Pilot Study: Impact of Service and Traditional Projects on Student Motivation, Learning and Professional Perspectives

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Abstract – A pilot study examining the impact of traditional versus service-learning projects on student self-reported motivation, learning and professional impact is presented. Both pre- and post- survey data were collected for a group of students (class size =30, completed surveys N = 18) in the junior level, mechanical engineering fluid mechanics course (22.381) at the University of Massachusetts Lowell. The results indicate that students have strong preferences toward certain project types/pedagogies. Additionally, the results show trends regarding service-learning and traditional projects that warrant further study using larger populations of students and more varied projects.

Keywords: Service-learning, Traditional Project Based Learning, Motivation

INTRODUCTION
At the University of Massachusetts Lowell (UML), a unique service-learning program has been in place for over 8 years [1] (ref.: http://www.uml.edu/Engineering/SLICE/About-Us.aspx). Service-learning at UML is defined as a hands-on learning approach in which students achieve academic objectives in a credit-bearing course by meeting real community needs. The aim is to integrate service and learning into the students’ curricular experiences, while shaping their engineering education to have awareness and appreciation for community needs. The aim in short is to educate better engineers and better citizens. In several engineering departments, such as the mechanical engineering department, the service-learning program is mature and service is integrated into courses throughout the freshman through senior curriculum. The original motivation for attempting this service-learning program was rooted in the findings of classic studies in which service-learning was shown to be effective in a large number of cognitive and affective measures, including critical thinking and tolerance for diversity, and leads to better knowledge of course subject matter, cooperative learning, and recruitment of under-represented groups in engineering; it also leads to better retention of students, and citizenship [2].

This paper presents a pilot study that was designed to examine (1) student motivation toward mechanical engineering projects and (2) student motivation, preference and self-reported learning efficacy in regard to service-learning projects as compared with traditional learning projects.

DESCRIPTION OF THE RESEARCH STUDY
The Study Design
The students were assigned to perform two class projects simultaneously over the course of approximately ½ of the semester, one a “service-learning” project and the other a traditional engineering project. The students were given the same total amount of time as they would have traditionally been given for two projects assigned one after the other. Each project was carefully designed to reinforce core fluid dynamics course content. All students were required to perform both projects for course bearing credit, but students voluntarily participated in the research study data collection process, without any direct incentives. One pre-project and one post-project survey was administered.
A Description of the Assigned Service-learning Project

The United Teen Equality Center (UTEC, ref: www.utec-lowell.org/) was the community partner for this particular 22.381 fluid dynamics class. The goal for the students was to examine the feasibility of installing a small wind turbine on/around their LEED-Platinum certified Green Building in Lowell MA (Figure 1). The goal of the 4-5 person team-based, service-learning project was to perform a short-term wind assessment/feasibility study of the power on and/or around the United Teen Equality Center (UTEC) newly LEED-platinum certified green building. Based on their study, students were to recommend a location for installing a wind turbine, and UTEC and the author would make use of this to develop a grant proposal for the wind turbine. The following core fluid dynamics principles were to be explored by the students: (a) integral conservation of mass & momentum (b) conservation of energy (c) dimensional analysis. The following tasks suggested as minimum tasks for completion of the project:

1) **Background Research:** Perform preliminary background research on wind/flow speed measurement techniques, collect background data on Lowell’s wind characteristics, and perform preliminary research about urban wind turbine installations. Students were assigned to visit the UTEC facility and identify 3 potential wind turbine sites near or on the facility and propose those sites in a preliminary deliverable.

2) **Design Component:** Perform research on commercially available wind turbines that can be installed in the various proposed locations. For each of the locations, students were to develop an installation proposal for the wind turbine. This included a mounting strategy including a fluid dynamics loads analysis/estimate.

3) **Analysis:** Students were to determine how they would calculate the equivalent wind power density for recorded wind speeds. A Matlab code or an excel spreadsheet was to be used to post-process the actual wind data from 2 different locations (unbeknownst to the students these locations were unfortunately not on the UTEC building due to difficulties installing the wind-logs on the building in the timeframe of the project).

4) **Final Report:** A final report (~4 pages) was required providing the site analysis, the background research, engineering analysis of the potential installation, and the wind-logger data analysis.

Students were initially given an approximately ½ hour overview of UTEC’s mission by Mr. Derek Mitchell, a UTEC employee at the time. During this in-class overview, students were exposed to UTEC’s educational mission and the aim to improve the visibility of green energy solutions in the Lowell and more specifically with the UTEC population. The students also had the opportunity to discuss the specific goals of the project at this time with the community partner. Students were also offered tours of the UTEC facility, in which multiple students participated.

A Description of the Assigned Traditional Project

In this project students explored the aerodynamics of the NACA 2412 airfoil using a subsonic wind tunnel experiment constructed and run by the author, and the XFOIL [3] airfoil analysis computer code. A foam wing with this airfoil profile was also provided to each group to construct a free flight glider as a deliverable. The following fluid dynamics principles were to be explored by the students: (a) the Bernoulli equation (b) Conservation of linear momentum (c) Dimensional analysis. This project was to be performed in groups of 4-5 students. The following tasks were the suggested minimum tasks for completion of the project:

1) **Background Research:** Students were tasked to perform preliminary research about the aerodynamics of NACA series of airfoils, research methods that can be used to measure lift and drag as well as airfoil surface pressure distribution using a wind tunnel.
2) **Laboratory Demo:** Each group participated in one five 45-minute wind tunnel laboratory experiments. Students were not allowed to run the wind tunnel – they were simply told via detailed instructions what data collection was necessary during the laboratory experiment.

3) **Post-laboratory Demo Analysis:** Students were provided some guidance to assist them in processing wind tunnel data. This included guidance toward calculating the wind tunnel velocity from an inclined manometer-pitot tube combination, calculating the static pressure at different static taps around the airfoil, as well as calculating non-dimensional coefficients such as lift and drag coefficient, pressure coefficient and the Reynolds number. Plots of the pressure distribution as well as an integration of pressure to find forces were also required. Students were also provided an online video tutorial for using the XFOIL and were tasked to perform a calculation of the airfoil properties. These computations were to be compared with the laboratory data and used in the design and build project.

4) **Design and Build Project:** Students were tasked to design a hand-launch glider that used a provided NACA 2412 airfoil section foam wing provided to the students by the author. The glider could be constructed with any additional materials of the students’ choosing. Specifications for the glider were imposed (max glide distance empty and max glide distance with a payload).

5) **Final Report:** A final report was assigned as the deliverable along with the teams’ fabricated glider. The report was to contain the information derived from the above tasks.

**Some Faculty Comparisons Between the Two Projects**

The two projects were designed to be as representative of the two project types being studied as possible. The traditional project deliberately offered more student scaffolding, and less “real-world” experience. The project was encapsulated in the university landscape, and was a little simpler to develop and guide on the part of the faculty due to the ability to tailor the project to directly address the specific and desired learning objectives. This project had elements of laboratory-demonstration (the wind tunnel test) as well as student hands-on experiences (the computer code analysis and the glider build component). The service-learning project was a combined on- and off-campus project that required students to work a little more independently. The community partner for the service-learning project had specific, real world, requests and the role of the faculty was at times more complicated to match the community partner need(s) with the specific learning objectives in the course. While the service-learning project involved a real world problem, with some hands-on engineering opportunities, the combined faculty and S-L community partner involvement and attention was critical to ensuring the success of project. At the end of the service-learning project, unfortunately minimal deliverables were provided to the community partner due to the challenges faced by the faculty in devising practical installation of wind-loggers on/near the UTEC building.

**DATA COLLECTION AND PROCESSING METHODS**

Data were collected in the form of a self-reporting student survey. The survey had a pre-project and a post-project component that was used to assess student motivation, learning and professional perspectives. The pre-project and post-project surveys were linked for all individuals who completed both surveys (N = 18). The majority of the questions on the survey were evaluated using an 11-point Likert scale. The only segment of the survey that did not use this scale for data collection was the section where direct comparisons were requested between service-learning and traditional projects and is clearly indicated in this paper.

The data were imported manually into MS Excel for all paired pre- and post-project surveys. These data were sorted in groupings for presentation and a statistical analysis was performed in Excel. For data where the average is reported, we also report the associated 95% confidence interval as the plus/minus of the data. In addition, for comparisons that are made between the pre- and post-project survey data, a paired t-test was also performed to determine whether the computed mean differences in the pre and post responses of each individual were significantly different from zero (i.e., a measure of change). In the paired t-test a p-value < 0.05 is used to indicate statistical significance.

**DISCLAIMER AND POTENTIAL SOURCES OF ERROR**

Due to the small number of respondents in this survey, we caution the reader from making specific or broad conclusions with regard to the differences between service-learning and traditional projects. The data are presented to derive preliminary (pilot) insight into potential areas for further study and to promote discourse in the community regarding effective project based approaches to learning. In order to derive more meaningful results, we strongly recommend a more comprehensive study that examines many different project based learning approaches, many
different implementations of these project types and a large population of students in order ensure a fully representa-
tive and meaningful study.

RESULTS & DISCUSSION

The results of the 11-point Likert scale survey responses are presented in this paper on a zero-ten scale with a mean
value of five. Values greater than five indicate agreement or positive student association with the survey ques-
tion/statement, while values less than five indicate a negative student association with the survey question/statement.
For each survey question the mean value as well as the 95% confidence interval of the mean estimate are reported.
For pre- and post- project surveys, several questions are linked. In these cases a paired-t-test is performed using a p-
value < 0.05 to indicate statistically significant changes. Almost all results are presented in a pre- and post- project
pairing, with the exceptions being clearly stated in the paper.

Overall Student Motivation

In this section, the results for the general questions on the pre- and post-project surveys are presented and discussed.
These general questions were used to determine the level of motivation students had toward various overall effectors
at the beginning and at the end of the project. These questions were implemented to provide a level of control for the
study and to ensure that there were not significant changes in overall student perception. The results of the relevant
survey questions are shown in figure 2, and each question is discussed individually in the context of this study in the
paragraphs that follow.

Figure 2: The results for the overall student self-reported motivators in the course. For Q1, Q2, and Q4 the black bar indicates pre-survey data, while the white bar indicates post-survey data. In Q3, the results for student interest in the project topics were assessed, showing the interest in the service-learning project topic (black bars) and the interest in the traditional project (white bars).

Q1: How personally motivated are you to study engineering? The student responses on this question indicated a high commitment to studying engineering, with a nearly identical, tightly bounded, mean value in both the pre- and post- project survey (pre-project mean = 8.28 ± 0.71, post-project mean = 8.28 ± 0.69, pre-post t-value = 0.0, t-test p-value = 1.0). This is deemed to be an important metric in the overall study, as it shows that the general motivation and persistence of these students remains constant over the duration of the project. This first question is indicative of a high level of motivation towards engineering in the student participants.

Q2: How personally motivated are you to understand fluid mechanics as a subject? The student responses on this question indicate a high commitment to studying the subject matter (fluid mechanics), with a similar trend in mean value in both the pre- and post-project survey (pre-project mean = 8.33 ± 1.46, post-project mean = 8.17 ± 1.38, pre-post t-value = 0.53, t-test p-value = 0.60). This is an important metric in the overall study, as it once again shows that the overall motivation and persistence of these students does not significantly change over the project duration.

Q3: My interest in the service-learning project topic positively impacted my motivation. (white-bars): My interest in the traditional project topic positively impacted my motivation. In this post-project survey only question, the students were asked to report their motivation towards performing the specific project topics that were assigned. The results indicate that the students do not appear to have a preference for either topic, with the mean in this case nearly identical between the service-learning wind energy topic (mean = 7.89 ± 1.00) and the traditional
aerodynamics project topic (mean = 7.94 ± 1.08). It was important to try to assess biases, including each project topic, in order to try to ensure fair comparisons in this paper. 

Q4: How important it is for practicing engineers to provide service or volunteering work for their community? This pre- and post- survey question is asked to determine students’ perspectives on service in the engineering profession. The result shows a higher than average response (greater than 7/10), indicating students value service and volunteering work. The pre-project survey mean (7.78±1.24) is slightly higher than the post project survey mean (7.22±1.31); the paired t-test results in a t-value = -1.65, and a corresponding p-value = 0.12. Despite this, only 3 of 18 respondents said they reported regularly participating in volunteer work. 

Pedagogy and its impact on Student Motivation

In this section of the study, the impact of general and specific project pedagogical approaches on student motivation are examined. The processed survey results are summarized in Figure 3. These approaches include commonly used approaches such as hands-on, real-world, and analytical projects. These data are examined to assess whether there are any changes in student attitude during the study due to pedagogical factors. In this series of results, the survey questions are discussed in logical pairings.

Q1: Rate your interest level if a class did not include projects of any kind – ie. simply lectures/homework/exams?

Q2: How personally motivated are you to complete engineering class projects? The responses to these two questions suggest that students show a keen interest in performing projects. In Q1, students report higher than mean, but still not very high interest if a class does not have a project; in Q2 there was high motivation reported towards completing projects. This interest level is similar between the pre- and post- project surveys. No significant change between pre- and post- project survey was observed (Q1: paired t-test p-value = 0.34, Q2: paired t-test p-value = 0.57).

Q3: How personally motivated are you to participate in group-projects in your engineering classes?

Q4: How interested are you in group-projects rather than individual class projects? Since the projects that are performed by the students were group projects, it was important to examine whether there were any underlying preferences or changes in student perception with regard to group versus individual work. From the responses, it appears that students are slightly more interested and have more motivation to work in groups as opposed to individually. No significant change between pre- and post- project survey was observed (Q3: paired t-test p-value = 0.75, Q4: paired t-test p-value = 0.83).

Q5: A service component improves my overall experience in a course.

Q6: Traditional projects improve my overall experience in a course. In this pair of questions, the pre-project results indicate a near-to-the mean expectation for the impact of a service-learning project and a traditional project in the overall course experience. Following the performance of the project there was a statistically significant positive change in the mean for both the service-learning (pre-project mean = 6.13 ± 1.17, post-project mean = 6.72 ± 0.92, pre-/post- project paired t-test, t-value = 2.21, corresponding p-value = 0.043 < 0.05) and the traditional projects (pre-project mean = 6.65 ± 1.06, post-project mean = 7.24 ± 1.00, pre-/post- project paired t-test, t-value = 2.43, corresponding p-value = 0.028 < 0.05).
survey results indicate a statistically significant, positive change in perception of both project types over the course of the study. This may indicate several things, including, a positive student experience in both projects.

Q7: Because of my past experiences in service-learning projects, I am more interested in performing service-based projects in the future. Q8: I am glad when there is not a service-learning component in the project for a class? This set of survey data examines the student perception of service-learning projects. In this study, 15 of the 18 respondents had performed at least one prior service learning project at UMass Lowell, with a mean of 2.07 projects completed per student (standard deviation = 1.22). In the reported data, there is no statistical significance between the pre- and post- project responses (Q7: paired t-test p-value = 0.33, Q8: paired t-test p-value = 0.94); however, the mean values themselves indicate a positive overall perspective towards service-based projects.

Specific Motivators Related to Project Pedagogy

In the results reported in this section, summarized in Figure 4, some specific pedagogical components of projects are examined in the context of increasing/decreasing self-reported motivation. For most of the data compared, there are three separate categories: (1) the overall motivational impact of the general pedagogy, (2) the motivational impact of the pedagogy in the context of service-learning and (3) the motivational impact of the pedagogy in a traditional project setting.

![Figure 4: The pre- and post- data clusters showing student self reported perspectives on general, service based and traditional approaches on their learning.](image)

Q1: Hands-on/build component to projects (black-white : pre-post) How personally motivated are you when your engineering projects include a “hands-on/build component” (blue-cyan : pre-post) The hands-on nature of the service-learning project positively impacts my motivation. (red-magenta : pre-post) The hands-on nature of traditional learning projects positively impacts my motivation. In these results (Figure 3, Q1), we observe that “hands-on/build” components result in high motivation results for all engineering project types. When comparing pre- and post-project results, the generally posed question, as well as the service-learning version both show slight reductions (Q1 general: paired t-test p-value = 0.23, Q1 S-L: paired t-test p-value = 0.15). Interestingly, the opposite trend is true for the traditional projects: on the pre-project survey, the students reported much lower motivation toward traditional projects with “hands-on/build” components; however, the results on the post-project survey were higher for this question (Q1 traditional, paired t-test p-value = 0.66). There are several reasons possible for this change. One possible reason for this could be the hands-on glider build component performed in the traditional project.

Q2: Real world components to projects (black-white : pre-post) How motivated are you when your class projects include a “real world problem”? (blue-cyan : pre-post) The real-world application of a service-learning project positively impacts my motivation. (red-magenta : pre-post) The real-world application of a traditional learning project positively impacts my motivation. Students responded positively to “real-world” components. The pre- and post-survey data indicate students’ sentiments did not change substantially in their rated importance of this metric (all pre-/post- project paired t-test p-values > 0.68). The most largest mean change was observed in the service-learning response; however, based on the paired t-test p-value = 0.69, this is considered a statistically insignificant change.

Q3: Customer driven project deliverables (black-white : pre-post) How personally motivated are you when there is a “customer” that is going to use your engineering project? (blue-cyan : pre-post) How personally motivated are
you when your engineering project serves a community member in need? (red-magenta : pre-post) Overall, the presence of a community partner in the service-learning project was positive for my motivation. The student responses are positive in response to the motivating impact of a customer for the project. The responses were also positive for the motivation toward helping a community member in need. In both of the aforementioned cases the decreases in the post-project survey are deemed statistically insignificant (paired t-test p-value = 0.53 and 0.54 respectively). Finally, while students are positively motivated by the presence of a community partner in the service-learning project, the responses for this question did not rank as highly as the other two community/customer metrics in this question category in both pre- and post-project responses (no significant change, paired t-test p-value = 0.43). It is not clear why this is the case, and further investigation into this question is suggested.

**Q4: Serving the needs of the community** (black-white : pre-post) Serving the needs of the community in a service-learning project positively impacts my motivation. (blue-cyan : pre-post) The presence of a community partner in a service-learning project positively impacts my motivation. (red-magenta : pre-post) Because there is no community partner in a traditional project I apply less effort? **Q5: Servicing the needs of the community** (black-white : pre-post) How personally motivated are you when your projects include only an “analysis” component? (blue-cyan : pre-post) I have no interest in the service component of a project (asked on the survey portion on traditional projects) (red-magenta : pre-post) I have no interest in the service component of a project. (asked on the survey portion on traditional projects) Several different phrasings of the incorporations of the needs of the community were tested. These questions were interspersed throughout the survey. The results show similar trends as those previously reported in Q3. One of the unique results presented here is that regarding “analysis only” projects – Q5- (black-white : pre-post). This response shows average motivation reported by students towards projects with purely analytical tasks. This is not a surprising result considering engineering projects are considered applications of subject matter.

**Self-Reported Learning/Subject Matter Application**

In this series of survey questions, the impact of the projects on student self-reported learning was examined. The data are clustered into six sets of question clusters with four responses presented for each (see **Figure 5**). For each, the pre- and post- answers for the service-learning related data are presented (blue-cyan : pre-post) and then data related to traditional projects are presented (red-magenta : pre-post).

![Figure 5](image)

**Figure 5:** The survey responses for pre- and post-project survey results related to student self-reported learning efficacy. For Q1, Q2, Q3 and Q6: Service learning responses are presented using blue and cyan for pre- and post-project survey responses respectively, similarly, traditional project responses are presented using red and magenta bars for pre- and post-project survey results respectively. The keys for Q4 and Q5 are provided in the text.

**Q1: How students perceive their learning efficacy using projects** (blue-cyan : pre-post) How much of the core subject matter do you learn from projects compared with lecture/homework? (red-magenta : pre-post) How much do course projects help you apply and use subject matter? In the responses to these two questions, the students report a near mean learning efficacy from projects as compared to homework and lecture; whereas, the response to Q1-(red-magenta : pre-post) indicates students believe that projects can positively enhance application of the material.
Q2: Hands-on learning efficacy (blue-cyan : pre-post) The hands-on component of the service-learning project positively impacts my grasp of the subject matter. (red-magenta : pre-post) The hands-on component of a traditional learning project positively impacts my grasp of the subject matter? In the responses to these two questions, students reported a similar perspective on service-learning projects and traditional projects in the pre-project survey – that projects help students grasp subject matter. In the post-project survey, however, students were less positive about the hands-on learning efficacy from the service-learning project (paired t-test p-value = 0.02) as compared with the traditional project that saw a mild increase in reported value (paired t-test p-value = 0.66). This could be due to several factors including the two project designs, student perception, etc. This warrants further investigation.

Q3: “Real World” component, learning efficacy (blue-cyan : pre-post) The real-world nature of a service-learning project positively impacts my grasp of the subject matter. (red-magenta : pre-post) Real-world applications in traditional learning projects positively impact my grasp of the subject matter? The results that are presented here illustrate an interesting pre-/post- behavior in terms of reported learning efficacy. The service-learning and traditional projects had similar positive pre-project reported values; however, post-project responses show a dip in the service-learning learning efficacy (paired t-test p-value = 0.33) and a rise in the traditional project learning efficacy (paired t-test p-value = 0.41). These pre- and post-project comparisons do not suggest statistical significance in this result.

Q4: “Service-Learning” component, learning efficacy (blue-cyan : pre-post) The presence of a community partner in a service-learning project positively impacts my grasp of the subject matter. (red-magenta – pre-post) Overall, the presence of a community partner has a positive impact on my grasp of the subject matter. In this result the overall trends are near the mean for the reported benefits due to the service-learning partner involvement. This is contrary to the expected response – further investigation is suggested.

Q5: Does “Service-Learning” augment the student experience (blue-cyan : pre-post): I believe that service adds no value to my engineering education – reported in the service component of the survey (red-magenta : pre-post): I believe that service adds no value to my engineering education – reported in the traditional project component of the survey: In this series of results, the same question was asked in different parts of the survey. The results are plotted for the pre- (blue) and post (cyan) for the service-learning and the pre- (red) and post- (magenta) traditional project parts of the survey. It appears that the service was given less positive reflection when students were considering traditional projects than when they were considering service-learning questions. This suggests a potential skew due to what part of the survey is being completed, or potential fatigue during the survey. Changes observed between pre- and post- surveys are not considered statistically significant.

Q6: Overall perception of traditional vs. service-learning efficacy (blue-cyan: pre-post): Overall, the presence of a community partner has a positive impact on my grasp of the subject matter. (red-magenta: pre-post) Overall, traditional projects have a positive impact on my grasp of subject matter? The results of these questions once again appear to follow the trends observed in Q1, Q2, and Q3. The students initially report similar perceptions of service-learning and traditional projects in the pre-project survey; however, they report a lowered post-survey score for service-learning projects (paired t-test p-value = 0.05) and a higher post-survey score for traditional projects (paired t-test p-value = 0.34). There could be many reasons for such changes, including project design, implementation specific issues, student perceptions of learning, survey wording, etc. Once again, this warrants further investigation.

Specific Comparisons of Traditional Project-Based-Learning and Service-Learning Based Projects

Direct comparisons between service-learning and traditional projects are presented in this section (Figure 6). These direct comparisons were performed early in the actual survey by asking students to select the project-type that best answered the question/statement posed. Responses are presented as (0) “Traditional Learning” (1) “Neutral” (2) “Service-Learning”. The results are shown in Figure 6; black bars = pre-project, and white bars = post-project.

Q1: Which type of project is more interesting to perform? In the pre-project survey there was a strong preference for “service-learning” approaches; however, a mildly significant change (paired t-test p-value = 0.13) was observed towards the “neutral” choice. In the pre-test the students did not know the project definition.

Q2: Which type of project is more rewarding to perform? In this case the service-learning project received a high preference in both the pre- and post-survey testing. This is an expected consequence of working with a community partner with a specific need. No statistically significant change from pre- to post- project survey is observed.

Q3: Which type of project is more motivating to perform? In this case the students’ expected a more motivational experience in the service-learning project; however, there was again a mildly significant (paired t-test p-value = 0.11) change in perception of the motivational impact toward “neutral” in post-survey responses.
**Q4: Which type of project is more fun to perform?** In this case, the service-learning project was initially seen as slightly more favorable choice than the traditional project; however, in the post-project survey, the students significantly changed their opinion toward the traditional project (paired t-test p-value = 0.048). While “fun” is not a technical reason to adopt a project approach, this result warrants some further investigation.

![Figure 6](image)

**Figure 6:** The averaged student responses when selecting “service = 2”, “neutral = 1” or “traditional = 0” as the best response to eleven questions. The pre-project survey results are plotted using black bars, while the post project responses are indicated using white bars.

**Q5: Which type of project is more frustrating to perform?** Students’ initial perspective was that the service-learning project would be the more frustrating of the two. Here, again a mildly significant change toward neutral was observed (paired t-test p-value = 0.096). This was somewhat unexpected, since students will often be uncomfortable with the messy nature of service-learning projects and become easily frustrated. This result may indicate that, though students expect a “messier” service-learning project, they are capable of handling some lack of scaffolding in a service-learning project by the time they are in their Junior year.

**Q6: Which type of project is more time consuming to perform?** An insignificant bias toward service-learning.

**Q7: Which type of project contributes more to your learning engineering principles?** The pre-project survey responses to this question were relatively neutral. In the post-project survey, a statistically significant change (paired t-test p-value = 0.0006) had occurred toward a traditional project. This may reflect a number of things, including the project design and self-perceptions of learning. This is further discussed in the general discussion that follows.

**Q8: Which type of project contributes more to your learning about the engineering profession?** These results exhibit neutral results with a slight preference to service-learning pedagogies in the pre-project responses.

**Q9: Which type of project contributes more to your development as a student?** The response is neutral.

**Q10: Which type of project contributes more to your understanding of the engineering design process?** The responses are neutral.

**Q11: Which type of project is more useful for your future as an engineer?** In this response, students in the pre-survey had high expectations for service-learning approaches, however, in the post survey, a statistically significant change in perception towards a neutral answer was recorded (paired t-test p-value = 0.0015).

**General Discussion**

Results of a preliminary study comparing student perceptions of their motivation, learning and profession have been reported in the context of understanding what differences exist between traditional engineering projects and service-learning projects. In most of the survey responses, students reported positively toward both types of projects. In general, service-learning projects appeared to have consistently higher mean pre-project survey responses than traditional projects; however, in the post-survey responses service-learning projects showed somewhat less positive responses (although many changes were deemed statistically not significant). Of the pre- and post- project changes that did have statistical significance, there are several concerns and cautions regarding the nature of this pilot study that must be carefully considered in future development and investigation:

First, the sample size in terms of the number of students and the number of projects being evaluated is too small to draw too many meaningful conclusions. Although the best intentions were applied in the design and implementation of both projects, there is too significant a dependence on the two project types in the survey results to make objec-
tive statements. The lack of absolute equivalence between projects will clearly be responsible for some of the changes presented in the pre- to post-project survey. It is also quite possible that the service-learning project was not as well implemented as the traditional project, resulting in survey responses reflecting the specific student experience rather than the project type. Additionally, the core content covered by the two projects is different, and based on the topics covered it is distinctly possible, that the content in the service-learning project was more difficult for the students to assimilate. It is because of these unintended dependencies that the results presented be considered with some caution as merely a pilot study, rather than an unequivocal comparison between the two types of project.

Second, overall there was a higher perception of the service-learning project type for students entering the study; however, the perception of the service-learning project type was lower on some responses in the post-project survey. This raises an interesting series of questions that are left largely unanswered by the present survey. (1) How much do prior S-L project experiences impact the pre-survey expectation (15-of-18 students had prior UML S-L project experience, average number of S-L projects = 2.07, $\sigma = 1.22$)? (2) How much does the positive connotation of the term “service” impact pre-survey responses? (3) How much does project implementation, service partner involvement, faculty involvement and ‘student measured success’ in the project impact students’ perceived motivation and learning?

Third, student self-reported sentiments may be quite different than actual experiences. For example, in the case of learning efficacy, students’ responses may not accurately reflect their actual learning efficacy. An example to illustrate this is the comparison between students’ self-reported learning, versus the average grade in each project which was very similar (mean grade on service learning project = 21.4/25 with $\sigma = 4.67$ vs. the mean grade for the traditional project = 21.7/25 with $\sigma = 4.63$). This suggests self-reporting may not be a valuable comparison metric. A more comprehensive comparison that includes actual measurement as well as interviews regarding the student learning experience and their development as engineers is recommended.

**CONCLUSIONS**

Three recommendations result from this study: (1) Further study of measured vs. self reported learning efficacy of service-learning compared with other project types (2) Further study into trends over a large collection of projects and student samples (3) Future studies should occur using both pre- and post-project surveys and in some cases interviews performed in a timely fashion so as to capture the short term memory of student experiences.

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**References**


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