AC 2007-2871: ATTRACTING UNDERREPRESENTED GROUPS TO ENGINEERING WITH SERVICE-LEARNING

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Attracting Underrepresented Groups to Engineering with Service-Learning

Abstract

The University of Massachusetts Lowell College of Engineering has an objective to integrate service-learning into core required courses in every department so every student every semester has at least one course with S-L (SLICE: Service-Learning Integrated throughout a College of Engineering). Why? Because past research has shown service-learning (S-L) to be effective meeting course learning objectives while addressing real community needs and to be successful for students on a number of cognitive and affective measures. In addition, the college wishes to attract and retain underrepresented groups in engineering. For example, the college in 2004-05 had only 12% females in its undergraduate engineering population of 914 full-time students compared to 17.5% national average. Since past research has shown that women students respond to applied knowledge and helping people, and underrepresented minorities to community connections, there are many ways in which service-learning is a good fit.

Responding to the SLICE initiative, 25 engineering faculty members actually implemented S-L into at least one of their courses during the 04-05 academic year and 34 faculty in 05-06. In 2005-06 over the two semesters an average of 700 undergraduate students participated in S-L projects in 52 courses, some with required S-L projects and others elective. This wide variety of courses included, for example, a first year introduction to engineering with 300 students, kinematics, soil mechanics, heat transfer, engineering ethics, electronics, plastics design, strength of materials, and a senior EE capstone course on assistive technology with 70 students. Community partners included the Lowell National Historical Park, many local rehabilitation clinics, a local food bank, the City Transportation Office, as well as remote villages in a developing country.

There is evidence that females are attracted to service-learning projects in 16 universities that have adopted the EPICS program in which elective courses are chosen that are entirely focused on S-L projects by women at a rate more than double that of the underlying population. There is emerging evidence from the SLICE project that S-L may attract more females and minorities also. 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. 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 a long-standing voluntary S-L program involving design and installation of systems in a remote region of a developing country, thirty-five percent of the engineering students have been female, three times the underlying population. In a faculty survey (with 70% of the 75 faculty responding), females were significantly more confident that S-L can be academic rigorous and take no more course time than males (t-test at the 5% level). In a post survey in the spring of 2006 fourteen percent of the 433 students said they came to U Mass Lowell because of S-L. Thus, there is growing 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.

1. Introduction

University of Massachusetts Lowell Francis College of Engineering's objective to integrate service-learning into core courses comes out of a desire to improve engineering education and the community as well as to attract and retain underrepresented groups. This college of engineering has its base as a commuter school, originally established to train talent for its industrial city center. The decline of manufacturing was eventually followed by a growing high technology sector, which continues to be supported by the college today. On average, 60% of students entering this university are first generation college students. The school is an entrance point for those who have not previously considered higher education. In a high technology area, there are both job opportunities and a culture of engineering innovation. Given these realities, the College of Engineering sees itself as the vanguard of attracting underrepresented students for its region.

2. Underrepresented Groups in Engineering

The lack of engineers in the USA is a huge problem, made worse by the retiring of a generation originally motivated by the space race.[1,2] and a declining interest in engineering.[3] More engineers are needed overall, even aside from underrepresented groups, to replace the aging out of the engineering workforce.

In order to have a US workforce of diverse, prepared professional engineers we must have them come to college in representative numbers and choose engineering as a field of study. Underrepresented groups in engineering programs, and the profession, include women and specific minority populations. ASEE categorizes the latter as "Black/African, Hispanic/Latino, and Native/Pacific Islander Americans".[4]

2.1 Underrepresented Groups in College

When it comes to college in general, attracting women does not appear to be an issue. The fact is women are already overrepresented. In the 2000 US Census 51.6% of the population age 18 and over were women,[5] and the proportion of the population enrolled as college undergraduates was 54.8%.[6]

However, the percentage of who has a college degree by race and Hispanic origin may be surprising, Figure 1, with Asians being relatively high and Hispanics low.

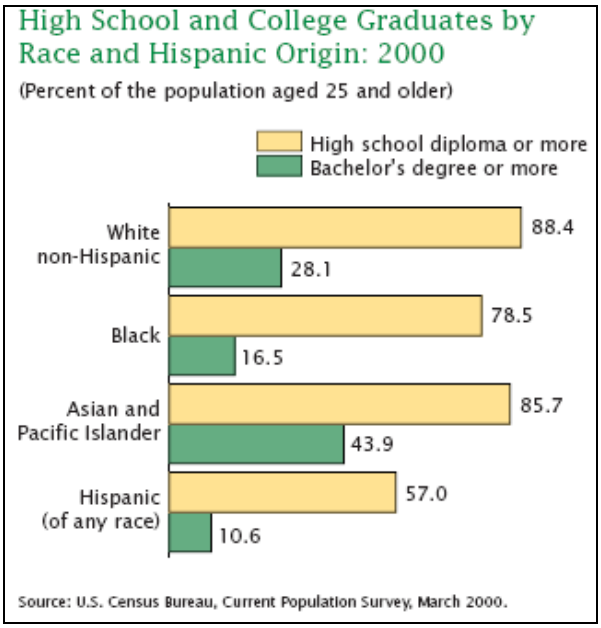

Figure 1: US Census 2000 Percentage of HS and College Graduates[7]

Enrollment rates are higher than completion rates for these two groups as illustrated in Figure 2.

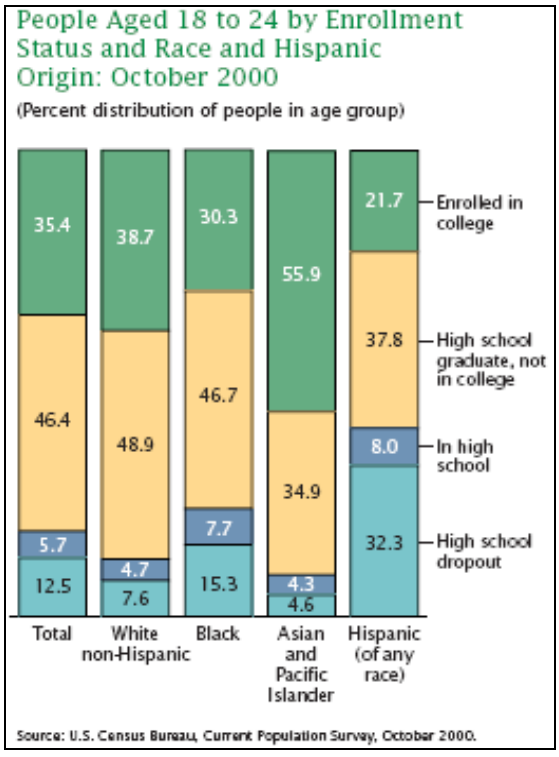

Figure 2: US Census 2000 Percentage of College Enrollment[8]

Dropout rates for Hispanics and Blacks are obviously higher than the general population.

Since the census, more studies have been done. The Sallie Mae Fund's commissioned Harris Poll in 2002 identified two barriers for minorities: not only are there insufficient resources to pay for college, but there is a serious lack of access to information about the resources that do exist to those at the lowest income levels who need it most.[9] This was later echoed by the United Negro College Fund's (UNCF's) Patterson Institute 2005 nationwide survey of African-American families 99% identified "that a college education is an important part of success in life" but even one source of financial aid couldn't be named by almost half of the parents.[9]

The picture for Hispanic youth looks complex. In 2004 the Educational Policy Institute reported out on a longitudinal study following eighth-graders through eight years after the date of their cohort's high school graduation:

> Risk areas where Latinos were overrepresented include parents without a high school degree, low-family income, having sibling dropouts, being held back in school, changing schools, earning a C or less GPA, and bearing children while still in high school.[10]

Clearly, we are still fighting an uphill battle in getting minority youth to college, and through college.

2.2 Underrepresented Groups in Engineering at U. Mass. Lowell and Nationally

The current state of engineering bachelors degrees awarded to underrepresented groups at University of Massachusetts Lowell is summarized in Figure 3 and compared to the national figures for the same year.

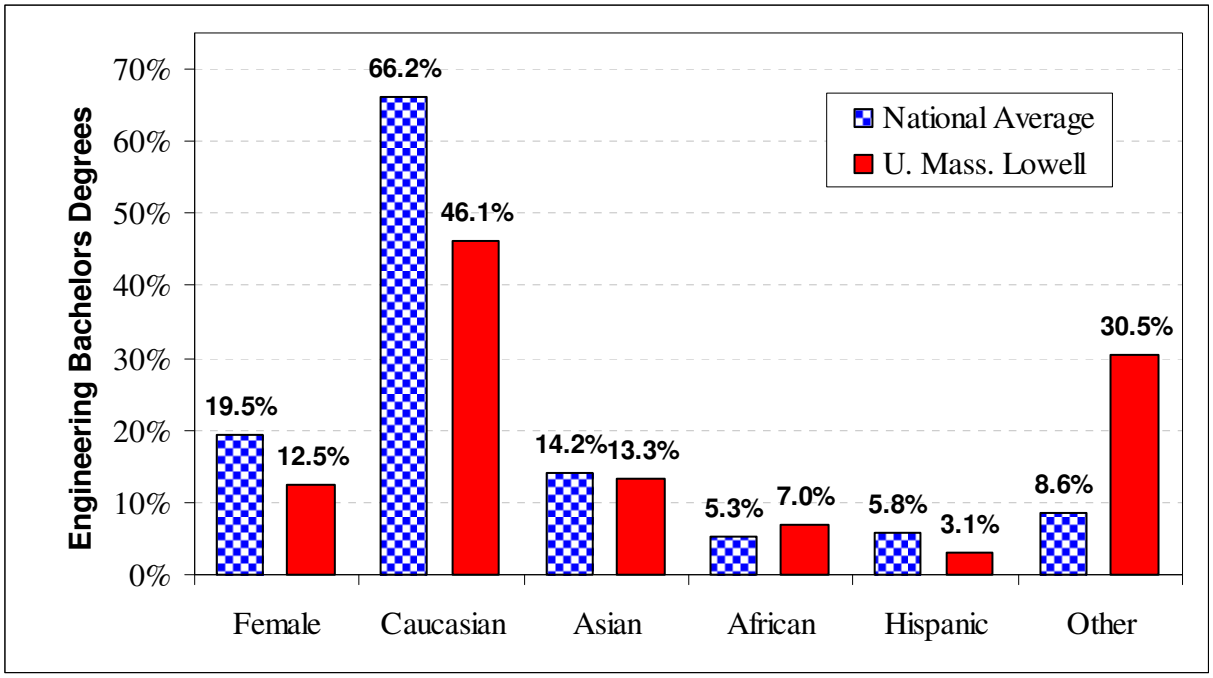

Figure 3: Underrepresented Group Engineering Bachelor's Degrees at U. Mass. Lowell vs. National Average 2005 [11,12]

Nationally, women constitute 19.5% of engineering students as compared to 54.8% of all college students.[6] About 80% of engineering students are Caucasian or Asian, whereas 5.3% are African American, 5.8% are Hispanic, and 8.6% have other backgrounds. The Francis College of Engineering has a lower than average proportion of women in engineering, but similar proportions for other underrepresented groups. Note that the "Other" category for U. Mass. Lowell data includes Native Americans, Foreign students, and a significant number of non-respondents.

Compared to the original cohort of students, Figure 4, it is important to note the effect of

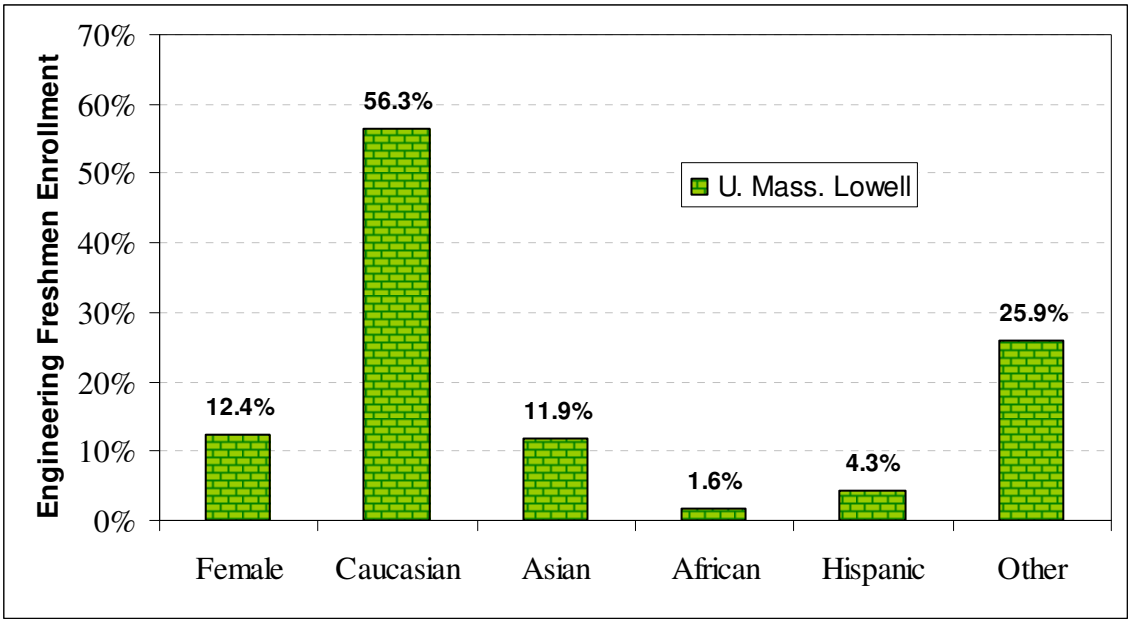

Figure 4: Underrepresented Groups Enrolled in UML Engineering as First Year Students in the Fall 2001[13]

transfers in from Community Colleges. While the proportion of women did not change significantly, the proportion of students of African and Asian origin who graduated increased, as the percentage of Caucasians and Hispanics dropped. The total number of full-time and part-time Engineering freshmen was 371 in the Fall of 2001, compared to 128 bachelor's degrees awarded in May, June and December of 2005. Retention is an issue across all groups. By comparison, in 2000 the US student population (not just college), was 69.3% Caucasian, 4.3% Asian, 14.9% Black/African American, 14.9% Hispanic/Latino, and 11.6% other. [6]

The University of Massachusetts Lowell and the Francis College of Engineering are aware of the need to increase access to underrepresented groups. Currently U. Mass. Lowell has five formal college access programs operating relatively independently as well as a variety of informal programs. The five formal programs are listed in Appendix A.

3. Attracting Underrepresented Groups to Engineering

College access may be different for women than it is for underrepresented minorities, but for getting students to choose engineering the challenge is the same.

3.1 Attracting Women to Engineering

The Extraordinary Women Engineers Project (EWEP) showed that despite taking virtually the same math and science courses in high school as their male counterparts, females do not choose engineering in the same proportions.[14] Julie Chen, a female faculty member in Mechanical Engineering, reflected on her observation that her women students tended to be A and B students, while her male students covered the full range of grades. From talking to students she observed that if girls were very smart in HS science and math, they were encouraged to consider engineering. But male students of any achievement level were not discouraged from pursuing an interest in engineering.[15] The recent in-depth EWEP study interviewing girls ages 14 – 17 provides insight into why. Relevance emerged as the key career motivator for girls. They need to be able to picture themselves doing that job, and to have it "be enjoyable, have a good working environment, make a difference, offer a good salary, and be flexible."[14] Instead we in the engineering community tell girls that they will have to work hard at their math and science, but it will be worth it. This is not the message most girls care about! No wonder we are being tuned out.

UML's DESIGNCAMP provides a fun environment for middle school and high school youth. A hands-on engineering design summer camp with excellent industrial support for need-based scholarships, girls accounted for 30% of enrollment in 2006, slightly lower than in many years; and about 25% students were from ethnic minority groups. "Girls only" sessions facilitate young women working with those who look like them. In a follow up study even two to five years after having attended DESIGNCAMP, 40% of respondents cited their DESIGNCAMP experiences as "a factor" or "a major factor" in deciding their career interests, and this includes the 12% of female respondents who cited DESIGNCAMP as the major reason they have decided to pursue a science or technology career.

The annual spring Assistive Technology Design Fair (ADTF), in which teams from area high schools identify a person in their lives with a problem, engineer, build and display their solutions for each other to see, 30 out of 124 students were girls in 2006. Only 41% of students surveyed said they had seriously thought about pursuing engineering/ technology careers prior to ATDF. After having participated in ATDF, 70% students said they were much more interested, or somewhat more interested, in pursuing engineering/ technology careers.

Once women are in school, especially in the first semester, we have more influence over retaining them. Out of the 13 students who voluntarily chose the service-learning project in last spring's U. Mass. Lowell's Freshmen Mechanical Engineering course (69 total), the only two women in the class participated. UML Executive in Residence, Ed March, has taught the Engineering Project Management course five times in the past 2 ½ years. He asks all students to e-mail him with their career and professional interests, and course goals and expectations. He reports:

> Most women in the class indicate a desire to utilize their technical skills in a way that advances environmental quality and social responsibility. There is a "systems perspective" that these students have; they look at engineering as an enabler that can support the "greater good" of society. Money is not a motivator for these students, but the ability to help others using their technical knowledge excites them about their future. These students tend to purse technical interest in bioengineering applications, environmental remediation, and renewable energy. Several have expressed interest in joining non-profit organizations upon graduation. In particular one student now works for a non-profit renewable energy organization bringing electrical power to remote villages in Thailand. Another student is working for a non-profit company, utilizing her construction management skills for series of projects in Africa.

Blaisdell, et al. found that women who see other women in their classes (students and faculty), have a place to connect with each other, see the relevance of their coursework and its applications in the work world are much more likely to graduate.[16] This fits with what Belenky, *et al.* have long shown about women's learning styles: women generally ground what they believe in personal experiences; taking in facts and reason, integrating it with their sense of themselves in their lived world.[17] Along with all students, women were also found to benefit from faculty and advisors who are aware of their needs and from programs that teach and support life management and study skills.[16] In the case of Ed March, he adjusted his course:

> Having seen this interest in using engineering skills to benefit society, I have incorporated the concept of sustainable development into the course. Rather than portraying Engineering Project Management as simply a method for effectively introducing products or services that increase revenue or reduce cost for a company, I present it as a method to help a company succeed in completing projects that advance it's commitment to sustainability; achieving simultaneously the objectives of financial success while operating in an environmentally sound manner and a socially responsible way.

3.2 Attracting Minority Students to Engineering

The same caliber of research on women is not readily available on minority career motivators toward engineering. In fact, Black, Hispanic and American Indian/Alaskan Native men may be attracted to engineering at the same rates as white men, but the retention and graduation rates are poor.[18] As already shown, overall college enrollments are low to begin with. Much of the focus for minority students is on readiness for college, obtaining solid math and science foundations, and paying for college. [9, 19, 20] The National Society of Black Engineers (NSBE) Pre-College Initiative (PCI) program outlines the following goals:

- Help pre-college students develop a positive attitude towards academic excellence
- Encourage and support parental commitment to their children's education
- Stimulate enthusiasm about engineering and science among pre-college students
- Raise cultural awareness among African-American youth
- Provide support to students throughout the college application process[21]

Two simultaneous strategies are called for in a large study of best practices: the "lift all boats" approach of improving STEM education for all students in the US and the "targeting the underrepresented" approach of additional special programs.[22] A comprehensive approach of connecting college students with HS students, community colleges and industry may provide an effective future path as suggested by Pong and Shahnasser.[23] This is the approach our very active student chapter of U. Mass Lowell's Society of Hispanic Professional Engineers (SHPE) is taking, with much future promise.

Two particular findings out of Howard University warrant attention as well. The first is the negative impact of merit-based scholarships in the retention of qualified engineering students: students who struggle in their first year drop out to protect their GPAs and maintain their scholarships, rather than pursue an engineering career.[24] Similar cases have been observed at U. Mass. Lowell--a disturbing phenomenon that begs further study. The second relevant Howard finding is one of the major reasons their engineering students cite for leaving engineering: "lack of civic engagement."[24]

4. Service-Learning as a Preferred Method for Underrepresented Groups

Since women students respond to applied knowledge and helping people, and underrepresented minorities to community connections, there are many ways in which service-learning is a good fit.

4.1 Service-Learning as an Attractive Teaching Methodology

Although service-learning has been around for many years, there can still be confusion of terms. Based on the definition of Jacoby *et al*. (1996),[25] service-learning is defined here as 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. As a result, service-learning is not a catch-all term for community-university partnerships nor synonymous with civic engagement, but rather, it is one sub-category of these. In contrast to field-work, internships, community volunteering, and co-operative education, service-learning is a credit-bearing activity that is truly reciprocal between the academic institution and the community organization, i.e., a teaching methodology that meets real community-defined needs.

Eyler and Giles in a classic study included 1500 students from 20 colleges/universities in a study of the effect of S-L.[26] 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 of 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."[26] 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).

As part of the evaluation process of service-learning in engineering at U. Mass. Lowell, a focus group was conducted by independent assessor, Cathy Burack of Brandeis University. Detailed results are listed in Appendix B. Although small, half of the attendees were women (3 out of 6) and one was Hispanic. The students liked hands-on activities in their classes, and working in groups. They also valued the diverse cultures represented at U. Mass. Lowell, cited the importance of working with others and were oriented toward making the world a better place by solving real world problems. They crave opportunities for interdisciplinary projects and getting out into the community more often in more significant ways.

Purdue University's EPICS program (Engineering Projects in Community Service), which is being spread nationally with the support of the National Science Foundation (NSF), is an all volunteer model where students self-select to take a track of successive 2-credit course projects. Women students enroll in EPICS in proportions 2 – 3 times those of their majors. No enrollment numbers are reported out for minority students. Out of 2044 student participants reporting, the top "three most valuable things" about EPICS were teamwork, communication and organization and planning in that order.[27]

At the University of Michigan a choice of service-learning section of a required freshman course resulted in students who were significantly more satisfied with the course and the instructor. That section was made up of a higher number of women and underrepresented minorities than the general first year population.[28]

4.2 The uniqueness of SLICE

In 2004, U. Mass. Lowell's Francis College began implementation of a project called "Service-Learning Integrated throughout a College of Engineering" (SLICE). As such, it is the "I" that makes the curriculum reform at UML the most unique: Integration. The goal of SLICE is to fully integrate service projects into core courses of the undergraduate curriculum of every discipline of engineering, in addition to voluntary service-learning opportunities, so that every student has at least one course with S-L every semester.

Responding to this initiative, 25 faculty members actually implemented service-learning into at least one of their courses during the 04-05 academic year and 34 faculty in 05-06. In 2005-06, over the two semesters an average of 700 undergraduate students participated in S-L projects in 52 courses, some with required S-L projects and others elective. This wide variety of courses included, for example, a first year introduction to engineering with 300 students, kinematics, soil mechanics, heat transfer, engineering ethics, electronics, plastics design, strength of materials, and a senior EE capstone course on assistive technology with 70 students. Community partners included the local National Historical Park, many local rehabilitation clinics, the Cambodian Association, the City Transportation Office, as well as remote villages in a developing country. Details of service-learning in courses during the 2005-06 academic year at Francis College of Engineering are in Appendix C and with other specifics in published works.[29-32]

5. SLICE and Underrepresented Groups

Based on the experience of U. Mass. Lowell and others, when underrepresented groups get to choose service-learning they do so in overrepresented numbers. The SLICE model of integration brings this attractive pedagogy to a new level.

5.1 Village Empowerment Peru Project

The Village Empowerment Peru Project began as a student outreach bringing student-designed engineering innovations to improve the lives of indigenous people in remote desert areas of the western Andes. Students travel to Peru twice a year to install and maintain these applications. The gender and ethnicities of past engineering student participants are in Figure 5.

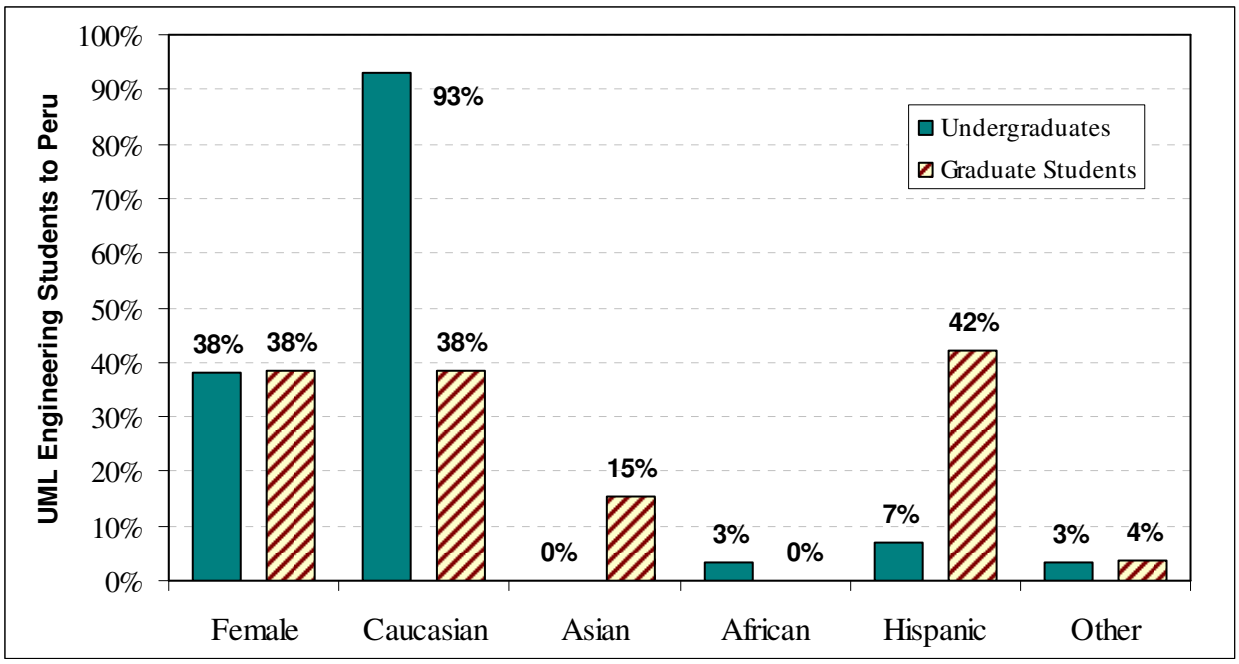

Figure 5: Engineering Student Volunteers for UML's Village Empowerment Projects (18 trips)

Note how much higher the 38% female self-selection rate is compared to the 12.5% in all of U. Mass. Lowell's undergraduate engineering. This current semester, there are only 2 mechanical engineering female students in the graduating class in mechanical engineering, and both of them (100%) traveled to Peru in January and are working on a capstone project to benefit a village in Peru.

Many students joining the Peru Project reported in written comments to the project organizer an increase in their level of confidence and enhanced capacities to improvise and problem-solve. Students also commented on the enormous sense of accomplishment, seeing their designs implemented, the potential to make an impact, a new passion for their vocation, and a chance to see the lives that can be changed by their work. As related by one female student, "When you know that your work will impact someone's life, you know you need to get it right, and it makes you driven to succeed. I think that all too often, students are more focused on just getting the

work done, rather than on the impact their work may have in the future." Another female student commented that, "the obstacles were learning experiences. I learned much more from solving community problems than from pushing paper." Another said, "This [capstone project] is the best thing I have ever done."

5.2 Faculty Surveys

Two surveys of our engineering faculty members (averaging 46 or about 70% of the faculty responding) 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. Detailed results are in Appendix D. Faculty ranked time as the biggest barrier to trying S-L. The level of agreement to various statements about the efficacy of service-learning (including attracting underrepresented groups) faculty members were significantly different from neutral. 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. Female faculty members were significantly more confident than males that S-L can be academic rigorous and take no more course time (t-test at the 5% level).

More specifically, the items that showed significant differences by gender were: 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.) more agreement by female faculty by an average of 3 points (on a one to 9 scale); item 3 (I feel that social problems are not my concern.) 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.) more disagreement by an average of 2.2 (n=5 female, n=30 male).

5.3 Student Surveys

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 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 1).

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 2004-2005 U Mass Lowell had 12% females in its undergraduate engineering population of 914 full-time students.[11] That fraction of female students was below the national average in the same year of 17.5%,[12] so the above results of the differences by gender are 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.

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).

Table 1: Fall 2004 Student weighted averages of ranking of reasons for being in engineering (weighting: 5 for 1st, 4 for 2nd, 3 for 3rd, 2 for 4th, 1 for 5th)

Reason	Male Weighted Average	Male Rank	Female 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**

More recently, 740 "pre" and 433 "post" S-L questionnaires in both academic years 04-06 were analyzed. The survey instruments are available in Appendix E and the results detailed in Appendix F. Some interesting results emerge: 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.[33] On essentially all the opinion questions, the students and faculty both show significant differences from neutral.

6. Discussion

6.1 Where we are in Integrating Service-Learning

On the whole in engineering education we're not attracting enough engineers of any type. While women go to college in sufficient numbers, and are prepared for engineering, they do not choose engineering. Not enough non-asian minorities go to college at all, and preparation for and attraction to engineering are barriers. While not aimed at preparation, nor solving the financial obstacles, service-learning attacks the attraction barrier head on by helping potential engineers see engineering as a helping profession. If we can get the word out, maybe we have the potential to engage those who hadn't considered college to get the preparation to become engineers.

Engineering programs with large numbers of women are wonderful for contributing to the camaraderie for women's engineering success. However; if a school doesn't have large numbers, service-learning can provide a place to connect small numbers of women to each other while engaging them in meaningful work. Boosting preparation before and during college to enhance retention helps with all groups, especially underrepresented minorities. Issues such as Fleming discusses, maintaining financial aid dependent GPA while struggling with calculus, for example, are relevant at U. Mass. Lowell as well.

In general, the overall goal of S-L at the University of Massachusetts Lowell on target. 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 improve the quality overall of S-L projects and therefore their impact on the students, faculty, and community partners. Much remains to be done also in integrating into the courses analysis/reflection of the sociological impacts of engineering S-L systems on the community.

6.2 How Do We Market What We Have?

Doing S-L is great, but it doesn't attract anyone unless they know about it. After 15 years of Assistive Technology in Francis College of Engineering's EE dept., the proportion of women in EE is right at the national average. Working with the admissions office we have been told that the HS science teachers are the influencers – not the overworked guidance staff. We have also discovered that it's not too late to influence HS juniors and seniors.

Messages at college open houses are one way to get the word out. However, the high school students in attendance are those students already considering engineering. The poster in Figure 6 is used at open houses and other events for recruiting purposes, and even wider audiences such as the Industrial Advisory boards. Note that service-learning is listed as the number two reason for going to the COE of UML, following outstanding value.

7. Conclusions and Recommendations

Mounting evidence shows that service-learning is an important tool in the attraction and retention of underrepresented minorities in engineering. The good news is that there is a good supply of academically well-prepared girls who would not otherwise have considered engineering who are attracted to service-learning if we can reach the influencers. Women will stay in engineering if it fits their learning style, sense of altruism and purpose, and if they have other women in engineering with whom to identify. Service-learning provides these components.

We need to do a better job of documenting the needs and responses of underrepresented minorities in engineering. Since the numbers are small, consider more qualitative measures, such as targeted focus groups or individual interviews, rather than quantitative surveys.

Figure 6: Promotional Slide for U. Mass. Lowell's Francis College of Engineering

8. Acknowledgements

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APPENDIX A: University-wide activities focused directly on college access

1. Young Scholars/College Prep Programs	These linked programs, run by the University of Massachusetts Lowell Center for Field Services and Studies (CFSS), work with 150 middle and high schoolers from the Lawrence Public School System. Each summer, the 7-12 grade students live in the University of Massachusetts Lowell dorms and receive college tours, enrichment classes and application assistance. Most of the students in this program are Latino youth who come from low-income backgrounds and would be first generation college students. This program has been running for over 20 years.
2. GEARUP Lowell	This program, a partnership of Lowell Schools, University of Massachusetts Lowell, Middlesex Community College, and many local youth-serving organizations, is a federally funded initiative that works with a local cohort of students through the middle and high school years to help with college preparation. The cohort of students is in five local middle schools and will be followed through high school. (They are currently in eighth grade.) This program includes classroom support, tutors, after-school enrichment activities and parent outreach, college visits, assistance in selecting colleges, preparing college applications and the financial aid process.
3. University of Massachusetts Lowell - Lowell High Partnerships for College Success Project	Begun in 2004, the partnership brings together leaders from Lowell High Guidance and University of Massachusetts Lowell to make systemic changes that will increase college access. The partnership (a) developed a new guidance curriculum for Lowell High to help prepare students for college, (b) disseminated information on the college application processes and financial resources for funding college, (c) created Lowell HS graduate 'role model' bios to share with Lowell High students so that they could learn of others who struggled to go to college and succeeded, (d) created materials using Conley's College Knowledge to enable students and their parents to incorporate these ideas into their college planning.
4. New Horizons Program	The project, in effect for nineteen years, and facilitated by the CFSS with McNair funding, helps with college preparedness. Students at Lowell High School who could be college-eligible with added ancillary support that typically is not available at large urban schools receive support through a structured course in college prep. This course covers everything from choosing a college to applying. Many of the students in this program are Southeast Asian, as Lowell has the 2nd highest Cambodian population in the USA.
5. The University of Massachusetts Lowell Admissions Office	offers many programs, including "on-the-spot" acceptance on site visits arranged by the high school Guidance Departments. With the help of guidance counselors, students submit transcripts that are evaluated prior to the University of Massachusetts Lowell visits to the high school. Nine area high schools have signed up for this process, and the Admissions staff have noted an increase in applications again, this second year of the program.

APPENDIX B: Focus Group Feedback

Conducted by Cathy Burack, Senior Research Associate, Higher Education Center for Youth & Communities, Heller School, Brandeis University

Lowell Student Focus Groups 5/2006 – Overview—by Cathy Burack, Brandeis U.

Two separate one hour-long focus groups were conducted with students to discuss their experiences with service-learning, and their perceptions of its impact and utility on their learning and career goals. The students who identified departments were from Mechanical and Plastics Engineering. There were 3 males and 3 females who represented sophomore, junior and senior classes. Five students appeared to be Caucasian, and one appeared to be Latina. Students were asked to respond to four questions, and to provide recommendations.

1. **What made you choose UMass Lowell?**

   Since one of the aims of SLICE is that service-learning will become a recruitment tool, it was important to determine if service-learning was part of the decision of these students to attend UML.

   At this point, service-learning opportunities did not factor into these students' decision to attend. Although, one noted that when s/he visited the institution prior to enrolling s/he noted that there were lots of "hands-on opportunities" which factored into his/her decision making. Other commonly stated reasons were affordability and some connection to a person who knew the school and championed it – a relative, the co-worker of a parent, a neighbor. The Scholar Intern Program was noted as a positive factor by one student. .

2. **Tell me about the culture of the College of Engineering**

   The purpose of this question is to understand the extent to which students perceive service-learning activities and mission being consistent with the culture of the College.

   Nearly all of the students described the college as being "diverse." They noted that they were able to interact with people very different from themselves and had the opportunity to make friends with people from different countries. Another common theme that emerged was that most students work while going to school, and many, if not most are enrolled full-time. As one student noted, "You meet a lot of people who are balanced." S/he contrasted UML with a private institution and went on to say that "no one here looks down their nose at anyone." At the same time, nearly all the students also described the College as "cliquish." One student noted that all freshmen have to live in a dorm, and all the engineers are grouped together. For students who are starting as freshmen it is a way to meet a broad array of people. However, cliques by areas of study develop after freshman year. After freshman year it appears that there are very few opportunities for students to work with other engineers outside their disciplines.

   These students were heavily involved in clubs and felt that there were enormous social and professional benefits that came with membership. They noted that the clubs give them an opportunity to network, to go to conferences, and to make connections with faculty. One student noted, "If you have a 4.0 and can't work with people than you are a failure." There was consensus that clubs are a way to develop your "people skills."

Students noted that the other ways that students interact and practice leadership and team skills is through team projects and group work that is assigned by professors.

On the positive side it appears that appreciation of diverse cultures and orientation toward group and team activities is consistent with service-learning activities and outcomes. A possible challenge to service-learning in the culture of the College as described by students is the lack of interdisciplinary opportunities.

1. How important is it that engineers help solve community problems?
3a. Should there be something in classes about community issues and problems?

Students were emphatic and consistent in their response to this question. In their view helping to solve community problems is central to being an engineer. One student summed it up when s/he said, "If you are an engineer you need to use your talents and knowledge to solve problems," Another, who argued for including something in classes about community issues and problems said, "If you have a real world problem you can really think and connect to people. You have to be able to relate to the real world."

Another student talked about a final project that involved making a casing for a lantern. Guest lecturers came to the class and some focused on recyclable or biodegradable plastics. The student appreciated this and noted that as engineers, "You have to make the world livable for future generations." Another student found someone that could benefit from assistive technology and worked to design the unit. A third student talked about a model design project in a class. S/he noted that students could take any project they wanted, not necessarily projects that are oriented toward the community. This student was part of a clicker system design that was a student led project that addressed a community need.

Students appreciate hands-on, experiential learning opportunities. However, they especially appreciate when the opportunities are tied into a real issue or problem. It is consistent with, and reinforces, how they conceptualize their roles as engineers.

2. What is your experience with service-learning?
If "yes" follow-up prompts include: What did you do?
How much time did you spend? How much interaction did you have with the community? When you finished the project, how much did you talk about (or write about) what this project meant to the community?

All of the students had some experience with service-learning, though initially not all of them were familiar with the term. One student recounted that in his/her Introduction to Engineering Class they had to do a service-learning project. They assembled a project in the class and then were visited from the St. Francis Children's Center. For this student this was a transformative moment. S/he decided s/he wanted to design products that are lower cost and enable families (with a child with a disability) to "be able to just make it through a day." Seeing the direct impact

of this project and getting the community feedback made all the difference for this student and assistive technology became his/her focus.

All the students talked about their increased learning through their service-learning projects. One student noted, "Community service projects open your mind, let you see what the problems are. You have to apply your knowledge, and come up with solutions that no one has thought of before." S/he contrasted this with doing a structured problem set where you learn the steps and check your solution in the answer book at the end. Another student framed it as the "practical versus the theory." Classes with service-learning allow students to get the theory, "but to also see how the theory fits, and that the work means something in the real world. Calculus and physics give you the basics, then you use that to solve real life problems."

Students believe that interacting with the community is important, and that it is something that they wish they could do more. One student noted that interacting with the community "makes you always keep the big picture in mind." Another student said,

> "The community comes in rather than us going out. We want to go out into the community more, meet with people, learn more about them and their needs, act as 'consultants'. We need the skills. The professor should be a contact and guide, but the students want an opportunity to form a relationship with the community. Engineering is all about 'networking' and 'relationships.' We don't get a lot of feedback from the community. We want their feedback at various stages of a problem – the planning, development, presentation and implementation."

The other benefits that students cited from service-learning were related to working across disciplines, student engagement in UML, and career enhancement. Students noted that working in the community is one of the few instances they work with other engineers from other disciplines/departments. One student talked about the power of that experience in that it enabled him/her to "see the connections" between the fields. A second student was in a class that met with someone from Ethics. S/he liked that s/he was exposed to a different (i.e. non-engineering) perspective.

Students noted that service-learning projects made them feel more engaged with UML and gave them a sense of pride in their school. This may have implications for recruiting in that, as noted in the first question, institutional "champions" yield a lot of influence. One student said, "Working on service-learning projects makes me feel responsibility and more involved in the school. I feel like I made a difference through being here. It provides invaluable skills."

Career benefits were also mentioned by students as an outcome of their service-learning experience. "You need real world experience to get a job and not everyone can do an internship. Service-learning is a good alternative," noted one student. Another said, "Companies appreciate seeing service-learning on a resume because they know you can relate to the real world, it gives you hands on experience. UML has a reputation for hands on."

The activities associated with "reflection" as commonly discussed in service-learning literature was not occurring in these students' classes. They were required

to write about, discuss, or take tests about their service-learning projects. However, assessment of coincidental civic skills, competencies, and attitudes gained through the projects was largely absent.

1. Has your community/ service-learning experience at UMass Lowell changed your thinking about what it means to be an engineer?
Prompt – how you see your role in the community when you graduate

Students were asked about the extent to which their experience working on real problems impacted their notion of what it means to be an engineer. One student summed it up as follows,

> "Doing something for others makes you feel good. To be a good engineer you have to be able to solve a real world problem. The main thing about community service is that there is a goal, but it doesn't have a clear path, you have to figure it out. When I am sitting in my microchip class there are some really smart boys in there. I'm not the smartest student and I get scared I won't know the answer. This allows me to be creative and use my knowledge. When I work on Assistive Tech I feel like an engineer not a student."

Students drew clear distinctions between the skills they needed to solve problems and build things in labs and the creative ways they need to apply knowledge in order to solve problems.

I asked the women students if they thought that service-learning might attract more women to UML. They thought that it would. One said, "Women often want to help, to make a difference. If this were advertised it would attract more women. Engineering can give me the opportunity to solve problems and be *creative*. You have to have them connect emotionally" to engineering.

Recommendations

I closed the focus group by asking for their general recommendations and comments. The following are their responses:

1. All students wanted to see service-learning integrated into more classes. Students varied as to whether or not to have it as a class requirement. Students want service-learning classes to have responsibility for visiting and meeting with the client, and keeping the website up-to-date (see #6).
2. One student requested that I write that s/he wishes "I could get a Master's in Assistive Tech – and put that in caps!"
3. Make more interdisciplinary teams.
4. Make contact with community groups, bring them in and ask them how we can help them solve problems. If UML became more known for this it would really show people that we're not like other schools. It would help our reputation and people would want to come here rather than this being their safety school.

APPENDIX C: Service-Learning in Courses 2005-06 at the Francis College of Engineering

Table C-1. 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	Dave 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	multiple - J. White, coord.	COE Recycling component w/ Krishna Vedula Contact: Rich Lemoine	34	34
Jr	10.305	S	3	Heat Transfer	Al Donatelli	Winter heat loss/alterations analysis for Merrimack Valley Food Bank (MVFB) Contacts: Amy Pessia, Corinne St. Hilaire	18	18
Jr	10.308	S	3	Materials	Krishna Vedula	COE Recycling project Contact: Rich Lemoine	27	27
Civil Engineering								
Fr	25.108	S	2	Intro. To Eng. II - CEE	Jackie Zhang	Parking lot re-design: LCHC Contact: Paulette Renault-Caragianes	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 Rvr Watershed Coun Contact: Christine Tabak	41	41
Jr	14.332	S	3	Environmental Eng. Lab	Cliff Bruell	Town of Dunstable road salt/chem analysis Contact: Bill Moeller	36	36
Electrical Engineering								
Fr	25.108	S	2	Intro. To Eng. II - EE	Weitzen, Rux, Haileselassie	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 contact: Peter O'Connell	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	43	43

						Assistive Technology project to be accomplished in 16.499.		
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, Jay Fu, 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) contact: Deb Gustafson	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 Contacts: individuals known by students	3	52
So	22.213	S	3	Kinematics	Faize Jamil	Local playground rides Contact: John Duffy	44	44
Jr	22.341	S	3	Conduct'n & Radiation	Hongwei Sun	Air conditioning system analysis for the Eng. Building Contact: Mark Lukitsch	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 Avitabile	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)	Amad 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) contact: Christine Tabak	23	23
So	26.218	S	2	Intro. to Design	Steve Orroth, Nick Schott	Design and manufacture of rechargeable headlamp casings for Peru Contact: John Duffy	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 - contact John Duffy; Waterwheels for Indust Hist Museum - contacts: Rick Smith, Peter O'Connell; Chat PC holder - contact: Ellen Heerlein;	8	17

ELECTIVE/GRADUATE COURSES								
INTERDISCIPLINARY ENGINEERING								
So	25.200	S	1	Community-based Engineering Design Project I	John Duffy	Canal trash cleaning devices contact: Ted Davis	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 Contact: Rich Lemoine	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) contact: Raul Raudales	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 collecgtor 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 contact: Nathan Biggs	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
# related courses	6
Total Courses:	**52**

Professors	32
Teaching Staff	5
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**	

The chart below (Table C-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 C-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	☻	☻ ☻	☻	☻ ☻ ☻ ☻		

APPENDIX D: Faculty questionnaire results

Faculty survey, Dec. 2004,			Mean responses to Likert scale of 1 (disagree) to 9 (agree)				
(Green signifies significant difference, 5%)			Significant Difference (5%) t-test			ChiSq and t-test	t-test
	mean	number	gender, f=6, m=38	tenure, no=13, yes=34	diff. from neutral (5)	diff w/ faculty 05	diff w/ 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	1.7, female higher	1.3, no tenure higher			
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	3.7, female higher				

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	2.3, female lower				
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	2.2, female lower				

Faculty survey, Dec. 2005			Mean responses to Likert scale of 1 (disagree) to 9 (agree)				
{Green denotes significant difference, 5%}			Significant Difference (5%) t-test				t-test
Statement	mean	number	gender, f=6, m=38	tenure, no=13, yes=31	diff. from neutral (5)		diff w/ student 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		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	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					

APPENDIX E: SLICE Survey Instruments

Student "pre" survey, fall 2004

Student ID # _____
Date: _____ Course Number: _____
Questions for students ("pre")
Please take a minute to answer the following questions. 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. Thanks from the SLICE project, UML College of Engineering.

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 from campus? ____ miles

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 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

These are issues that people disagree on; 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

Student "post" survey from spring 2006

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

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

Like this: ● Not like this: ✓ ✗ ⊘

Instructor's name: _____

Student ID (ISIS No.): Course #

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).

F. What is your age?

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

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?

(Y) Yes

(N) 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?

(Y) Yes (go to 16a)

(N) 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?

(R) Required

(O) 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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APPENDIX F: Student questionnaire results

Student surveys 2004 pre and 2006 post							
Note: Green indicates significant effect							
Likert scale for statements below: 1 = strongly agree; 5 = neutral; 9 = strongly agree				Significant Difference (5%, t-test, unequal variances)			paired t F05 - Sp06
	year	mean	number	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	04	6.23	728			0.14	-0.77

involves helping people	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	Significant Difference	(5%, t-test, unequal variances)		
Note: Green indicates significant effect				neutral (mean minus 5)	gender: M minus F	ethnicity 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	