now have a significant fraction of the faculty involved in the process of starting and eventually improving S-L in their core courses.

A second survey of our engineering faculty members found that 66 percent agreed to the goal of this project, with only about 15 percent indicating they were not planning to try S-L. Faculty ranked time as the biggest barrier to trying S-L.

Other results are tabulated in Table 3 below for the December 2004 survey. They are compared to results tabulated in Table 4 for the December 2005 survey.

On most of the responses in both years, faculty members were significantly different from neutral, that is, they either agreed or disagreed rather than being neutral (neutral would be 5 on the Likert scale). It is interesting to note that the faculty in 2004 showed no significant differences with the students in their responses except for one. The faculty mean responses were not significantly different from one year to the next.

Table 3. Faculty Survey, Dec. 2004

	Mean responses to Likert scale of 1 (disagree) to 5 (neutral) to 9 (agree)						
(Yellow signifies significant difference, 5%)			Significant Difference (5%) t-test			ChiSq and t-test	t-test
	mean	num-ber	gender, f=6, m=38	tenure, no=13, yes=34	Mean minus 5, different from neutral	different from faculty '05	different from student '04
Statement 2004							
a. With service learning, course learning objectives are met in a credit-bearing course while real community needs are met.	6.43	44					
b. With service-learning that is well done, research has shown that students learn the subject matter better.	6.36	45					
c. With service-learning, research has shown that students become better citizens.	6.28	46					
d. There is evidence that underrepresented groups in engineering (e.g., women) participate in s-l projects voluntarily at a much higher rate than their proportion in the population of students would predict.	6.13	46					
e. With service-learning, academic credit is earned for learning gained from the experience, not for the service itself; the courses are academically rigorous.	6.20	46	By 1.7, F higher than M	By 1.3, no tenure higher than tenure			
f. In principle, service-learning would be beneficial to the students in the courses I teach.	6.30	46					

h. I agree in principle to the goal of having at least one service-learning course available every semester for every undergraduate in our college of engineering.	6.26	46					
i. It is possible to integrate service-learning into existing non-s-l courses without adding to the overall workload of students by replacing existing homework, projects, lab experiments, lectures, etc. with similar activities solving real problems.	5.04	47	By 3.7, female higher than male				
1. Service and academic coursework should be integrated.	6.04	46					
2. Engineers should use their skills to solve social problems.	6.26	46					
3. I feel that social problems are not my concern.	3.00	46	By 2.3, F lower than M				
4. People who receive social services largely have only themselves to blame for needing services.	3.35	46					
5. Social problems are more difficult to solve than I used to think.	5.81	47					
6. The problems of unemployment and poverty are largely the fault of society rather than of individuals.	4.83	46					
7. I feel that I can have an impact on solving problems that face my local community.	6.13	46					
8. I feel that I can have an impact on solving problems that face under-served communities internationally.	6.15	46					
9. It is important to me personally to influence the political structure.	5.82	45					
10. It is important to me personally to have a career that involves helping people.	6.23	43					
11. I feel uncomfortable working with people who are different from me in such things as race, wealth, and life experiences.	2.89	37	By 2.2, female lower				

There were a few significant differences in the mean responses by gender and tenure status (t-test with unequal variances at the 5% significance level). Item e (With service-learning, academic credit is earned for learning gained from the experience, not for the service itself; the courses are academically rigorous) the difference of male (n=37) minus female (n=6) means was -1.725, indicating more agreement with the statement for female faculty members. Item e was also the only one in which the non-tenured (n=13) showed a significant difference relative to the tenured faculty (n=33), by an average of 1.34, indicating more agreement. Thus, it appears that female and non-tenured faculty are more confident that S-L courses can be academically rigorous.

Table 4. Faculty Survey, Dec. 2005

	Mean responses to Likert scale of 1 (disagree) to 5 (neutral) to 9 (agree)						
{Yellow denotes significant difference, 5%}			Significant Difference (5%) t-test				t-test
Statement	mean	num -ber	gender, f=6, m=38	tenure, no=13, yes=3 1	different from neutral (5)		different from student s '05
4. With service learning, it is possible to meet course learning objectives in a credit-bearing course while also meeting real community needs.	6.07	45					
5. When service-learning is done well, students learn the subject matter better than in a traditional classroom.	6.57	44					
6. With service-learning, students become better citizens.	6.73	45					
7. Service-learning can be an effective way to increase the involvement of women and other underrepresented groups in engineering.	6.36	45					
8. Service-learning courses can be academically rigorous.	6.22	45					
9. In principle, service-learning would be beneficial to the students in the courses I teach.	6.33	45					
10. I agree in principle with the goal of having at least one service-learning course available every semester for every undergraduate in our college of engineering.	6.86	44					
11. It is possible to integrate service-learning into existing engineering courses without adding to the overall workload of students by replacing existing homework, projects, lab experiments, lectures, etc. with similar activities solving real problems in the community.	5.64	45					
12. Service and academic coursework should be integrated.	6.33	45		By 1.3, no tenure higher			
13. Engineers should use their skills to solve social problems.	7.89	45					
14. I feel that social problems are not my concern.	2.20	45	By 1.2, female lower				

15. People who receive social services largely have only themselves to blame for needing services.	2.82	45					
16. Social problems are more difficult to solve than I used to think.	5.77	44					
17. The problems of unemployment and poverty are largely the fault of society rather than of individuals.	5.49	45					
18. I feel that I can have an impact on solving problems that face my local community.	6.80	45					
19. I feel that I can have an impact on solving problems that face under-served communities internationally.	6.29	45					
20. It is important to me personally to influence the political structure.	6.20	45					
21. It is important to me personally to have a career that involves helping people.	7.16	45					
22. I feel uncomfortable working with people who are different from me in such things as race, wealth, and life experiences.	2.64	45					

There were three other items that showed significant differences by gender: item i (It is possible to integrate service-learning into existing non-s-l courses without adding to the overall workload of students by replacing existing homework, projects, lab experiments, lectures, etc. with similar activities solving real problems) had more agreement by female faculty by an average of 3 points; item 3 (I feel that social problems are not my concern) had more disagreement by an average of 2.3, and 11 (I feel uncomfortable working with people who are different from me in such things as race, wealth, and life experiences) had more disagreement by an average of 2.2 (n=5 female, n=30 male).

Students

About 750 "pre" and almost 400 "post" S-L questionnaires in 2004-05 were obtained from the students, with the survey questions given in Appendix B. Some of the pre surveys are undoubtedly, and unavoidably, duplicates as some students were in more than one S-L course. Some interesting preliminary results emerge: In the "pre" surveys, in a ranking of 12 possible reasons for wanting to go into engineering, "helping others" ranked second to "challenge, self-development" among females and non-Caucasians, but did not rank in the top four for Caucasians, losing out to challenge, income, creativity, and security (Table 5). One of the expected outcomes of the project is to attract underrepresented groups to engineering. The trend of difference continued in the pre-survey in the fall of 2005, with over 500 responses: females and males showed significant differences in the "helping others" category ranking with a Chi-Square test at the 5% significance level. U Mass Lowell had 12% females in its undergraduate engineering population of 914 full-time students in 2004-2005 (http://asee.org/publications/profiles/). That fraction of female students is below the national average of 17.5% (http://asee.org/publications/profiles/upload/2005ProfileEng.pdf), so the above results of the differences by gender is encouraging in the sense that they support the notion that

S-L will be a factor in attracting females into engineering in general and U Mass Lowell in particular.

Table 5. Fall 2004 Student Weighted Averages:

Ranking of reasons for being in engineering (weighting: 5 for 1st, 4 for 2nd, 3 for 3rd, 2 for 4th, 1 for 5th)

Reason	Weighted Average	Male Rank	Weighted Average	Female Rank
Challenge	607	1	249	1
Income	401	2	145	4
Creativity	391	3	147	3
Security	366	4	123	5
Helping	198	5	173	**2**

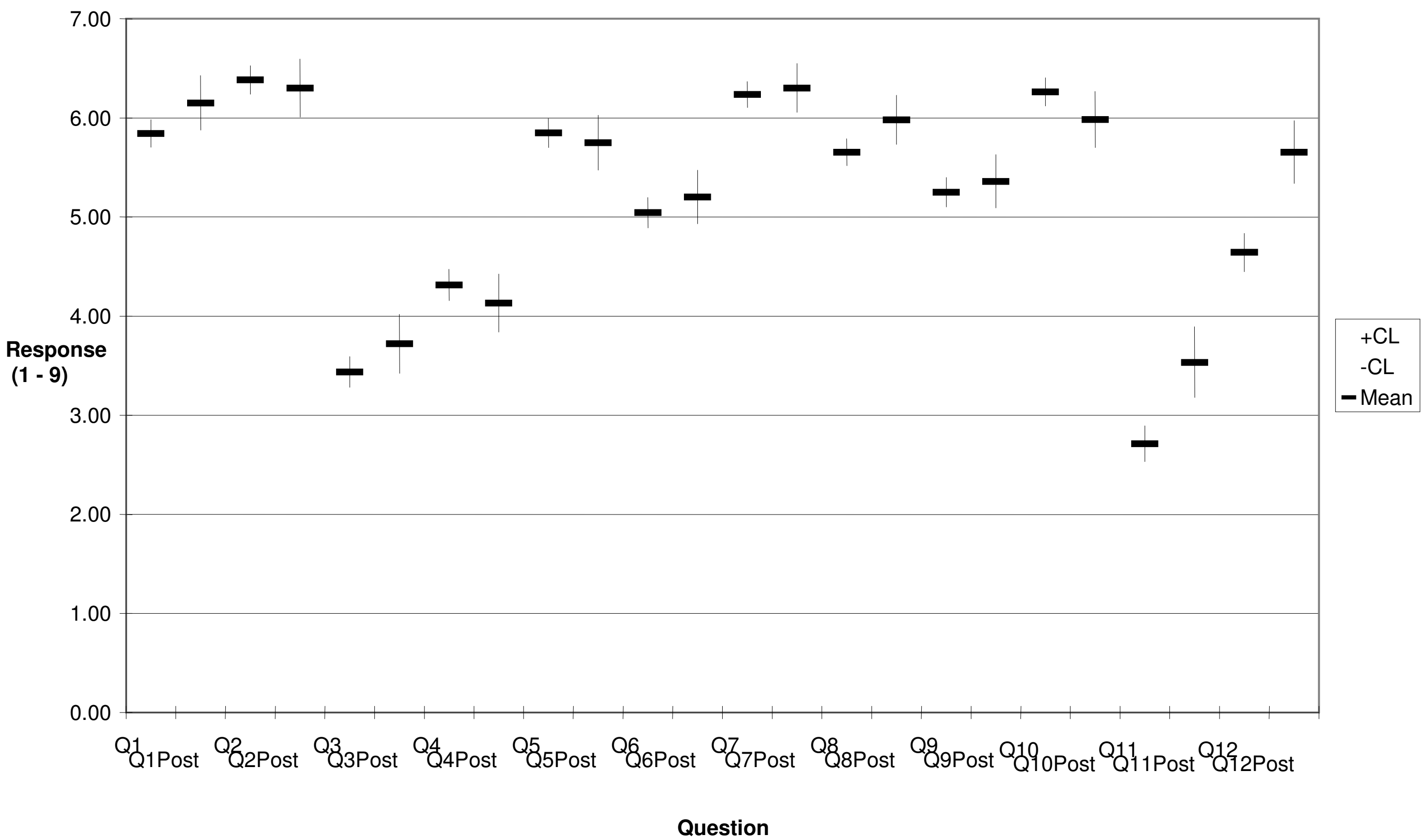
In response to the statements that service and academic coursework should be integrated (question 1) and whether students felt empowered to solve social problems (questions 7 and 8), students showed a significant increase (in a t-test at a 5% level) in positive agreement from "pre" to "post." A Pearson Chi-Square test yielded a significant increase at the 5% level in agreement between pre- and post-surveys on the statement that engineers should use their skills to solve societal problems (question 2).

To the statement "The amount of effort I put into the project in service to others was greater than what I would have put in for an equivalent project not involving service," only 20 % disagreed in the post-survey. Presumably more effort leads to more learning. This is presumably voluntary extra effort, not required by the instructor, as one of the goals of the project is to not increase the time students spend in course work.

The chart below (Figure 1) displays the mean responses to questions 1 through 12 in the pre and post surveys along with the 95% confidence limits (i.e., (1.95) * standard error of the mean).

Interestingly enough, there is no significant difference in the means of students and faculty responses to the "attitude" questions 1 through 11 (Table 6 for Fall 2004), except question 4 where the faculty average disagreement differed significantly from the students. The students more than the faculty believe that people who receive social services largely have only themselves to blame for needing services.

Fig. 1. Pre and Post Mean Student Responses 04-05 (and 95% confidence limits)



The focus in this study on assessment is on expected long-term results, so individual course pre- and post-surveys were not necessarily taken. The results are pooled across courses. It is expected that it will take S-L in several core required courses before dramatic results are seen in students.

Courses with S-L projects in 2004-05 and the fall of 2005 had enrollments totaling about 700 students for each of the semesters. A wide variety of courses included S-L, as is evident in the tables described above. To quantify the S-L impact, a "pool" of student questions was developed with S-L staff at MIT with the hopes that pooling of data could be started and that sharing of the data could help research on the impacts of S-L[19]. The UML questionnaire is shown in Appendix B at the end of the paper.

Table 6. Common questions in both student and faculty surveys
1. Service and academic coursework should be integrated.
2. Engineers should use their skills to solve social problems.
3. I feel that social problems are not my concern.
4. People who receive social services largely have only themselves to blame for needing services.
5. Social problems are more difficult to solve than I used to think.
6. The problems of unemployment and poverty are largely the fault of society rather than of individuals.
7. I feel that I can have an impact on solving problems that face my local community.
8. I feel that I can have an impact on solving problems that face under-served communities internationally.
9. It is important to me personally to influence the political structure.
10. It is important to me personally to have a career that involves helping people.
11. I feel uncomfortable working with people who are different from me in such things as race, wealth, and life experiences.

About 750 "pre" and almost 400 "post" S-L questionnaires in 2004-05 were obtained from the students. Some of the pre surveys are undoubtedly and unavoidably duplicates as some students were in more than one S-L course. Some interesting preliminary results emerge: The trend of difference continued in the pre-survey in the fall of 2005, with over 500 responses: females and males showed significant differences in the "helping others" category ranking with a Chi-Square test at the 5% significance level.

In response to the statements that service and academic coursework should be integrated and whether students felt empowered to solve social problems, students showed a significant increase (in a t-test at a 5% level) in positive agreement from "pre" to "post."

To the statement "The amount of effort I put into the project in service to others was greater than what I would have put in for an equivalent project not involving service," only 20 % disagreed in the post-survey. This is presumably voluntary effort, not required course time.

The focus in this study on assessment is on expected long-term results, so individual course pre- and post-surveys were not necessarily taken. The results are pooled across courses. It is expected that it will take S-L in several core required courses before dramatic results are seen.

An exception to this approach was taken with the first-year introduction to engineering course 25.107, since the class was large with 300 students in the fall of 2005 and since the S-L project represented 25% of the course. A paired-t test was performed on the 100 pre and post surveys that had ID numbers entered and that could be matched. At the 5% level, there was a significant difference in the average level of agreement on questions 1, 2, 3, 8, 9, 10, and 12. All the mean changes in responses were in the positive direction pre to post, except the responses to question 3; that is, all were in the direction one would expect in terms of improvement. The first-year introduction to engineering course has shown an increase in grade point average over the two years in which S-L has been introduced relative to before it was introduced[18].

Based on 740 "pre" and 433 "post" S-L questionnaires in both academic years 04-06, some interesting results emerge: To the statement "The amount of effort I put into the project in service to others was greater than what I would have put in for an equivalent project not involving service," only 20 % disagreed. In the spring 2006 post survey, to statements that S-L helped increase interest in learning, increase commitment to the community, improved writing and speaking skills, leadership ability, personal ability to "make a difference," value of teamwork (among others) 433 students recorded a range of agreement to non-agreement on a 1-9 point Likert scale, and a majority agreed. Paired t-tests on 114 pre and post surveys matched by student ID number in 2005-06 showed significant increases in three measures: of the importance of a career that involves helping people, that engineering should use their skills to solve social problems, and of a close personal working relationship with a faculty member. The later measure has been shown to effect retention of students (Astin et al., 2000)[6]. Table 7 shows more detailed results. On essentially all the opinion questions, the students and faculty show significant differences from neutral.

In capstone design courses involving clients with disabilities and involving work with indigenous people in remote villages in Peru, a few students in these courses have indicated in unsolicited comments that the experience has resulted in their changing the focus of their careers.

Independent analysis of initial additional assessment information (i.e., select interviews with 7 faculty, analysis of 10 student research/design/interview papers, and written feedback by 8 faculty by Dwight Giles and his associates in the summer of 2005) led to the conclusions:

- Students are using subject matter to solve "real world" problems in a variety of service-learning projects.
- Students are motivated and active in their learning.
- Students and faculty are experiencing increased sensitivity to the social, cultural and environmental consequences of engineering decision making.

Community Partners

Community partners varied from the Lowell National Historic Park, many local rehabilitation clinics, the Cambodian Mutual Assistance Association, and the City of Lowell Transportation Office to remote villages in Peru and India.

We had a structured survey for the community partners, and we also collected unsolicited responses from partners. The nature of engineering interaction with community partners is more akin to that of a "customer" needing a product or system, rather than what appears to be more typical of social science S-L courses in which students are placed to work along side community service personnel. Feedback was generally positive from our community partners. For example, the Lowell National Historic Park indicated that the displays designed and built by first-year students are equivalent to those for which museums typically would pay $5000 to $10,000. The lives of clients receiving assistive technology devices from the students have improved, sometimes dramatically.

Table 7. Student surveys 2004 pre and 2006 post

Note: Yellow indicates significant effect							
Likert scale for statements below: 1 = strongly disagree; 5 = neutral; 9 = strongly agree				Significant Difference (5%, t-test, unequal variances)			paired t F05 - Sp06
	year	mean	Num -ber	neutral (5)	ChiSq pre vs post	04 - 06	n = 114
Statement							
Service and academic coursework should be integrated	04	5.84	735			-0.07	-0.11
	06	5.91	430			-0.07	
Engineers should use their skills to solve social problems	04	6.35	744			-0.25	-0.54
	06	6.60	432			-0.25	
I feel that social problems are not my concern	04	3.47	735			-0.26	-0.19
	06	3.73	433			-0.26	
People who receive social services largely have themselves to blame	04	4.43	733			0.33	-0.20
	06	4.10	433			0.33	
Social problems are more difficult to solve than I used to think	04	5.86	734			0.22	-0.19
	06	5.64	433			0.22	
The problems of unemployment and poverty are largely the fault of society	04	5.08	729			0.11	-0.12
	06	4.96	432			0.11	
I feel that I can have an impact on solving local problems	04	6.32	731			0.05	-0.15
	06	6.28	432			0.05	
I feel that I can have help solve problems in under-served communities internationally	04	5.70	727			-0.08	-0.29
	06	5.78	429			-0.08	
It is important to me personally to influence the political structure	04	5.36	729			0.25	-0.41
	06	5.11	430			0.25	
It is important to me to face a career that involves helping people	04	6.23	728			0.14	-0.77
	06	6.10	428			0.14	
I feel uncomfortable working with people who are different from me	04	2.76	732			-0.29	-0.59
	06	3.05	432			-0.29	
I have developed a close personal working relationship with at least one faculty	04	4.69	721			-1.14	-1.23
	06	5.83	432			-1.14	
Statistics							
Post Spring 2006 survey		Mean	N	Signi-ficant Dif-ference	5%, t-test, un-equal vari-ances		
Note: Yellow indicates significant effect				neutral (mean minus 5)	gender : M minus F	Ethni-city ANOVA	
Chose UML because of S-L (1 = yes; 0 = no)		0.14	433			F stat	

No. of classes with SL		2.02	381				
Likert scale for statements below: 1 = strong negative impact; 5 = neutral; 9 = strong positive impact							
I can make a difference		5.54	478	0.54	-0.22	3.8	
Increased interest in learning		5.54	479	0.54	-0.44	5.0	
Increased commitment to community		5.47	479	0.47	-0.19	3.7	
Improved writing and speaking		5.38	479	0.38	0.02	3.5	
Improved ability to find info		5.44	479	0.44	-0.26	4.8	
Can evaluate information		5.53	479	0.53	-0.24	4.7	
Decision making skills		5.57	479	0.57	-0.17	4.1	
Leadership skills		5.48	479	0.48	-0.10	3.2	
Value of teamwork		5.65	479	0.65	-0.04	3.9	
Ability to plan and carry out project		5.79	479	0.79	-0.15	4.3	

Informal S-L collaborations or contacts outside the United States have occurred with communities in Peru. Our experience with the Village Empowerment Peru Project provides an approach to international service. In this project, the College has "adopted" the small network of Peruvian villages where we have worked for the last nine years. Many design projects keep springing from the needs of the villagers, including projects in water supply, water purification, water pasteurization, micro hydro, photovoltaic, biomedical, and assistive technology devices, computers in schools, sterilizers, refrigerators, and radio transceivers. These projects lend themselves to work related to all our departments of engineering to say nothing of departments of nursing, physical therapy, languages, education, health education and work environment. The students and faculty typically share the knowledge gained from the local people and projects there with students who will work on projects but not necessarily travel to Peru. This focus on adopting villages can also provide continuity from the first year through senior years. Chemical engineering freshmen, plastics engineering sophomores, mechanical engineering juniors, and civil engineering seniors have performed S-L projects associated with the "Peru Project." Medical personnel in clinics in remote villages in Peru have said repeatedly that the solar-powered transceiver radio networks designed and installed by students with local help have saved many, many lives. Whole villages get water from solar water systems instead of from irrigation canals hand-carried in buckets. The community impact assessment is quite dramatic in these cases.

Nevertheless, with community partners in general we need to improve the follow through (actually delivering student designs and analyses and devices) and assessment. Increased communication with S-L involved faculty, students and community partners represents our first step in facilitating germane improvements.

Discussion and Conclusions

Based on the information and assessment data discussed above, we can provide some answers to the previously posed questions related to the long-term goals of the project:

(1) Can enough faculty members be recruited to offer service-learning throughout the core curriculum? Almost half of the engineering faculty members have incorporated service-

learning into their courses (several faculty with more than one course) by spring 2006. No engineering faculty member to date has stopped using S-L after trying it. This is a truly encouraging number and fulfills a necessary but not sufficient condition to meet our strategic goal of at least one S-L course available to every student every semester because the distribution of S-L courses across the curriculae. We need more faculty and courses in chemical and plastics engineering to provide enough S-L opportunities for students in those programs. Progress is being made in those areas. Surveys and nterviews indicated positive attitudes in using S-L in courses.

(2) Will a significant number of students be open to doing S-L projects in several courses? Only a relatively small fraction of students (about 15%) report disagreeing with the practice of combining service and academic course work with 62% agreeing in the spring survey 2005 and basically repeated in the spring 2006 survey. A majority of the students perceive that they put in more effort on S-L projects voluntarily than on similar non-service projects. There are significant increases in perceptions of an obligation and personal empowerment to make changes in society. Changes in basic attitudes of both faculty and students toward the role of engineers in societal issues will take time to change, understandably.
(3) Will this program attract underrepresented groups into engineering? Initial indications in surveys are that women and minorities at UML consider the helping of others high on the list in their career choice. A disproportionate number of women have chosen to participate in the Village Empowerment Peru Project and other voluntary S-L projects. The evidence in this study and elsewhere that S-L may be able to attract and keep students, particularly females and other underrepresented groups in engineering. A separate paper has more information and discussion related to this question[20].

In general, the project implementation is on target relative to its goals. S-L integrated into core required courses seems to be achieving the hoped-for results, so far. The numbers of courses, students, community partners, and faculty involved is encouraging; now the challenge is to ensure continuous improvement of the quality overall of S-L projects and therefore their impact on the students, faculty, and community partners. Much work remains to be done to integrate analysis and reflection of the sociological impacts of engineering on the community.

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Appendix A: Courses with Service-Learning, 2004-2006

Table A1. Courses into which service-learning was integrated in 2004-05*

Common First Year Courses

Course	F S	C R	Course Title	S-L Activities	S-L Students (2004-2005 academic year)	Course Students (2004-2005 academic year)
25.107	F	2	Intro. to Engineering I	Tsongas Center exhibits for K-12 illustrating principles of engineering with Rube-Goldberg devices	270	270
25.108	S	2	Intro. To Eng. II - Chem	Vinegar maker for disinfectants for remote clinics;	19	19
25.108	S	2	Intro. To Eng. II - ME	Pilot: teaching modules for middle school children on principles of renewable energy	8	55
25.108	S	2	Intro. To Eng. II - PL	Plastic box for assistive technology speech recognition voice boxes	31	31
25.108	S	2	Intro. To Eng. II - EE	Circuits for assistive technology speech recognition voice boxes with Plastic Dept.	73	73
25.108	S	2	Intro. To Eng. II - CE	Traffic study, parking lot study and design, and measurement of the CMAA Mill Building	37	37

Upper Division Required Courses

Mechanical Engineering						
22.213	S	3	Kinematics	Design playground rides for kids with disabilities; playground safety analysis; design canal surface cleaning device	51	51
22.202	S	2	Design Lab II	Manufacture device to help relative/friend with disability with everyday activities	48	48
22.341	S	3	Conduction and Radiation	UML Engineering Building window replacement analysis for energy conservation	54	54
22.403	F	3	ME Lab II (Appls)	Develop method to test local playground surface hardness for safety	12	34
22.423	S	3	Capstone Design	Assistive technology motorized tricycle; low-cost leg prothesis for villages; solar water system for Peruvian villages; hydro educational exhibit for Tsongas Industrial History Center; FIRST robot competition advisors for high schoolers	9	27
22.521	F	3	Solar Fundamentals	Analysis of monitored weather data for design of solar systems for villages in Peru	8	8
22.527	S	3	Solar Systems Eng.	Design, installation, testing of solar systems for remote Peruvian villages;	10	10
22.504	F S	3	Energy Systems Design	Lowell Regional Housing Authority elderly housing analysis for energy savings; solar lantern and LED headlamp designs for Peruvian village microenterprise	5	5

Civil Engineering						

14.286	F	3	Probability & Statistics	Crime analysis for Police, youth organizations	45	45
14.330	S	3	Soil Mechanics	Soil analysis for Lawrence Community Works, villages in India	47	47
14.204	S	3	Strength of Materials	Structural analysis of the CMAA Mill Building	33	33
14.460	F	3	Wtr Resources Eng.	Open channel design for irrigation in Peruvian village	17	17
14.485	S	3	Capstone Design	Renovation design for the CMAA Building in Lowell.	11	11
14.559	S	3	Structural Engineering	Structural analysis of the CMAA Mill Building as part of a feasibility study	9	9
Plastics Engineering						
26.215	F	1	Lab	Testing of enclosure materials for solar lantern for Peru	24	24
26.518	F	3	Plastics Design	Casket liners for National Cemetery Assoc.	13	13
26.218	S	2	Intro to Design	Design/manufacturing of housings for assistive tech. voice box project	50	50
26.418	S	3	Plastics Design	Casket liner refinement; design of solar lantern enclosures	12	12
Electrical Engineering						
16.311	F	2	Electronics Lab I	Build subaudible detector circuits for radio modem systems in the Andes	62	62
16.312	F S	2	Electronics Lab II	Build proximity sensor for blind; study IC for assistive technology voice boxes	80	80
16.399 (senior)	F S	3	Capstone I	Reverse engineer product for persons with disabilities; VA Hospital computer station design	80	80
16.499	F S	3	Capstone II	Assistive technology devices: e.g., voice recognition switches, proximity sensors, environmental controls; 80 clients; 80 devices	80	80
Other Courses						
45.334	F S	3	Eng. Ethics (required)	Students examine whether introducing TV to remote villages in Peru is ethical	180	180
42.406	S	3	Writing in the Community	Writing narratives of experiences of former Peru students for SLICE research	14	14
				Total student-courses for 2004-2005:	**1392**	**1479**

*[Notes: The last column of the table, the number of student-courses refers to numbers of students enrolled in the courses indicated. Note that some students took more than one S-L course at a time, particularly those taking engineering ethics, a required course for most students. We estimate that roughly 15% of the students are thus double counted. Most of these students did not take the surveys more than once, however. The second to the last column contains the number of students who completed S-L projects in the courses; these are different in courses in which the projects are voluntary. The "CR" column indicates the number of credit hours for the course.]

Table A2. Courses with Service-Learning, 2005-2006

Yr	Course	F,S	Cr	Course Title	Faculty	Activities	# S-L stdnts	# of stdnts
Common First Year Course								
Fr	25.107	F	2	Intro. to Engineering I	David Kazmer	Tsongas Center exhibits for K-12 illustrating principles of engineering with historical devices; and with GEARUP presenting/testing model bridges to middle school students and parents.	294	294
Other Required Courses								
Chemical Engineering								
Fr	25.108	S	2	Intro. To Eng. II - ChE	Sammy Shina	COE Recycling component w/ Krishna Vedula	34	34
Jr	10.305	S	3	Heat Transfer	Al Donatelli	Winter heat loss/alterations analysis for Merrimack Valley Food Bank (MVFB)	18	18
Jr	10.308	S	3	Materials	Krishna Vedula	COE Recycling project	27	27
Civil Engineering								
Fr	25.108	S	2	Intro. To Eng. II - CEE	Jackie Zhang	Parking lot re-design:	24	24
So	14.286	F	3	Probability & Statistics	Oz Gunes	Crime analysis for Police, youth organizations - voluntary to improve grade during Winter break	6	37
Jr	14.341	F	1	Transportation Engineering	Nate Gartner	Optimizing the traffic signals of selected intesections/arterials in the City of Lowell.	43	43
Jr	14.330	S	3	Soil Mechanics	Pradeep Kurup	Soil analysis for Merrimack River Watershed Council	41	41
Jr	14.332	S	3	Environmental Eng. Lab	Cliff Bruell	Town of Dunstable road salt/chem analysis	36	36
Electrical Engineering								
Fr	25.108	S	2	Intro. To Eng. II - EE	Weitzen & Rux	Big button switch construction and distribution.	94	94
Jr	16.365	S	3	Electronics I	Joel Therrien	Electronic display for waterwheel at Tsongas Industrial History Museum	14	14
Sr	16.399	F	3	Capstone I	Donn Clark, Alan Rux, Senait Haileselassie	Develop a business plan to fund the design and development of a product which would be considered an "Assistive Technology" device. Students must interact with prospective end users of the product, then choose a Capstone Assistive Technology project to be accomplished in 16.499.	43	43

Sr	16.399	S	3	Capstone I	Donn Clark, Alan Rux, Senait Haileselassie	Business plan to fund the design & development of Assistive Technology device. Meet with clients and choose an Assistive Technology project for 16.499.	37	37
Sr	16.499	F	3	Capstone II	Donn Clark, Alan Rux, Senait Haileselassie Chuck Maffeo	Students are required to design, test and deliver a device that would enhance the quality of life for a disadvantaged person. Students are required to have direct contact with their client throughout the project.	38	38
Sr	16.499	S	3	Capstone II	Donn Clark	Design, construct, test and deliver a device which would enhance the quality of life for a disadvantaged person. Project includes direct contact with the end user.	41	41

Mechanical Engineering								
Fr	25.108	S	2	Intro. To Eng. II - ME	Sammy Shina	Design and Temp. meas. in solar ovens; Robert William for Grtr Lowell Tech HS (GLTHS)	13	69
So	22.201	F	2	Design Lab I	Bob Parkin	Design device to help relative/friend with disability with everyday activities	59	59
So	22.202	S	2	Design Lab II	Bob Parkin	Design/manufacture of assistive tech devices - some in Machine shop; some to senior Plastics Design class	3	52
So	22.213	S	3	Kinematics	Faize Jamil	Local playground rides	44	44
Jr	22.341	S	3	Conduct'n & Radiation	Hongwei Sun	Air conditioning system analysis for the Eng. Building	45	45
Jr	22.342	F	3	Convective Processes	Gene Niemi	Friction loss in pipes, water supply system design for village in Peru	49	49
Jr	22.361	F	3	Applied Analysis	John McKelliget	Statistical analysis of student questionnaire data	53	53
Sr	22.403	F	3	ME Lab II (Appls)	Pete Avitable	Develop method to test local playground surface hardness for safety, optional	12	45
Sr	22.423	S	3	Capstone	John Duffy Sammy Shina	4 groups: Village Empowerment Peru project; 1 group: FIRST robot program w/ high schoolers	15	46
Sr	22.425	F	3	Design Machine Elements	Chris Niezrecki	Lowell canal surface cleaning mechanism; tank supports; Tsongas display part improvement; etc.	9	45
Sr	22.441	S	3	Thermo Applications	Majid Charmchi	Air-to-air heat exchanger for CMAA by Jesus Solis (1 group)	3	44
Sr	22.473	F	3	Design Theory	Sammy Shina	Design of Experiments for plastic windshield scraper molding, Plastics Department outreach	8	47

Plastics Engineering								
Fr	25.108	S	2	Intro. To Eng. II - PE	Carol Barry	Assessed Nano modules for middle school outreach program for CHN	20	26
So	26.211 22.211	F	3	Mechanics (Statics)	Amid Tayebi	Extra credit: tower design for water tank for village school	3	60
So	26.215	F	1	Plastics Process Lab I	Carol Barry	Plastics Museum, Leominster, MA: Middle school level displays illustrating oil-to-polymer process or alternative.	23	23

So	26.216	S	1	Plastics Process Eng. Lab II	Carol Barry	Design of the synthetic drain layer for a green roof for Merrimack River Watershed Council (MRWC)	23	23
So	26.218	S	2	Intro. to Design	Steve Orroth Nick Schott	Design and manufacture of rechargeable headlamp casings for Peru	23	23
Jr	26.348	S	3	Heat Transfer	Jim Huang	Fresh water condensation - solar through plastic	26	26
Sr	26.418	S	3	Plastics Design	"Francis" Fang Lai	Laterns for Peru -; Waterwheels for Industrial Hist Museum - Chat PC holder	8	17

ELECTIVE/GRADUATE COURSES								
INTERDISCIPLINARY ENGINEERING								
So	25.200	S	1	Community-based Engineering Design Project I	John Duffy	Canal trash cleaning devices	1	1
Sr	25.401	S	3	Interdisciplinary Engineering Capstone Design	John Duffy	Sand filtration water purification; improvements to water supply systems	2	2
Sr	16.499	S	3	Capstone II	John Duffy	Transfer of emails and files via transceiver radio modems and PCs in Peruvian clinics and WiFi prototype.	3	3
CHEMICAL ENGINEERING								
Gr	10.508	S	3	Materials Science and Engineering	Krishna Vedula	COE Recycling project	4	4
CIVIL ENGINEERING								
Gr	14.570	F	3	Wastewater Treatm. & Storm Water Management Systems	Bill Moeller	Wastewater technology evaluation for application in developing countries	10	10
Gr	18.510	S	3	Water Resource System Assessment	Bill Moeller	Water resource assessment for El Hormiguero, Nicaragua (MDI)	9	9
ELECTRICAL ENGINEERING								
Gr	16.671	S	3	Advanced Computer Architecture	Yan Luo	Deployment and monitoring of real-time sensors for UML project (see 22.341 Heat Transfer above)	10	10
MECHANICAL ENGINEERING								
Gr	22.504	F	3	Energy Systems Design	John Duffy	Feasibility study of PV and green building improvement for Lowell Technical High School	4	4
Gr	22.521	F	3	Solar Fundamentals	John Duffy	Analysis of monitored weather data for design of solar systems for villages in Peru; solar collector optimized layout for Lowell Tech feasibility study	8	8
Gr	22.527	S	3	Solar Systems Eng	John Duffy	Green building & solar designs for UTEC	14	14
Gr	24.532	S	3	Selected Topics in Energy	John Duffy	Green building S-L modules	1	3

Non-Engineering Courses								
Jr	45.334	F	3	Engineering Ethics (required for engineering students)	Gene Mellican	Examine opportunities for application of nanotechnology for our "adopted" Peruvian villages	80	80
Jr	45.334	S	3	Engineering Ethics (required for engineering students)	Gene Mellican	Research nanotechnology applications for Peruvian villages: pros and cons	45	45
So	31.251	F	4	Chemistry of Health & Evironment I	John Warner	Developed 5 modules for 8th grade science curriculum, collaborating with an 8th grade science teacher at the Jackson Street Charter School	15	15
So	31.252	S	4	Chemistry of Health & Evironment II	John Warner	Developed 5 modules for 8th grade science curriculum, collaborating with an 8th grade science teacher at the Jackson Street Charter School	17	17
Gr	31.523	S	3	Sustainable Materials Design	Amy Cannon	Developed and staffed Earth Day exhibits for the Revolving Museum entitled "Green Chemistry: The Next Industrial Evolution"	12	12
Gr	31.572	S	2	Green Chemistry Colloquim	John Warner	Students went twice a month to K-12 schools to teach about Green Chemistry	12	12
						2005-2006 Total S-L Student-Courses	1476	1866

# Fr Eng courses	6			
# Up Eng courses	32			
# Gr Eng courses	8	Professors	32	
# related courses	6	Teaching Staff	5	
Total Courses:	**52**	**Total # Faculty:**	**37**	
			Unduplicated First Year Undergrads	294
			Unduplicated Upper-level Undergrads	427 (min.)
			Unduplicated Undergrads	721
			Unduplicated Grads	58 (min.)
			Total Unduplicated Students	779

Appendix B: Student post-survey Spring 2005

{The pre-survey was similar with the elimination of the obvious questions relating to the completion of the S-L course activity. A scantron version of the questionnaire was also used.}

UML Student ID (ISIS No.) ___________________

Today's Date: ___________________ Course Number: _________________

Questions for students ("post")

This survey is a follow-up to the one you took at the beginning of the semester or year. Your responses will form an important part of a research project on service-learning. You may elect not to answer any question you choose. All responses will remain confidential and anonymity in any reported results is assured. The instructor of this course will not view the individual questionnaire responses. Filling out this questionnaire is completely voluntary, and you will not be penalized in any manner if you decide not to participate. The ISIS ID number is very important for research purposes. Thanks from the SLICE project, UML College of Engineering.

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

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

Appendix C: Student post survey, Spring 2006

Instructions:
For each question, make a solid mark that fills the oval completely.

Like this: ● Not like this: ✓ ⊗ ⊘

SURVEY (post) on Service-Learning, UML College of Engineering

Instructor's name: ______________________

Student ID (ISIS No.):

___	___	___	___	___	___	___	___
0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9

Course #

___	___	.___	___	___
0	0	0	0	0
1	1	1	1	1
2	2	2	2	2
3	3	3	3	3
4	4	4	4	4
5	5	5	5	5
6	6	6	6	6
7	7	7	7	7
8	8	8	8	8
9	9	9	9	9

This survey is a follow-up to the one you took at the beginning of the year. Your responses will form an important part of a research project on service-learning. You may elect not to answer any question you choose. All responses will remain confidential and anonymity in any reported results is assured. The instructor of this course will not view the individual questionnaire responses. Filling out this questionnaire is completely voluntary, and you will not be penalized in any manner if you decide not to participate. **The ISIS ID number is very important for research purposes.** Thanks from the SLICE project, UML College of Engineering. NOTE: If you are taking multiple classes with service-learning and you have already answered this survey, you can just skip to questions 15, 18 and 19 about this particular course.

A. What is your gender?

- (M) Male
- (F) Female

B. Are you an International student?

- (Y) Yes
- (N) No

C. What is your ethnicity?

- O Asian
- O Black
- O Caucasian
- O Hispanic
- O Native American
- O Other

D. If eligible, have you voted in a public election?

- (Y) Yes
- (N) No
- O Not eligible

E. How many miles do you live from campus? (if you live on campus, put zero).

___	___
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9

F. What is your age?

___	___
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9

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

___	___
0	0
1	1
2	2
3	3
4	4
	5
	6
	7
	8
	9

H. Have you ever been involved in community service activities before this course? (check all that apply)

- (N) No
- (Y) Yes, during high school
- (Y) Yes, during college

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

___ ___

(0)	(0)
(1)	(1)
(2)	(2)
	(3)
	(4)
	(5)
	(6)
	(7)
	(8)
	(9)

J. What is your current academic status?

- (F) Freshman
- (S) Sophomore
- (J) Junior
- (S) Senior
- (G) Graduate

K. Please rank your **five** (and **only five**) most important career values (1 = highest, 0 = those you don't choose):

- (0) (1) (2) (3) (4) (5) *Challenge*: Learning new skills or information, self-development
- (0) (1) (2) (3) (4) (5) *Creativity*: Doing things in a new way or inventing things
- (0) (1) (2) (3) (4) (5) *Helping*: Doing things for others, building a better world
- (0) (1) (2) (3) (4) (5) *Income*: Making a high salary
- (0) (1) (2) (3) (4) (5) *Independence*: Being our own boss, deciding how and when to do your work
- (0) (1) (2) (3) (4) (5) *Outdoors*: Working outside, in different types of weather
- (0) (1) (2) (3) (4) (5) *Physical*: Being physically active at work, or being physically inactive
- (0) (1) (2) (3) (4) (5) *Prestige*: Doing work that is seen as important, and for which people respect you
- (0) (1) (2) (3) (4) (5) *Public*: Providing information to, and interacting with the public
- (0) (1) (2) (3) (4) (5) *Security*: Having stable employment and income, not worrying about lay-offs
- (0) (1) (2) (3) (4) (5) *Variety*: Doing many different activities, not doing the same things all the time
- (0) (1) (2) (3) (4) (5) *Team*: Being cooperative, getting to know co-workers

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

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

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

"Service-learning" is a hands-on learning approach in which students achieve academic objectives in a credit-bearing course by meeting real community needs.

13. Was being able to take classes with service-learning one of the reasons you chose UMass Lowell?

Ⓨ Yes

Ⓝ No

14. Since enrolling at UMass Lowell, how many classes have you taken where service-learning opportunities were part of the class?

___	___
⓪	⓪
①	①
②	②
③	③
④	④
	⑤
	⑥
	⑦
	⑧
	⑨

15. To what extent has/have your service-learning project(s) at UML had an impact on the following:

[1= Strong Negative Impact, 5=Neutral, 9=Strong Positive Impact]

a. Increased my belief that I can make a difference in the community	①	②	③	④	⑤	⑥	⑦	⑧	⑨
b. Increased my interest in learning	①	②	③	④	⑤	⑥	⑦	⑧	⑨
c. Increased my commitment to being involved in community issues as an engineer	①	②	③	④	⑤	⑥	⑦	⑧	⑨
d. Improved my ability to write and speak credibly about community issues as an engineer	①	②	③	④	⑤	⑥	⑦	⑧	⑨
e. Improved my ability to find information about an issue or a problem in the community	①	②	③	④	⑤	⑥	⑦	⑧	⑨
f. Taught me how to evaluate many different types of information for usefulness and accuracy	①	②	③	④	⑤	⑥	⑦	⑧	⑨
g. Taught me decision-making skills	①	②	③	④	⑤	⑥	⑦	⑧	⑨
h. Increased my leadership skills	①	②	③	④	⑤	⑥	⑦	⑧	⑨
j. Increased my understanding of the value of teamwork in addressing community issues	①	②	③	④	⑤	⑥	⑦	⑧	⑨
k. Increased my ability to plan and carry out a project for the community	①	②	③	④	⑤	⑥	⑦	⑧	⑨

16. This semester did you participate in a class project that addressed a real community issue or problem through service-learning?

- Ⓨ Yes (go to 16a)
- Ⓝ No (go to question 19)

16 a) If yes, approximately how many hours did you spend working on this project?

____	____
⓪	⓪
①	①
②	②
③	③
④	④
	⑤
	⑥
	⑦
	⑧
	⑨

16 b). If yes, was participation in this project required or optional?

- Ⓡ Required
- Ⓞ Optional

16 c) If yes, please check which best describes your role in the project:

- O I was in a leadership role
- O I was very involved as a team member
- O I was a moderately involved team member
- O I carried out the project on my own
- O Other

17. Please respond based on your honest reaction to each item. 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 class project not involving service.	①	②	③	④	⑤	⑥	⑦	⑧	⑨
b. In the service project, I learned how engineers apply the concepts I learned in class to real-life 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
d. The service project(s) made it more likely that I would continue in engineering.	①	②	③	④	⑤	⑥	⑦	⑧	⑨

18. What formal mechanisms did you use in your service-learning class to assess what you learned through your service-learning project? (*Check all that apply*)

- O Discussion
- O Making a presentation
- O Keeping a journal/log
- O Written reports
- O Written assignments other than a report
- O None
- O Other

19. Comments and suggestions:

Thank you!

For more information about service-learning, please contact
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