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Civic Engagement in Engineering - Creating the Civic-Minded Engineer

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Civic Engagement is a cornerstone of our democracy and engineers must play a part in that engagement. Engineers use math and science to solve today's problems through design and development of a variety of items. The Engineer's Council also expands on the definition by including "to advance the human condition and thus serve society" [1]. Engineers are in our every day lives from the homes we live in, the technology we use daily and the healthcare we engage in. The National Society of Professional Engineers (NSPE) has developed a code of ethics for engineers to follow. As part of the code of ethics, NSPE Code of Ethics, a fundamental canon is to "hold paramount the safety, health and welfare of the public [2]." In order to satisfy or abide by this canon, I propose that engineering students must be civically engaged and as such it should be embedded into the engineering curriculum.

Civic Engagement in Engineering

"Civic Engagement involves working to make a difference in the civic life of one's community and developing the combination of knowledge, skills, values, and motivation to make that difference" [3]. It also goes on to say that this involves political and non-political processes. Engineers design structures, systems, devices and/or various machines that are used by society in a variety of ways. All of these devices have long lasting impacts to society. Think of all the medical devices and medical equipment. These impact everyday individuals. What the public interacts daily with are the structures, roads and bridges. How these are designed impact the community and require government approval and oversight. In order to uphold the fundamental cannon "hold paramount the safety, health and welfare of the public," Engineers must understand their role in the civic engagement process to be effective.

Civic engagement education leads to the development of democratic capacity. According to Nelson, "Democratic capacity should comprise a broader set of attitudes and behaviors, including political empowerment and acts of public voice [4]." He also goes on to explain that young people are distrustful of political institutions and government however they do want to participate in democratic processes. Nelson goes on to explain that as educators we need to not only provide education but also provide connections between acts of collective action and political frustrations. This is where education needs to lead towards a participatory set of activities [4].

Civic engagement in engineering education needs to provide a link between an engineer's role as a professional and their role in serving society [5]. This link can happen in a variety of ways. There is traditional lectures and assignments along with discussions. There can be intentionally designed activities that are community projects with service learning, or, improvised instructional strategies. In order to be effective in adding civic engagement to the curriculum, one must decide what king of citizen do you want to develop [6]. Westheimer and Kahne go on to explain that there are three kinds of citizens: the personally responsible citizen; the participatory citizen; and the justice-oriented citizen. Using the Engineers Code of Ethics and the "Engineers Creed," the focus should be on a combination of the participatory citizen and the justice-oriented citizen. The last part of the pledge is "to place service before profit" and "the public welfare above all other considerations [7]." With that in mind, the project management course was redesigned and civic engagement was introduced.

Course redesign with Civic Engagement

When deciding how to redesign the course, there were several objectives. The first objective was to have a hands-on project that the students could plan and execute. The second objective was to introduce the concept of civic engagement and have that as the core foundation of the project the students would plan and execute. Research in engineering education talks about a framework for engineering projects, the EPS formula [8]. The framework includes a timetable of activities and topics that should occur throughout the semester. It starts with teambuilding/teamwork and then moves to project management topics and theory, and ends with the execution of the group project. With this in mind, the essential topics for the course were reviewed. The learning objectives for the course were as follows:

1. Learn and apply Project Management Methodology.
2. Work effectively as a member of a small team with self and peer evaluation
3. Learn how to lead a project and other people.
4. Apply Project Management tools through the execution of a community project.
5. Foster understanding between engineers and the community they serve through their semester project.
6. Create awareness and engagement in community engagement as part of the profession of engineering.
7. Effectively use oral, written and graphical communication techniques in a variety of manners throughout the course.
8. Learn and effectively use Microsoft Project

With these learning objectives as a guide, the following topics for project management were included:

1. Modern Project Management
2. Strategy and project selection
3. Defining the project
4. Project Managers
5. Project Teams
6. Project estimation and scheduling
7. Project constraints and scheduling changes
8. Ongoing progress and performance measurement
9. Project Closeout

There was not a specific day to discuss engineering and civic engagement. It was discussed as part of the semester project requirements. We will address this point later in the paper.

The elements that were part of the course redesign were as follows:

- The theoretical topics in the order of the project management cycle.
- Cases and homework to ensure technical knowledge
- Linked in Learning Courses for MS Project
- Comprehensive Civically Engaged Project.

Finally, the class was primarily a combination of experiential learning and collaborative learning, with some lecture days for theory. All lectures were done in the order of the project management life cycle and the assignments coincided with those phases also. The intent was to have a fully interactive immersive experience throughout the semester. The approach was intended to simulate how you would plan, manage, and execute a project in industry. Previous research showed that experiential learning needed to happen in Project Management to meet the needs and concerns of industry [9].

Along with the topics, the redesign included a group project that was intended to be a civically engaged project. The project was to plan, manage and execute an event called Girl Scout Engineering Day. The goal of the team project was to have students apply project management techniques using a structured approach to project management that was part of the theoretical learning in the class. This project was designed to have students engage in a civic activity and give back to the local community of the University of Miami to reinforce that engineers serve the public. The project had elements for the participatory citizen and the justice-oriented citizen. The specific course outline and course structure was addressed in a previous paper by the author, "Putting the Project Back in Project Management Courses [10]."

Civic Engagement in the Project

As engineers, they are part of a community in which their solutions aim to make the world a better place; however, the current curriculum doesn't put it into practice. An issue that has been identified is recruiting students from underrepresented populations. Most engineering schools have less than 25% female students [10]. In a study published by the US Department of Education, only 21.3% of conferred engineering degrees were awarded to women [11]. In addition to the cultural barriers, there is also an inherent bias in the field against women [12]. A study in 2022, indicates that the primary reason girls do not choose engineering is because of lack of knowledge and understanding of what engineering is and what they do [13]. This societal issue is what the civic engagement project was designed to address and has definite elements of social justice. In addition, having engineers incorporate these issues into their design work is a requirement of not only our accrediting body ABET, it is a professional obligation according to the Engineer's Code of Ethics[2, 14].

As stated many girls don't consider engineering because of lack of knowledge, understanding, or access to positive information depicting women in engineering, the project was to plan and execute a "Girl Scout Engineering Day". It ties in with the author's passionate belief that girls need to be introduced and stimulated about engineering at a young age. Research shows that many girls have decided entering middle school that they are not good in Math. Media portrayal influences this image about who is good at math and this becomes a self-fulfilling belief [15]. Current programs to expose and encourage girls into engineering are usually directed at girls starting in Middle School and later. Girl Scouts is an organization that has invested time and money in badges and programming for girls in STEM. Finally, a project such as this allows the instructor to control the phases of the project to enhance learning.

The objective/purpose/goal of Girl Scout Engineering day is to have a fun filled afternoon learning about engineering for Girl Scout levels of Daisies (K-1st grade), Brownies (2nd – 3rd grade), and Juniors (4th – 5th grade). The goal is to stimulate a real interest in STEM and specifically in Engineering for girls from K-5th Grade. Currently there are many programs for girls at a Middle School and High School age to introduce them to Engineering at many universities. SWE promotes and annually executes "Introduce a Girl to Engineering Day" for high school girls. However, research and experience show that girls need to be stimulated and engaged at a younger age in order to pursue higher levels or Math and Science as they enter Middle School [15].

Effectiveness of the civic engagement elements of the course

The course has been taught twice and during each iteration the intentionality of civic engagement has been revised. During the first iteration, students were introduced to civic engagement as part of the project; however, there was no reflection or assignment to assess how much learning in civic engagement was realized. During the second iteration, students were again introduced to civic engagement and they were asked to reflect on their experiences and learning as it related to civic engagement. Table 1 shows the course demographics of the engineering students and the girl scout participants.

Course Demographics

Course Offering	Spring 2023	Spring 2024
# of students	36	33
# of teams	9	8
# of engineering majors represented	2	5
# of Girl Scout Participants	65	113

Table 1

It was noted that the low number of girl scouts registered during the first iteration of the course was due to two factors: $25 cost to the girl scout participants and advertising. To address this issue, the student chapter of IISE (the official host of the event) decided to have an outreach campaign to Girl Scout leaders so that awareness was high among leaders and that more girls would register for the event. In addition, IISE embarked on a fundraising campaign so that need based scholarships could be award for the event. As a result of both of these actions, the event registration fee was reduced to $20 and 30 need-based scholarships were awarded to girl from a very low socio-economic community in the area. This resulted in over 100% increase in participation and increased the attendance of girls from lower socioeconomic groups in Miami. This provided a greater impact to the communities who could least afford this type of event. This also increased the impact on "social justice" by removing the cost barrier to those girls.

Reflection Results

During the second iteration of the course, a reflection assignment was added at the end of the semester. Students were asked a two-part question: "The Project Management Course is also considered a Civic Engagement Course. Please reflect on your role in this project as being Civically Engaged. In addition, describe why it is important for Engineers to consider and

practice Civic Engagement." The answers to the questions were analyzed by reviewing the responses and categorizing the results into four categories:

- Great Response (GR) – provided an in-depth thoughtful reflection
- Adequate Response (AR) – answer the question however provided a minimal reflection
- Minimum Response (MR) – answered the question with minimal information
- Not a Reflection (NR) – provided an answer that didn't address the question nor provided a reflection.

The results from the Spring 2024 cohort is listed below in Table 2 and Table 3.

Student's role of being civically engaged	
Great Response (GR)	7
Adequate Response (AR)	10
Minimal Response (MR)	11
Not a Reflection (NR)	4
Total Responses	**32**

Table 2

Importance of being civically engaged	
Great Response (GR)	3
Adequate Response (AR)	15
Minimal Response (MR)	11
Not a Reflection (NR)	3
Total Responses	**32**

Table 3

From the results it is evident that the current course format does not create a "Civically Engaged" Engineer. More than half the students didn't believe they were civically engaged as a result of the course. In addition, almost half the students did not believe it was important for an engineer to be civically engaged. The only part of the course that addressed civic engagement was during the project explanation and in the instructions for the challenge activities. However, this did not translate in students believing the importance.

Future Directions for the Course and Research

If the intent is to develop civically engaged engineers, then the instruction and course needs to be more intentional. The connection between engineering practice and professional conduct needs to be explicitly made in the course and curriculum. Based on this, the following changes will be introduced in the next iteration in the course:

- Update the course objectives to include an explicit inclusion of Civic Engagement.
- Add a series of lectures or readings about civic engagement and the link to engineering.
- Create a course case study to highlight engineering and civic engagement.

The other question to consider is whether civic engagement in the engineering classroom helps with diversity in STEM. To improve diversity in STEM to underrepresented groups you need to provide opportunities for engagement and participation of these groups. The underrepresented groups need to be exposed to the possibility of careers in STEM. For engineering students to make this connection, assignments and projects need to require the civic engagement component. Action requires intent which hopefully translates into change.

At the end of the semester, we will once again administer the same reflection question, "The Project Management Course is also considered a Civic Engagement Course. Please reflect on your role in this project as being Civically Engaged. In addition, describe why it is important for Engineers to consider and practice Civic Engagement." The goal is to see if there is an improvement in the perceptions of students as it relates to engineering and civic engagement.

From these changes we hope to determine what information and assignments need to be included in courses in the future where we want to address civic engagement in engineering. From there it can be expanded to the curriculum in various engineering degrees. This notion of civic engagement and a civically engaged engineer is acknowledged as necessary; however, it is typically implied or an afterthought. It needs to be intentional if we are to produce this civic minded engineers.

References

[1] Engineers' Council for Professional Development, "Canons of ethics for engineers". 1947.

[2] National Society of Professional Engineers, "NSPE Code of Ethics for Engineers", Retrieved 9/24/24 from https://www.nspe.org/resources/ethics/code-ethics.

[3] Civic Engagement, Retrieved 7/31/24 from https://youth.gov/youth-topics/civic-engagement-and-volunteering.

[4] M. Nelson, "Lesson in Empowerment: the Civic potential of Historically grounded conversations among racially marginalize youth," The Annals of the American Academy, January 2023, 174-191, 2023.

[5] S. Namasivayam and J. Moganakrishnan, "Linking Professional Conduct for Undergraduate Engineering With Civic Engagement through Teaching and Learning," Journal of Engineering Science and Technology, vol 13, 421-434, 2018.

[6] J. Westheimer and J. Kahne, "What kind of Citizen? The politics of educating for democracy," American Education Research Journal, vol 41, 237-269, 2004.

[7] National Society of Professional Engineers, "Engineer's Creed 92021)", Retrieved 9/24/24 from https://www.nspe.org/resources/ethics/code-ethics/engineers-creed.

[8] L. C. de Campos, E. Tadeu Dirani, and A.L. Manrique, "The European Project Semester: A useful teaching method in engineering education," Project Approaches to Learning in Engineering Education; The Practice of Teamwork, 15-28, 2012.

[9] C. Berggren and J. Soderlund, "Rethinking project management education: Social twists and knowledge co-production," International Journal of Project Management, vol 26, 286-296, 2008.

[10] N. Miville, "Putting the Project Back in Project Management Courses", 2024 ASEE Annual Conference, Portland, Oregon.

[11] U.S. Department of Education, National Center for Education Statistics, Earned Degrees Conferred, 1949-50 and 1959-60 through 1969-70; Higher Education General Information Survey (HEGIS), "Degrees and Other Formal Awards Conferred" surveys, 1970-71 through 1985-86; Integrated Postsecondary Education Data System (IPEDS), "Completions Survey" (IPEDS-C:87-99); and IPEDS Fall 2000 through Fall 2021, Completions component. (This table was prepared September 2022.) Retrieved 3/23/2024 from https://nces.ed.gov/programs/digest/d22/tables/dt22_325.45.asp

[12] C. Lang, "Why aren't there more female engineers," Interview on Quora.com(2018), retrieved February 5, 2024 from https://www.quora.com/Why-arent-there-more-female-engineers?q=%E2%80%9CWhy%20aren%E2%80%99t%20there%20more%20female%20engineers%2C%E2%80%9D%20.

[13] Society of Women Engineers, “Engineering Messaging to Tween Girls”, 2018, Retrieved 3/23/2024 from https://swe.org/research/2018/engineering-messaging-to-tween-girls-a-review-of-the-literature/.

[14] ABET, “Criteria for Accrediting Engineering Programs, 2024-2025”, Retrieved 3/23/2024 from https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2024-2025/#GC2

[15] Anderson-Rowland, M. (2003, June), *Why Aren't There More Women in Engineering: Can We Really Do Anything?* Paper presented at 2003 Annual Conference, Nashville, Tennessee. 10.18260/1-2—11566.