

Service-Learning in Introduction to Engineering at the University of San Diego: First Lessons

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Abstract - Service-Learning, which involves matching a community need with academic goals, is becoming increasingly important in higher education. Middle schools need to keep students interested in science and motivated to go to college, become technically literate, and possibly pursue technical careers. First-year engineering students need to learn about what engineering is, why it is useful to society, and other nontechnical skills such as communication and teamwork. Thus, in the fall of 1998, Community Service-learning was introduced into Introduction to Engineering at the University of San Diego (USD) to meet community and academic needs. In this project, first-year engineering students worked with 6th grade students in a science class at a local middle school with an economically disadvantaged and ethnically diverse student body. Students worked in teams to prepare a hands-on, fun, and educational activity. The academic learning goals for the project were to effectively communicate to a "real live" nontechnical audience, to creatively design and implement an activity, to complete a project as a team, and to deepen students' understanding of engineering related topics. Students produced the following deliverables: materials for 6th grade students, team teaching in class at USD before going to the middle school, team teaching at the middle school, and a reflection memo. Although some students were initially resistant to the idea of service-learning in engineering, after working with the middle school students, most college students were excited that they had done something worthwhile. The engineering students reported that the service-learning project helped them learn about communicating to a real audience and working as a team. The 6th graders were enthusiastic and appreciative of the college students' efforts. The experience of the instructor in incorporating service-learning for the first time as well as initial evaluation and response of the students are discussed.

Motivation

Service-learning, which involves matching a community need with academic goals, has become increasingly important in higher education particularly the humanities and social sciences.[see for example 1 or 2] More recently, service-learning has begun to be used as an effective

pedagogy for engineering education. For example, engineering faculty at several institutions including Purdue University, the University of Massachusetts-Lowell, and the Cooper Union have effectively integrated service-learning into senior level capstone courses.[3] Dr. Edmund Tsang has successfully used service-learning in his introductory mechanical engineering course.[4] Since these capstone and introductory engineering courses focus on design, communication, and teamwork, they are particularly well suited to Community Service-Learning where students can put their skills in these areas in practice. Demonstrated ability in design, communication, and teamwork is also important for ABET accreditation under the Engineering Criteria 2000.[5]

In the Fall of 1998, Community Service-Learning was introduced into Engr 5 *Introduction to Engineering* at the University of San Diego (USD) for several reasons. In the first semester of USD's yearlong freshman engineering sequence, Engr 5, students learn about topics including what is engineering, the engineering design process, problem-solving, and communication skills. A key aspect of learning the design process is completing team projects and making presentations. In previous offerings of Engr 5, to develop oral communication skills, students chose an engineering-related topic and gave a brief presentation in class. On the whole, these presentations did not appear to meeting the learning goal. Students were reluctant to criticize each other and it was easy for the presenter to assume knowledge on the part of the audience and the audience to assume that any confusion was due to their limitations rather than the presenter's clarity. Service-Learning offered the possibility of having a real nontechnical audience who might not be so forgiving if something was unclear. Also the stakes for doing a good job would be higher. Students who might not care much if they received a mediocre grade might care if they let down a room full of 6th graders. In addition, since most definitions of engineering involve using science or technology to benefit society, participating in service-learning could be a good way to learn about engineering and its impact on society. Working with a diverse group of people can help enhance civic awareness and appreciation of diversity can make students better engineers. Other motivations included a desire to increase retention by showing students that engineering can be relevant to their

lives and to appeal to nontraditional students including women and minorities who might be particularly interested in reaching out to the community.

Course Structure/Logistics

The staff of the USD Office for Community Service-Learning and the instructor identified middle school specifically 6th grade as a good age for a partner. Middle schools need to keep students interested in math and science and motivated to go to college, become technically literate, and possibly pursue technical careers. Also, first-year engineering students should feel comfortable that they have more knowledge than 6th graders. We chose a school that is within a few miles of USD and has an economically disadvantaged and ethnically diverse student body. Many of these students may not know anyone who has gone to college so the USD students can serve as role models for college as well as engineering. Once we chose a school, we found two teachers who agreed to work with us on this project.

The Learning Goals for the project were articulated to the students on the syllabus as

- To effectively communicate to a "real live" nontechnical audience
- To creatively design and implement an activity
- To complete a project as a team
- To deepen students' understanding of engineering related topics

The class was divided into four teams of four to five students each. Each student team was required to provide the following deliverables

- Materials for 6th grade students
- Team teaching in Engr 5 a week before going to the middle school
- Team teaching at middle school in a science class (about 1 hour)
- Documentation and Reflection

Student Projects

Peer review revealed that in-class practice presentations were not well prepared and the students agreed that the presentations needed improvement. Most groups realized that they needed to work harder to not disappoint the 6th graders. By the time they went to the middle school, each group had a reasonably planned activity.

At the beginning of each presentation, students introduced themselves and said why they chose engineering. This was difficult for the students and most simply said, "I became an engineer because I like math and science." Some students might have trouble doing this because they are still investigating their career options and are uncertain of their

own decision to continue in engineering. Others may have needed more examples of how to present their stories. Helping the students to examine and express their motivations for choosing engineering could be more directly addressed next time this course is offered.

Table 1 summarizes the projects that the students did with the 6th graders. We were all nervous before the first presentation. However, we left the classroom with a great feeling amidst 6th graders chanting for specific USD students to come back next time. The 6th graders impressed us with their knowledge and one provided a better definition of engineering than the freshmen had done. We learned several valuable lessons the hard way: DO NOT give candy until the end, let the students into the hallway, or visit a classroom with a substitute teacher. One group asked the 6th graders what they remembered from two previous groups' visits and were excited that students remembered the main ideas of friction and bridge building.

Group 4 had a different experience because they did their presentation three times and chose to do less interactive activities. One of the most interesting aspects of their presentation was at the end of their time when the USD students talked about what it was like to go to college and how the choices that you make in 6th grade can impact your future. Answering questions from the 6th graders, the USD freshmen learned more about why they had chosen to go to college. Seeing the improvement as the students answered the same questions three times was rewarding for the USD professor. While answering these questions, the USD students realized their potential impact and so found themselves saying things like "In college, you go to class because you want to learn, not because you have to." Issues of responsibility, the importance of math and science, and how college provides opportunities permeated the discussion and built upon topics the teacher had raised previously with her class. This middle school teacher initially hesitated about having us come but by the time we left, wanted us to return, a testimonial to the usefulness of the project.

Preliminary Evaluation

An important component of service-learning is reflection.[1] Students participated in activities that promoted reflection and assessment of their service-learning experience including writing in blue books, answering questions on exams, preparing a reflection memo, and completing a survey. In addition, two students specifically mentioned the service-learning project as contributing most to their learning in the end of the semester course evaluations.

Students' Perspective

Blue books were used as journals. Before going to the middle school, students were asked to reflect on their concerns, the skills they had acquired that would be useful,

and how relevant this project is for their training as an engineer.[6] Most students expressed some concern about not knowing what to expect from the 6th graders. They hoped to use their communication skills including some that we had worked on in Engr 5 earlier in the semester.[7] They identified the relevance of this project as primarily in helping them to improve their communication and teamwork skills. After they went to the middle school, most students

were impressed and surprised with the intelligence of the 6th graders. Several expressed that they were initially nervous but ended up enjoying working with the 6th graders. Some were pleased that they had taught the students something or that they had discovered new ways to talk about engineering themselves.

TABLE 1 USD Student Service-Learning Projects and Corresponding Curriculum Standards.

Group #/ 6 th Grade Content Standard	Project
1. The student develops an understanding of the relationships among science, technology, and society.	<ul style="list-style-type: none"> • Teamwork is key to successful project • Marshmallows and toothpicks for pyramids and bridges • Contest: which bridge supports most weight
2. Friction is a force that resists motion.	<ul style="list-style-type: none"> • Friction is found in three states of matter • Air resistance as example of friction • Building paper airplanes to turn to right, left or go straight • Contest: which airplane goes farthest
3. The student develops an understanding of recurring big ideas and unifying concepts that prove fruitful in explanation, in theory, in observation, and in design.	<ul style="list-style-type: none"> • Engineering Design Process Steps • Marshmallows and toothpicks for boats • Contest: which boat supports most weight
4. Different substances have different solubilities; a substance's solubility is a characteristic of that substance.	<ul style="list-style-type: none"> • Solubility (Kool-Aid vs. salad dressing) • Fire needs oxygen (egg in bottle) • Teamwork (to solve puzzles) • Questions on College

On an exam, students were asked to choose the academic learning goals from the syllabus that they felt they

learned the most about during their project. About half of the students felt that they learned the most about working as a team and half about effectively communicating to a real audience. Here are some examples from student responses.

By having a real audience, I was able to understand what I needed to do better and what I did well. This project was very good practice and I learn best by practicing.

One of the most important things about being an engineer is being able to help people understand something that they know very little about and that you know a lot about. When I explained the concept of friction to a "real live" audience, I was very proud that they seemed to grasp it.

I feel that this service project is a great way to teach people to work as a team because if they don't, they will see just as we did, that the presentation will suffer.

In the students' reflection memos, many of the same themes emerged as from the other evaluations: the USD students did not know what to expect from the 6th graders, learned about communication and teamwork, enjoyed helping the community, benefited from the in-class practice presentation, and had fun. The student reflection memos also showed some real insights into themselves, the value of learning, and being a role model as illustrated in these comments.

When I was up there explaining to the children reasons as to why I chose Engineering, it wasn't until that very moment when I heard myself explaining it to them that I had realized myself why I had chosen to be here studying Electrical Engineering.

Through this experience I was taught a valuable lesson: learning pays off. I now look back on all the years of schooling, the hours of homework, the A's and the F's, and all the knowledge that I gained from school and see how it has paid off in the end. ... I walked out of the building hoping that maybe just one of those kids was inspired to pursue a higher learning. The project inspired me to keep up my hard work and persevere through one of the rather rougher times of my life.

As is to be expected, not all students were initially excited about the idea of service-learning nor did they understand what it was.

When I first heard the words "Service-learning Project," I was not very excited to hear about what we would be doing. ... It wasn't until I learned that we would be sent to a middle school on our own to teach 6th graders about engineering that my attitude changed. The first feeling ... was excitement because I really like kids. After awhile though, the realization that these kids would need to get something out of this project other than horseplay brought out a little bit of anxiety in me.

Two students were honest in their reflection on their initial "hatred" or feeling that "it would be nothing more than a big waste of time." However, after doing the project both students felt that it had been worthwhile.

It turned out to be a great experience for me and I think that I learned a lot. One thing that I learned was how the design process can be used for any presentation and I would highly recommend it to anyone doing any type of project or presentation. I think that this project should be done in future engineering classes.

[After the in-class presentation, I realized] how important this project really was to our engineering education. I, like the rest of my group, realized that the ability to accurately and confidently present what we knew to a group was essential to being a good engineer.

During class time, students filled out a USD evaluation from the Office for Community Service-Learning where they were asked to answer twenty-five questions on a scale of 1 (very dissatisfied) to 5 (very satisfied). These related to service-learning in the classroom, personal response, agency placement, USD support, and impact on the community. Overall, the response was quite positive with the class average scores being greater than or equal to 3.58 for each question. Students who chose to provide written comments on these evaluations were generally positive and insightful. Students recognized the need for continued improvement in the service-learning component of the class but expressed their overall satisfaction with the experience. Regarding service-learning in the classroom, most students again highlighted learning about communication and teamwork.

The service learning project probably, in terms of education, helped the [6th grade] students more than us. Because we already understood the material, we did not learn much. The challenge was in conveying what we know to the sixth graders. In

fact, we benefited in other areas, mainly communication.

Several students' personal response to the experience are illustrated by the comment

The service learning is fun, plain, and simple. It is a new way to teach material to students in college, communicate those ideas, and help the community in an informal atmosphere.

Not all students agreed. For example, while one student said this was an experience that "I would definitely do again" another thought it was not "a very good use of our time." Students were generally happy with the support from USD particularly the transportation and faculty support. Ten of the students commented that they believed there had been a positive impact on the community. For example

It is a good educational experience for young students anytime students can come and talk about future schooling. I wish college students would have talked to me about my future when I was in grade school.

I feel that what we taught had a great impact on the 6th graders of Montgomery Academy and that the USD students were good role models.

Professor's Experience

This community service-learning project involved highs and lows for the students and the instructor. The most rewarding part was definitely working with the middle school students. Their energy, enthusiasm, and intelligence were impressive and contagious. The worst part of the experience was the practice sessions in class. With the experience gained in working with 6th graders during this first implementation, the professor can provide more guidance to the USD students in selecting appropriate projects and describing what to expect from the 6th graders next time. This should help improve these practice presentations.

Service-learning did provide a motivation for students to do a good job. Not only did the students believe that they learned about teamwork and communication, but in the professor's judgement, by the end of this service-learning project, the USD students did demonstrate their ability to work in teams (ABET EC 2000 Criteria 3d) and to communicate effectively (ABET EC 2000 Criteria 3g). Since the students did not know each other at the beginning of the semester, working together as a team was challenging. Several groups did not really work together until after their in-class presentations. Most groups would have benefited from more time spent in brainstorming and working out the details of the projects. Next time, more interim deadlines might result in more creative and effective projects. In their

oral presentations, the USD students were forced to be sure that they were effective in directing their middle school student audience. The USD students' written comments, such as those chosen as examples in the previous section of this paper, serve as evidence of their developing skill at expressing themselves in writing.

This project was not only the first experience with service-learning for the instructor and most students, it was also the first incorporation of service-learning into an engineering class at USD. As such, there were many challenges to face. Having assistance with developing community partnerships is crucial. The assistance of the staff at the USD Office for Community Service-Learning was invaluable to the instructor in handling the logistics of identifying community partners. Having a relationship with the middle school that extended beyond one professor and two teachers helped this project to succeed. However, timing was still a problem this first time. Since arranging the logistics took several weeks, the trips to the middle school occurred in November. By this time, students also had another engineering laboratory design project and many felt overburdened particularly those who had not begun the service-learning project when it was first assigned. By having the service-learning project earlier in the semester, so that it is completed before the other project, perhaps students can make use of what they learn about working in groups in their second project.

After this first implementation, it appears that service-learning is effective for helping first-year students learn about communication and teamwork. However, more experimentation is necessary to fully assess the usefulness of service-learning as a pedagogy for first year engineers.

Summary

Community Service-Learning was introduced into Engr 5 *Introduction to Engineering* at the University of San Diego in the Fall 1998 semester. First-year engineering students prepared and presented lessons for sixth grade science students. Initial assessment by faculty and students indicate that this experience achieved its learning goals of helping students develop skills in teamwork and communication.

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