

Developing Global Perspective through Service-Learning

Sirena Hargrove-Leak¹

Abstract – Engineering educators have been charged to engage in engineering outreach and include opportunities for engineering students to develop skills necessary to be successful in the changing workplace. The global reach of engineering is included in the list of desirable skills. A carefully crafted service learning project can address both needs. This paper describes one approach using the Engineering is Elementary® units developed by and available from the Museum of Science in Boston. Preliminary qualitative data from a service learning partnership between an Engineering Thermodynamics class and a select group elementary school students show that the Engineering is Elementary® curriculum is an effective tool for all of the students to learn more about engineering.

Keywords: service-learning, K-12 outreach, global perspective.

INTRODUCTION

The Engineering Education for a Changing World report released by the American Society for Engineering Education (ASEE) [1] states, “colleges of engineering must re-examine their curricula and programs to ensure they prepare their students for the broadened world of engineering work.” Among the list of action items is a call for engineering colleges to ensure that curricula and programs include some emphasis on “an appreciation of different cultures and business practices, and the understanding that the practice of engineering is now global.”

In an earlier paper, I highlighted the value placed upon and recognized benefits of service-learning in engineering education and engineering outreach [2]. Here, I present an approach that combines service-learning, engineering outreach, and lessons about some potential global benefits of engineering using the Engineering is Elementary® series. When implemented as an integrated course project in partnership with local elementary schools, there is the potential for both student groups to benefit.

IMPLEMENTATION

Overview

As a private, liberal arts university, Elon’s Dual Degree Engineering Program is a unique blend of a liberal arts education and a traditional engineering education. The mission and commitment of Elon, emphasize “putting knowledge into practice” and the establishment of an “ethic of service.” Since engineers serve humankind, integrating service learning projects into the engineering courses was embraced by all. With an established record of success in doing so in the first year engineering course, I also ventured to use it in an upper level course. Engineering Thermodynamics is a course offered to third year engineering students at Elon University. The course is a traditional exploration of how energy transformations are used to benefit and improve the quality of life through such practical systems as gasoline and diesel engines, steam power plants, refrigerators, and heating and cooling systems.

Engineering is Elementary® is a project of the Museum of Science in Boston to develop and support engineering literacy among elementary students and teachers. The project encompasses curriculum units themed by engineering discipline and science topic, professional development, research and assessment, multimedia resources, and a soon-

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to-be-released curriculum series for extracurricular use. Each curriculum unit includes a storybook to introduce the engineering design problem, lesson plans, and worksheets to assess student learning. Central for the purpose of this paper, each storybook features characters from a distinct culture or background that are facing a problem that can be addressed through engineering.

The unit that seemed most appropriate for use in the Engineering Thermodynamics class is entitled “Now You’re Cooking: Designing Solar Ovens.” In terms of science topic and engineering field, it is categorized as energy and green engineering. The accompanying storybook is entitled, Lerato Cooks Up a Plan. The unit description available on the Engineering is Elementary® website [3] reads:

This unit guides students to explore energy, and how heat energy from the Sun can be harnessed by a solar cooker to heat food. Many students might take technologies such as stoves, ovens, and toasters for granted, but these conveniences aren’t available to Lerato, a girl who lives in Botswana. Through the storybook Lerato Cook Up a Plan, students will be introduced to Lerato and her family. Lerato and her siblings have to gather firewood in order to build a cooking fire to heat their food. When Tsoane, another villager, returns from University, Lerato learns about the field of green engineering. Green engineers are concerned with designing technologies that have as little impact on the environment as possible. Tsoane shows Lerato how she could use a well-insulated solar cooker to help cook food, eliminating the chore of gathering firewood and the environmental impacts of creating cooking fires.

Though included in the engineering thermodynamics textbook, modes of heat transfer and sustainable practice through green engineering are typically not emphasized in the course due to time restraints. Therefore, incorporation of this unit offers a unique opportunity for students to study, teach, and apply this material. The connection to the developing world gives them a stronger appreciation for the applicability of engineering to improve quality of life.

Our Community Partner

We partnered with the Academically and Intellectually Gifted (AIG) program at a local public elementary school. This program serves fourth and fifth grade students who have been identified as gifted learners. They are instructed by a resource specialist in the areas of reading and/or mathematics. The school principal and resource specialist identified the participating students and obtained parental permission. Since the resource specialist knew the students best, she also assigned the elementary student teams. The engineering thermodynamics students travelled to the elementary school to engage in the activities for one hour immediately following the Wednesday afternoon dismissal.

Method

The Now You’re Cooking: Designing Solar Ovens unit contains curricular materials and lesson plans organized into one preparatory lesson and four subsequent unit lessons. The Preparatory Lesson introduces the elementary school students to engineering, technology, and the engineering design process. The four unit lessons build upon one another, starting with reading the storybook, a life-cycle assessment to explore how technology can impact the environment, exercises for students to collect data about heat transfer rates of different types of materials, and finally the design, testing, and improvement of a solar oven. Each lesson is divided into 2-3 parts, which are expected to last on average 45-50 minutes.

Due to coordination of academic calendars, we were limited to six meetings with the elementary schools students. Therefore, we were not able to complete the unit in its entirety. After reviewing the materials, the AIG teacher, engineering students, and I decided to have the AIG teacher read the story with the elementary school students before our first scheduled meeting and eliminate the life-cycle assessment lesson.

The engineering students shared the role of lecturer on a rotating schedule. Each engineering student was assigned a team of three elementary school students and facilitated the weekly team activities. To ensure that everyone was on one accord, the lecturer for the week and I would prepare a plan of approach for each session. Naturally, each engineering student had to have read the materials and plan of approach in order to serve as an effective facilitator. We also had a designated supply gatherer.

The initial lesson was devoted to helping the elementary school students understand what engineers do. As mentioned earlier, the subsequent lessons built upon one another with lessons such as exploring the heat transfer properties of different materials and the environmental impacts of different materials, to the culminating lessons guiding students through using the engineering design process to design a solar oven. The closing session was a fun time for all to test their final designs by making s'mores. All teams had great conversations about the outcomes and potential design improvements as they enjoyed the gooey treats.

Assessment

For the preliminary evaluation of the effectiveness of the Engineering is Elementary® Now You're Cooking: Designing Solar Ovens unit, the assessment of the elementary school students included periodic five minute papers in which students responded to a teacher-supplied prompt. A parent evaluation was also requested at the conclusion of the unit, but unfortunately, none were actually returned.

One of the five minute papers queried students on their understanding of green engineering. This was given prior to the engineering students' initial visit to the class and again the week following. Table 1 contains some representative student responses.

It is also important to note that each Engineering is Elementary® unit includes well-crafted tools to assess learning. This includes a diagnostic pre- and post-assessment questionnaire about engineering and technology, rubrics to accompany each lesson plan, and worksheets for students to complete at the end of each lesson. Learning objectives are clearly outlined for each lesson as well.

Table 1. Representative Pre and Post Elementary Student Responses to “What is green engineering?/What do green engineers do?”

Response Prior to Instruction	Response One Week Following Instruction
“Green engineering is basically engineering to help the earth.”	“Now I think engineering is designing things to improve people's lives.”
“Thinking of ways to make inventions to help save the environment, so they don't use fuel or gas.”	“Now I think engineering means people who build things to help humans, like helping the environment or helping inventions be better.”
“I think engineering means building machines and some to help the environment.”	“Building an invention to make human life easier.”
“I think green engineering is to make things to help the earth.”	“Now I think engineering is where you design or make something better.”
“I think a green engineer tries to help the environment.”	“Engineers are people who design things that help either people and the environment.”
“Someone who helps preserve the planet.”	“Someone who builds or improves something.”

The five minute papers also contained some interesting comments from the elementary school students that are reflective of their interest and enthusiasm. This is important to note because the engineering profession is commonly plagued by a poor image among young people, especially in the United States, due to problems such as misconceptions about the work of engineers, lack of interest in/low confidence in math and science, and previous negative experiences with math and science teachers. Here are a few of the additional comments included in the five minute papers:

“I got lots of info about what engineers really do!”

“I hope that I will learn more.”

“I didn't know that some engineers helped make bubble gum better.”

“I want to get better at science and learn how to be more green.”

“Last week I learned what engineering was. It was pretty cool.”

The engineering students were assessed on their ability to communicate about engineering with novices and facilitate their assigned team of elementary school students. They were encouraged to maintain a journal to capture candid thoughts about the experience. It was clearly evident that the engineering students initially struggled with explaining the complex concepts related to the project to the novice audience, but dramatically improved over time. They also frequently expressed appreciation for the opportunity to engage in a hands-on project related to thermodynamics, citing the particular utility in strengthening their understanding. The underlying theme of the potential for engineering to truly change the lives of people in developing nations also resonated with the students and increased their interest in civic engagement. Unfortunately, this is all anecdotal evidence because the students did a nice job of discussing their experiences in class, but failed to maintain their journals.

Conclusion

Preliminary assessment data indicates that the Engineering is Elementary® units are effective tools for engaging elementary and engineering students in an engineering service-learning project. The elementary students' preliminary assessment data indicates they improved and deepened their understanding of engineering and enjoyed the experience. Their teacher praised the clear connection to social studies and opportunity to expand her students' understanding of the world. The engineering students appreciated the opportunity to serve in the community, engage in a hands-on project, and learn about one way that engineering can be used to serve globally. Several important lessons were also learned in this initial implementation. In the context of this paper, the most important ones are to be more diligent in the collection of parent evaluations and enforcement of engineering student journals. I eagerly share this preliminary information because it shows that this is an effective way to help students of all ages broaden their appreciation for how engineering may be used to improve the quality of life and broaden their global perspective. The results have inspired plans for future Engineering is Elementary®-based service learning projects with full implementation of the assessment tools included in the materials.

REFERENCES

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