SPCEET Service Learning Faculty Learning Community
Executive Summary

Our 2019-2020 faculty learning council studied service-learning in engineering. Through a survey and conversation with faculty in the college we learned a that a few SPCEET courses incorporate various service-learning components, but most do not completely meet the QEP definition. Most, if not all, of these classes are orientation courses, capstone courses, and electives. In the academic literature most examples of service learning in engineering were also focused on orientation, elective, or capstone courses. We believe that the easiest way to increase SPCEET's QEP-level involvement in service-learning is to identify and work with faculty who are already doing something related to service-learning as it is defined in KSU's QEP proposal and help them achieve the required standards. In addition, we believe that incorporating service-learning as defined by the QEP into more of our orientation and capstone classes is an easy first step.

While few faculty completing the survey said that they have previously been teaching with service learning, 17 faculty who did not think they have previously taught with service-learning said they would be at least somewhat interested in doing so. This represents a significant opportunity for the college to engage more faculty in the high impact practice. There were a few examples in the academic literature of integrating service-learning into a broad array of engineering courses so that students can be exposed throughout the curriculum. We believe that supporting these types of smaller exposures – such as incorporating real world problems related to the greater community in a variety of courses - throughout the curriculum will allow for a scaffolding of learning that is believed to be beneficial to student engagement and should be encouraged.

Approximately two-thirds of the faculty responding to the survey had each of the following concerns: extra time and effort required, ability to find community partners/projects, and mapping service-learning activities to course learning outcomes. Given the extra workload required to teach courses with service learning, the FLC recommends that if the college truly wants to encourage its use, the college needs to be clear that service-learning "counts" for something in ARDs for faculty. Support should also be provided for as many of the logistics as possible for the faculty to lighten the administrative burden of teaching with service-learning.

Introduction:

A faculty learning council to study service-learning in engineering was formed for the 2019-2020 academic year. Committee members are Adam Kaplan, Adeel Khalid, Lori Lowder, Christina Scherrer, Roneisha Worthy, and Tom Yannuzzi (Executive Director of the Department of Student Leadership and Service) in an advisory capacity. The council's objective, simply stated, was to explore how to thread service learning throughout SPCEET students' educational experiences, from first-year seminars to capstone courses.

Current status of service learning in SPCEET:
The FLC began by investigating how service-learning was already being incorporated in the college. We found that a few courses incorporate various service-learning components, but most do not completely meet the QEP definition. Most, if not all, of these classes are orientation courses, capstone courses, and electives.

One course, the orientation course in industrial and systems engineering, included the all of the requirements for service-learning based on the QEP definition; including a signed MOU/agreement, specific connections to course learning objectives, and a reflection component following the service experience.

The FLC also assisted in bringing the mechatronics and mechanical engineering orientation courses closer to the QEP definition by adding a reflection component, a core requirement of the QEP definition, to the service activities. (A submitted ASEE conference publication on this topic was written by two members of the FLC with two other orientation faculty and is included in Appendix A.)

Finally, we found that several of the majors' capstone courses are using a form of service-learning, and could more easily be adapted to meet the QEP definitional requirements.

Survey and Results:
In January the FLC administered a survey to SPCEET faculty about service-learning. The purpose of the survey was to gather information about faculty's understanding of service-learning, their experience, if any, in teaching service-learning courses, thoughts about the benefits and challenges of service-learning, and interest in teaching service-learning courses at KSU. Twenty-seven surveys were completed (Full results are in Appendix B). All but one of the responses was from a full-time faculty member, representing a completion rate of 26.5% of the 98 full-time faculty (included limited-term) in the college. Most notable was that while only three of the faculty completing the survey said that they have previously been teaching with service learning, 9 (33%) said they were very interested and 11 (41%) said they were somewhat interested in teaching with service learning.

Primary concerns from faculty related to teaching a service-learning course were:

- Extra time and effort required (68% of faculty responding)
- Ability to find community partners/projects (68%)

- Mapping service-learning activities to course learning outcomes (64%)

Information from the literature and other universities:
Throughout the Fall, 2019 semester, the FLC gathered information from the academic literature on service-learning, with an emphasis on engineering programs (the full list is available in Appendix C). The literature supports our current practice in that most studies were about service learning in orientation, elective, or capstone courses; including the pioneering EPICS program from Purdue. However, there were a few exceptions, such as the SLICE model at the University of Massachusetts-Lowell which integrates service-learning into a broad array of engineering courses so that students can be exposed in at least one course every semester.

Georgia Tech is another example of a university that has service-learning integrated throughout their engineering curriculum, though only in a small percentage of their sections. We scheduled phone and in-person meetings with GT's Serve-Learn-Sustain (SLS). The SLS group coordinates service-learning initiatives that are related to the SLS mission of integrating sustainability throughout the curriculum. Accordingly, the definition of service-learning used is much less restrictive than the KSU QEP definition. They felt strongly that it is important not to put too many restrictions on supporting service-learning or that it will turn faculty away from being interested. SLS is also fortunate to have significant funding from their QEP to pay for service-learning and curriculum enhancement work. As a result, they are able to pay faculty to develop courses, GTAs to lead classes, and community partners to participate. SLS documents are open source and they are willing to share any documents and tools to assist KSU's faculty. However, we must make sure the any documents or tools used are consistent with KSU's environment, culture, and approach.

FLC Suggestions for increasing implementation of service-learning in SPCEET:
According to the survey results, 17 faculty who have not previously taught with service-learning are at least somewhat interested in doing so, which suggests a very positive potential for involving more faculty in service-learning throughout the college. In light of this finding, the FLC has the following recommendations.

1. We believe that the easiest way to increase SPCEET's QEP-level involvement in service-learning is to identify and work with faculty who are already doing something related to service-learning as it is defined in KSU's QEP proposal. The focus should be on bringing these faculty up to the required standards, perhaps by pairing them with a knowledgeable faculty member, consulting with service-learning support through the Department of Student Leadership and Service, or through CETL workshops. In addition, we believe that incorporating service-learning as defined by the QEP into more of our orientation and capstone classes is an easy first step.

2. However, we believe the QEP definition restricts a lot of what has been proven as an engaging teaching method and we hope that the college will support and encourage service learning even if it doesn't meet the QEP standard, such as courses where the service learning component is a less significant part of the class. There are examples in

the literature of incorporating real world problems, and specifically real world problems related to the greater community, in courses as diverse as thermodynamics, manufacturing and wastewater treatment. Yet the specific content necessary for mastery of those engineering topics precludes service learning as a significant enough component of the course to meet the QEP definition the way our engineering curriculums are currently set up. Exposure to lesser levels of service learning incorporated throughout the curriculum will allow for a scaffolding of learning that is believed to be beneficial to student engagement and should be encouraged.

3. Given the extra workload required to teach courses with service learning, the FLC recommends that if the college truly wants to encourage its use, the college needs to be clear that service-learning "counts" for something in ARDs for faculty. With many demands on faculty's time, especially new demands on research and publishing, the value of spending the additional time required for developing and teaching service-learning courses needs to be clear. Support should also be provided for as many of the logistics as possible for the faculty to lighten the administrative burden of teaching with service-learning. This includes the mechanics of the MOUs with community partners, logistics of transportation for the students, as well as identifying and vetting community partners. Some of this support is in place, but not currently being used by faculty. More awareness of and access to this support is needed. Finally, in addition to recognizing faculty involved in this work, the college should recognize students who participate in a certain number of service-learning designated classes to further increase their engagement with these courses. The college should also support (at the college or university level) a service-learning symposium that showcases the service-learning work being completed by our engineering students.

Appendix:

A. ASEE submitted conference proceeding
B. SPCEET faculty survey results
C. Literature review summary

Appendix A: ASEE Conference Proceeding

Engagement in Practice: Establishing a Culture of Service Learning in Engineering Orientation Courses at Kennesaw State University

Authors: Lori Lowder, Christina Scherrer, Kevin McFall, David Veazie

Engagement in Practice: Establishing a Culture of Service Learning in Engineering Orientation Classes at Kennesaw State University

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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Service-learning FLC Survey results from faculty spring 2020

27 usable responses (24 with IRB consent/publishable)

This survey was conducted with faculty in the College of Engineering during spring semester 2020 to obtain information about faculty perceptions of service learning.

Demographics

Time at KSU:

Less than 3 years = 4
3-6 years = 8
7-12 years = 3
>12 years = 12

Faculty Category:

21 tenured/tenure-track
5 full time, not tenure track
1 part time

Experience teaching service-learning:

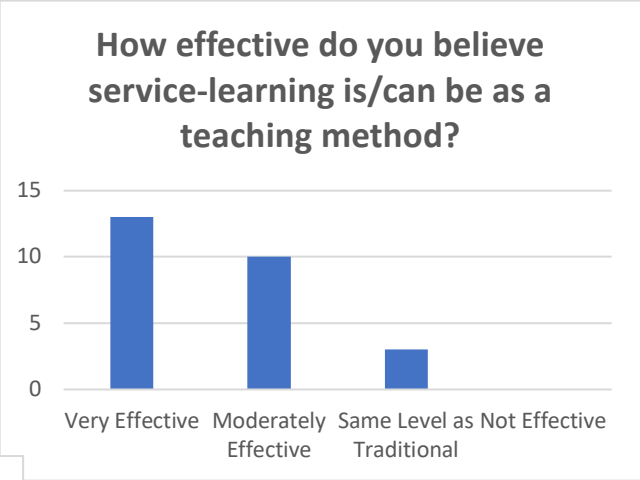
Never = 21
Not sure = 3
At least 1 = 2
Frequently = 1

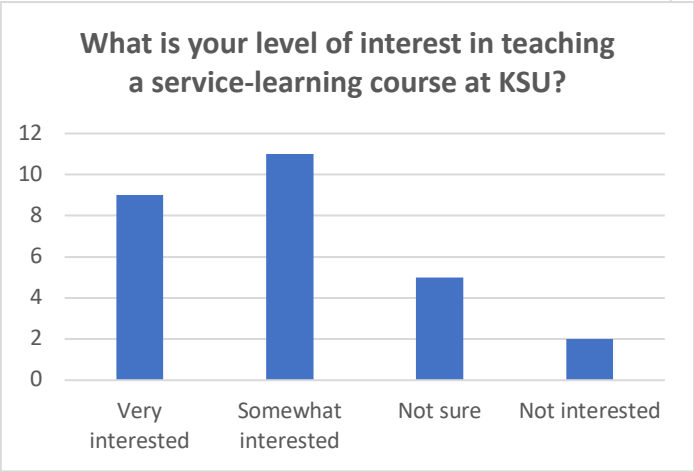
Department:

ME=10
SIE=4
CE=3
MTRE=2
ET=2
CompE=2
EE=1
Other=2

How effective do you believe service-learning is/can be as a teaching method?

Very effective = 13 (50%)
Moderately effective = 10 (39%)
Same level as traditional = 3 (11%)
Not effective = 0 (0%)





What is your level of interest in teaching a service-learning course at KSU?

Very interested = 9 (33%)*
Somewhat interested = 11 (41%)*
Not sure = 5 (19%)
Not interested = 2 (7%)

This represents 17 faculty who do not think they have previously taught with S-L who would be at least somewhat interested in doing so.

"What do you perceive to be the benefits of offering service-learning courses?"

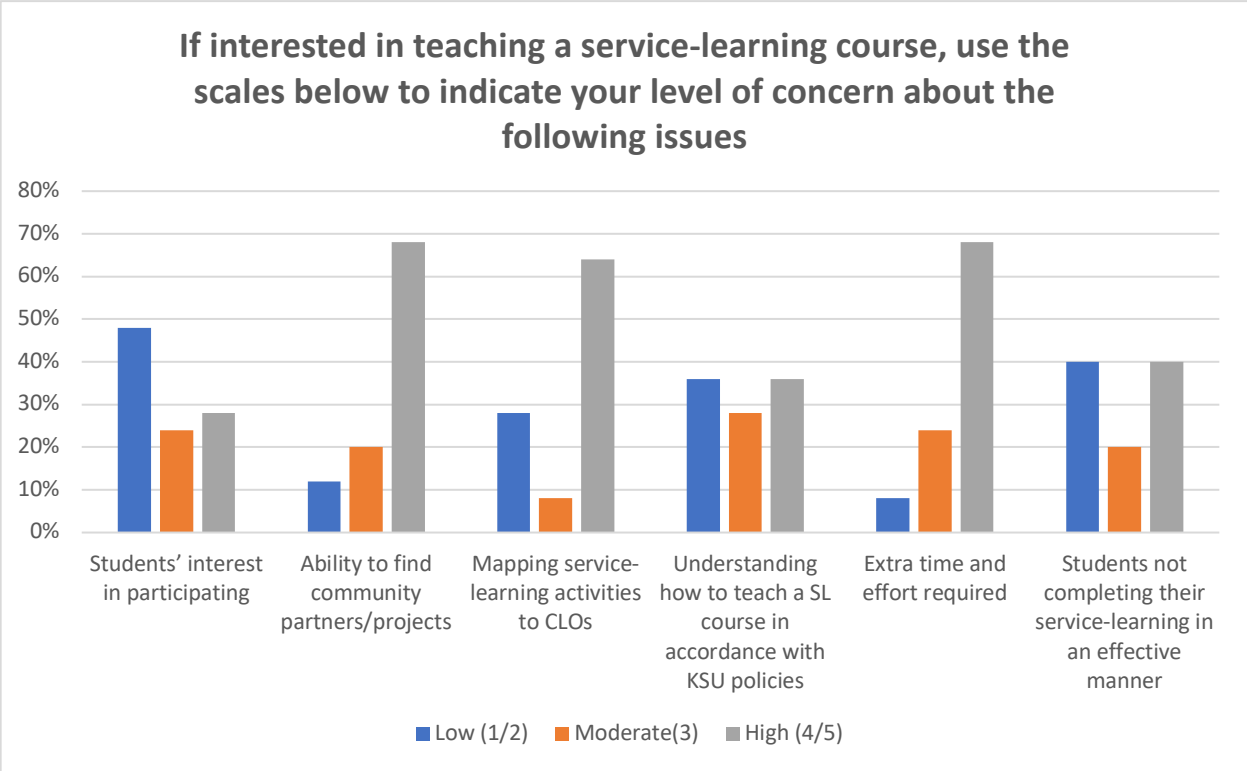
- Students have a focused example that I can tie back to. When students have a project goal, with no knowledge of how to complete it yet, students stay more engaged.
- Student engagement with course material in a realistic setting can improve interest and enthusiasm for material.
- Students grasping the big picture and understanding why their course material is important/relevant. Being better prepared for the workforce.
- It will connect transportation engineering students with real world.
- Could help students with broader perspective on their lives and careers.
- Real world experience that gives meaning to what is being taught for students.
- experience and visual achievement
- It will increase the learning outcomes of students.
- At minimum I could learn and participate.
- Hands-on application that enables more intuitive learning. Satisfaction from making an impact.
- "Connecting students with the community they live in provides them with a better understanding of the community and how they, as individuals, can meaningfully contribute and make a difference. If this type of learning is done well, it can be very impactful. The key, as always with this type of program, will be how well it is implemented. Past experience has shown that most initiatives like this begin with great enthusiasm and potential. Driven by a few dedicated implementers who bring passion and purpose to the effort. Typically these efforts have institutional support as long as they do not require significant resources and are driven primarily by faculty volunteering extra time end energy. Hopefully when it comes time for the university to step up and properly support the program with real money and non-volunteer time, it won't go the way of so many other programs in the past. True commitment is never measured in words but in the actual resources (real resources) that are invested."
- Hands-on experience associated to it will be the benefit, but many of learned methods in our courses will be difficult to implement in one semester and need more time than a part time student time. Also, it will reduce our available time to teach methods in one course.
- Without seeing some examples, I cannot comment definitively on benefits. Perhaps a project-type course involving and benefitting members of a community would work, but it might not have much technical rigor and I see that as a detriment. A project that was done in cooperation with a company that interacted with a community group might be designed to be more rigorous. Developing relationships with outside entities is a way to increase visibility and possibly lead to such research projects.
- Service-learning enables the student to apply the course concepts in a real-world situation while they are still current in their minds. When students wait too long to try to use what they learned in school, they often forget much of what they were taught. Also, it's difficult to truly understand concepts without being able to use them, and service-learning enables me to assess how well they understand the course materials. It also shows me areas where I can improve how I teach.
- Students who want to become best prepared for successful careers in engineering must obtain and develop good problem solving skills. There is a gigantic difference in learning outcomes between successfully copying a solution, and from figuring out a potentially successful outcome. The latter process, combined with real-life scenarios, can help develop especially useful problem solving skills, making our students best prepared for "the real world."
- These courses can provide tangible applications of learning that apply to the real world, while also having the potential to connect students to members of our community that they may not

otherwise have the chance to get to know. Further, they can create excellent opportunities for experiences or accomplishments that are resume worthy and may help students have specific experience to talk about in job interviews etc.

- Student engagement and learning, plus community outreach

"If interested in teaching a service-learning course, use the scales below to indicate your level of concern about the following issues (score of 1-5):"

Concern Level	Low (1/2)	Moderate(3)	High (4/5)
Students' interest in participating	48%	24%	28%
Ability to find community partners/projects	12%	20%	68%
Mapping service-learning activities to CLOs	28%	8%	64%
Understanding how to teach a SL course in accordance with KSU policies	36%	28%	36%
Extra time and effort required	8%	24%	68%
Students not completing their service-learning in an effective manner	40%	20%	40%



"if you have any other concerns about teaching a service-learning course please describe them below."

- I think this is something students have been asking for.
- The liability associated with engineering projects is a major concern. Engineering is typically an apprentice type industry so that even recent graduates cannot complete projects without major input and guidance from a senior engineer.
- It is a lot of effort to make a course service learning and there is little or no incentive, other than altruistic, for a faculty member to pursue it.

- I think it should be 4 cr hrs course because of its tough nature
- service learning activities should be spread in two or three semester if we want to have a better outcome. The best approach is starting it via summer internships and continuum of it with courses through fall and spring and next summer. One semester, one course makes it very difficult to manage.
- It does take time to find good projects that are not too overwhelming and not too easy - projects that have "local" relevance, and projects that are perceived as opportunities to solve serious problems. It also takes extra time to craft excellent lesson plans so the goals and objectives of the class are maintained while performing service-learning activities. It would be great to introduce the SL concept to those in our Industry Advisory Committee, to let them know we are looking at them as partners while the benefits could involve enriched student learning outcomes while potentially help in solving real-world solutions.

"Please share any other comments you believe helpful in the college's ability to incorporate service-learning in its curriculum."

- Partners that can supply "lab equipment" would be excellent. For example we needs a partner that can purchase the equipments for the students (to keep!)
- Grading and meeting learning outcomes is extremely important to accreditation.
- I try to provide the research skills to my DS students which they learn in classes. I would say, start this as a pilot project and implement it inside the campus.
- Possibly train faculty about it. Then the faculty can be the driver.
- Perhaps schedule a meeting whereby faculty who have successfully used service-learning could share what/how they used it with other faculty.
- Need to create some good examples and success stories of service-learning within SPCEET to inspire other faculty to embrace it.
- design one credit hours internship, engage students from summer before their graduation, continue with courses above during last year, see better results in Senior design project.
- I envision the ""ultimate learning experience"" involving four major components (in no specific order of importance):
  1 - Heutagogical learning strategies (involves, among several other things, giving students the choice to select among instructor-approved projects)
  2 - Accomplishing the goals & objectives of the course
  3 - Implementing service-learning projects in at least some of the learning activities
  4 - Using experiential learning opportunities (which often have major overlap with SL activities)

Service Learning Literature for FLC:

The following resources were useful for our FLC as we studied service learning in engineering. We have split the resources into the following subcategories:

- Books
- Integrated/throughout curriculum
- Impact on recruitment/retention/progression
- Introductory engineering classes
- Capstone engineering classes
- General or not specific to engineering

BOOKS:

Oakes, W. (2004). Service-learning in engineering: A resource guidebook. Boston: Campus Compact.[had a list of 33 universities that had S-L in engineering and described a number of examples of S-L.]

- Highlights EPICS and Engineers Without Borders
- Notes that engineering lags other fields in using S-L

- Guidebook was developed for leading workshops to teach about S-L in engineering
- Lists many benefits of S-L for all stakeholders (page 16)
- Lists 33 colleges of engineering they say are using S-L (page 19) followed by some of the courses they have used S-L in.
- Walks through steps to take to begin S-L

INTEGRATED/THROUGHOUT CURRICULUM:

1. Lord, S. M.; Tsang, E., and Duffy, J. (2000). *Service Learning In Engineering: What, Why, And How?* Paper presented at 2000 Annual ASEE Conference, St. Louis, Missouri. Available at https://peer.asee.org/8694

- This one is more of an explanation of what S-L is.
- "The challenge in implementation is maintaining subject matter content in courses while meeting real community needs."
- A survey was distributed to 350 Deans of engineering colleges throughout the US to discover how widespread service learning and community-based projects are in engineering. Received 52 responses. 61 S-L courses reported; mostly senior and 1st year courses. Page 5 of the article gave some examples.

2. Duffy, John, Linda Barrington, Cheryl West, Manuel Heredia, and Carol Barry. "Service-learning integrated throughout a college of engineering (SLICE)." *Advances in Engineering Education* 2, no. 4 (2011): n4.

- Talks about implementation of S-L throughout the various engineering curriculum at UMass with a lot of survey data on perceptions of faculty and students.

- "Of the 32 required courses in the academic year that had an average of 753 students each semester doing S-L projects related to the subject matter of the course…60% were …not explicitly design or first-year introduction courses. More than fifty courses having S-L components have been offered under the program. Over two-thirds of the students and faculty members expressed agreement with the basic idea of SLICE, with about 15% opposed. Twenty-three percent of entering students cite S-L as one of the reasons for enrolling in engineering at UML, and more than two-thirds of the students reported that S-L helped keep them in engineering."
- NOTE: Duffy et al have several conference papers with more details of what the school is doing.

3. Duffy, J., Moeller, W., Kazmer, D., Crespo, V., Barrington, L., Barry, C., West, C. 2008. "Service-learning projects in core undergraduate engineering courses." *International Journal for Service Learning in Engineering* 3 (2): 18-41.

- This paper gives some more detailed examples of SLICE through the curriculum.

4. Jawaharlal, Mariappan, Uei-Jiun Fan, and Saeed Monemi. "Implementing service-learning in engineering curriculum." In *Proceedings of the ASEE Annual Conference and Exposition*, no. 2614. 2006.

- Somewhat vague/light: talks about how to make partnerships, gives some examples, mentions some strategies. No data.

5. Dewoolkar, M. M., George, L. A., Hayden, N. J., & Rizzo, D. M. (2009). Vertical integration of service-learning into civil and environmental engineering curricula. International Journal of Engineering Education, 56 (6), 1257–1269.

- 200 students in the major
- Required Courses: Intro, Geomatics, Environmental&Transport systems, Water&wastewater engineering, Modeling Environmental&Transport systems, Capstone, And then also 2 electives. They explain how used in the intro, capstone, elective, but not much detail for the others.

- Discussed reflection and assessment
- Many survey results presented, including "Between 76% and 100% of the students thought the projects enhanced their learning experience and they could relate the course material to real world situations."
- Mentioned need for faculty and administrative (resource) support.
- Noted sophomore and junior year integration hardest.

6. E. J. Coyle, L. H. Jamieson and W. C. Oakes, EPICS: Engineering Projects in Community Service, Int. J. Eng. Educ. 21(1), (2005), pp. 139±150.

- Multidisciplinary, integrated across grade levels, and students participate for up to 7 semesters. Teams of 8-20. Started in 1995. Students can use credit toward technical elective and capstone.

7. X. Zhang, N. Gartner, O. Gunes and J. M. Ting, Integrating service-learning projects into civil engineering courses, Int. J. Service Learning in Eng. 2(1), (2007), pp. 44±66. ISSN 1555-9033
   - Two core (intro and transportation engineering) and one elective (design of masonry structures)
   - For the intro class, at the end of the semester teams visited and redesigned a parking lot, maximizing the number of spaces and allocating a bike trail.
   - For transportation engineering 2 labs were combined to assess and optimize a traffic signal
   - Noted the only real difficult part is fitting the site visit in

8. Murat Tiryakioğlu, Tara E. Maxwell, Christopher P. Bird, Bryan W. Dempsey, James A. Harbodin II, Justin R. Laughner, Timothy A. Skelton, Michael Wood, Arif Şirinterlikçi, Sushil Acharya. Integration of Service Learning into a Manufacturing Engineering Course: A Case Study (2009) International Journal of Service Learning in Engineering. https://ojs.library.queensu.ca/index.php/ijsle/article/view/2226

   - The implementation of a service learning project into a manufacturing engineering course at Robert Morris University is discussed within this paper. The project has entailed the analysis of the production system of a local company utilizing several tools available in the literature, as well as recommendations for improvement.

IMPACT ON RECRUITMENT/RETENTION/PROGRESSION

1. Zarske, Malinda Schaefer. (2012). Impacts of Project-Based Service-Learning on Attitudes towards Engineering in High School and First-Year Undergraduate Students. Dissertation.

   - University of Colorado. "examines the evolving identity and attitudes towards community service for both high school and first-year engineering students engaged in project-based design, and whether a service-learning context influences these changing attitudes".
   - There is a lot of information in here (and a large lit review) on retention and progression in engineering.

2. Bucks, G.W. & Ossman, K.A. & Bailey, T.J. & Folger, L.A. & Schwind, R & Notorgiacomo, G.A. & Wells, J.D.. (2015). Engineering your community: Experiences of students in a service-learning engineering design course. ASEE Annual Conference and Exposition, Conference Proceedings. 122.

   - Vertically integrated and multidisciplinary like EIPCS, but one semester
   - Not really data-driven; more reflection – intended to help with retention but that wasn't measured

INTRODUCTORY ENGINEERING CLASSES:

1. E. Tsang, J. van Haneghan, B Johnson, E J Newman and S Van Eck, A report on service-learning and engineering design: service-learning's effect on students learning engineering design in

`Introduction to Mechanical Engineering', Int. J. Eng. Educ. 17(1), (2001), pp. 30±39.

- U of S. Alabama: Freshman helping with middle school STEM education. Students do a design project to design some sort of demonstration that middle school students can do in a science lab.

2. Kalamas Hedden, M.; Worthy, R.; Akins, E.; Slinger-Friedman, V.; Paul, R.C. Teaching Sustainability Using an Active Learning Constructivist Approach: Discipline-Specific Case Studies in Higher Education. *Sustainability* **2017**, *9*, 1320. https://www.mdpi.com/2071-1050/9/8/1320

- In this paper we present our rationale for using an active learning constructivist approach to teach sustainability-related topics in a higher education. To push the boundaries of ecological literacy, we also develop a theoretical model for sustainability knowledge co-creation. Drawing on the experiences of faculty at a major Southeastern University in the United States, we present case studies in architecture, engineering, geography, and marketing. Four Sustainability Faculty Fellows describe their discipline-specific case studies, all of which are project-based learning experiences, and include details regarding teaching and assessment. Easily replicated in other educational contexts, these case studies contribute to the advancement of sustainability education.

CAPSTONE ENGINEERING CLASSES:

1. Dinehart, David W., and Shawn P. Gross. "A service learning structural engineering capstone course and the assessment of technical and non-technical objectives." *Advances in Engineering Education* 2, no. 1 (2010): n1.

- Villanova University structural capstone course that incorporates an international service project/trip.

- Students participating on the service trip achieve significantly higher non-technical outcomes compared to those students that work solely on the design project.

2. Bielefeldt, Angela R., Mandar M. Dewoolkar, Kevin M. Caves, Bruce W. Berdanier, and Kurtin G. Paterson. "Diverse models for incorporating service projects into engineering capstone design courses." *International Journal of Engineering Education* 27, no. 6 (2011): 1206.

- General information about how well service learning works in capstone. Duke, MichTech, South Dakota SU, University of Colorado

3. Rhee, Jinny, Clifton M. Oyamot, Leslie Speer, David W. Parent, Anuradha Basu, and Larry N. Gerston. "A Case Study of a Co-Instructed Multidisciplinary Senior Capstone Project in Sustainability." Advances in Engineering Education 4, no. 2 (2014).

- San Jose State U with students and faculty from electrical and mechanical engineering, business, political science, and industrial design

4. G. D. Catalano, P. Wray and S. Cornelio, Compassion practicum: a capstone design experience at the United Sates Military Academy, J. Eng. Educ. 89(4), (2000), pp. 471±477.

- One specific design team that worked on a project for someone with cerebral palsy

5. G. Padmanabhan and D. Katti, Using community-based projects in civil engineering capstone courses, J. Professional Issues in Eng. Educ.and Practice, 128(1), (2002), pp. 12±18.

- North Dakota State University

6. Lundy, M., A. Rodriguez, and J. Aceros. (2018). Engineering, Physical Therapy and the Community: A Service Learning Course. Paper presented at 40th Annual International Conference of the IEEE Engineering in Medicine and Biology Society.

- School of Engineering at the University of North Florida partners undergraduate engineering students with physical therapy students in design projects for rehabilitation technology for children with disabilities

7. Hey, David W., Lynne A. Slivovsky, Brian P. Self, James Widmann, and J. Kevin Taylor. 2014. "Learning Design through the Lens of Service: A Qualitative Study." *International Journal for Service Learning in Engineering, Humanitarian Engineering and Social Entrepreneurship* 9 (1): 1–23. https://doi.org/10.24908/ijsle.v9i1.5257.

- projects involved the design of equipment to facilitate physical activity for people with disabilities
- Students completing these projects were shown to appreciate user-centered design, exhibit greater motivation when able to meet and develop a relationship with their client in person, discuss altruistic factors regarding their capstone experience, and were able to develop strong multidisciplinary skills.

8. Onal, Sinan, Joel Nadler, and Megan O'Loughlin. 2017. "Applying Theory to Real-World Problems: Integrating Service-Learning into the Industrial Engineering Capstone Design Course." *International Journal for Service Learning in Engineering, Humanitarian Engineering and Social Entrepreneurship* 12 (2): 57–80. https://doi.org/10.24908/ijsle.v12i2.6659.

- The deliverables for this project include (1) a detailed report describing the design, analysis, performance, and alternative approaches, (2) the physical prototype developed by the team, and (3) a network of experienced young professionals who can be recruited as employees for local community organizations.
- A pre-test and post-test were administered at the beginning and end of the semester to assess learning over time.

GENERAL OR NOT SPECIFIC TO ENGINEERING

1. Eyler, J., Giles, D.E., Stenson, C.M., & Gray, C.J. (2000). At a glance: What we know about the effects of service-learning on college students, faculty, institutions, and communities, 1993-2000. (3rd Ed.). Nashville, TN: Project funded by the Corporation for National Service and Learn and Serve America National Service Learning Clearinghouse. Available at. https://kdp0l43vw6z2dlw631ififc5-wpengine.netdna-ssl.com/wp-content/uploads/resources/downloads/aag.pdf

- 120 page literature review of S-L. Not many engineering specifics. Split by category so you can review references in that category.

2. Prentice, M., and Robinson, G. (2010). Improving Student Learning Outcomes with Service Learning. Washington, DC: American Association of Community Colleges.

- A few different community colleges that each chose their own course to measure
- survey validated that service learning was a positive part of learning and engagement.

3. Bringle, Robert & Julie A. Hatcher (2000). Institutionalization of Service Learning in Higher Education, The Journal of Higher Education, 71:3, 273-290, DOI: 10.1080/00221546.2000.11780823

- Discusses how to make S-L part of the institutional culture; more from the administrative side

4. Astin, Alexander W, Lori J. Vogelgesand, Elaine J. Ikeda, & Jennifer A. Lee. (2000). How Service Learning Affects Students. Higher Education Research Institute, University of California, Los Angeles.

- service projects within an academic course had many benefits, especially in writing skills.
- service-learning aspect increased a student's interest in the field.
- quantitative and qualitative results confirming that providing students with the opportunity to reflect and process their service-learning experience was crucial in proportion to the outcome.

5. Honnet, E.P. and Poulsen, S.J. (1989). Principles of Good Practice of Combining Service and Learning. A Wingspread Special Report, Johnson Foundation, Racine, WI. Available at: https://www.coastal.edu/media/academics/servicelearning/documents/Principles%20of%20Good%20Practice%20for%20Combining%20Service%20and%20Learning.pdf.

- Good explanation of some best-practices for S-L

6. Harkins, Debra A.(n.d.). Service Learning: A Case Study of Student Outcomes." Suffolk University.

- the researchers speak on the importance of "utilizing effective, ongoing critical reflection
- study also speaks to the civic benefits of service-learning.

7. Kezar, Adrianna, and Robert A. Rhoads. 2001. "The Dynamic Tensions of Service Learning in Higher Education: A Philosophical Perspective." *The Journal of Higher Education* 72 (2): 148-171.

- Debates whether or not service learning should be an in-class activity or one organized by a group created to enhance student involvement, like campus outreach and community involvement clubs
- Notes service-learning is an important aspect of education, especially the specialized nature of higher education, and that it will be affective in distinguishing between cognitive and curricular learning.

8. Lundy, B.L. 2007. "Service learning in life-span developmental psychology: Higher exam scores and increased empathy." Teaching of Psychology 34 (1): 23-27.

- showed that students who participated in a service-learning project had consistently higher exam scores than those who participated in an interview or research project

9. Smith, J., Turner, J., Compston, P., "Impact of Humanitarian Engineering Education Pathway on Student Learning and Graduate Outcomes," International Journal for Service Learning in Engineering, Humanitarian Engineering and Social Entrepreneurship, Vol. 14, No. 1, pp. 1-20, Spring 2019, ISSN 1555-9033

- In this paper, the authors describe the engineering curriculum where humanitarian / service learning is part of the curriculum throughout the engineering degree program. They discuss the data collected from students participating in this program and how they benefited in their education and careers. They also list the engagement outcomes including the skills learned, employability, motivation etc.

10. Knakiewicz, B., "A methodology for civil engineering technology senior capstone projects with public, private, and federal agency collaboration to assist underserved communities." ASEE 2017,

- In this paper, the author discusses the collaboration between civil engineering students and the US Environmental Protection Agency (EPA) and other organizations to address economic hardship in rural Georgia. As part of the senior design project, students design office layouts and present them to the city leadership
- The author discusses the student benefits, faculty benefit and the community benefits.
- Step by step project methodology is described
- Several accolades including those from the Mayor were received