Engagement in Practice: Establishing a Culture of Service-Learning in Engineering Orientation Classes at KSU

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Before coming to Kenesaw State University, Dr. McFall lived abroad for more than ten years. His international experiences began with a study abroad for his entire undergraduate senior year at the Luleå University of Technology in Sweden 50 miles south of the Arctic Circle. After graduating with his B.S. in Mechanical Engineering from Virginia Tech, his international travels continued during masters studies at MIT with an appointment at the Japan Atomic Energy Research Institute in Japan. His work there involved heat transfer in the superconducting magnet systems for the International Thermonuclear Experimental Reactor project.

Such positive international experiences led to a research fellow position at Dalarna University in Sweden after graduation from MIT with his M.S. in Mechanical Engineering. His research shifted to artificial intelligence and image/signal processing where he was involved in developing an automated winter road condition sensor using artificial neural networks to classify road condition using image and sound input data. The research fellow position at Dalarna University quickly led to a permanent faculty position in the Department of Computer Engineering and Informatics.

In order to help advance his career in academia, he left Dalarna University to pursue a Ph.D. in Mechanical Engineering at Georgia Tech's European campus in Metz, France. He continued working in artificial intelligence by developing an alternative method for solving boundary value problems using artificial neural networks. After getting married soon after graduation, he moved his wife to France where he worked as a Visiting Assistant Professor at Georgia Tech for two years before accepting a tenure-track position Penn State's Lehigh Valley campus. His current position in mechatronics at KSU allows Dr. McFall to live closer to family and pursue his passion for scholarship at a student-centered technical university. His current research focuses on autonomous vehicles, directing numerous student teams to develop sensor systems and actuation control for self-driving cars.

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Dr. Veazie received his B.S. in Mechanical Engineering from Southern University in 1986, and his M.S. and Ph.D. in Mechanical Engineering from Georgia Tech in 1987 and 1993, respectively. He worked for AT&T Bell Laboratories in New Jersey as a Member of the Technical Staff and was a National Research Council (NRC) Postdoctoral Fellow at the NASA Langley Research Center. In 1994, he joined Clark Atlanta University's Department of Engineering, and was the Director of the Mechanical Testing Laboratories (MTL) and Associate Director of the NASA funded High Performance Polymers and Composites (HiPPAC) Center. Presently, he is a Professor of Mechanical Engineering and the Director of the Center for Advanced Materials Research and Education (CAMRE) at the Southern Polytechnic State University.

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Introduction and Literature Review

With a goal of increasing access to more engaged learning opportunities, service learning was chosen as one of the three high-impact practices for our university to focus on in our accreditation quality enhancement plan (QEP), along with undergraduate research and internships. However, within the college of engineering very little formal service learning was being conducted at the time. In our orientation classes, service learning was newly a part of the industrial and systems engineering orientation course and fall 2019 it was incorporated into the mechanical engineering and mechatronics engineering courses. These are the first courses in our college that met or will meet the service learning definition in our QEP. This paper details the successes and the 'lessons learned' through service learning in those classes at Kennesaw State University, including feedback from the instructors and students. We also explain future plans for expansion into other engineering courses.

Service learning has been shown to enhance personal outcomes, social outcomes, learning outcomes, career development, and student retention [1]. In engineering specifically, Pierrakos et al. found sophomore students in a service learning experience better learned and were able to apply engineering knowledge, they valued and were challenged by working in a team setting, they recognized the relevance and connection of the project to real-world engineering practice, and they could "see themselves as engineers or at least becoming engineers" [2]. In surveying first-year engineering undergraduates as well as high school students exposed to service learning, Zarske found positive impacts in identity and attitudes towards community service, especially in underrepresented populations, that may help in recruitment and retention of those groups [3].

There are a variety of definitions of service learning that are employed in education. For the purposes of this paper, we will use the definition adopted by Kennesaw State University's quality enhancement plan (QEP) for regional accreditation review. "Service learning is an intentional and collaborative pedagogical practice that engages students in structured service to address an identified community need and help them 'gain further understanding of course content, a broader appreciation of the discipline, and an enhanced sense of civic responsibility [4]'[5]." Support documents for our QEP go on to highlight the importance of service learning being academically integrated with the course learning objectives while focusing on community needs, involvement of the community partner in the design of the service learning project, the importance of structured student reflection throughout the project, and a preference for the service learning experiences to last the majority of the semester. A service learning taxonomy is provided to lead faculty toward deeper involvement in service learning pedagogy [6].

For those interested in more background on service learning in engineering, Oakes' 2004 guidebook provides many resources and examples [7]. Perhaps the most well-known engineering service learning program is EPICS, originated in Purdue in 1995 [8]. In light of the positive impact of service learning on retention, some engineering programs have added service learning components to their orientation or introduction to design courses. For example, at the University of South Alabama an introductory mechanical engineering design course pairs teams of mechanical engineering students with math and science teachers to design, build and deliver hardware and software to meet the needs of those teacher clients [9].

Kennesaw State University (KSU) is a fast-growing, predominantly undergraduate, comprehensive public institution that offers more than 150 undergraduate, graduate and doctoral degrees to its more than 35,000 students. With 13 colleges on two greater-Atlanta area campuses, KSU is one of the 50 largest public institutions in the country and the Southern Polytechnic College of Engineering and Engineering Technology (SPCEET) is the second largest in the state. SPCEET serves more than 4,500 students with 20 undergraduate and graduate engineering degrees and engineering technology degrees. The orientation courses highlighted in this paper were primarily made up of first year students and first year transfers to the college of engineering.

Introduction to Industrial and Systems Engineering

In a course focused on building enthusiasm for industrial and systems engineering (ISYE) while educating students about the basic tools of the field, service learning appeared to be an excellent fit to include in a fall 2018 redesign of the course. A semester-long project was designed with groups of 4-6 students matched to community partners to solve an appropriate industrial engineering-related problem for them. The service learning project was designed to be a hands-on approach to the material in the project management, communication, and teamwork modules of the course, in addition to giving students the opportunity to practice ISYE functions related to their community agency's problem.

Logistics

KSU has a Department of Student Leadership and Service that oversees service learning. The coordinator of service learning e-mailed his database of community partners and then the instructor also solicited potential partners at the community service fair held on campus. The service learning project was offered to one 30-person class in fall 2018 (6 projects) and two classes for a total of 69 students in fall 2019 (13 projects). Additional project details and survey results for the fall 2018 course can be found at Scherrer(2019) [10].

Early in the semester the instructor explained the various projects and had students rank their preferred projects. Students were then given two weeks to meet with their community partner to define scope and deliverables, another week to put together a project plan, and about eight weeks to "work the plan". The instructor gave feedback on the plan and also met with all students partway through the semester to go over their progress and provide feedback. At the end of the semester students gave a short, informal presentation to the class and turned in a final report. Students were also involved in reflection toward the beginning and at the end of the project. Some example projects have been: creating a process flow document for a local recycling center, developing an industrial engineering module for an outreach program to elementary students, optimizing storage and ensuring food safety for a community garden, and launching the inventory system for a new KSU Clothing Closet.

Lessons Learned

Student feedback was almost uniformly positive. In their reflections and survey results they found value in the experience and most groups felt that their involvement would make a difference for their community partner. The instructor also saw significant value in this project for most students. The project tied well to course and program outcomes in a very engaging way. It also seemed to have a positive impact on team and communication skills. In both years, friendships and study groups formed within these project groups, which helps students to feel more connected to the university and hopefully will improve retention.

One significant negative found by the instructor was that some of the projects ended up not being as related to industrial engineering as the community partner first described them. A few groups were reduced to essentially clerical or manual work. In addition, there was a significantly increased workload for the instructor to help find and manage all of the community partner relationships. The instructor is planning to use only one community partner per class with multiple groups working on the problem and each coming up with alternative solutions for the partner next year in hopes of reducing her time commitment and ensuring engaging industrial engineering projects for all students.

Introduction to Mechatronics Engineering

This introductory course (MTRE 1000) orients students interested in Mechatronics Engineering in their intended field of study. The course consists of both a lecture and laboratory component where student teams participate in a semester-long project designing, constructing, testing, and competing with a small mobile robot. Students come to this course with varying levels of experience with robotics, and teams are constructed to mix experience in the teams and encourage mentoring among students. The drawback of this approach is that less experienced students can feel outclassed and lose confidence, even though the competition represents a small portion of the course grade and teams compete only with others in the course. To boost confidence, the college students were encouraged to interact with students from a visiting high school robotics team on the day of competition, so that everyone on the team could gain confidence by explaining their work to near peers.

Lessons Learned

After the competition, the college students were asked informally to share their experiences interacting with high school robotics students. Responses about the experience were overwhelmingly positive:

- “Sharing the technical details of it was encouraging to me as it gave me an opportunity to use the knowledge that I have gained through this experience and helped me to appreciate how much I've learned over the last several months.”
- “It grew my confidence in my abilities because I could see how much they appreciated and seemed to be learning…”
- “This experience made me far more likely to look into further outreach for younger students.”
- “…it is a great opportunity both to reach out to future minds and to grow my own experience in the field.”
- “I think that it does bolster confidence… and… you’re able to respond intelligently”

Students identified the experience could bolster their own confidence and be mutually beneficial for everyone involved. In the Spring 2020 offering of this course, a local middle school robotics team will be paired with the college students to interact multiple times throughout the semester. This will occur via videos posted online about both groups' robotics projects. Commenting back and forth on these videos through the duration of the semester should make meeting during the competition at the end of semester even more valuable for both parties.

In the Fall 2019 iteration of the course, the service learning component involved a simple meeting between college and high school students to share experiences with the intention to build confidence on both sides. To be a truly effective service learning exercise, the interaction should be continuous throughout the semester and offer a true opportunity to reflect on the experience. For Spring 2020, the course is incorporating several checkpoints of interaction between college and middle school robotics teams where both post videos to YouTube describing the progress of their robotics projects. Posting videos multiple times and commenting on each other's videos throughout the semester should build community, leading up to finally meeting in person during the end of semester competition.

Introduction to Mechanical Engineering

The Introduction to Mechanical Engineering course (ME 1001) has many goals, including incorporating methodologies to increase the retention rate of the program by giving students something to look forward to in the field of Mechanical Engineering [11]. A specific learning strategy that embodies this involves having first year students in the course demonstrate their ability to design and create in a major semester-long project called 'The Pumpkin Launch Extravaganza'. This project involves student teams consisting of 8-10 students who conduct research on how to design launch devices, construct full size machines to launch actual pumpkins at a competition, test-prototype, and finally report their final project to the class and guests. The competition event, which has industry sponsors, is marketed heavily by the university, and attracts hundreds of spectators.

Two examples of service learning were recently included in the course that were not a part of the course previously. First, ME 1001 students collaborated with representatives from the School of Culinary Sustainability and Hospitality to feed sustainable farming chickens leftover pumpkin scraps. Second, they engaged with middle and high schools, local churches and community youth service institutions to promote engineering. These service learning activities were exclusively done as part of the pumpkin launch project.

Lessons Learned
Structured student reflection did not take place throughout the semester, but this will be incorporated in the future to enhance the service learning experience. The relevance of service learning is realized as an important component for this course because it 1) motivates students who often struggle to get over the challenges of difficult coursework, 2) gives students real world experience, 3) teaches students key strategies such as team dynamics and out-of-class study, as well as 4) forms lasting friendships that span their entire undergraduate experience.

Discussion and Future Directions

Service learning is different than volunteerism or community service and it can be labor intensive for the course instructor. Therefore, institutions should provide training, and whenever possible, resources to equip faculty to incorporate service learning into their courses in a meaningful way. As mentioned, KSU has a Department of Student Leadership and Service that oversees service learning. The director of the department hosts workshops that describe how service learning is defined, discuss ways to incorporate it into courses, and introduce the resources and support, such as the community partner database, that KSU has in place to help. The fundamental requirements for a course to receive a service learning designation at KSU are reviewed [5]. For those institutions without a department devoted to the promotion of service learning, training by administrators or faculty is possible. Various resources are available that provide methods to engage, support, and sustain faculty in their service-learning work [12]-[14].

A key component preventing many of the courses within our college from receiving a service learning designation is that the reflection piece is missing or lacking. Incorporating effective reflection throughout service learning projects appears to be crucial in attaining important cognitive outcomes, such as improved cognitive moral development [15] and increased critical thinking performance [16]. While reflection was incorporated throughout the semester in the Industrial and Systems courses, it was superficial in the others and only followed the completion of the final project. Eyler has developed a reflection map that may be used in the future by professors to help ensure that the reflection is continuous, connected to the course content and the community experience, and is challenging [17].

While KSU's Department of Student Leadership and Service was helpful in identifying some of the partners for the Introduction to Industrial and Systems Engineering course, it was not critically important for the development of partnerships in all cases. Faculty teaching in the Introduction to Mechatronics Engineering and Introduction to Mechanical Engineering courses successfully identified local K-12 partners on their own through email communications. While forming these partnerships was relatively straightforward, institutions are reminded to keep in mind policies pertaining to minors on college campuses.

Moving forward our college hopes to have additional service learning designated courses that are not at the introductory level. Many of the senior design courses could receive a service learning designation provided reflection assignments are added, and the college is currently working to facilitate that. Teams in the courses already often work with an industry partner to design a solution to an industry-proposed question. Elective courses have also been identified that fall into this same category. Our Center for Excellence in Teaching and Learning is offering a paid Service Learning Course (re)Design Institute this summer and instructors of several of these elective courses have applied to participate.

Even if courses are not designated as service learning by the university, smaller experiences that do not last the majority of a semester are still valuable. For example, Attanayake found that the incorporation of a three-week service learning project into an introductory mathematics course had a measurable impact on students [20]. Construction management students who participated in 10-day service-learning class acknowledged a "responsibility to use their gifts to make the world a better place" after visiting Ecuador [21]. Our college is currently exploring opportunities to utilize guest speakers with knowledge of needs in the community to develop short-duration, service learning projects.

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