# Service Learning in the Freshman Engineering Course

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Abstract

The College of Engineering at NC State University has had an NSF-sponsored GK-12 project for the past four years that sent engineering students in to K-8 classrooms as science and/or math resources for teachers. Using the same model, in fall 2002, the Introduction to Engineering course that is required of all freshmen offered a design project that included service learning as an option. The "Outreach Project" required students, in teams of four, to propose and design a project that they could take to a K-8 classroom that would teach about engineering, math or science. The projects were required to align with the NC Standard Course of Study and national science and technology standards. Projects could be interactive or passive (e.g. a hallway display) and were required to meet strict acceptability guidelines before the teams were matched with a particular K-12 classroom. This paper describes the lessons learned as fifteen teams participated in this pilot project.

## Introduction

In the fall of 2002, the College of Engineering at NC State introduced a new semester design project into the Introduction to Engineering class required of all freshmen. The Introduction to Engineering class is taught in sections of just less than fifty students, for a total of about twenty-three class sections each fall. Every student is required to complete a team design project that they may choose from a menu of available options, although the options change from year to year. The teams of four students work outside of class to complete the project, give an in-class oral presentation, complete a comprehensive final report paper, and participate in a poster session at Freshman Design Day at the end of the semester. Most of the projects allow the students to enter a competition with their project, which is also held on Freshman Design Day.

In the Fall of 2002, students were allowed to choose from: building a trebuchet that could hit two different target distances over a five foot wall, building a device to transport three different balls from one side of a table to the other in the least amount of time, building a water rocket that would stay aloft the longest, inventing a device to measure the power output of a water-bath nuclear reactor, or writing a simple compiler for a computer. The bridge project that had been used previously was discontinued, since many of the students had experienced building bridges in high school.

In addition to the above offerings, an additional project was introduced this fall, the outreach project. The goals of this new project were to:

1- Appeal to a broader range of student interests
2- Highlight the importance of community service for engineers
3- Increase student self-esteem by placing them in a role-model position
4- Help create a sense of engineering identity in students

The project was clearly an attempt to break away from the traditional engineering projects while maintaining learning objectives consistent with the course. The goals for the project also included some (3 and 4) that came from research in the Women-in-Engineering program on increasing student retention.

Project Implementation

For this pilot year, to guarantee a minimum number of participants, one section of Introduction to Engineering was required to participate in the Outreach Project. Three teams from other sections asked to be included as well. To make sure that the experience of participating in this project was as positive as possible, the day-to-day teaching of the class included information on presenting to K-8 students, classroom management, inquiry instruction and other educational methods. Students were introduced to the concept of engineering standards as a part of the curriculum, and the outreach section was also introduced to the national education standards like the National Science Education standards [1] and state curriculum standards like the North Carolina Standard Course of Study [2]. All of the groups but one chose middle school. The other group chose fourth grade. Apparently, the middle schoolers were less intimidating to them!

Deadlines are a standard part of every design project, however this project had stricter requirements than some of the others. About a month into the semester the students were required to submit a proposal on what they wanted to do and the grade level with which they wanted to work. The course instructor responded to this proposal with suggestions and, eventually, approval. Three fourths of the way though the semester the students were required to participate in a critical design review that consisted of a brief written description and a comprehensive oral presentation of their plans for implementing their project in a K-12 class room. The instructor and the students in the course assessed the presentation. Teams from other classes joined the outreach section for this day of class.

The week before Freshman Design Day, each team was matched with a teacher in a local school, and the teams went into the K-12 classroom to present their project. All of the projects proposed, except one, involved interaction with the K-12 students in a hands-on manner. The course instructor went to the classroom with each group as support, but the conduct of the class was left to the engineering students. Without exception, each group completed an excellent interaction. The teams then prepared a poster display for Freshman Design Day, and some brought hands-on activities to do with the middle school students who typically attend the Day as a class field trip. The one team that did a passive display exhibited at Design Day.

Assessment

To evaluate the success of this project, the college students, the teachers and the K-12 students were surveyed. In addition, the college students' final papers were used to glean information about their perceptions of the experience as well. The results of each assessment are summarized below.

College Student Assessment

The students were asked to respond to the following statements using a Likert scale of 1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree. The right column lists the average numerical response to each statement.

| | |
|---|---|
| I feel that the visit to the middle or elementary school was a positive experience for me. | 4.5 |
| I feel that the visit was a positive experience for the K-12 students. | 4.3 |
| I did not enjoy working on this project. | 1.6 |
| I do not see how this project relates to engineering. | 1.7 |
| I felt that working on this project gave me insight into engineering. | 3.8 |
| I felt like an engineer when I was presenting to the K-12 students. | 3.6 |
| My team had problems working on this project. | 2.1 |
| I learned things I can use as a student of engineering. | 3.7 |
| I would recommend this project to others. | 4.1 |
| I felt like this project was more difficult than the others. | 2.6 |
| I felt that this project took too much time. | 2.6 |
| I would choose to do this project again. | 4.0 |

In addition to this list of statements, five short answer questions were asked. The answers were grouped and are summarized in the following table.

| Question | Answer | Number of responses |
|---|---|---|
| What did you learn? | teamwork | 8 |
| | don't underestimate kids | 9 |
| | design process/problem solving | 5 |
| | basic engineering/science | 10 |
| | learning from mistakes | 7 |
| What did you like most? | teaching the kids | 20 |

| | | |
|---|---|---|
| | teamwork | 6 |
| | the challenge | 5 |
| What would you change? | nothing | 15 |
| | needed more time | 6 |
| | the paper | 1 |
| | lack of structure | 10 |
| What did you like least? | nothing | 4 |
| | meetings/teamwork | 5 |
| | lack of structure | 5 |
| | being made to do the project | 3 |
| How does this project relate to engineering? | learned how to talk to groups who don't have vocabulary | 4 |
| | learned things engineers do | 14 |
| | learned communication | 3 |
| | learned design/problem solving | 10 |
| | it doesn't | 1 |

In addition to the above survey, many of the engineering students in the outreach section reported learning much more about engineering than their colleagues in other sections [3].

The participating teachers were also surveyed using a Likert scale of 1-5. 1=not at all, 2=not much, 3=neutral, 4=somewhat, 5=considerably. The questions and average numerical responses are listed below.

| | |
|---|---|
| My students enjoyed the presentation. | 5 |
| My students learned about engineering. | 5 |
| My students learned about something we studied. | 4.5 |
| I enjoyed the presentation. | 5 |
| I learned from the presentation. | 4.5 |
| I would consider hosting another group. | 5 |
| This type of presentation is useful to my students. | 5 |

The student survey used the same scale as the teachers. It is summarized below.

| | |
|---|---|
| I enjoyed the presentation. | 4.6 |
| I learned about engineering. | 3.7 |
| I learned about something we studied in class. | 2.7 |
| How much did you know about engineering before the presentation? | 3.4 |
| Engineering sounds interesting. | 3.6 |

The students cited the hands-on nature of the activity as the reason they liked it.

## Conclusions

Since the engineering students were not given a choice of which project they would do, the responses were quite positive. In addition, preliminary assessment shows the goals of the project to have been met.

1- Engineering students in other sections than the required section asked to be involved in the project, citing the appeal of a "different" kind of project. In addition, college students and other visitors to freshman design day expressed greater interest in the outreach project presentations than any other.
2- Many of the college students cited the community service aspect of the project as appealing to them. Students in the required section reported on their freshman experience survey that their understanding of engineering had been greatly expanded.
3- The self-esteem of the students was not measured, but is expected to manifest itself in future studies.
4- The students felt like engineers, they learned about engineering, and they were able to accurately articulate specific ways that this project applied to engineering as a profession.

In all, each group of participants claimed a very positive experience. The project coordinators feel that adequate preparation and guidance is an important part of ensuring this positive experience of going into a classroom. In addition to this, the excitement generated at Freshman Design Day as the teams described their experiences to visitors yields a positive outlook for the future of this type of project in the College of Engineering.

## References


1- National Research Council, National Science Education Standards, Washington, DC, National Academy Press, 1996. http://www.nap.edu/readingroom/books/nses.htm
2- NC Standard Course of Study, http://www.ncpublicschools.org/curriculum.
3- Bottomley, Laura J., et al., "The View from Here: How the Freshman Experience Looks to Young Women at NC State University," Proceedings ASEE Annual Conference June 2003, Nashville, TN.



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