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Amplifying the impact of leadership development for first-year engineering students through community-engaged team projects: a work in progress

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Amplifying the impact of leadership development for first-year engineering students through community-engaged team projects: a work in progress

Abstract:

This work-in-progress paper presents a semester-long first-year engineering leadership course, in which students participate in interactive seminars and apply their learnings through a community-engaged team project. Working in cross-disciplinary teams, students develop STEM lessons for a K-12 audience under the guidance of pre-service teachers. These projects allow students to actively contribute to the local community while improving teamwork and leadership skills. Additionally, the instructor provides mentorship, offering resources and opportunities for leadership development beyond the classroom.

The leadership course is part of the Grainger First-Year Experience (GFX) program at the University of Illinois Urbana-Champaign, designed to provide a small-cohort experience for first-year engineering students. Participants are selected through an application process, in which they identify a topic for further development. Most students enrolled in the course have prior leadership experience, having served as team leaders in various high school activities. The course focuses on leadership development through weekly interactive seminars, with guest speakers from different campus units sharing their areas of expertise. To apply their learning, students form cross-disciplinary teams so that they are working with peers from various engineering majors. Each team, mentored by a pre-service teacher, develops an interactive K-12 STEM lesson, concluding in a lesson delivery and final presentation at the end of the semester.

Preliminary findings reveal that students were more enthusiastic about their team projects compared to the earlier seminars and reflections, despite the additional time commitment needed outside of class. They highly valued the opportunity to engage with the local community and had a deeper appreciation for the effort put in by their instructors after going through the process of creating and delivering a lesson themselves.

This course can serve as a practical template for universities looking to develop or pilot leadership programs for first-year engineering students, particularly those with limited resources. The course's structure demonstrates how to effectively foster leadership skills and community engagement without requiring extensive resources.

Introduction

More than 15 years ago, The Grainger College of Engineering at the University of Illinois Urbana-Champaign launched a first-year experience program for incoming freshmen, designed to provide transformative learning experiences in small cohorts. Course topics varied annually based on faculty and staff availability. Past offerings included engineering grand challenges, such as urban infrastructure and secure cyberspace. Leadership courses, taught by various faculty and staff groups, ranged from applying leadership skills in student organizations to leveraging them for academic success.

The current iteration of the course was taught by the same instructor in both the 2023-2024 and 2024-2025 academic years. Incoming freshmen interested in the course submitted an application during the summer, including essay responses on their motivations for participation and prior leadership experience in high school. The Grainger First-Year Experience (GFX) program reviewed these applications and made the final decisions on enrollment. 11 students completed the course in AY 2023-2024, and 23 completed it in AY 2024-2025.

Leadership Development Offerings for First-Year Engineering Students

Iowa State University (ISU)

Engineering freshmen at ISU participate in a structured leadership program [1, 2] that begins with an off-campus community-building retreat during the first week of classes. During the first semester, they take a weekly seminar course taught by upper-class scholars and meet with course instructors or TAs twice a month to discuss development goals. They also attend monthly networking events to build connections within the engineering community. In the second semester, students complete a service-learning team project of their choice, following a Six Sigma process to apply problem-solving and leadership skills.

Brigham Young University (BYU)

BYU follows a structured four-year leadership development cycle consisting of engagement, learning, practice, and application [3]. In their freshman year, students take a leadership seminar, which meets three times per semester, and are encouraged to participate in extracurricular activities. Sophomores take Foundations of Global Leadership, a course which includes an experiential leadership lab focused on teamwork and collaboration. During their junior year, students apply leadership concepts in hands-on projects and team-based environments. Finally, in their senior year, they take on leadership roles in professional or research settings, integrating their skills into their future careers.

Louisiana State University (LSU)

LSU provides engineering peer mentor leadership training for second-semester freshmen and beyond [4]. Mentors must complete 12 hours of training annually and take on responsibilities such as serving as course assistants, working with K-12 robotics teams, leading K-12 outreach activities, and mentoring incoming freshmen. This program helps students develop leadership and communication skills while fostering a supportive academic community.

University of Southern Mississippi (USM)

USM offers a four-year leadership development program funded by scholarships [5]. Students are required to take a three-credit-hour course in the fall of their freshman year and complete 10 hours of community service per semester throughout all four years. Through service-learning participation, students reported increased awareness and understanding of others, stronger connections with peers and community members, and the ability to apply academic knowledge in real-world settings. Additionally, students gained practical experience in their fields of study and explored potential career paths. Many participants also expressed significant personal growth as leaders.

Rose-Hulman Institute of Technology

At Rose-Hulman, leadership principles from The Seven Habits of Highly Effective People are incorporated into a freshman civil engineering design course [6]. Students work in teams, interact with clients, and produce a final report in the form of a feasibility study and preliminary design. This experience enhances their teamwork, leadership, and problem-solving skills while simulating real-world engineering challenges.

University of California, Berkeley

At Berkeley, leadership development and service learning are integrated into Engineering Design and Analysis, a first-year survey course [7]. The first four weeks provide an overview of the engineering profession, while the remaining 10 weeks follow a "choose-your-own-adventure" format. One leadership module, Teaching as a Profession, is offered in collaboration with a local science museum. This module covers leadership development, diversity and teamwork, and K-12 outreach. Students work in teams to either revise an existing museum exhibit or design a new one. Through interactions with K-12 learners, they conduct user needs research and implement facilitation strategies and design challenges. Survey results indicate that students who completed this leadership module experienced a significant increase in confidence in their engineering and leadership skills compared to those who chose other modules.

Structure of the Course

The semester-long course carries one-credit hour, and the class meets once a week for 50 minutes. The first half features interactive seminars and workshops led by guest speakers on

various topics. For example, an assistant director of career services presented a session on professionalism and professional communication, while a U.S. Army Lieutenant Colonel facilitated a hands-on workshop on applying inclusive leadership practices taught in Army ROTC (Reserve Officer Training Corps) leadership courses. Encouraged by the instructor, guest speakers also highlighted leadership development opportunities for students to explore beyond the course. In the second half, students first learn the fundamentals of teaching pedagogy before collaborating in teams, under the guidance of a pre-service teacher, to design and deliver an interactive K-12 STEM lesson. The schedule for this first-year engineering leadership course is shown in Table 1. Student learning is assessed through reflective assignments after each seminar, in which they identify a key takeaway and explain how they plan to apply it in their daily lives and in the future as engineers. During the team project phase, each team is required to submit a set of deliverables, including a project proposal, progress report, lesson plan, project reflection, and final presentation slides.

Week	Topic
1	Course Introduction: Opportunities and Challenges of Leadership Development
2	Professionalism and Professional Communications
3	Cultural Competence
4	CliftonStrengths
5	Inclusive Leadership Practices
6	Engineering and Public Policy
7	Technical Communication with the General Public
8	Bloom’s Taxonomy and Active Learning Techniques
9	Universal Design for Learning
10	In-class Lesson Planning with Pre-service Teacher
11	In-class Lesson Planning with Pre-service Teacher
12	In-class Lesson Planning with Pre-service Teacher
13	In-class Lesson Planning with Pre-service Teacher
14	Project Delivery
15	Final Presentation

Table 1: schedule of the semester-long first-year engineering leadership course

Drawing from experience teaching a leadership course for graduate students, the instructor carefully selected topics that would be most beneficial for first-year students. For example, since the campus leadership center offers free CliftonStrengths assessments and follow-up workshops tailored for undergraduate students, this topic was incorporated into the course. Research studies have consistently shown that incorporating a strengths-based interventions in first-year seminar courses can enhance students' self-confidence, increase their awareness of personal strengths, and improve their ability to apply these strengths in academic and other settings [8, 9, 10, 11, 12, 13]. Nonetheless, one potential drawback is that students may become overly fixated on their existing strengths, leading to a fixed mindset and a performance-oriented approach rather than a growth mindset [14].

Furthermore, the instructor serves as a mentor, providing support such as resume critiques before career fairs and connecting students with additional opportunities, including networking events with alumni and corporate sponsors.

Community-Engaged Component & Student Reflection

The community-engaged team project was introduced on the first day of class to ensure students were aware of this unique component, which is not commonly found in other courses. Throughout the first half of the semester, the project was referenced whenever relevant to the weekly topics.

In Week 8, students formed teams under the following guidelines: (1) each team must have 3 to 4 members, and (2) no more than two members could be from the same major. Teams had one week to agree on a topic and then used a template provided in Week 9's Universal Design for Learning session to draft a project proposal, laying out the lesson and learning objectives.

Once teams were established, they could choose between presenting their lesson either at an on-campus outreach event during class time or at a local school on Week 14. The instructor partnered with a colleague to organize the on-campus event, which hosted local homeschooled children. However, teams without scheduling conflicts opted to teach at the local school, where the instructor coordinated with a teacher such that each team would present to all children of the same grade level.

Over four in-class lesson planning sessions, teams developed their lesson plans, which include a materials list, alignments with Next Generation Science Standards (NGSS), scaffolding activities, and assessments. Each team received frequent feedback from an assigned pre-service teacher to ensure their lesson was age appropriate. The instructor also checked in with the teams every week to monitor their progress. By Week 12, students submitted individual progress reports summarizing their contributions as well as challenges encountered and overcome. Before delivering their lesson, teams submitted their finalized lesson plans.

Prior to the final class session, students submitted individual reflections, and teams submitted their final project presentations. During the last class, each team gave a five-minute presentation summarizing their lesson, challenges faced, and reflections on the project experience.

Both individual and team reflections highlighted communication and teamwork as key takeaways. Overall, students valued collaborating across different majors and took pride in completing a project together. Many preferred the team project over weekly seminars and reflective assignments, and they truly valued the opportunity to engage with local children and contribute to the community. Several students also noted that designing and teaching a lesson made them appreciate the effort their instructors put into teaching.

Lessons Learned

Integrating a community-engaged team project into a first-year seminar course can have a profound impact on students. One described it as the coolest thing they had done since starting college, while another was inspired to consider switching their major to education after discovering a passion for teaching.

Careful planning is key for a smooth and rewarding team project experience. The process begins with selecting a class time that can be transformed into an outreach event at the end of the semester. Establishing a partnership with a local school for lesson delivery and recruiting pre-service teachers requires time and coordination. Additionally, a modest budget of approximately $150 per team is necessary to cover project materials, transportation costs, and hourly wages for pre-service teachers.

To build confidence in their teaching and ensure everything works as designed, each team should rehearse their lesson with the assigned pre-service teacher. Based on written reflections, students who delivered lessons in a local school engaged more deeply with the experience compared to those who participated in an on-campus outreach event.

Conclusion

This paper presents a semester-long leadership development course for first-year engineering students. A community-engaged team project is integrated into the curriculum, allowing students to collaborate in cross-disciplinary teams and apply the skills they learn in interactive seminars and workshops. Student reflections highlighted the project as a unique course experience for developing their teamwork and communication skills. Requiring minimal resources, this course effectively combines classroom instruction with hands-on practicum, providing a meaningful and impactful learning experience within a single semester.

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