



Differences by Student Gender in Engineering Service-Learning

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Abstract

Attracting and retaining women in engineering is critical in the USA today. While women are coming to college in overrepresented numbers, they are not represented equally to men in engineering majors. Though a university can only have limited impact on the attrition of women in the engineering workforce, we can (and must!) work to improve recruitment and retention and to graduate women with adequate preparation for an engineering career. An increasing number of engineering programs are integrating service-learning (S-L) into their curricula.

For the past eight years of one S-L program, students in a college of engineering have been widely surveyed at the beginning of their studies and at the end of each academic year. The purpose of the ongoing study is to investigate the impacts of S-L on the students, faculty, institution and community. Quantitative analysis of student survey responses over the years reveals a consistently marked difference in attitude between genders toward community engagement generally, and S-L specifically. For example, in the spring of 2012, 465 surveys were collected from engineering students of all grades and majors, of whom 57 identified as female. Among several other items, statistically significant differences (at the 5% level) arose in responses between the genders in their rating of Helping as a career value, their belief that service should be an expected part of the engineering profession, and their belief that S-L projects have helped them learn how to apply the concepts they learned in class to real life problems. A quarter of all spring 2012 survey participants reported that S-L was one reason they came to this college, or that it would have been if they had known about it. This included 23% of the men, but 47% of the women. Considering this study's finding that S-L is especially attractive for women, engineering departments hoping to improve their female-male ratio should consider the integration of S-L into their curriculum.

Keywords

service-learning engineering gender differences students

Introduction

The insufficient number of engineers in the USA is a problem made worse by the retirement of a generation originally motivated by the space race^{1,2} and a declining interest in engineering.^{3,4} More engineers are needed overall, even aside from underrepresented groups, to replace the aging out of the engineering workforce. In order to develop a national workforce of diverse, prepared professional engineers, promising students must come to college in representative numbers and choose engineering as a field of study. Underrepresented groups in engineering programs and the profession include women, specific minority populations, and people with disabilities.⁵ Strategies must be considered to attract diverse populations to the engineering fields, and to retain them.

For women in college, Blaisdell et al. found that women who see other women in their classes (students and faculty), have a place to connect with each other, and see the relevance of their coursework and its real-world applications are much more likely to graduate.⁶ 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.⁷ At the University of Massachusetts Lowell, the college wishes to attract and retain underrepresented groups in engineering. Without any programs, scholarships or resources targeted to women, the 2011 women represented 10.6% engineering undergraduate enrollment⁸ compared to the 2011 national average of 18.8% women in undergraduate enrollment.⁹

Background

A commonly utilized definition of service-learning is “a credit-bearing, educational experience in which students participate in an organized service activity that meets identified community needs and reflect on the service activity in such a way as to gain further understanding of course content, a broader appreciation of the discipline, and an enhanced sense of civic responsibility.”¹⁰ Many past studies, (e.g. Eyler and Guiles¹¹) have shown service-learning to result in positive outcomes in cognitive and affective measures for students as well as benefits to the community, faculty, and institution. Astin et al. found with longitudinal data of 22,000 students that service-learning 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. In all measures except self-efficacy, leadership, and interpersonal skills, service-learning was found to be significantly more effective than service alone.^{12,13} This longitudinal study is ongoing.

Since the 2004 inception of the UMass Lowell Francis College of Engineering college-wide service-learning effort (assisted by an NSF grant), 58 faculty members have taught at least one course with S-L, with between 25 and 30 faculty practicing each year. Over 50 separate courses have incorporated S-L, with 30 to 35 courses offered per year, providing 1,100 to 1,750 student S-L experiences annually, for over 1,000 unduplicated students per year out of a total undergraduate enrollment of over 1,700 students (2011.) Thirty-eight community based organizations (CBOs) and over 1,000 individuals with disabilities have been served from the city of Lowell to Peru, with about 15 to 20 CBOs and 80 to 100 individuals reached any given year.

Methodology

The approach has been to expose College of Engineering students to S-L, primarily through the integration of S-L engineering projects into core required courses. Students who wish to extend a project or become involved more deeply have the option of taking one three credit course, or a sequence of three one credit courses, which qualify as an engineering technical elective in all majors. Interdisciplinary engineering course numbers are used to facilitate collaboration between departments. For a listing of courses and project descriptions, please see the website <http://www.uml.edu/Engineering/SLICE/Welcome.aspx>.

To investigate what students think of this effort and how they report S-L is affecting them, qualitative and quantitative methods have been used. For the past several years, a “Pre” survey has been given to all students on the first day of the college-wide Introduction to Engineering I course and a “Post” survey has been given at the end of spring semester in the course with the greatest number of students at each level (Fr, So, Jr, Sr) in each department. The “Pre” survey collects demographic information and basic attitudes. The “Post” survey repeats these questions and expands to include feedback on their S-L experiences and impacts (Appendix A.) The

surveys are analyzed using SPSS software, at first looking at the whole cohort, to check for statistical significance from neutral (score = 5) for each of the items on the 9-point Likert scale using the 2-tailed T-test at the 5% level. Next, responses are broken down by various demographic information. The focus of this paper is to explore the trends in gender differences over the past few years.

Results

Looking at examples of “Post” data from the spring of 2012 for both genders is a good starting place. Question 1 asks students to rate the importance of each of five career values (Figure 1.)

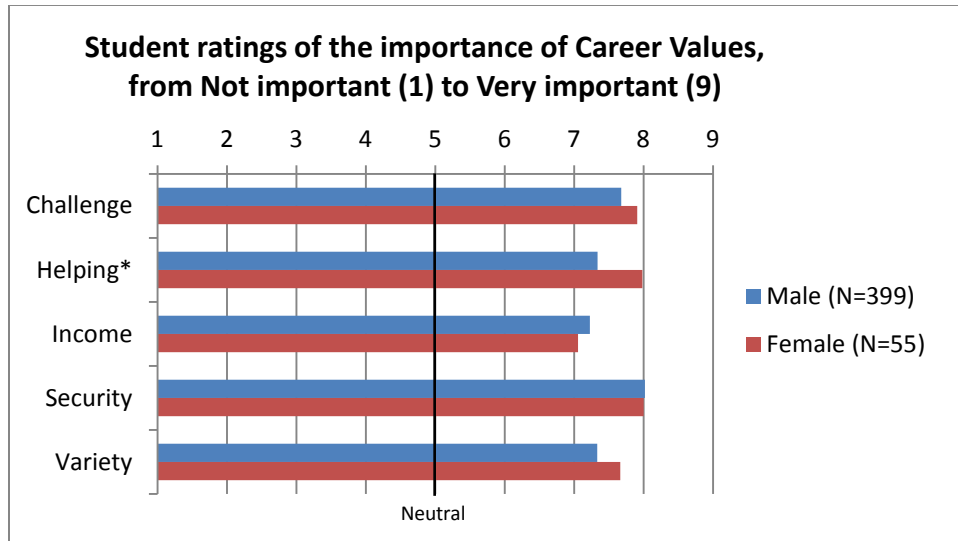


Figure 1: Mean responses by gender for Career Values, spring 2012

In this year, the career value of Helping was the only statistically significant difference between genders, as noted by the asterisk (*.) Likewise, the genders can be compared on the Attitude questions, q2 through q15 (Figure 2)

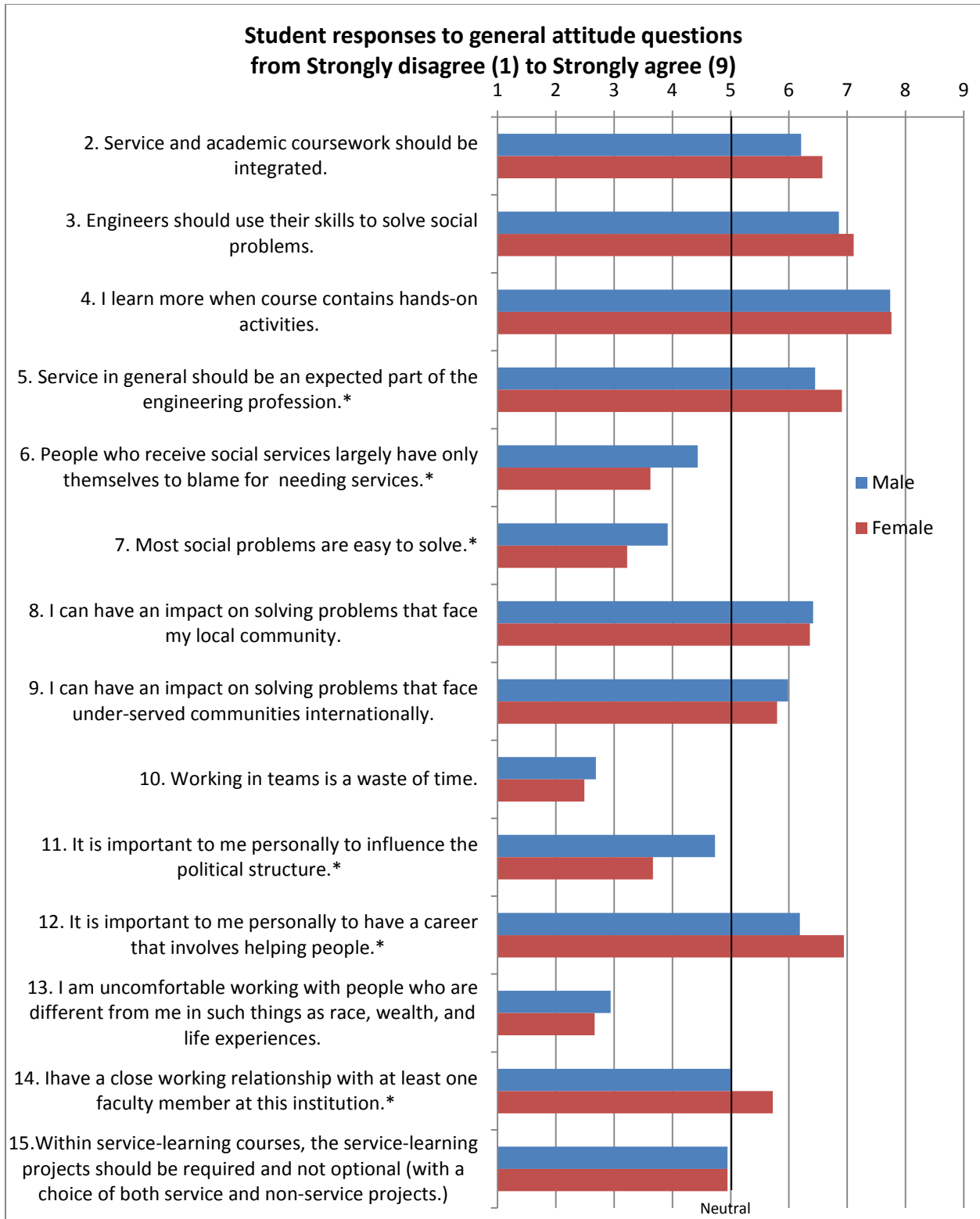


Figure 2: Mean responses by gender to general Attitude questions, spring 2012

and the Impact of Service-Learning questions, q20a through q20k (Figure 3.)

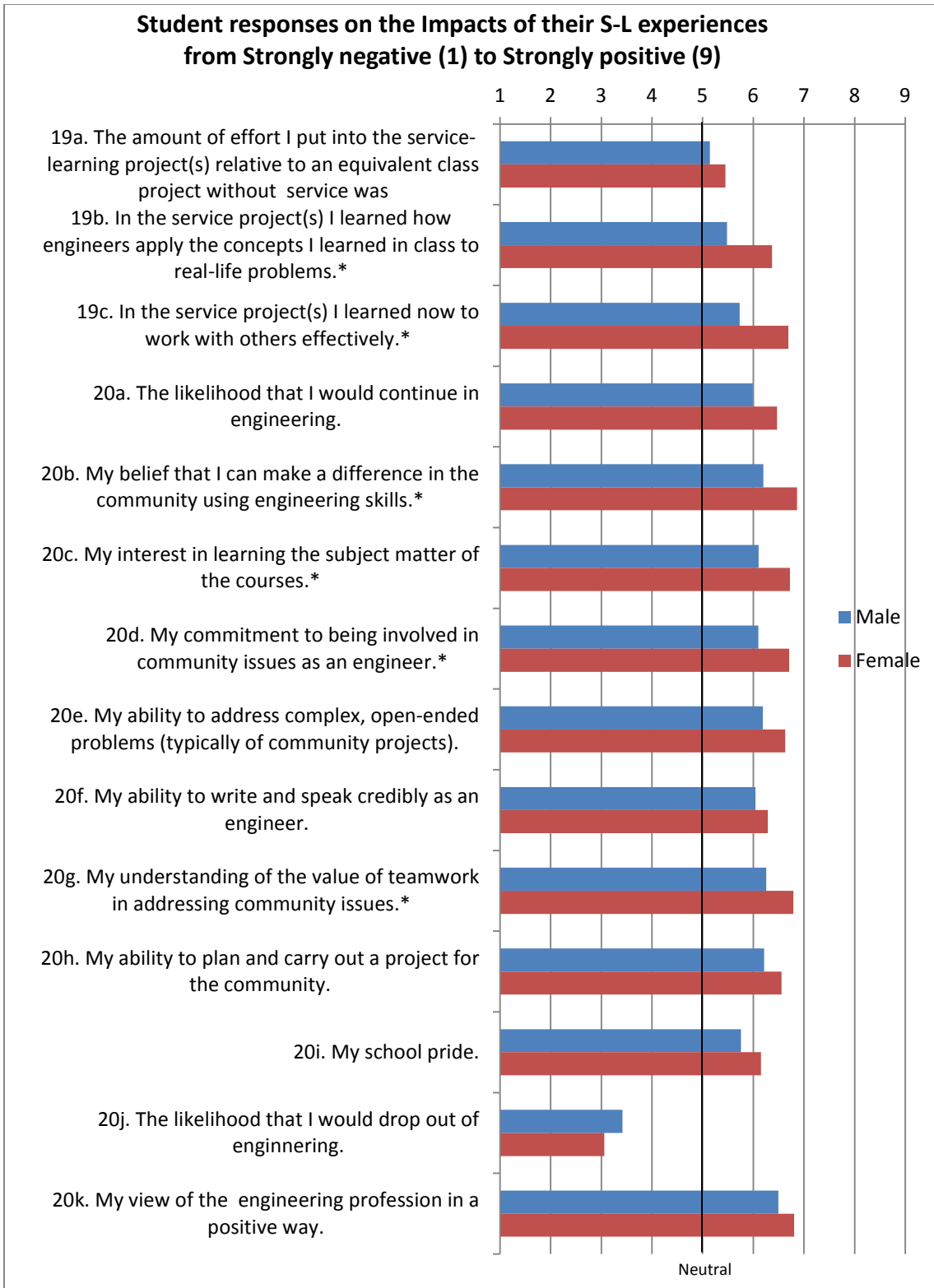


Figure 3: Mean responses by gender of the extent of S-L Impacts, spring 2012

Note that most questions are significantly different from neutral (score = 5), and that where there are gender differences the female cohort are more positive on positive questions and more negative on the reverse scored questions (i.e. q6, q7, q10, q11, q13 and q20j.)

Recently, the past four years of data was compiled to look at comparisons over time. The “Post” spring surveys were chosen for comparison since they sample students from a wide variety of academic levels. Returning to the Career Values questions, the means of female students that were statistically different from the male students were compared over the last four years (Figure 4.)

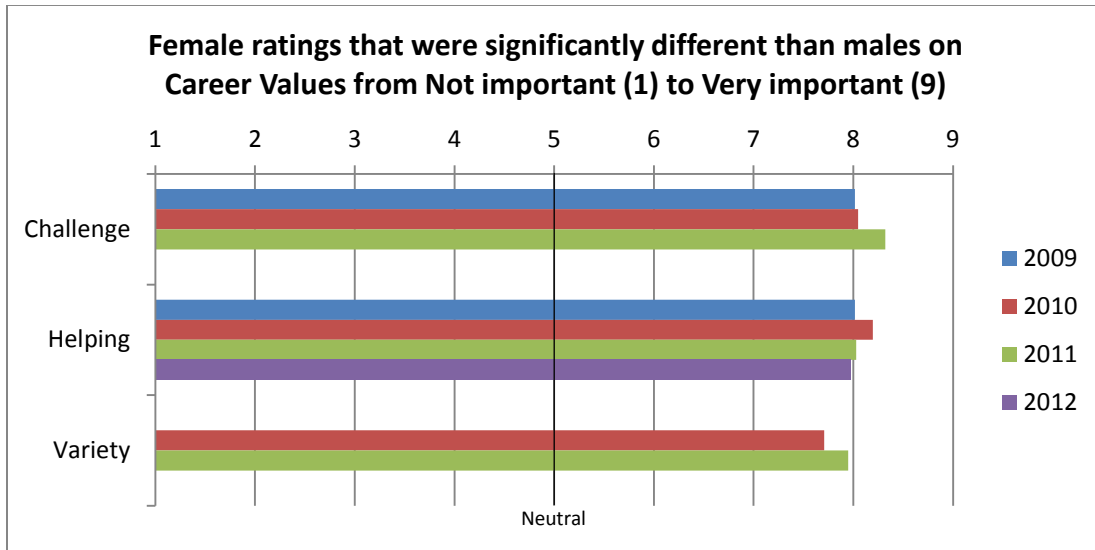


Figure 4: Female student means with significant differences from males on Career Values, 2009-2012

In some years, Challenge and Variety were significantly more important to women than to men; in all years Helping stands out: women consistently rank Helping as a more important career value than men do.

The Attitude questions, q2 through q15, echo the importance of helping people being consistently significant for women engineering students (Figure 5.)

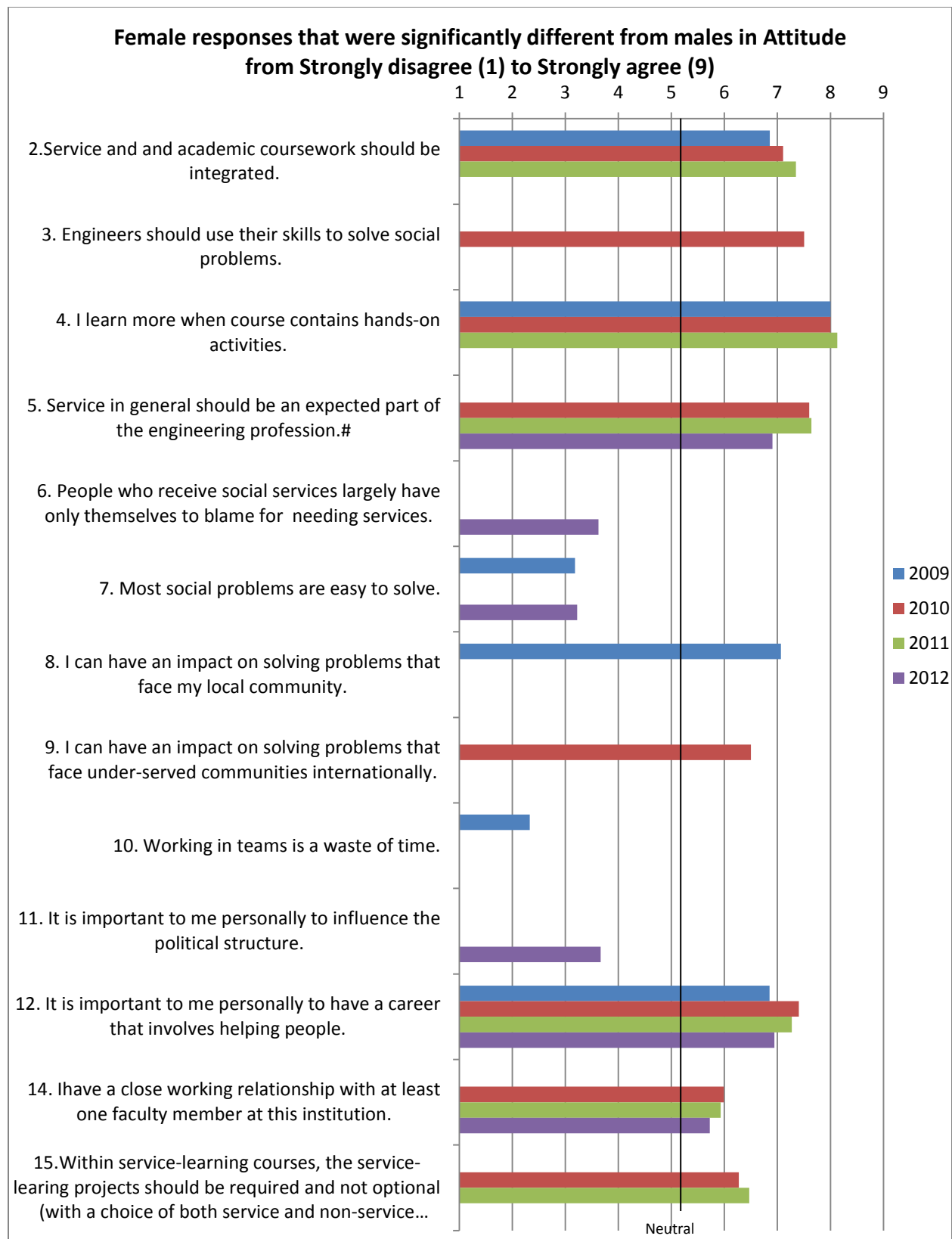


Figure 5: Female student means with significant differences from male means in Attitude, 2009-2012

The attitude that service should be an expected part of the engineering profession (q5) may have also been the same in 2009, however as indicated by the hash tag (#) this question was not asked on the 2009 survey. Instead, other 2009 questions with significant gender differences included items such as “I should give some of my time to help those in need” and “It is important to be involved in a program to improve my community.” The survey was shortened from seven sides of a page to the current four in 2010 to encourage greater student cooperation. Correlations were run to eliminate similar questions but maintain the survey integrity. Among all years above, note that one question is missing: “13. I am uncomfortable working with people who are different from me in such things as race, wealth, and life experiences.” This has not shown significant gender differences to date, tends to track slightly above or below 3 = disagree, with male and female students responding similarly.

Students are asked about their S-L projects on average (Figure 6.)

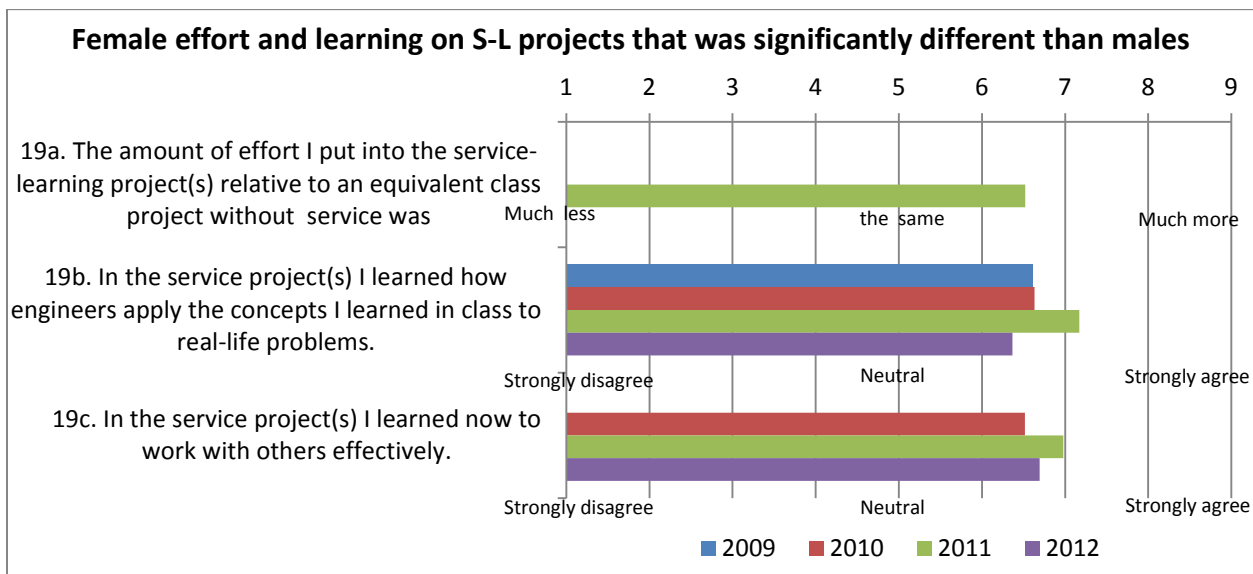


Figure 6: Female student means with significant differences from males in S-L project effort and learning, 2009-2012

For men and women across the years these answers are significantly positive and different from neutral, but for women even more so. The women particularly like applying their engineering to real problems.

Students tell us what impact their service-learning projects had on them (Figure 7.)

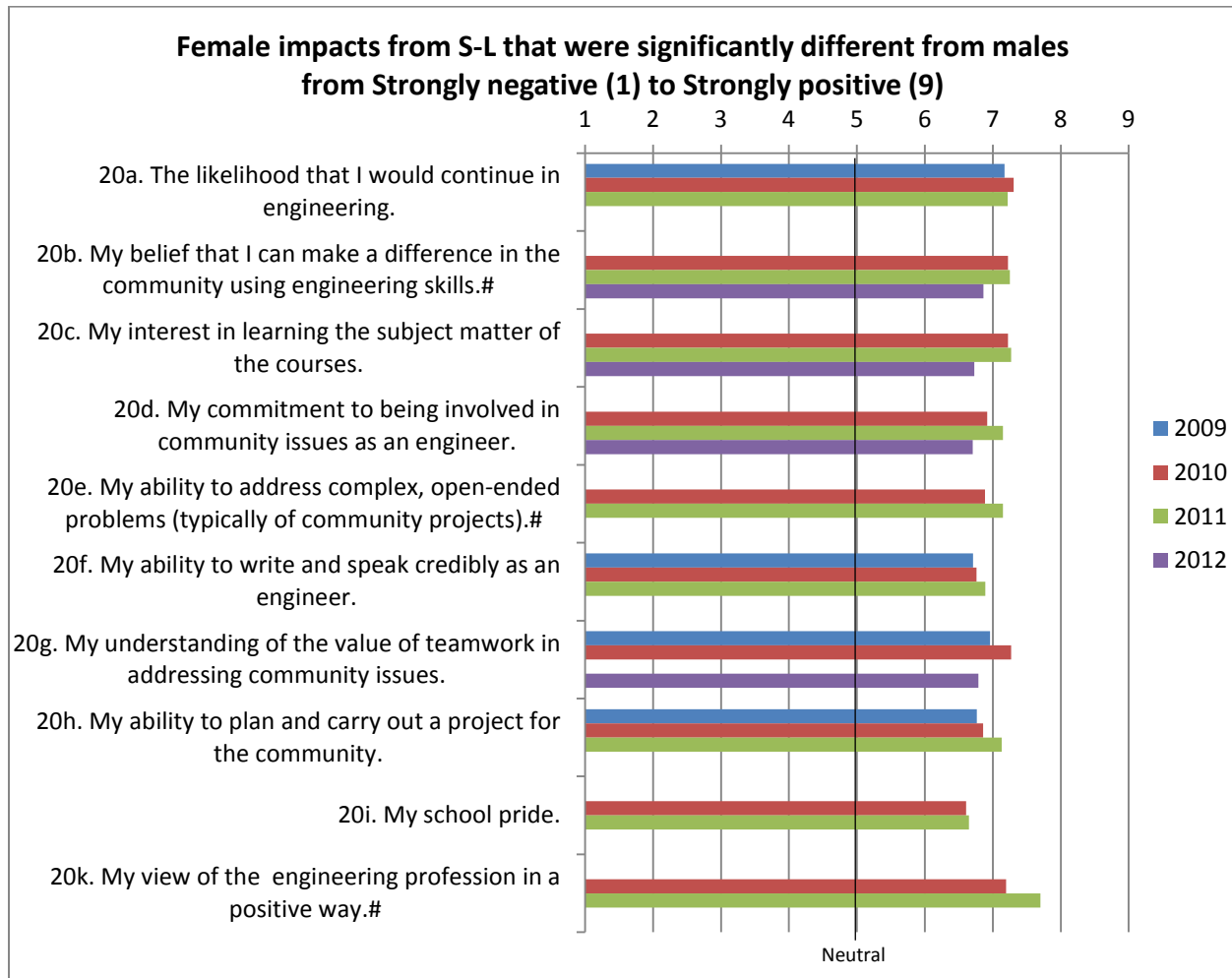


Figure 7: Female student means with significant differences from males on S-L Impacts, 2009-2012

The questions marked with hash tags (#) were not asked on the 2009 survey. Again, all responses for men and women were statistically different in a positive direction from neutral. Women consistently appreciate the opportunity to make a difference in the world using their engineering through community projects, significantly more than their male counterparts. The missing question above, “20j. The likelihood that I would drop out of engineering.” is a reverse scoring question from 20a above. While the positive version of the question show significant gender differences the negative version does not. Both men and women disagree with the statement that their S-L projects make it more likely they will drop out of engineering (with medians ranging from about 2.4 to 3.4 over the years) with women consistently lower than men, but apparently not significantly so.

While the numbers speak well for S-L’s impact on retention, there has also been a desire to look at recruitment. The way this question has been asked has evolved over time (Table 1.)

Table 1: Responses by gender for the influence of S-L on attending UMass Lowell, 2009-2012

16. Was being able to take classes with service-learning one of the reasons you chose UML?						
	MALE %	2009	2010	2011	2012	
Yes		8%	10%	6%	17%	of those who knew
No		92%	90%	73%	83%	
No, but if I knew it would have been a factor				21%	22%	
Yes + Would have been a factor		8%	10%	27%	23%	
	FEMALE %	2009	2010	2011	2012	
Yes		14%	19%	19%	40%	of those who knew
No		86%	81%	58%	60%	
No, but if I knew it would have been a factor				23%	30%	
Yes + Would have been a factor		14%	19%	42%	47%	

Prior to 2011 students were asked a yes-or-no question: whether being able to take S-L courses was one of the reasons for choosing UML. After receiving feedback that students were not always aware of S-L in the curriculum, a third mutually exclusive option was added as seen in 2011. Finally, in 2012 the question was broken down further to its current form (Appendix A, p.3.) The percentages in the 2012 Yes and No rows, above, reflect only those with a Yes response to the question if they knew S-L existed at UML before attending. In 2012, 17% of male students knew S-L was integrated into the curriculum at UML compared to 26% of the female student respondents.

Combining the number of students who reported that S-L was a factor in attending UML or would have been had they known, then dividing by the total number (N) of that gender, the percent shows a positive trend particularly with women (Figure 8.)

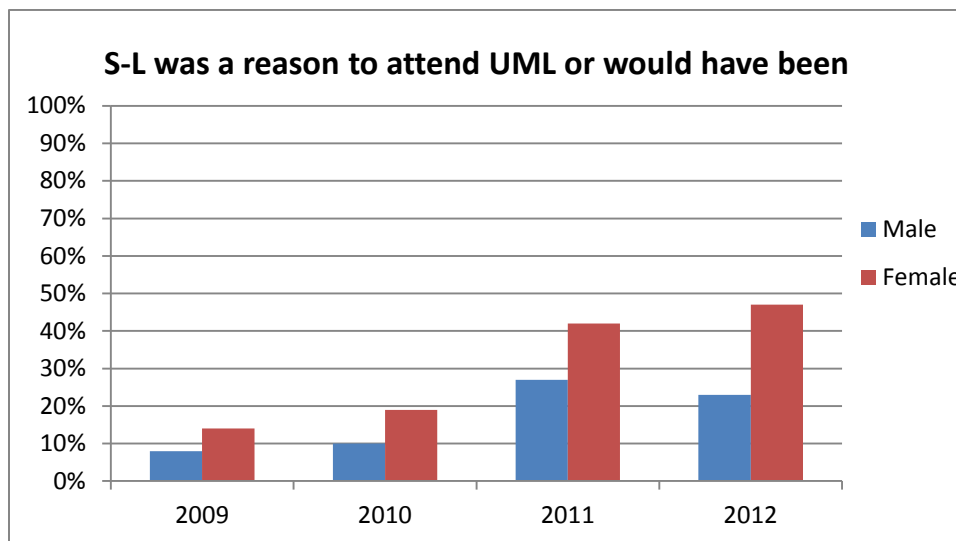


Figure 8: Percent of positive influence for S-L to UML choice by gender, 2009-2012

It will be interesting to see if the 2012 male cohort response was an aberration or a trend.

Discussion

The “Post” spring survey is given to students across engineering disciplines and academic levels, but not all of the courses selected chose to complete it. Therefore, the composition of the cohort varies from year to year. The survey is administered across a broad cross section of engineering students, not just those who are in S-L courses at the time. The extent of gender differences has emerged with certain elements showing a strong consistency while others varied somewhat from year to year. Consistent patterns include women valuing service overall and expecting it to be part of their engineering practice, and women acknowledging that S-L contributes to their professional growth. Service-learning resonates with women, as it connects the engineering practice to actual needs of physical entities. As such, S-L provides a learning opportunity to embody the technical knowledge female students are building. In addition to this quantitative evidence, anecdotal evidence corroborates women’s affinity toward service-learning. For example, voluntary participation in S-L projects involving work with and in developing countries continues to attract females at a rate of more than three times their underlying population.

Interestingly, the women who join engineering are expressing stronger feelings on average than men do (the mean of their response being always more pronounced than the mean of the response from male participants.) This may come from the fact that women feel like they have to defend their position in a male-dominated environment. Through the presentation of the differences on the students' survey responses by gender, the appeal of S-L for female students in particular has been confirmed. Prospective female students are sensitive to it: S-L is one of the reasons they join the institution in the first place and they are strongly attached to it when practicing. Service-learning is a great tool for attracting and retaining female students in the engineering program; the next step in developing it at this medium-size institution is focusing on projects with an added reflection component and also institutionalizing S-L at the campus level. The institution would benefit from advocating for and advertising S-L in the recruitment of all minority students.

Acknowledgements

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Student "Post" Survey about Service-Learning

Spring 2012

Please fill in this survey registration area. This information is used for research purposes only, and has no bearing on your academic or program status. Your responses will form an important part of a research project on service-learning. Responses are kept confidential. Your ISIS ID number is particularly crucial to track changes.

SURVEY REGISTRATION AREA

Student ID (ISIS No.): _____

1. What is your gender?

- Male
- Female

2. Are you an international student?

- Yes
- No

3. What is your race? (check all that apply)

- American Indian or Alaska Native
- Asian
- Black or African American
- Native Hawaiian or Other Pacific Islander
- White
- Other: _____

4. What is your ethnicity?

- Hispanic/Latino
- Non Hispanic/Non-Latino

5. How many miles do you live from campus? (if you live on campus, put zero: 0) _____.

6. What is your age? _____

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

8. How many credit hours are you taking this semester? _____

9. What is your current academic status?

- Freshmen
- Sophomore
- Junior
- Senior
- Graduate

10. I am a transfer student.

- Yes
- No

11. What is your major? (check all that apply)

- Biomedical Engineering
- Chemical Engineering
- Civil Engineering
- Computer Engineering
- Electrical Engineering
- Energy Engineering
- Engineering Technology
- Mechanical Engineering
- Plastics Engineering
- Undeclared Engineering
- Other

12. Prior to UML have you ever been involved in community service activities? Check all that apply.

- No
- Yes, during high school
- Yes, during college
- Yes, outside of school

13. If eligible, did you vote in a recent public election?

- Yes
- No
- Not eligible then

We define "service-learning" as a learning approach in which students achieve academic objectives in a credit-bearing course by meeting real community needs.

14. Please estimate the total number of service-learning projects you have participated in your entire academic career. _____



SURVEY RESPONSE AREA:

INSTRUCTIONS: 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.

1. Please rate the importance of each of these career values. Please choose the answer that makes sense to YOU; not what you think others would say.

[1=Not important, 5=Neutral, 9=Very important]

- Challenge: Learning new skills or information, doing things in a new way ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨
- Helping: Doing things for others, building a better world ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨
- Income: Making a high salary. ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨
- Security: Having stable employment and income not worrying about lay-offs. ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨
- Variety: Doing many different activities, not doing the same things all the time. ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨

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]

- 2. Service and academic coursework should be integrated. ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨
- 3. Engineers should use their skills to solve social problems. ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨
- 4. I learn more when courses contain hands-on activities. ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨
- 5. Service in general should be an expected part of the engineering profession ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨
- 6. People who receive social services largely have only themselves to blame for needing services. ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨
- 7. Most social problems are easy to solve. ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨
- 8. I can have an impact on solving problems that face my local community. ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨
- 9. I can have an impact on solving problems that face under-served communities internationally. ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨
- 10. Working in teams is a waste of time. ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨
- 11. It is important to me personally to influence the political structure. ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨
- 12. It is important to me personally to have career that involves helping people. ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨
- 13. I am 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
- 14. I have a close working relationship with at least one faculty member at this institution ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨
- 15. Within service-learning courses, the service-learning projects should be required and not optional (with a choice of both service and non-service projects). ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨



The next section is about your experience with service-learning. (“Service learning” is a learning approach in which students achieve academic objectives in a credit-bearing course by meeting real community needs.)

16 a. Before you came to UML, did you know that service-learning was integrated into the college curriculum?
 ___Yes (go to b) ___No (go to c)

16 b. If you did know, was being able to take classes with service-learning one of the reasons you chose UML?
 ___Yes ___No

16 c. If you had known about SLICE, would it have been one of the reasons for coming to UML?
 ___Yes ___No

17. Please indicate the number of classes in each semester in which you participated in a class project that addressed a real community issue or problem through service-learning.

FALL 2011

- a. Total number of classes with service-learning projects taken (0) (1) (2) (3)
- b. Number of the classes in which service-learning was required. (0) (1) (2) (3)
- c. Number of the classes in which service-learning was optional. (0) (1) (2) (3)

SPRING 2012

- a. Total number of classes with service-learning projects taken (0) (1) (2) (3)
- b. Number of the classes in which service-learning was required. (0) (1) (2) (3)
- c. Number of the classes in which service-learning was optional. (0) (1) (2) (3)

18. Approximately how many hours total did you spend working on all your S-L projects in each semester?
 [Please indicate the number of hours].

Fall 2011: _____ Spring 2012: _____

19. On average, across service-learning projects,

- a. The amount of effort I put into the service-learning project(s) relative to an equivalent class project without service was: [1=Much less; 5=Same; 9= Much more]
(1) (2) (3) (4) (5) (6) (7) (8) (9)
- b. In the service project(s) I learned how engineers apply the concepts I learned in class to real-life problems. [1=Strongly disagree; 5=Neutral; 9= Strongly agree]
(1) (2) (3) (4) (5) (6) (7) (8) (9)
- c. In the service project(s) I learned how to work with others effectively. (1) (2) (3) (4) (5) (6) (7) (8) (9)

20. To what extent have your service-learning project(s) this year had impact on the following:

- a. The likelihood that I would continue in engineering. [1=Strongly negative; 5=Neutral; 9= Strongly positive]
(1) (2) (3) (4) (5) (6) (7) (8) (9)
- b. My belief that I can make a difference in the community using engineering skills (1) (2) (3) (4) (5) (6) (7) (8) (9)
- c. My interest in learning the subject matter of the courses. (1) (2) (3) (4) (5) (6) (7) (8) (9)
- d. My commitment to being involved in community issues as an engineer. (1) (2) (3) (4) (5) (6) (7) (8) (9)
- e. My ability to address complex, open-ended problems (typical of community projects) (1) (2) (3) (4) (5) (6) (7) (8) (9)



- f. My ability to write and speak credibly as an engineer. 1 2 3 4 5 6 7 8 9
- g. My understanding of the value of teamwork in addressing community issues. 1 2 3 4 5 6 7 8 9
- h. My ability to plan and carry out a project for the community. 1 2 3 4 5 6 7 8 9
- i. My school pride. 1 2 3 4 5 6 7 8 9
- j. The likelihood that I would drop out of engineering. 1 2 3 4 5 6 7 8 9
- k. My view of the engineering profession in a positive way. 1 2 3 4 5 6 7 8 9

[1=Strongly negative; 5=Neutral; 9= Strongly positive]

21. Did your service-learning project(s) lead you to further action (for example, volunteering) with the community agency or organization your worked with, or the topic/issue you worked on?

Yes No

22. 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)

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

23. Comments and suggestions: