Service-Learning in Capstone Design Projects: Emphasizing Reflection

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Abstract

Service-learning offers opportunities for students to help their community while demonstrating ABET EC 2000 criteria. This paper gives a brief introduction to service learning concepts and then focuses on methods to increase student reflection

Introduction

Service learning projects are typically sponsored by a community partner and give students the opportunity to interact with people outside their socio-economic groups and disciplines, and also to include issues other than engineering. Key components of service-learning include reflection and reciprocity. [1] Reflection requires the student to ponder and articulate the service learning experience. Reciprocity requires that students meet actual community needs - not contrived needs -to address desired learning outcomes.

At Rose-Hulman Institute of Technology the senior mechanical engineering capstone design courses have included projects to help the disabled for more than ten years. These projects are initiated by a variety of groups such as local hospitals, schools, physicians, therapists, support groups, and members of the community who have heard of past projects. Past projects have been very diverse and have ranged from the design of a wheelchair accessible power tool bench for high school industrial arts to a modified pediatric crutch.

Attributes of Capstone Service Learning Projects

After supervising capstone design projects with both industry and service learning projects for more than ten years, the authors have recognized that there are some distinct opportunities that service learning projects offer; especially when compared with traditional industrial design projects. [2]

1. Problem statements are not given in engineering terms. In the service-learning projects the problem statements are often ill-defined and rarely specified in engineering terms. For example, one problem statement consisted of, "Dillon needs something to

improve his daily life." These broad statements require that students listen attentively, think creatively, and then design a product to meet a specific need.

2. <u>Projects often require a creative approach.</u> A high level of technical expertise may not be required, but rather an innovative use of common components to meet a very specialized need. For example, students used a four bar mechanism to allow a student with limited arm motion to brush her hair.

3. <u>Projects are almost always design, build, and test.</u> In the service-learning projects, the client is looking for something to improve his/her everyday life. This "something" is usually a physical device that the client does not have the skill to produce. This requires the students to take responsibility for the final product. In industrial projects, the company is typically looking for one or more designs detailed so that the company can construct prototypes. Typically, the companies do their own prototyping. The prototyping and subsequent testing may or may not be shared with the student group.

4. <u>Students must communicate effectively.</u> The students must communicate with disabled clients and usually medical personnel. Students, as seniors, have become familiar and comfortable with technical jargon. They must set aside their jargon in order to talk to their clients and they must learn to listen and understand medical terms.   In addition, many students choose to find funding for their client and they must ask local groups for money. Asking for donations is a new experience for most engineering students.

5. <u>Students work with a greater variety of outside groups.</u> When working on an industrial project, students usually work with the company and potential suppliers for their proposed design. In service-learning projects, students must work with a variety of different groups. From past experiences, the students have worked with the end user, the end user's family, the medical therapist, vendors, machinists, middle school teachers, and funding sources.

6. <u>Students develop empathy for those with disabilities.</u> For many of our students, this is their first opportunity to work the disabled. The students often voice how much they have taken for granted. They realize that for their clients even the simplest task is enormous. The groups see their client as an individual who is trying to cope with a serious problem.

7. <u>Students gain great personal satisfaction from helping others.</u> As they develop empathy for their clients, the students want to help them. In some cases, the group knows that their client will only get worse as the disease progresses. In other cases, the group knows that the client will not live a normal life span. This knowledge gives an urgency to their work: they want to help right now. Being able to see a person use their design and improve the quality of their life provides enormous satisfaction to the groups. They feel that they have made a difference for someone, and they see the results of their work.

8. Student reflection is more global. All students who take the capstone design course are required to write a section entitled, "Lessons Learned." In this section, students are asked to reflect on the quality of their learning experience in the course. For the industrial projects, students tend to be very detailed, for example, "We should have used a different fastener." or "The production department was not helpful." In the service-learning projects, students tend to discuss their role in the project. "I was happy that we could make a difference." or "I have a new perspective on engineering."

9. Students mature. In the service learning projects, students are the "experts" for the first time in their technical career. With industrial projects the students are seen as novices who might offer help to the company. In the service learning projects, the students are seen as the experts who will make a difference. They are the ones with the technical background who can make the decisions.

The authors have observed that these projects directly relate to EC 2000 Criterion 3 (g), "an ability to communicate effectively" and EC 2000 Criterion 3 (c), "an ability to design a system, component, or process to meet desired needs."

Reflection Methods

Typical methods for reflection in service-learning courses include essays, journals, and discussions. Edward Tsang at the University of South Alabama requires reflection writing exercises. [1] He asks students to read a portion of their textbook that maintains that engineering students should "give something back" as part of their development. [3] Students are then required to write short paragraphs justifying whether or not their projects meet the criteria of "giving back." Joan Kleinman from Middlesex Community College requires that her students record their service learning experiences in a journal. Students not only keep a record of what they did but also how they felt. They are asked to describe how their experiences contributed to their learning and personal growth. [4] In A Practitioner's Guide to Reflection in Service-Learning Student Voices and Reflections, the authors describe a wide variety of reflection activities. [5] The authors present reflection activities that involve reading, writing, doing, and telling. Reading activities can involve case studies of service or articles with conflicting positions. Writing activities include letters and memos, group journals, personal journals, answering critical questions, and preparing portfolios. Doing activities include constructing oral histories, videos, and service-learning theater. Telling activities include informal discussion, reflective interviews, and discussion groups.

 At Rose-Hulman Institute of Technology, students have expressed their reflection in a "lessons learned" section in the Appendix of their final design report. The reflections in the lessons learned section hint at a growing awareness among students that their projects are "really worthwhile." However, students have been more articulate and insightful in their reflections during informal discussions with faculty and staff. In order to help senior mechanical engineering students with their reflections, the authors decided to implement informal discussion groups.

It was decided that both professors would meet with between four and six students to discuss their experiences on their service learning projects. Initially, seven possible focus questions were identified:

1. Why did your group express a preference for a project with the disabled?
2. How was your project different from the industrial sponsored projects?
3. What was the most difficult aspect of your projects?
4. How did your peers (who were working on industrial projects) react to your project? (For example, did they think it was better or worse, easier or harder, etc?)
5. How did you feel about your project?
6. What did you learn working with your client that you might not have learned otherwise?
7. Did this project change any of your perceptions about the disabled?

The first discussion group consisted of four seniors who had completed the course and service-learning projects the preceding spring. It was felt that these students had already received their grade in the class and that they would not feel any pressure about giving the "right" answers. These students were asked to serve as advisors to help future students with their reflection.

The first point that the students made was that they felt a discussion group was the appropriate forum. They felt that journal entries or answering directed questions would be viewed as "just another hoop to jump through." A discussion group was viewed as a more relaxed forum. Some students felt that the discussion group also helped them to understand what they were experiencing and verbalize those experiences by listening to what other students had to say. The students did not like questions 1 or 6. They felt that those questions were "trivial and obvious." They wanted to discuss questions 3, 5 and 7 and suggested that we start with those questions. The authors had worried that there might be rivalry between groups that had industrial sponsored projects and groups that worked on service-learning projects. The students working on service-learning did not sense any rivalry although their language and mannerisms indicated that they felt that their projects were "better." They felt that they had more "manufacturing" experience than the industrial sponsored projects.

The most difficult aspect that students saw in their projects was getting started. They felt that they floundered some because their clients did not describe their projects in engineering terms. For example, the students felt that they were not given specific "deliverables." As the students started their projects they gathered an enormous amount of data and had some problems sifting through the data and "narrowing it down." One student felt that it would be good to require a design freeze or commit date because the group was continuously trying to improve the design and ended up under estimating the time it took to complete the design.

When discussing how their perceptions of the disabled changed, the students thought it was important to distinguish between physical disability and mental disability. Although all of the clients had severe physical disabilities, they did not all have mental disabilities.

The students indicated that they had unknowingly linked the two before their projects. Students also indicated that they would like to talk to their clients in a year or two and get feedback on how the design worked, how long it was used, and how the clients were getting along. In addition, each student indicated that the fact that they were working with an actual person caused them to improve their empathy for the disabled. They felt they had a greater understanding of the challenges faced by the disabled and the courage displayed by their clients.

In discussing how they felt about their projects, the students all agreed that they were more motivated than other students. They felt that the rapport that they developed with their client caused them to work harder. They also felt that their projects had an actual, immediate impact on someone. They were pleased that they were "giving back" intellectually. Some students felt that they experienced the importance of engineering for the first time. The students were proud of their projects and felt satisfaction from helping someone else.

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During the spring quarter of 2003, 8 groups worked on service learning projects. Each of the groups was encouraged to meet with a professor to reflect on their project. The reflections were scheduled after all grades had been submitted for seniors. Of the 8 service learning groups, 4 attended the reflection session. Initially the students were asked questions 2, 3, 5, and 7. However, as sessions continued, they became friendly discussions of the service learning projects. The common themes that emerged were as follows:

1) Each group developed empathy for their client. This empathy that was developed became the primary motivation for the project. They wanted to do a good job because of their relationship with the client. One student remarked, "I never thought of Dillon as disabled. I thought of him as a person that I could help to find another way to do things."
2) The students' relationship to the project had an additional emotional component that was not present in the industrial projects. They felt that their projects were more personal and that they had more interaction with their clients. Students felt a sense of fulfillment and appreciation.
3) Students felt that they got better response from both their clients and the faculty. For example, industrial contacts might not return a phone call or e-mail for a day or two, but students reported that the service learning clients always gave an immediate response. In addition, they described Rose-Hulman Institute of Technology faculty as more excited and willing to help with the service learning projects.
4) Students felt a sense of completion in that most groups got to see their designs used by their clients.
5) Students gained a respect for the disadvantaged. Comments such as, "I was impressed with his/her bravery." "I take bowling for granted, and here were these blind kids working so hard to bowl."

6) Students matured. They indicated that they were able to work on their own schedules and that their clients never questioned their decisions.
7) Students felt that using their skills and time to help was better than just giving donations to the disadvantaged.
8) Several students expressed a desire to continue with community service.
9) Students felt that their projects required more creativity. Several students indicated that the service learning projects were open-ended and initially quite frustrating. The ability to consider many possibilities was initially stressful and daunting.
10) Students felt that the reflection focus groups were worthwhile. Students indicated that the rush to finish up and graduate made it difficult to think about their project. Several students seemed to gain an appreciation for what they had done as they talked about their projects.

Future Work

The authors would like to have a reflection time with every student group. There is some concern about requiring students rather than encouraging them to meet. If the groups are held before grades are turned in, there is the chance that students will be trying to guess what we want to hear rather than stating their opinions. By not talking with every group, it is possible that the results we have gathered are biased – the students who chose to come and talk were those who were excited about their projects.

The reflection groups have been a rewarding experience for the authors because of the enthusiasm and emotion of the students. However, the authors are also hoping to develop a set of guidelines for evaluating the focus groups.   What do we specifically hope that students will experience as a result of the service learning groups? Is there a way to determine if students had those experiences?

Conclusion

Service learning design projects at Rose-Hulman have evolved over the years into a major component of the capstone design courses. As summarized above under "Attributes", the experiences gained by the students are quite different from the industrially sponsored projects, but are not less beneficial. Recently, increased emphasis has been placed on the requirement for "reflection" by the students after the completion of the project. As an example, the trial discussion group was a positive experience for both the students and faculty. As time progressed the students became more enthusiastic and talkative. Each student took part in the conversation and appeared to speak without inhibition. The interaction between students allowed students to clarify their thinking and articulate their positions. The authors had the pleasure of hearing students confirm the worth of their design project. The students expressed that they had learned more about design, manufacturing, and the disabled. They also expressed a desire to continue with community service when they graduated.

A continuation of this reflective dialogue is planned for future service learning design projects and the authors encourage other educators to implement this activity in their similar courses.

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