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Can Service Learning Impact Student Learning and Motivation in a Required Engineering Probability and Statistics Course?

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Introduction

There is growing evidence that service learning can substantially improve student understanding and retention of quantitative concepts and technical skills that are the core of engineering curricula, as well as help students gain communication and leadership skills and improved understanding of engineering ethics. However, to date, service learning has mostly been integrated in freshman or capstone engineering classes that have a fairly broad scope of learning objectives. This paper describes the design and assessment of a service-learning module in a required junior-level course in probability and statistics for engineering students at a large public university, which typically enrolls 90-100 students. This course is ideal for service learning because students struggle with the material, complaining it is "too theoretical", and can feel anonymous in a large lecture course. Yet, there are few examples of how to successfully integrate service-learning ideas, including reflection activities, into a high-enrollment course that traditionally focuses heavily on quantitative fundamentals.

This paper details the design, student work and outcomes associated with a service learning module for a junior-level probability and statistics course. In documenting the module, we attempt to provide enough detail to allow others to adopt these materials for their own courses. The paper then assesses the service learning modules in terms of impact on students' (i) motivation to continue in civil engineering and (ii) learning of probability and statistics. This assessment considers the student work produced, survey responses, and comparisons of the grades for the group of students who chose to participate in the service learning with the rest of the class. Recommendations are also made to improve design and management of the course for future offerings.

Background

Service learning is "a form of experiential education in which students engage in activities that address human and community needs together with structured opportunities intentionally designed to promote student learning".[1] Evidence shows that service-learning activities substantially improve student understanding and retention of quantitative concepts and technical skills.[1] Students also report that they work harder on service-type projects than conventional assignments.[2,3] Furthermore, service learning has been shown to be effective for teaching skills such as communication, leadership, teamwork, and ethics.[2,4,5] These skills are difficult to fit into traditional class material, but gaining prominence in civil engineering educational objectives and accreditation criteria, reflecting their significance in the workplace.[6,7] There is also evidence that participation in service learning helps students to develop and maintain a perspective of the broader context of engineering and to develop a sense of civic responsibility.[2,5]

Service learning may also support the objectives of retaining and developing a more diverse student body and profession in engineering. There are many benefits of a more diverse student body and workforce, and workplace innovation, creativity, knowledge and productivity have been shown to be enhanced when many perspectives and experiences are represented.[9] Although

retention in engineering is a problem for all students, it is particularly problematic for women and minority students, whose representation in engineering decreases at every education and career milestone.[9,10] Indeed, women and minorities still make up a small fraction of those earning engineering degrees (nationally, approximately 20% of the undergraduate engineering population is women and 11% are underrepresented minorities). Student retention of all students, regardless of background or gender, has been shown to increase with service-learning activities in the curriculum.[8,11] Students also report that they are more comfortable working with people of different backgrounds after participating in service learning.[8,11] However, data suggest that the impact of service learning may be more significant for women and minorities. For example, women make up 40% of students participating in *Engineers without Borders* nationwide, twice the proportion of female engineering students.[12]

The service-learning module proposed here attempts to maximize the benefits of service learning through principles described by Barrington and Duffy[13] and others, by offering a course-based service-learning opportunity that is credit bearing, addresses a community need, and incorporates student reflection designed to further understanding of course content, broaden appreciation of the discipline, and promote an enhanced sense of civic responsibility. The design of the reflection activities (which are described in more detail below) attempts to address the multiple levels of reflection articulated by Lima and Oakes[14] – "What?" "So what?" and, "What now?" – utilizing models of previously successful reflection activities.[15]

Service Learning in a Probability and Statistics Course

Design

The probability and statistics course has three primary objectives for student learning. By the completion of the course students should be able to: (1) explain concepts, methods and models related to probability applications in civil engineering and compute event probabilities; (2) apply statistical methods to (a) summarize properties of a data set, (b) fit probability distributions or regression models to data and (c) conduct hypothesis testing; and (3) critically evaluate data and statistics from applications in civil engineering and identify design situations that must incorporate concepts of uncertainty. The service-learning module for the probability and statistics course was designed to address these learning objectives, grounded in the local community and oriented towards students interested in civil engineering. Accordingly, the service-learning module has the objectives of: (1) improving student learning in probability and statistics through community-based practical learning experiences, and (2) supporting the retention of a diverse group of civil engineering students.

It was critical that the project lend itself, either directly or indirectly, to collection of data and statistical analyses, in order to tie in with the learning objectives of the course and to help students relate the course material to the real world and their future engineering careers. After brainstorming a number of ideas, the faculty instructor approached the local Habitat for Humanity (HfH) affiliate and asked them if they would be willing to collaborate. This choice made sense because HfH is active in the local community, and they are seeking to deepen partnerships with the university and university students. At the time, the local HfH affiliate was focusing their efforts on rebuilding homes in a nearby community that had experienced

devastating floods two years before. They invited the students to work on one of their projects which involved reconstruction of a home that had been completely destroyed, pictured in Figure 1. In addition, the local HfH communications and outreach director agreed to visit the class, providing an overview of the organization's mission and their local activities.

Due to the large size of the class, and the fact that this was the first time this service learning module was being developed, participation in the service-learning module was optional. For those who participated, the grade for the service learning activities replaced their grade on the second (of two) midterm exams. The students who chose to participate (about 20% of the class) were first asked to respond to a Likert-type survey asking for their views on service learning, engineers' local and global responsibilities, and their sense of personal efficacy in affecting change in the community. Students then volunteered for at least one eight-hour HfH workday in a local community that was severely affected by recent flooding. They were expected to complete three assignments: (1) a reflective journal entry written shortly after their volunteer day, (2) a report exploring a specific student-chosen application of probability and statistics to the activities of HfH, and (3) an in-class presentation. The service-learning activities were designed, coordinated and assessed by the faculty instructor for the course and a graduate student assistant (the authors of this paper; hereafter referred to as the "instructors").

Figure 1. Home damaged by flooding. Students worked on building a new home on the same property. (Photo: HfH).

Activities and Student Work

Student Participation

Participation in the service-learning module was optional. To select students for the service learning opportunity, an application was distributed to the entire class. The application asked students whether they wished to participate in service learning and their preferred date for working on site. In addition, it asked two short-answer questions: *Have you participated in Service Learning or Community Service before?* and *Why do you want to participate in the Service Learning Option in this course?* Students were informed that participation in the service-learning module would require commitment of a Friday or Saturday outside class time, and that their grade for the module would replace the grade from the second of three exams (corresponding to 25% of their final grade). The handout provided to students to provide information on the service-learning option is provided at http://www.abbieliel.com/educational-materials.

Forty-four (out of 103 students in the course) applied for the 30 service learning spots. To narrow the list, the instructors each read the short answer responses and assigned a score from 1 (indicating a short, vague or trite response) to 3 (indicating a thoughtful response). Any response that received a 1 from either of us was discarded, resulting in five students being eliminated from consideration. Among the remaining students, the 30 participants were chosen randomly, with the other nine given the opportunity to serve as alternates.

Two dates were originally scheduled as work days with the local HfH affiliate: February 27 and March 13. Fifteen students and 4-5 alternates were assigned to each day. However, the February 27 workday was canceled due to snow. As a result, HfH agreed to accommodate our entire team on March 13. Since not all of the students were available on that date, the final team consisted of 19 students attending on March 13, and 3 students participating on March 14. The final group of 22 students was 50% men and 50% women.

Work Day

On the appointed date, students spent the entire day working at the HfH construction site, accompanied by the course instructors and one additional faculty member. After the short safety orientation, students worked in groups of 3-5. At the time of our work, the home had been framed, and some exterior walls were installed. Throughout the day (Figure 2), students installed ceiling vapor seals; measured, cut, and hung drywall on ceilings; installed lateral bracing for handrails; dug a ditch for piping; measured and cut additional wooden support pieces; and distributed rocks beneath the porch for drainage. Students ate lunch together, and with the other volunteers, in the local town hall.

Journal Entries

Providing multiple opportunities for student reflection at various levels has been identified as an important component of successful service-learning courses.[14] Students were asked to spend some time over the weekend immediately following the work day reflecting on their experience in a journal entry (inspired by suggestions from Moffat and Decker[15] and others). Journal entry prompts included: *What did you do while you were there? Did you meet the homeowners? If so, what did you talk about? What aspects of the project were surprising? What aspects were challenging? What applications of probability and statistics might you consider for your report? What technical and nontechnical information did you learn about the project from the people you worked with? Is there a difference between what we think is needed and what the recipients of the service think is needed? Will this relate to your work in the future?* Students were required to submit the entries, but the content was not graded.

The submitted entries ranged from detailed reflections on the volunteer experience to a step-by-step description of the workday activities. The paragraphs below provide excerpts from two of the entries.

Student 1 We as a group help put up the plastic that is required to cover the entire ceiling (for insulation purposes I believe) and start the dry wall process, which goes over the plastic. I wish we got to meet the homeowner, but instead there were local community members that stopped by, thanking us for our work. They expressed quite a bit of appreciation for the work that we were doing, since they had seen the direct effects their community had to deal

with as a result of the flood. I found this project incredibly fulfilling, and realized that I never checked my watch or cell phone once! I was shocked that I was that consumed by this work. I also found it enjoyable to work with a group of people you interact with on a daily basis, and getting to know my peers outside of the engineering center, was a great experience … Working on this project with Student A, Student B, and Student C allowed me to get to know them on a personal level. I learned more about what they are involved with in their engineering program… Some technical information I received was from Student A, who has worked on construction projects with her dad ever since she was a kid. She taught me some construction practices that I would have never thought about in regards to measuring the plastic more efficiently and effectively. This project was such a great experience, that I would recommend doing it again, the same way. Thanks to this project, I want to get more involved with Habitat where ever I am this summer, and continue with other service oriented clubs on campus like Bridges to Prosperity.

(a) (b)

(c) (d)

Figure 2. Students at the HfH worksite on March 13, 2015 working on (a) hanging the vapor barrier, (b) installing dry wall, (c) digging conduit trenches for electrical lines, and (d) placing rocks and barrier underneath the porch.

<u>Student 2</u> Last Friday, I was very grateful to be able to have the opportunity to join HfH in helping to build a home that was destroyed during the floods … While winding through the canyon, it was obvious how powerful the flood waters were by looking down in the creek bed … Everyone sort of broke up into groups, all doing different tasks on the property. Myself and a few others took initiative in securing vapor barrier to the ceiling studs. After getting the vapor barrier installed, we began to start hanging drywall … When it was time to start shutting down for the day, we had made some good progress with getting drywall installed on the ceiling of the main room. After cleaning up and making certain all tools were stored where they needed to be, we all went outside and talked a bit with the Habitat crew. They thanked us, and said they really appreciated our help. I felt grateful as well, it was very nice to have given some time to such a great cause. Trying to imagine losing your home to the fast waters is difficult, but it is reality for the owners of that property. So, I am very happy to have had the chance and opportunity to participate in the event.

The authors used emergent coding techniques to qualitatively identify the themes that students expressed in their entries. Almost all of the entries (20 out of 22) reflected on themes of volunteerism. Seven included a reference to future volunteering, while 13 reflected on what spending the day volunteering meant to them. In addition, 7 entries discussed the flood event that had damaged the community where we worked, 7 described their interactions with or empathy for the homeowner, and 5 discussed issues affecting the community where we worked. Other journal entries reflected on themes of construction challenges (3 entries), house location (1) and the HfH mission or organization (2).

Reports and Presentations

The primary deliverable for the service-learning module was a report (detailed at http://www.abbieliel.com/educational-materials), which students could complete alone or in pairs. Students were asked to choose a topic that related to (a) probability and statistics and the quantitative analysis methods being discussed in the class, and (b) HfH activities. The report topics were selected by the students, with review by the faculty instructor. Table 1 lists the topics that students identified, which ranged from aspects of construction and flood risk, to the HfH organization, to social issues associated with the project.

Table 1. Report topics selected by students.

Topics related to construction
Statistics of Injuries on Construction Job Sites
The Purpose and Use of Vapor Barriers
Topics related to volunteerism
Volunteer Participation and Demographics in the United States
Volunteering To Decrease Poverty: Poverty, Population Growth and Habitat
The Risks of Volunteering with HfH
Topics related to the HfH organization
Factors that Affect the Number of Households Assisted
HfH's Worldwide Impact
Evaluation of HfH's Conformity with Homeownership Rates based on Race
Sources of Support for HfH
Topics related to flood risk
Flood Prediction and Flood Plain Accuracy
Flood Prediction
Topics related to housing
Poverty and Affordable Housing
The Social Benefits of Home Ownership

The assignment asked students to first describe the topic being addressed and justify its relationship to probability and statistics and to the HfH project. Students were asked to collect data, and conduct statistical analyses of these data. They were then asked to present key data using plots and statistics related to the topic of interest responding to prompts that focused on aspects of probability and statistics as applied to real world problems: *What are the variables of interest? What are the important trends? What can we learn from these data?* Two examples of report topics and data analysis are provided in Figure 3 and Figure 4. In addition, students provided recommendations to HfH related to their research topic (covering actions that could be taken or additional data that could be collected), and to the faculty instructor on ways of improving the service learning module (discussed in detail below).

The final activity of the service-learning module was a set of presentations, held approximately one month after the workday. These presentations were 10 minutes long and conducted in groups of 3-5. These groups were formed based on students who had worked together at the construction site, bringing their shared workday experience to the presentation. Each group described first the work that they did at the HfH worksite and summarized findings from each student's report. This discussion provided an opportunity for students to provide feedback to faculty and other students about their experiences.

Table 4: Floodplain Data statistical analysis.[2,4,5]

FEMA Floodplain Data	Homes Damaged	Homes Not in Floodplain	Ratio of Accuracy (%)
Jamestown	34	15	55.88
Boulder County	247	41	83.40
Weld County	274	60	78.10
Larimer County	175	33	81.14

Figure 3. Table provided in one student's report. This table examined the number of homes that experienced severe flood damage in the recent flood event and computed the ratio of those homes that were in the FEMA-defined floodplain to those that were not. This student collected data on flood damage from published sources, but conducted her own analysis and defined what she meant by "accuracy".

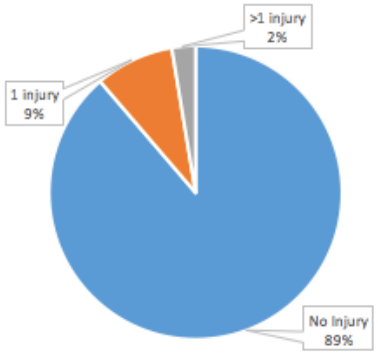

Figure 4. Figure taken from a report submitted by two students. These students collected data on the number and type of injuries experienced by HfH volunteers. This plot shows that 89% of volunteers have no injury, 9% experience one and 2% experience more than one. This reports' authors then predicted that our group would experience roughly 2 minor injuries, and polled their classmates as to who had experienced any injuries on the worksite.

The guidelines used to evaluate the reports was provided to students, and included with the web documentation provided with this paper. Reports were graded following the guidelines shown by both instructors, and the scores then discussed and adjusted if needed.

Assessment

Survey

Before participating in the service-learning module, students were asked to respond to a 10 question survey, responding on a Likert scale (using a 5-point scale ranging from "strongly agree" to "strongly disagree"). These questions, which are listed in Table 2, aimed to explore the students' views on service learning, their interest in the challenges of their local or global

community, and their personal ability to affect change. Some of the questions came from existing validated survey instruments[3,15], while others were developed specifically for our purposes.

Survey responses from the students who participated in the service-learning module for selected questions are provided in Figure 5. The majority of participants agreed or strongly agreed with the statements about service learning being beneficial to education and beneficial to community, and that engineers and citizens can work together. The responses were somewhat less strong in response to the statement that "service and academic coursework should be integrated" and the connections between probability and statistics and service learning, although most students did report that they could see a connection between probability and statistics and service learning. We were somewhat surprised by the responses to this question, but they may reflect the strong emphasis throughout the course on engineering and real world applications of probability and statistics such that the relation to HfH was not too much of a stretch.

The results in Figure 5 also show that women respondents reacted more strongly to statements about the importance of service learning, benefits to the community and "it is good for me to engage". However, women expressed more uncertainty than male students about the connection between probability and statistics and service learning. In addition to these differences by gender, it is worth noting here also that the students self-selected for the service-learning module, and that women were significantly more likely than men to choose to participate. The final group of participants includes 17% of the class, consisting of 44% of the 25 women enrolled in the course and 14% of the men.

The survey also asked students if they had previous volunteer experience. These findings, an example of which appears in Figure 6, showed that those students with previous volunteer experience were generally more likely to identify benefits of service learning, both for their own education and for the community. Approximately one-third of the students who participated in the service-learning module had never volunteered in their community before.

Student feedback

Although we had initially planned to ask students to participate in a post-survey, we found that the journal entries, reports and presentations provided sufficient student feedback to gauge their perceptions of the value of the service-learning module for their education, careers and lives more generally. This feedback is summarized here.

Overall, students were overwhelmingly positive about the service learning in this course, and described it as a unique and foundational experience, as in this example: *"I really enjoyed the entire day. We got to help out our fellow community and learn some new things on the way. I have never had an opportunity like this in a class before. Overall, this was an awesome experience."* Other responses included: *"It was a completely different approach to experiencing learning than any other classes I've been in"* and *"I am glad I chose to take this opportunity because I definitely learned some things that, in my opinion, are more important than things I could learn in a classroom."* Almost all of the students expressed positive feelings about the day with statements like: *"This experience was WAY more fun and gratifying than what I was expecting."* Another wrote: *"I'll be honest and say that, had Professor X not presented this opportunity, I would not have specifically sought it out. Regardless, I'm glad she did…"*

Table 2. Likert questions used in pre and post survey. Students responded on a 5-point scale ranging from "strongly agree" to "strongly disagree".

I believe that service learning is educationally beneficial.
I believe service learning is beneficial to the community.
I see a connection between Probability & Statistics and service-learning
Service and academic coursework should be integrated.
It is good for me to engage in community service.
I don't worry about what's going on in the world because I can't do anything about it.
The Boulder flood brought personal and economic loss to many people.
I have paid close attention to flood rebuilding efforts.
I believe I can have a positive effect in the greater Boulder community.
Engineers and citizens can work together to solve problems.

Figure 5. Histogram of responses to selected Likert survey questions, separated by gender of the respondent (where 1=strongly disagree and 5=strongly agree). There were 22 total participants with equal numbers of men and women.

To investigate these responses more scientifically, we used emergent coding techniques to identify the various ways that students described how they benefitted from the service-learning experience. One common theme was volunteerism. In a representative comment expressing this idea, one student wrote: *"Overall, I had a good time working with HfH and I hope I can get out and help more on my own. I'm glad this class gave us incentive to get out and help and I hope it fuels me to get out and do more even without additional incentive."* A number of students described a new or renewed interest in volunteering more generally through HfH or other organizations. For example, one student wrote, *"I really enjoyed getting to be outside of the classroom and being able to work with my hands. Not only did our time go to a great cause and much deserving family. I hope to continue to volunteer with HfH in both flood restoration and design-build projects. Their representatives were great teachers and some of the most genuine and selfless people in our community."* A similar comment from another student read, *"Thanks to this project,*

I want to get more involved with Habitat where ever I am this summer, and continue with other service oriented clubs on campus like Bridges to Prosperity. I left feeling proud of my work and inspired to continue volunteering with organizations like HfH." Others discussed their perceptions of volunteering more generally, including reflection on the significance of this volunteer opportunity, with both positive and negative implications. One such excerpt reads: *"In fact, being conscious of ways you might be able to affect change at little to no cost to the individual is an important cause. Volunteering presents a reminder to I do think my participation was worthwhile for me; however, I felt that the impact of this gesture was somewhat minor on a larger scale. I found myself thinking "I wonder how much of a difference I'm making right now." However small, I walked away from this experience feeling empowered and humbled."*

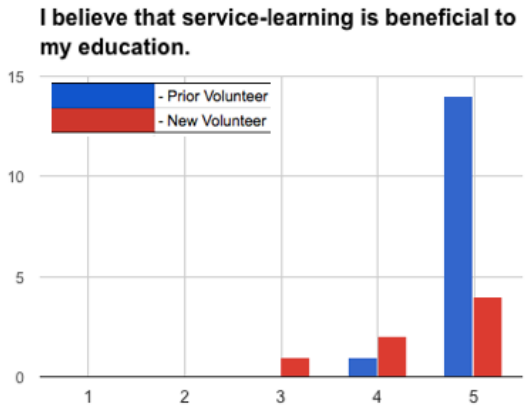

Figure 6. Histogram of responses to Likert survey questions (where 1=strongly disagree and 5 = strongly agree), separated by previous volunteer experience of the respondent. There were 22 total participants, of whom 15 had previous volunteering experience.

Other students saw the primary value of the service-learning module in the opportunity to have real world or hands-on experience in the construction industry. *"It gave me a real life lesson of what constructing a house looks like"*, according to one participant. A second student wrote in his report: *"This experience did relate to what I will be doing in the future. I do want to be a field/project engineer and within this career, it will help me manage the site when I have had firsthand experience and know what can happen on a job site and how to prevent certain situations in order to run the project more smoothly."* Another student described his skill development on the worksite in even more fundamental terms, explaining: *"This experience is really important to me since I learned basic things such as using drills on the wall and cutting the [dry] wall."* Another student talked about generally about how the day confirmed her choice of major, but also helped her see engineering opportunities and constraints differently: *"Yesterday, we had our construction day for H for H and I absolutely loved it! The work made me realize that I really do love construction and made me more confident with my choice to be in CE…It took a little trial and error to make measurements. I realized that every mistake we made would cost them money."* Some students also directly connected the experience to concepts discussed in probability and statistics, with statements such as *"Examples such as the 100-year flood given in class relate to what is being used in the real world."*

Students also valued the opportunity to see first-hand how disaster response and recovery happens. One example of statements expressing this idea excerpted here reads, "*I had a great experience seeing how team work and community can come together to make a tragedy into a hopeful situation"*. Another classmate wrote: "*The Service Learning option was a way for the participants to see the actual effects of one of these natural disasters that may occur even with a minute probability."* Other students appreciated the opportunity to focus on development of non-technical skills in their coursework. For example, one participant wrote that s/he liked, "*the emphasis of communication in the graded portions [of*

the service-learning module], this is something that Engineering classes do a very bad job at teaching even though it is essential in CE".

Finally, a large number of the student participants said a major benefit of the experience was the opportunity to get to know their classmates and professors better. "*This also helped me meet and bond with classmates, which means more study buddies!",* wrote one participant. Other examples stated, "*During the build day, it was rewarding to work with our peers in a challenging setting outside of school. We were able to apply skills in leadership, creativity, and initiative"* and, "*Volunteering and working with our peers in the community improved our future relations with each other because we were helping other people together."*

Although the students were positive about the service learning module, they did make a number of recommendations to the instructor as to how to improve the experience. The themes extracted from these recommendations are reported in Table 3. As highlighted in the table, these suggestions mostly related to expanding the scope of the effort, through including all the students in the class, increasing the time frame for the project, involving more partner organizations, or requiring more statistical analysis in the report. None of the students suggested that the service-learning component be eliminated from the course or scaled down.

It is difficult to judge from the feedback how the experience affected different groups of students (male vs. female, or with vs. without volunteer experience). The tone of the female respondents' feedback was more enthusiastic, but more work is needed to know how much of this is due to differences in writing/communication styles, and how much is due to differences in how they viewed the service-learning experience. Women participants were also more likely to provide detailed feedback of how to improve the service-learning module.

Table 3. Suggestions made by students for improving the service-learning module for probability and statistics.

Suggestions for how service-learning module fits into the course
Make service learning mandatory
Present service-learning findings to the entire class, rather than just those that participated in the module
Offer service-learning option for both midterms
Consider incorporating in other courses (e.g. Introduction to Civil Engineering, Hydrology, etc.)
Suggestions about organization of the service-learning module
Organize workday so that students can work in smaller groups
Provide more volunteer opportunities with different organizations and focuses (e.g. United Way)
Provide more dates to choose from
Involve more professors
Extend the project over the entire semester
Suggestions about specific service learning deliverables
Provide more opportunities for pre-work day reflection/preparation
More suggestions for research topics for report
Require students to conduct own data analysis, rather than describe others' statistics
Ask students to prepare a second journal entry after completing the report
Provide more direction on the job site

Grades

Student graded work is used to explicitly evaluate learning achieved in probability and statistics with relation to the technical content of the course from the service-learning module. This assessment compares the group of students who participated in the service-learning module with those who did not (the control). We focus on comparison of the final exam grade, which represents the culmination of the course for both groups of students. The final exam was cumulative and split between 60% problem solving related to probability and statistics (referred to as quantitative below) and 40% short answers about probability and statistics related concepts and applications (referred to as the qualitative part below). As shown in Table 4, the total final exam grade was very similar between the two groups with the non-service-learning group receiving an average grade 0.5% (our 0.5 out of 100 total points) higher than the service-learning group. Further deaggregating these results by the two parts of the exam shows that, on average, the service learners earned slightly lower scores on part 1 (the qualitative short answer portion) and slightly higher scores on part 2 (the more quantitative portion of the exam). None of these differences are statistically significant according to a t-test at the 10% significance level. To further compare the learning experienced by both groups, we computed the ratio of the final exam score to midterm 1. Recall that between midterm 1 and the final, the non-service learners took a second midterm, whereas the others engaged in the service-learning activities. Table 4 reveals that both groups earned higher grades on the final exam than midterm 1, and the relative increase was almost the same for the two groups. In the end, the only significant difference in grades between the two groups is that the service-learning module had a higher average grade than midterm 2, which it replaced. Anecdotally, the students participating in service-learning also reported spending more time on the report/presentation than their classmates did studying for midterm 2. In summary, the results suggest that service-learning did not enhance learning or technical mastery relative to the control group, but nor was there any dilution of the technical learning.

Table 4. Summary of grades earned by students participating in service learning module ("SL") and students not participating ("no SL").

Description of Graded Item	*Avg. Grade for SL*	*Avg. Grade for non-SL*
Final Exam, part 1 (qualitative) (out of 40)	30.5	31.8
Final Exam, part 2 (quantitative) (out of 60)	56.3	55.6
Final Exam, total	86.8	87.3
Ratio of Final Exam score to Midterm 1 score	1.08	1.06
Service-learning module (replaced midterm 2)	93.3	N/A
Midterm 2	N/A	85.1

Conclusions: "It definitely sends a strong message to everybody about why we want to be engineers"

This paper describes the design and assessment of a service-learning module for a required

engineering probability and statistics class. The module had a number of positive outcomes, including engagement of a high percentage of (underrepresented) women students from the class, improving students understanding of disasters/flood risk, real world engineering and construction projects, and fostering a sense of community both within the class and the broader community. Student feedback on the workday, as well as the associated reflection and reports, was very positive. In addition, comparison of the course grades between the service-learning participants and those who did not participant suggests that the service-learning did not significantly alter understanding of the core probability and statistics content of the course. This experience serves generally to document the value of service learning in this kind of theoretical and quantitatively-oriented class.

Based on these findings, we plan to continue to offer this module in the future. However, we plan to lengthen the engagement of the student with the HfH community, through more workdays, as well as increase the level of rigor expected from the statistical analysis submitted as part of the reports. Ideally, in future offerings, we will work more closely with HfH and other partners to collect ideas for report topics that directly address needs of the organization, as well as the class project. It would be ideal to extend the service-learning module to all students, but more work is needed to generate the relationships and opportunities for this to be possible for a course with this size of enrollment. We also plan to extend the pre and post survey investigation, including questions regarding interest in civil engineering to see if there is a difference in interest gained between genders as a result of participation in the service learning project.

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