120th ASEE Annual Conference & Exposition
FRANKLY, WE DO GIVE A D*MN
June 23-26, 2013

Paper ID #7092

Assessing Service Learning Reflections

Dr. Lawrence E. Whitman, Wichita State University
Mrs. Cindi Mason, Wichita State University

Cindi Mason is an Industrial Engineering Ph.D. student at Wichita State University with a focus on engineering education. She has a B.S. in Industrial Engineering and an MBA. She also has nine years of experience in the aircraft industry.

Assessing Service Learning Reflections

Abstract

Engineering is a discipline that contributes much to society. However, most engineering undergraduates do not see this aspect. Engineers can, and do, provide substantial service to the community and world. A service-learning course in engineering helps students become aware of their personal contribution as engineers, as well as the global impact of engineers. Wichita State University (WSU) has implemented the "Engineer of 2020" program, which must be completed by all undergraduate students. One of the six potential criteria for this program is service learning. Service-learning courses highlight the opportunities available for engineering undergraduate students. The objective of providing a course with a service learning experience is to expand the student perspective that engineers can have a positive impact on their community and the world. Students from all engineering disciplines at WSU take this course and work as a team on several course requirements. This paper describes the existing service-learning course and presents the motivation behind its development with a review of the literature on service learning and the content of the course. The paper then focuses on the structured reflection component of the class. The reflective component of the class instills the broad aspects desired by industry.

MOTIVATION

The primary goal of the Wichita State University (WSU) College of Engineering (CoE) is to educate and prepare students to succeed in the engineering field upon graduation. In order to make continuous improvements, maintain relevance, and ensure course material matches current engineering needs and requirements, the CoE has fostered a unique relationship with local engineers through its very active Industrial Advisory Board (IAB). The IAB consists of professional engineers from various local industries. The IAB members have expressed their desire for our graduates to have a competitive advantage by possessing more than just the technical skills of an engineering degree. To this end, we have launched a strategic initiative, the Engineer of 2020, in order to prepare graduates for effective engagement in the engineering profession. This initiative is in part motivated by two reports from the National Academy of Engineering, of the National Academies, entitled *The Engineer of 2020*[1] and its follow-on *Educating the Engineer of 2020*[2]. These reports, written by two groups of distinguished educators and practicing engineers from diverse backgrounds, were developed in response to a concern that engineering students of today may not be appropriately educated to meet the demands that will be placed on the engineer of the future. The reports tackle the demands facing current engineering students without refocusing and reshaping the undergraduate engineering learning experience.

Numerous articles and papers have been written regarding the evolution of the engineer and the need to therefore evolve the education of engineering students, due to breakthrough technologies, fast-paced technological advances, environmental concerns, and globalization[1, 3]. Two major sources have spurred on this interest and sense of need, namely the Accreditation Board for Engineering Technology (ABET) Engineering Criteria 2000 (EC2000)[4] and the two-phase publication by the National Academy of Engineering (NAE) *The Engineer of 2020: Visions of Engineering in the New Century*[1] and *Educating the Engineer of 2020*[2]. ABET EC2000's Criterion 3, sections "a" through "k"[4] address some hard skills as well as some so-called "soft skills" or preferably termed "professional skills"[3].

A number of noted engineering education leaders have responded and commented on these reports. Butcher claims the reports call for, "ingenious leaders — ingenious engineers" and calls these engineers, "well-rounded Renaissance Engineer[s]"[5]. Turns, Atman, et al.,[6] use these reports as a gage of what an engineer needs to know. Dym, et al. present how engineering education is being challenged to require students to consider additional design constraints required as part of a "new fundamentals"[7]. In response to this challenge, the CoE hopes to establish its leadership in reshaping the undergraduate experience to prepare the engineer of 2020: making the educational experience more meaningful to the student and the student more desirable to local and national industries. As such, the CoE proposes that to fulfill the requirements for an Engineering BS degree, each student will complete the program course requirements including at least three of the following six activities:

1. Undergraduate Research
2. Cooperative Education or Internship
3. Global Learning or Study Abroad
4. Service Learning
5. Leadership
6. Multidisciplinary Education

Previous papers have described global learning efforts[8] and leadership[9]. The complete plan for "The Engineer of 2020" was also reported[10, 11]. The focus of this paper is centered on the service learning opportunity made available to engineering students by the CoE through the creation of the ENGR 202 course "Service Learning in Engineering", which will be described in further detail in a subsequent section of this paper.

SERVICE LEARNING IN ENGINEERING

The aim of this section is to answer four basic questions regarding service learning:

1. What is it?

2. Why is it necessary?

3. How can it be incorporated?

4. How can it be assessed?

Although concise definitions of the term "service learning" vary in presentation, there are some definitive attributes associated with the term. Service learning is "experiential education"[12] or "hands-on learning"[13] in which students learn academic objectives by completing a project that addresses human and community needs[12, 13, 14]. Factors that differentiate service learning from community service are the credit-bearing aspect[13] and the reflection aspect14, forcing the student to focus on the project process, outcomes, and lessons learned. Reflective judgment promotes a deeper appreciation and understanding of the engineering profession and its societal impact[14].

At the WSU CoE, the definition of a service learning activity is broadly described with three aspects:

1. An educational experience that is course-based and credit-bearing;
2. An organized service activity consisting of an intentional and thought-provoking application of classroom learning to active and engaging work by participating in a group project that meets identified community needs (In the context of the class, a community is broadly defined and opportunities for service can address a wide variety of community needs.);
3. Structured reflection on the service activity to gain further understanding of course content, a broader appreciation of the discipline, and an enhanced sense of civic responsibility[15, 16].

Service learning is a necessary aspect of engineering education. Globally, there is an increasing sense of social consciousness making it progressively more important for engineering students to understand the effects of their work as engineers[17]. Studies have shown that service learning results in greater ethical and moral development, increasing student initiative and engagement[18, 19]. Following Vanasupa's Four Domain Development Diagram (4DDD), service learning allows the student to develop an understanding of the broad context their engineering work dwells in, which in turn increases motivation, engagement, and moral/ethical development[19]. This relationship has proven even stronger for female students[20, 21], and offers a secondary benefit of service learning—it assists in the recruitment and retention of underrepresented groups[21]. Additionally service learning has positive effects on personal and interpersonal development, tolerance for diversity, and college/community relationships[22]. The partnership between the college and the community recipient offers a two-sided benefit: the engineering students receive college credit through a real-world project experience, while the community partners receive low-cost technical expertise to achieve real-world solutions[23].

Although the need for service learning is becoming increasingly evident, the question of how it can be affectively included in engineering education remains. There are several methods being used to various degrees that incorporate service learning into the engineering curriculum. Techniques range from the addition of a required service learning course to the integration of service learning into existing courses.

Perhaps one of the widest known and largest platforms of service learning programs in the field of engineering education is Engineering Projects In Community Service (EPICS). Purdue's electrical and computer engineering departments first implemented the EPICS model in 1995, and it has been adopted and expanded by numerous other schools and departments since that date[23]. This model of service learning integrates students of multidisciplinary areas of study, across grade level, beyond a one-semester timeframe, mimicking the features of an engineering design firm[23].

Another approach for implementation is fully integrating service learning into existing curriculum. The University of Massachusetts-Lowell followed this approach in 2004 with a program called SLICE (Service Learning Integrated throughout a College of Engineering)[21]. The ultimate goal of SLICE aimed to integrate service learning projects into so many classes that each student would have at least one course per semester with a service learning project all four years of college[21]. The main advantage of this structure is that it does not require additional coursework or credits for the student, but a disadvantage is that it requires more time, schedule adjustment, and planning by more faculty members[23].

Whether service-learning courses are added to a program, or an aspect of service learning is incorporated into current courses, the need arises to assess the resulting student learning. The learning of technical or “hard” skills is easier to gauge using the traditional methods of written homework assignments, quizzes, and tests. These types of skills can be gained through the coursework. Professional skills, on the other hand, are not as easily acquired through coursework alone, but can be earned through means such as global and service learning[3]. However, this raises the question of how this experiential form of learning—service learning, can be assessed.

According to Shuman et al.[3], an assessment analyzing the learning of professional skills has been delayed due to the following three obstacles: “a consensus on definition, the scope by which the outcome is assessed, and the nature of the outcome itself.” As mentioned previously in this paper, a key component differentiating service learning from community service is reflection[3], and is therefore the primary tool for assessment. There are different forms of documenting and relaying students’ reflection process. Some examples include journals, surveys addressing participation and learning objectives, presentations[24], attitude surveys, focus groups, and project reports[25]. By comparing the results of any of these modes of reflection to the learning objectives provides the means of assessment. The quantifiable modes, therefore, such as Likert scale surveys offer opportunity for a more direct comparison between learning objectives and outcomes.

The next section provides an overview of the service learning course purpose and course content and proceeds to explain how the course utilizes the assessment methods as prescribed above.

COURSE DESCRIPTION

To satisfy the curricular requirements of service learning, students typically enroll in the “Engineering 202, Service Learning in Engineering” class, which is the basis of this paper. It is scheduled for a one-hour period once a week. Service Learning in Engineering is an intentional and thought-provoking application of classroom learning to active and engaging engineering work by participating in a group project that meets identified community needs. The course is project based, with a report and reflections due throughout the term. The project is identified by the student and could be mentoring or leading a team of students in an engineering service effort. Typically, the faculty provides a set of options for the project, and the student selects the option that best fits the student’s objective and schedule.

The projects have typically been of two different types: 1) mentoring or 2) leading the design and build of a LEGO Robotics course.

The mentoring has been implemented in many different ways. Some examples include students mentoring a LEGO robotics team, mentoring a BEST robotics team, and mentoring a little brother or little sister as a Big Brother Big Sister (BBBS) mentor. Each of these is further described in the next several paragraphs.

LEGO Robotics – For students to mentor a LEGO Robotics Team, the student must become familiar with LEGO Robotics and the LEGO Robotics software. The student mentor should meet with their group once a week during the semester. The mentoring time commitment was in addition to class time. Students are requested to carry on in mentoring the team through the competition (in mid-March). The students mentored are in 4th through 8th grades. More details about the Shocker MINDSTORMS competition can be found on the website: http://www.wichita.edu/mindstorms.

BEST Robotics – For students to mentor a BEST Robotics Team, the student could, but not necessarily, become familiar with robotics or the programming software. The student mentor should meet with their group once a week during the semester and through the competition (early November). The mentoring time commitment was in addition to class time. The mentored students are in high school. More details on BEST can be found on the website at: www.kansasbest.org.

Big Brothers Big Sisters (BBBS) - BBBS mentoring focuses around a partnership with the Big Brothers Big Sisters Great Expectations in Math and Science (GEMS) program, which is a special mentoring program designed to foster children's enthusiasm for math, science, and engineering. Student mentoring responsibilities include mentoring a child at a nearby elementary school by sharing design knowledge and skills in utilizing math and science. To participate in this type of mentoring, the student had to complete a background check form and participate in a short interview with a staff member from Big Brothers Big Sisters. Students went to an elementary school once a week either during lunch or after school to meet with an elementary school student. The mentoring time commitment was in addition to class time.

LEGO Robotics Course Design – Student mentors led the designing, building and running of a LEGO Robotics course required to learn about LEGO Robotics, and they completed two of the "apprentice courses." Student mentors used the engineering design process to design a course to a specified theme (for 2011 it was a sustainability theme entitled, "Saving the World: One brick at a time"); have the design approved; build the course; have the course build verified against the course design; and run the course on trial and challenge days.

OVERVIEW OF ASSESSMENT

The types of assessment are related to the assignments for the class. Students must complete the following:

- Journal: Written discussion of the engineering process and how it applied to efforts
- Reflections: Discussion of observations after an activity (detailed in subsequent section)

- Presentations: Oral presentation of what worked and what did not work
- Homework: Periodic assignments related to the specific requirements for the service learning area selected by the student

Many engineering students actually do very little writing (especially non-technical writing) in their junior and senior years. Many engineering students are also unfamiliar with using a rubric to guide their writing. Students tend not to think critically about their own writing. These students believe they are already “good” writers and that writing assignments are “easy A’s.” For this reason, the assignments receive low weighting early in the semester and receive increasing weighting throughout the semester. Students are provided feedback regarding their reflective assignments that allow them to improve their writing on subsequent assignments. The grade is not focused on their grammar and spelling, but rather rates the reflective nature of their writing.

A key component of this class is the reflective writing. The next section describes the purpose of the reflection, the grading rubric, and some common difficulties with the writing.

DISCUSSION OF REFLECTIONS

A key part of what makes service learning an activity worthy of college credit is its reflective nature. The reflection rubric evaluates four areas: evaluative thinking (the excellent rating is when students use information to support beliefs and indicates a need to gather more information to further support beliefs); divergent thinking (the excellent rating is when students demonstrate that they organize available relevant information into viable framework to achieve goals and obtain additional relevant information to create a plan towards goals); convergent thinking (the excellent rating is when students provide interpretation and analysis of information from multiple perspectives and present new perspectives using additional relevant information); cognitive memory (the excellent rating is when students apply a range of relevant information to validate with additional points if the student provided additional relevant information, demonstrating self-learning).

As mentioned previously, students did not refer to the rubric when writing and thus, these areas were typically not addressed. After the first two reflections, students began to identify limitations, but still had difficulty addressing them. Students consistently had difficulty with how to validate that what they were doing was of any real value.

Students in the Service Learning in Engineering class are required to write three to five reflections. Each reflection is typically over one or more events. For example: if students are mentoring a robotics team, the students write a reflection over each visit (or over the first visit, the next several visits, the practice day, the game day and then a final reflection about the entire service learning experience). Many engineering students have difficulty writing reflectively and are often not accustomed to writing to a specified rubric. The rubric by Olds as reported by Tsang[26], requires aspects of writing that many engineering students are both unfamiliar and uncomfortable with. However, with instruction, many engineering students are able to think and reflect in a structured manner.

The class requires the reflection to have five components. The first component is simply a summary of the actual activity (mentoring a robotics team, mentoring a student in science and math, etc.). The next four sections are directly from the rubric by Olds as presented in Tsang[26] (Table 1). The numbers in the first row designate the point values assigned to each column. This means that a 'perfect score' would give the student 14 points. This is actually graded with a maximum of 10 points. This allows students to receive a maximum score even without scoring perfectly on the rubric. Some of the sections, such as 'cognitive memory' are very difficult to achieve maximum points. The terms: evaluative thinking, divergent thinking, convergent thinking and cognitive memory are nebulous to many students. Most students focus all their efforts on an activity summary. Therefore, when describing the assignment of reflective writing, the students are instructed to focus on the far right column of the rubric to maximize their points. Specifically, for 'evaluative thinking', an explicit description of limitations observed in the activity along with providing a viable strategy to overcome the identified limitations is considered the approach for that section of their reflection. For the section on 'divergent thinking,' students are advised to discuss a primary goal of the activity and how to organize information to achieve that goal. If possible, additional effort should be made to obtain information outside of simple student observation to aid in the successful accomplishment of the goal. Convergent thinking is the most difficult aspect for many engineering students. Convergent thinking requires students to consider perspectives other than their own. Students are told that this cannot simply be what they observed others doing, but they must reflect on what the others were thinking at the time. For example, what are the middle school or high school students thinking, what are their teachers and parents thinking? This is a key development for our students to master. For example, when involved in design work, engineers should consider multiple perspectives in the actual design.

RESULTS

Reflective writing was a key component of the course, and it appears that it had an impact on the students. Students are more aware of their attitudes and can think about engineering in broader context. Several students have commented on how this class made them more aware of how engineering can impact their community as well as how to present engineering to a non-technical audience.

Students have two primary difficulties in this class: 1) Students consider this class less important than other classes and therefore do not provide as much effort toward this class as other classes, and 2) Students do not follow the rubric for the assignments and therefore their grades are lower than expected. Concerning point number one, most students are able to adjust their schedules and complete the assignment on time and with sufficient attention to detail. However, a few students in each section do not spend the time necessary to complete the class in a timely manner.

Concerning the second point, students are instructed about the rubric for the reflective writing on the first day of class when the first reflection is due, but many students do not pay attention to the instructions or to the level of detail in their reflections in a proper manner.

Table 1. Reflective Writing Rubric (modified from Tsang, 2002[26])

	(0)	(1)	(2)	(3)
Activity Summary	Limited discussion of activity	Decent description of activity, but nothing usable by others	Clear description of activity with useful commentary	
Evaluative Thinking	Unable to evaluate information: relies primarily on unexamined beliefs	Superficial understanding of info to support beliefs; acknowledges gap	Use info to support beliefs; indicates need to gather more info to further support beliefs	Suggest viable strategies to correct identified limitations
Divergent Thinking	Does not make connections among relevant information to achieve goal	Somewhat among relevant information towards goal	Organize available relevant information into viable framework to achieve goal	Obtain additional relevant information to create plan towards goal
Convergent Thinking	Presents information and makes no attempt to interpret or analyze	Provides limited interpretation and analysis of information	Provides interpretation and analysis of information from multiple perspectives	Presents new perspectives using additional relevant information
Cognitive Memory	Relies on external authority for validation	Use limited information but acknowledges the possibility of limitation	Applies a range of relevant information to validate	Validation based on additional relevant information

SUMMARY

Wichita State University College of Engineering has implemented a new program called, "The Engineer of 2020." This program requires students to complete three of six criteria identified by the National Academy Report, "The Engineer of 2020." One of these criteria is service learning. This paper presented several definitions of service learning, proposed a new definition, discussed a classroom implementation, and a reflection rubric. The development of the ENGR 202 course has proven to be an active step in the right direction for the CoE. It aligns with the ABET requirements and NAE recommendations to strengthen the professional skills of engineering students. The course exposes students to an aspect of engineering that is often neglected in education and forgotten in practice—service to the community.

REFERENCES

1. National Academies of Engineering. (2004). The Engineer of 2020: Visions of Engineering in the New Century. Washington, DC, The National Academies Press.
2. National Academies of Engineering. (2005). Educating The Engineer of 2020: Adapting Engineering Education to the New Century. Washington, DC, National Academies Press.
3. Shuman, L. J., Besterfield_Sacre, M., & McGourty, J. (2005). The ABET 'Professional Skills' – Can They Be Taught? Can They Be Assessed? Journal of Engineering Education. 94(1), 41 – 55.
4. ABET Board of Directors (2011). 2012 – 2013 Criteria for Accrediting Engineering Programs. Baltimore, MD.
5. Butcher, D. R. (2006). *Redefining engineering for the year 2020*, ThomasNet.Com Industrial Market Trends.
6. Turns, J., C. J. Atman, et al. (2005). "Research on Engineering Student Knowing: Trends and Opportunities." *Journal of Engineering Education*: 27-41.
7. Dym, C., A. Agogino, et al. (2006). "Engineering design thinking, teaching, and learning." *IEEE Engineering Management Review* 34(1): 65-92.
8. Whitman, L., Toro-Ramos, Chaparro, B., Hinckle, V. Z., Davidson, C. and C. Wilkinson. (2009). "A practical global design competition," *Proceedings of the American Society for Engineering Education Conference, Austin*, TX CD June 14-17, 2009.
9. Malzahn, D., Whitman, L., Toro-Ramos, Z., & Acosta, J. (2010). The Engineer as Leader: Course Design. Proceedings of the 2010 Midwest Section Conference of the American Society for Engineering Education.
10. Whitman, L., Toro-Ramos, Z., & Skinner, S. (2007). Educating the engineer of 2020: A practical implementation. Proceedings of the American Society of Engineering Education Midwest Section Conference. Wichita, KS, September 19 -21, 2007.
11. Whitman, L., Reynolds, K., & Toro-Ramos, Z. (2011). Service Learning in Engineering. Proceedings of the 2011 Midwest Section Conference of the American Society for Engineering Education.
12. Jacoby, B. (1996). *Service-Learning in Higher Education: Concepts and Practices*. San Francisco, Jossey-Bass.
13. Duffy, H., C. Barry, et al. (2009). Service- learning in engineering science courses: Does it work? *Proceedings of the ASEE Annual Conference and Exposition*, Austin, TX.
14. Self, B. P., Slivovsky, A., Taylor, K. & Alptekin, S. (2007). Service Learning in Engineering at Cal Poly. Proceedings of the 2007 American Society for Engineering Education Pacific Southwest Annual Conference.

15. Bringle, R. G. and J. A. Hatcher (1996). "Implementing service learning in higher education." *Journal of Higher Education* 67: 221-239.
16. Totten, S. and J. Pedersen (1997). *Social Issues and Service at the Middle Level*. Neddham Heights, MA, Allyn and Bacon.
17. Oberst, B.S., & Jones, R.C. (2003). Megatrends in Engineering Education. Proceedings of the 2003 American Society for Engineering Education Conference.
18. Slivovsky, L.A., DeRego Jr., F.R., Jamieson, L.H., & Oakes, W.C. (2003). Developing the reflection component in the EPICS Model of Engineering Service Learning. Proceedings of the Frontiers in Education Conference. Boulder, CO.
19. Vanasupa, L., Stolk, J., & Herter, R. J. (2009). The Four-Domain Development Diagram: A Guide for the Holistic Design of Effective Learning Experiences for the Twenty-first Century Engineer. Journal of Engineering Education. 98(1), 67 – 81.
20. Goodman, L., Cunningham, C., LaChapelle, C., Thompson, M., Bittinger, K., Brennan, R., & Delci, M. (2002). Final report of the women's experiences in college engineering (WECE) Project. 2002. Cambridge, MA: Goodman Research Group, Inc.
21. Duffy, J., Barrington, L., West, C., Heredia, M., & Barry, C. (2011). "Service-Learning Integrated throughout a College of Engineering (SLICE)." Advances in Engineering Education. 2(4), 1 – 23.
22. Eyler, J., & Giles, D. (1999). Where's the learning in service-learning? San Francisco; Jossey-Bass.
23. Coyle, E.J., Jamieson, L.H, & Oakes, W.C. (2006). Integrating Engineering Education and Community Service: Themes for the Future of Engineering Education. Journal of Engineering Education, 95(1), 7 – 11.
24. Dinehart, D.W., & Gross, S.P. (2010). A Service Learning Structural Engineering Capstone Course and the Assessment of Technical and Non-technical Objectives. Advances in Engineering Education. 2(1), 1 – 19.
25. Hayden, N.J., Rizzo, D.M., Dewoolkar, M.M., Neumann, M.D., Lathem, S. & Sadek, A. (2011). Incorporating a Systems Approach into Civil and Environmental Engineering Curricula; Effect on Course Redesign, and Student and Faculty Attitudes. Advances in Engineering Education. 2(4), 1 – 27.
26. Tsang, E. (2002). Service Learning: A Positive Approach to Teaching Engineering Ethics and Social Impact of Technology. Proceedings of the 2000 ASEE Annual Conference & Exposition. St. Louis, MO, June 18 -21, 2000, Session 3630.