Engagement In Practice: Community Engaged Capstone Design Experience

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Abstract

Service learning in engineering has been criticized on the basis that it often reproduces colonial and globalist tendencies that ultimately undermine already-marginalized communities. A major problem with sending engineering students into communities of which they are not members is that student learning often takes precedence over project outcomes, and community partners suffer as a result. The motivation for developing this course was to alleviate this problematic aspect of service learning. A curriculum was designed with the goal that students would see themselves in solidarity with, instead of separate from or better than, struggles in their home or campus communities.

Background

"Engineering to Help" (ETH) is a term coined by Schneider, et al., [1] to encompass the growing number of collegiate programs- including service learning, humanitarian engineering, sustainable development, and others- that share a mission to "help" communities "in need". ETH programs have been broadly criticized on the basis that they often reproduce colonial and globalist tendencies that ultimately undermine already-marginalized communities [1], [2]. For instance, Nieusma and Riley [2] use two case studies to illuminate ways in which problematic assumptions about technology's role in community development can impede social justice goals. One case study examined a Product Entrepreneurship course in partnership with two Nicaraguan universities. Despite a strong faculty effort to frame the project educationally around process rather than product, emphasis on product prevailed as students' preconceived assumptions about the value of product over process were not challenged consistently enough, and structural influences like funder interests reinforced the emphasis on product. Another problematic assumption made in the students' economic proposal was that what works under consumer capitalism in the U.S., where a high percentage of the population has expendable income, would work in the very different economic circumstances of Nicaragua. The project was ultimately stalled at the proposal stage because of disagreement about this point.

By the time they reach their senior capstone, engineering students have often had few- if any- courses that require them to consider empathic approaches to designing for a client or community whose racial, ethnic, national, socioeconomic, or other demographic background

differs from their own. This experience gap is reflected when students don't have the tools to understand the needs of community members. Even as students have good intentions, there is a tendency to focus on what seems solvable over what community members indicate are priorities. This is a result of years of outcomes-focused, over relational, educational practices. In the absence of meaningful relationships, it is easy to lose sight of the purpose of community engagement. Technologies that students create do not serve the needs of community partners, and community partners suffer as a result.

At the same time, engineers' desire to help and strong work ethic lend themselves well to working on issues of social justice [3]. In recent years, critical pedagogy has influenced service-learning programs as educators have attempted to engage the action-reflection-transformation model proposed by Freire [4]. Further, Santiago-Ortiz [5] suggests that community engaged pedagogical approaches are not necessarily bad, but that "Perhaps service-learning requires shifting its "service" approach to a more horizontal and solidary community–university partnership. The former implies a hierarchical relationship from the outset, and the latter opens the door for epistemic disobedience that transgresses colonialist understandings of knowledge and relationships."

The goal for the development of this course was to explore whether asking students to address problems of equity and social justice with engineering solutions in a "horizontal" context- i.e. in their own communities- would alleviate the tendency to reproduce globalist and colonialist tendencies, instead encouraging students to see themselves in solidarity with struggles in their home communities. In this case, "solidarity" borrows from Freirian pedagogy and refers to the act of people from different social locations working together to transform social conditions, and "community" was defined by students at the outset of the project.

Project Design and Execution

A Community Engaged Design course was introduced as a senior design capstone at a small, liberal arts college. Fifteen students from three majors (Civil Engineering, Engineering Studies, Mechanical Engineering) enrolled by choice in the two-semester, project-based course.

Students were introduced to the topic of community engaged design by completing a discussion-based identity mapping exercise in which they were encouraged to consider how "community" is defined by thinking about what communities they belong to. In the first group meeting, the instructor asked students to free-write about communities they belong to: What are those communities? What defines them? Who are the members? How does one come to belong? After sharing, students discussed initial ideas of what it means to do an engineering project that is "engaged with a community".

Following the initial meeting, students spent two weeks reading (out-of-class) and discussing (in-class) critiques of ETH projects, including references [1], [3], [6], [7]. The first week of readings were assigned by the instructor, while the second week of readings were generated by the class. They summarized their reading responses by defining a list of desired project attributes, which they categorized into "wants" and "needs". The project attributes the students chose are listed in Table 1.

Our project MUST...	We would LIKE our project to...
utilize existing skills of all teammates, from different majors	engage the "most vulnerable among us"
engage one or multiple community partners	[undergo] multiple prototypes
encompass a critical mindset about "helping" in engineering	be frequently used
NOT end up harming the community	[be a] long lasting solution or [have long lasting] impact, [be] easy-to-fix
be novel / innovative	have a social justice lens/impact
	[apply] to life after [college]

Table 1: Student-defined project attributes for their Community Engaged Senior Capstone

After their background reading and group discussion, the team decided to define their "community" as the small city (~30,000 residents) in which the college was located. Other options considered included the hometowns of team members, the college campus, and other identity- and interest-based groups with which team members identified, such as the volunteer fire department, the soccer team, and the Black Student Union.

To define their stakeholders, the team used a combined approach that included: soliciting input from community leaders, including city government officials, local business owners, city and campus police, and staff of nonprofits whose mission had to do with community development; and soliciting input from the public, where students surveyed members of their own communities and canvassed in public spaces. Students used surveys and interviews, at different stages of the design process, to acquire community input.

To define their engineering design problem, students used three rounds of topic and design ideation and selection to narrow their focus first to pedestrian safety, and then more specifically to driver awareness of cyclists at city intersections. Each round of design selection consisted of large group brainstorming of possible topics, small group researching and presentation of possible topics, individual ranking of the project's fit according to the project attributes (Table 1), and individual preference voting. The results of these selection rounds are presented in Table 2.

Community input influenced the project selection process at each stage but didn't drive it until the last stage. The lack of consistency in community influence was in part due to the timing (more stakeholder relationships existed by Round III as opposed to Round I), but in part because students struggled to develop appropriate questions about broad community values. In Round I, interview questions focused on what people thought needed improvement about the city and community, and the results weren't easily translated into possible design projects. By Round III, it was clear that the team would be working on a bicycle safety project, so it was easier to interview cyclists about their experiences navigating city roads via bicycle. Input was gathered continuously throughout the design selection process, but outreach efforts were inconsistent and inadvertently favored individuals who were associated with the college campus or living in the immediate vicinity. Students, most of whom had not taken any coursework in qualitative data analysis or quantitative methods in social sciences, struggled to make meaning of interview answers and survey results.

Round I (topic selection)	Round II (subtopic selection)	Round III (design selection)
Mass Incarceration	**Cyclist Safety**	Bicycle Turn Signal
Homelessness	Blind Corners / Intersections	Pedestrian Laser Cage
Sustainability	Inclement Weather	Cyclist Crashpack (airbag)
Community (Dis)connection	Roadside safety for Fire/EMS/Police	Cyclist Safety App
Traffic / Pedestrian Safety	Speeding / Collision Prevention	**Driver Awareness of Cyclists at Intersections**
Fire Safety	Crosswalk safety	Low Profile Helmet

Table 2: Project down-selection occurred in three rounds of brainstorming, community input, discussion, and team voting using the attributes from Table 1 as a framework for topic and design evaluation.

After the project was selected, efforts to maintain engagement with stakeholders were minimal. A few interviews with key stakeholders (whose interviews had driven project selection) and stakeholder surveys were done, but the results did not meaningfully influence design choices made along the way. For the remainder of the first semester, various technologies were researched and prototyped towards the end goal of increasing drivers' awareness of cyclists at intersections. During the second semester, a final design was chosen and a prototype built. The team's final product was a prototype of a system which detected and warned drivers of the presence of bicyclists.

Lessons Learned

1. *Allowing students to define their own community and project attributes was a successful technique.* The identity mapping exercise and assigned background readings, coupled with discussions guided by the instructor, were useful in fostering an environment in which students could come together across their own differences to generate shared values around their capstone design project. For the attributes listed in Table 1, there was very strong consensus among the team.

2. *Inviting social identity into the design process necessarily invites conflict as students navigate differences among themselves*. One of the concerns with ETH projects is that "privileged" students will perpetrate unintentional harms upon "less privileged" communities. When students were asked to see themselves as a community, and to see themselves as members of broader communities (e.g. campus, city), differences in social position among the students entered the design process.

   For instance, one of the project ideas that students proposed involved working closely with city police. Some students had been taught as young people that the police were trustworthy and kept people safe; others had been taught that the police were dangerous and made people less safe. Others were indifferent, and it's possible that some students came from countries or neighborhoods with little to no police presence. It is not a coincidence that these differences in perspective occurred along axes of social identity (race, gender). While the generation of shared values had resulted in strong consensus, the interpretation of which possible topics and designs achieved those values resulted in relatively weak consensus. Neither the students

nor the instructor were adequately equipped to navigate conflicts resulting from deep-rooted societal inequities. In an attempt to mediate some of the conflict, the instructor implemented monthly 1:1 feedback conferences with each student. These meetings coincided with peer evaluations and were used to discuss critical feedback about intergroup dialogue skills, e.g. listening. These conferences seemed to help considerably, but were not enough.

3. *Several students saw the community engagement aspects of the project as being at odds with the technical aspects of the project*. Because the "community engagement" aspect of the project was left for students to define, there was widespread disagreement about how, and how much, to engage. For example, taking time to do in-depth stakeholder outreach was seen by some students as delaying technical progress. The technical and community aspects of the project would ideally be bound together in a holistic and unified vision. Additionally, the lack of experience in social research methods (both students and instructor) was a barrier to doing effective outreach, designing surveys and interviews, and interpreting qualitative results. A partnership with a faculty member, or the inclusion of team members, who have experience in social research methods would have strengthened the project considerably.

Conclusions and Next Steps

Recommendations for future improvement upon a Community Engaged Design Capstone course follow directly from the lessons learned:

1. More training in the area of conflict management, especially as it pertains to social identity, could have helped the students navigate conflict more professionally and safely.

2. A stronger emphasis on social justice, as an aspect of engineering ethics, should take place earlier in the curriculum.

3. Specific requirements about stakeholder engagement, in addition to the technical requirements, could have helped the students prioritize and maintain relationships with community partners. This may include dedicated team members whose role is stakeholder outreach.

Asking students to see themselves as members of a community in solidarity with their fellow community members means that the classroom becomes a microcosm of that community. With that microcosm comes inequities existing in the greater community, for instance along the lines of race and class. This was a major tension in this course, as students have little experience in the engineering classroom thinking critically about what it means to share community with people whose identities and experiences differ substantially than their own, including their own teammates. While this tension was difficult, and while the lessons learned point to more productive uses of that tension, the tension itself is a good thing. Multiple students wrote in course evaluations that some of the main takeaways from the course included the ability to consider others' perspectives, the ability to navigate disagreement, the ability to speak out against injustice, or the ability to defend their positions. These outcomes weren't what was originally intended from the course, but they are social justice outcomes.

This paper is intended to be a reflective account of ideas and lessons learned about community engaged design. However, it does not fully answer the question of whether the burden placed on community partners can be alleviated by teaching students to see themselves in solidarity with their home or campus communities. A more rigorous answer to this question would likely require a comparative study between comparable design projects, including survey and interview data from students and community partners.

References

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