Diverse Perspectives, Engineering in Context, and Experiential Learning in Engineering Education

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Introduction

Across engineering codes of ethics, accreditation standards, and field-defining mission statements, one theme remains consistent: a commitment to promoting the public good and enhancing human welfare. Ideally, then, a robust engineering curriculum inculcates students to the humanitarian aims of their technical work. And yet, how often are students trained in "doing good"? In what ways are they given opportunities to practice enhancing "human welfare," and whose welfare are they taught to prioritize? Just as importantly, when they are given these critical opportunities, do they have the skills to think critically about what the "public good" actually means? Have they been taught to listen to members of the public and value the different forms of expertise that diverse community members offer? While engineering, as a discipline, prioritizes public welfare, engineering curriculum often provides students with a technical skill set while neglecting to develop their aptitude in humanistic inquiry and critical listening.

One pedagogical approach that encourages students to think through the complexities of service to the public good lies in community engagement projects. In such projects, students are partnered with local or global communities and work to devise solutions to the given community's technical challenges. However, if these projects are created without a social justice framework, or undertaken without appropriate student training, they can often reify the inequities they seek to resolve. When students are motivated by a "design-for-charity" mindset, they may devise effective short-term solutions to a specific technical challenge, but fail to adequately implement a successful long-term resolution [1]. These projects can often have a paternalistic quality, in which engineering students, outsiders to the community, decide upon the best course of action for community members without taking into consideration the community members' needs, goals, or desires [2]. Students are positioned as "experts" with the ability to solve community problems, while community members are the passive recipients of the students' beneficence.

In this piece, we discuss a community engagement project that we implemented in an undergraduate technical communication course, in which we attempted to account for the challenges discussed above. Looking to teach engineering and computer science (CS) students about the value of honoring the diverse perspectives of end users and factoring contextual factors (social, economic, and environmental) into their problem-solving process, we developed a project that partners students with an NGO located in Tanzania. After learning about the NGO's projects related to affordable and clean energy, sanitation, and gender equality in the region, students were asked to compose proposal reports outlining potential solutions to community challenges. Both authors were teaching online during the delivery of the project, and working remotely introduced unique opportunities for global collaboration as well as challenges regarding meaningful engagement. Throughout this paper, we discuss our approach to implementing a social justice framework for the project through guided research, regular reflective exercises, and meetings with our community partners.

At the time of this writing, we have incorporated the project into two semesters, and are in the process of finalizing IRB approval for a more in-depth, data-informed study. In future publications, we intend to incorporate both quantitative data gathered from student surveys, as

well as qualitative feedback from interviews with our partners and a closer assessment of student writing. At present, we offer a reflective assessment of the project with the goal of sharing strategies and resources with fellow educators.

This paper begins with an outline of the challenges associated with community engagement assignments and methods of implementing a socially just project. We then discuss our proposal project, highlighting major milestones and deliverables. In the second half of this piece, we reflect on both the challenges and successes of the project, and conclude by summarizing our plans for future improvement and offering advice to others who may want to develop similar projects and partnerships. Ultimately, continual self-reflection is both a practice that guides our approach to the project and a skill we attempt to instill in our students. Through regular evaluation of both approaches and outcomes, we hope to develop a community engagement project that deconstructs the perceived boundaries between the technical and the social, values the input of all project partners, and results in tangible benefits for students and community members alike.

Literature Review

The following sections will discuss (1) ways in which engineering culture and curriculum struggles to incorporate an appreciation for how social, economic, and environmental contexts influence technical solutions, (2) how community development projects strive to teach students about context, but can still perpetuate harmful power dynamics, and (3) social justice frameworks that allow us to mitigate those issues.

Engineering Culture and Values

Cech has found that Engineering students' interest in public welfare decreases over the course of receiving their degree and suggests that this disengagement is part of the broader culture in the engineering profession [3]. That said, the report ends on a positive note: it is possible to produce a "new brand of engineer, one that thinks critically about the coconstruction of public welfare and the technological system on which he or she works" (p. 66). This engineer, however, must contend with implicit messages from the engineering community that devalue or exclude public welfare; these messages shape student perceptions of 'real engineering,' ultimately frustrating their ability to shape an engineering identity that includes equal concern for the technical and the social [4].

The National Academy of Engineering's (NAE) Grand Challenges, the National Society of Professional Engineer's (NSPE) Code of Ethics, and the Accreditation Board for Engineering and Technology's (ABET) accreditation criteria are three artifacts that offer us insight into how the engineering community understands (or presents their understanding) of how social, economic, and environmental factors play a role in technological solutions, which we'll briefly explore here. To clarify, by economic factors, we mean a community's economic system, methods of production, imports and exports, and technologies; by environmental factors we mean climate, landscape, natural resources, pollutants, risk for natural disasters, and so on; and by social factors we mean language, class system, gender relations/roles, religious beliefs, race and ethnicity, and various cultural practices.

The NAE's Grand Challenges for Engineering outline a series of goals to improve life on Earth [5] and, as Cech notes, have received significant attention from legislators, policymakers, and educators [6]. In her article "Great Problems of Grand Challenges," Cech provides an overview of Nieusma and Tang's critique of how the Grand Challenges report brackets the technical from the social, political, ethical, and cultural dimensions of the challenges. By presenting the problems as "exclusively technological" and not adequately emphasizing the roles of non-engineer expert and non-expert voices, the report dangerously simplifies the problems that engineers will work to solve [6].

Another important artifact that guides (or is intended to guide) the actions of engineering professionals is the NSPE Code of Ethics. In our experience, when students read this code of ethics, they easily accept that "engineers shall hold paramount the safety, health, and welfare of the public" [7]. However, as we delve further into what that canon means, the ambiguity of its language poses challenges. As Lambrinidou et al. point out, the codes of ethics do not contain any mention of concepts such as listening, diverse perspectives, context, or non-technical perspectives, implying that a good engineer is perfectly "equipped to define on behalf of the public subjective values like public 'safety,' 'health,' and 'welfare'" [8]. To achieve a solution that is in the best interests of the public welfare, not only do the social, cultural, and economic factors need to play a role that is held in the same regard as the technical, but engineers need guidance as to how to understand and incorporate this information into their practice.

The Grand Challenges and the NSPE Code of Ethics are artifacts of a culture that arguably still grapples with how to incorporate the social, cultural, and economic factors that are so inherently tied up in technological solutions. Another organization that shapes engineering education is ABET and their accreditation requirements. The goal of ABET's review process is to "determine if educational programs meet defined standards of quality" [9]. Their criteria includes student outcomes, three of which are specifically applicable to our technical communication course [10].

➔ ABET (3) an ability to communicate effectively with a range of audiences

➔ ABET (4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

➔ ABET (5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

While ABET acknowledges the importance of global, economic, and societal contexts in engineering work, it does not define these terms. It is left for instructors to unpack these concepts for students, but in an overloaded and fast-moving engineering curriculum that prioritizes technical knowledge, consideration of societal impacts is often dealt with cursorily or unacknowledged. Sustainable community development projects provide a way to involve students in the process of conscientiously factoring context into technical solutions and working directly with the people affected by engineering work; however, as we'll explore in the next section, those projects come with challenges of their own.

Challenges of Sustainable Community Development Projects

The field of engineering for development, also sometimes known as humanitarian engineering, works to bring together "communities, businesses, students, faculty, non-governmental organizations (NGOs), and governments . . . with the intention of working collaboratively to solve global challenges" and "to create technological interventions in accordance with the needs and wants of individuals living in complex, low-resource settings" [11]. This work makes especially explicit the importance of context, communication, and working with diverse experts and non-experts. There is a relatively small but growing contingent of academic programs specific to these fields [12] and ABET outcome #4 indicates that engineering programs across disciplines are seeking to help students develop approaches to their work that involve more than just technical expertise.

Technology has played a role in developing countries and communities in complex ways; while clean water, sanitation, and other innovations provide benefits, the process of implementing these technologies without acknowledging and incorporating the economic, social, political, and cultural contexts can lead to perpetuating harmful power dynamics [13]. In their review of two community development cases, Nieusma and Riley [14] describe how even in projects that actively sought to involve the community and pay attention to the context, "the prioritization of engineering expertise in particular served to reinforce this prioritization of product over process, of technical functionality over participatory practice" (p. 37). For instance, in an engineering exchange development project in Nicaragua, despite conscious planning to create a collaborative experience in which students were placed in non-expert roles, the focus on the final product caused students to not fully engage with the product development process and community needs.

Lucena, Schneider, and Leydens [15] raise important questions about the effort to help "underserved" communities: "Is there anything problematic with wanting to help a community? How do engineers listen to a community? If invited, how do engineers work with a community?" Indeed, how do engineering students prepare for this work, especially if they are immersed in a culture which values their technical expertise above all else? The next section will explore frameworks that can help instructors approach the task of preparing students for this work the classroom.

Social Justice Tools and Practices

A social justice approach to providing engineering solutions in developing countries demands that engineers engage with the communities they serve, ask them questions about their needs, and actively listen to their responses. Jones and Walton [16] describe a social justice approach as one that is "a collaborative, respectful approach that moves past description and exploration of social justice issues and taking action to redress inequalities" (p. 242). Listening and self-reflection are two overarching strategies that can guide such an approach.

Factoring in Community Perspectives First

When working with a community, the Engineering Problem Solving approach inhibits students' ability to incorporate information outside of the technical boundaries, and engineering mindsets make it difficult to consider social justice issues [15]. A response to this is the Problem, Definition, and Solution approach which is designed to illuminate **location** (one's social location or position), **knowledge** (the various types that stakeholders bring to a project), and **desire** (the selfish, altruistic, political agendas, visions for the future, etc. that stakeholders have). This approach, developed by Gary Downey, allows students to examine their own strengths and limitations, realize the value of diverse local knowledges, and take note of all stakeholders' goals and desires (p. 141).

In order to approach understanding community knowledge and desire, a useful strategy is contextual listening, a complex task that puts a spotlight on a listener's biases [17]. In order to address the types of biases that are most salient in sustainable community development contexts, Leydens and Lucena ask two questions: "(1) In listening, **what kind of voices** count? and (2) **whose voices** count?" (p. 369). Lambrinidou et al. [8] share that when they surveyed engineering students about what voices their education trains them to listen to, students responded with their professors, renowned leaders in the field, and rules and regulations, and notably stated that there was never any encouragement to listen to voices of non-experts.

To this end, Leydens and Lucena [17] "advocate factoring in the community perspectives before identifying a solution (during problem definition)" (p. 369). Ultimately, any community development project needs to be sustainable; it needs to be able to be *owned* by the community members. Agboka's [18] notion of participatory localization highlights the importance of shifting who is actually in control of the design, and proposes "a user-driven approach, in which a user (an individual or the local community) identifies a need and works with the designer or developer to develop a mutually beneficial product that mirror the sociocultural, economic, linguistic, and legal needs of the user" (p. 44). A helpful way of framing this for engineering students comes from Lambrinidou et al. [8] "It is time to begin training students to see themselves not as 'definers' and 'solvers' of society's problems, but as society's technical experts who have the moral duty to *partner* with professionals and non-professionals alike" in order to ensure long-term success (p. 8).

Self-Reflection: The 3Ps, Cultural Competence, and Design Justice

Self-reflection is a useful tool for moving towards valuing voices and knowledge seen as non-traditional in engineering culture. Jones, Moore, and Walton [19] offer a framework for inclusive research using the 3Ps: positionality, privilege, and power. The goals of this heuristic are to aid researchers in "(1) thinking more critically about how certain groups are marginalized and disempowered and in (2) recognizing specific ways that our research can either reinscribe marginalization and disempowerment or promote agency and advocacy" (p. 220). We must address the ways in which students proceed to gather information and create a plan, and in order to do that in an ethical and inclusive way, addressing the ways their identity as an engineer affects the way they approach any problem is a place to begin [17].

Jones, Moore, and Walton [19] provide reflective questions about how aspects of our identity inform the way we think about research and how we approach any research task (p. 222). This

reflective work is essential in order to move towards contextual listening practices and ethical intercultural communication practices. This approach also supports Handford et al.'s [20] notion of "small cultures" and resisting the idea that culture is only an attribute of "foreign people." By reflecting on the various cultures they are a part of, students can begin to understand how their own worldviews influences their approach to engineering (p. 172).

In addition, the Design Justice Network offers a series of principles to reframe the way designers think about how they work with those who are affected by what they create. As we noted earlier, artifacts of engineering culture do not focus on the affected community or, for that matter, the oppressive systems they participate in. Just as we saw in cases of development projects [14], the Design Justice Network acknowledges that good intentions are not enough and works to develop practices that help designers avoid reproducing inequalities and analyze the assumptions they are bringing with them to their designs [21]. The Design Justice Network principles detail elements missing from the NSPE Code of Ethics: centering the voices of those impacted by design outcomes and seeking solutions which sustain and empower communities [22].

Creating a Community Engagement Project

The course that we teach is a required, undergraduate technical communication course, and our classes typically have an even distribution of sophomores, juniors, and seniors. Traditionally, the final project of the semester asks students to work in groups on a proposal report project, identifying any problem of interest and proposing a viable solution.

Looking to revise the proposal project to focus on community engagement, we found inspiration for a new assignment in the United Nation's 2030 Agenda for Sustainable Development. The Sustainable Development Goals (SDGs) are seventeen distinct goals covering different areas of sustainable development, ranging from zero hunger to clean water and sanitation to gender equality to sustainable infrastructure [23]. We thought that encouraging students to identify community challenges within individual SDGs would help them make a stronger connection between their own technical abilities and the communities they serve. The project planning took an exciting step forward when we discovered that the Experiential Learning Network (ELN) on campus was advertising an "SDG Action and Awareness Week," in which they were aiming to connect interested students with SDG-related projects. After getting in touch with the director of the ELN, it was clear that she was equally excited about the potential collaboration.

The ELN was already working closely with the Hope Revival Children's Organization (HRCO), an NGO dedicated to community empowerment in the Mara region of Tanzania. More specifically, the HRCO is working on sustainable solutions to community challenges related to education, gender equality, and meeting the basic needs of community members in crisis [24]. By forming strategic partnerships with both the ELN and the HRCO, our students could build upon this established foundation and continue to support sustainable development in the Mara region by proposing projects that would be reviewed by the director of the HRCO. If particular projects were deemed desirable and viable, students could then put their plan into action by working with the ELN to bring the project to fruition. Students working with the ELN can earn digital badges (similar to micro-credentials that students can advertise on their resume or LinkedIn page) in areas including sustainability, community engagement, and global

collaboration. For the purposes of our project, each class of approximately 25 students was divided into five groups, with each group of four-to-five students comprising an interdisciplinary mix of majors within engineering and computer science.

While we, the authors of this paper, have considerable experience teaching technical communication, we are not engineers. Trained in English, we bring our backgrounds in the Humanities to the technical communication classroom, helping students to navigate the challenges of working across disciplinary divides. We were enthusiastic about piloting the new proposal project with our local and global partners, but also wanted to ensure that the project operated according to the framework discussed earlier in this paper; it should allow students to reflect upon their own positionality and privilege and it should facilitate dialogue with community partners in order to better meet the needs of end users. Indeed, during our earliest conversations with the Director of the ELN, we agreed that all parties – students, course instructors, the ELN, and, most critically, the HRCO and local Tanzanian community members – must receive tangible benefits from the project.

In the following sections of this paper, we will discuss select project milestones and major deliverables in which we attempted to deconstruct boundaries between the technical and the social, and encourage responsible community engagement work. See Appendix A for an overview of the project's schedule. More specifically, in the following sections of this paper, we 1) Provide an overview of our project and associated context-setting material; 2) Discuss how we implemented a socially just community engagement project via Partner Meetings and assignments; 3) Reflect on the project's challenges and successes; and 4) Offer advice and strategies for implementing similar projects

The Proposal Assignment and Context Setting

The Collaborative Proposal Report: Assignment Guidelines

Students' first introduction to the proposal project comes in the form of the assignment guidelines (which can be found in Appendix B). The proposed project needs to contribute to the HRCO's work toward one of the UN's 17 Sustainable Development Goals in a practical and meaningful way. While there are 17 SDGs in total, a smaller subset is relevant to the local Tanzanian community. These include: SDG #4: Quality Education, SDG #5: Gender Equality, SDG #6: Clean Water and Sanitation, SDG #7: Affordable and Clean Energy, SDF #9: Industry, Innovation, and Infrastructure, and SDG #17: Forming Partnerships. Students were given the freedom to focus on any goal that they found interesting or most relevant to their own areas of technical expertise.

Context Setting Material: Course Blogs

To supplement the assignment prompt, students were given additional "context-setting" material, which helped to both flesh out the project's goals in greater detail and provide students with information about their community partner. The first of this context-setting content was delivered in the form of course blogs. Using Google slides, the authors created a series of

"blogs" that provided students with additional information about the project in the form of written content (composed by the authors), YouTube videos, and images. The blog format allowed students to respond informally to course concepts as they were introduced to each new subtopic. In the blog titled "Engineering in Context: Valuing Diverse Perspectives and Finding Sustainable Solutions," students were introduced to the overarching goals for the proposal project. Students were introduced to the following goals:

Goal 1: Recognize your own positionality as engineering and CS experts

Per Jones, Moore, and Walton [19], students are encouraged to consider their own positionality, and how parts of their identity (culture, upbringing, education, etc.) shape the way they approach and define a problem. Here, we anchor the discussion with the following questions: How might their perspective and approach differ from the perspectives of people who are affected by their work? What assumptions might they be inclined to make and how can they actively challenge and address those assumptions? What power dynamics are inherent in the work they do as engineers or CS professionals?

Goal 2: Value the diverse knowledge and expertise of others

To encourage students to see themselves as working in partnership with local and global community members, we show students that engaging with and listening to others will be central to their work. Students are encouraged to notice the way that communication and listening skills are frequently discussed in the standards set by important engineering bodies, such as the US NAE's description of "The Engineer of 2020" [25]. We highlight for students the emphasis on listening skills and the importance of taking diverse perspectives into consideration when working on technical solutions to community challenges.

Goal 3: Find a solution to a technical challenge that works for the end users

Students are encouraged to think about the "context" of their work, and the way in which social, economic, and environmental factors will have an impact on any proposed solution to community challenges. The following image (Figure 1), is taken from the course blog and illustrates the interconnectedness of the different contextual spheres and their impact on the end goal or technical solution.
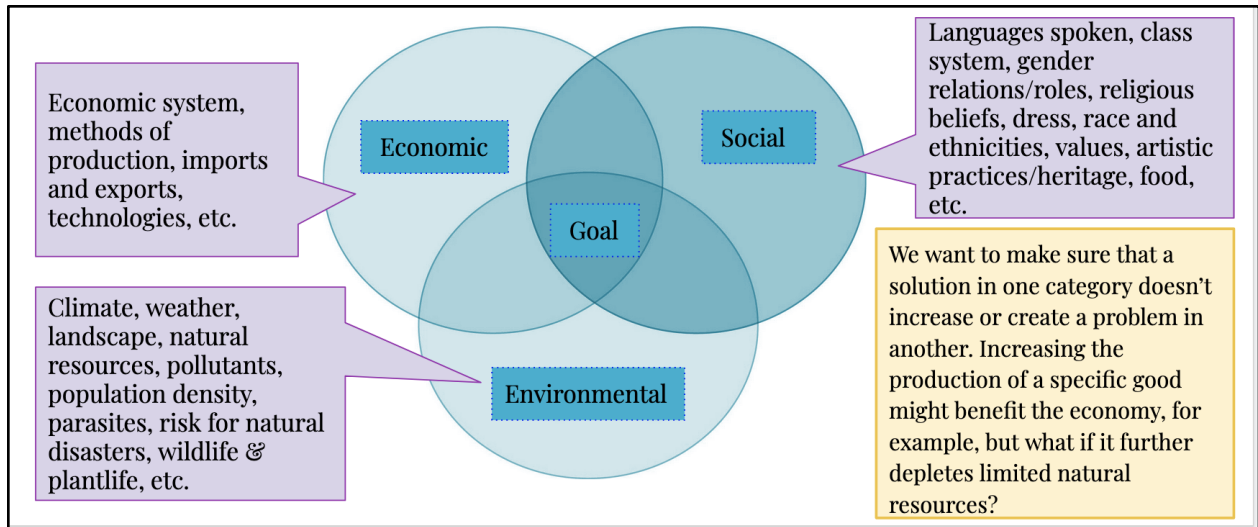
Figure 1: Image taken from course blog illustrating the overlap of economic, social, and environmental influences

Context Setting Material: Tanzania and HRCO Overview Document

The second piece of context-setting material provided to students at the start of the project is the "Tanzania and HRCO Overview" document compiled by the Director of the ELN. Having worked extensively with the HRCO on various projects, including a study abroad experience, she compiled a document that provides general information about Tanzania and, more specifically, the Mara region, as well as information about the community's needs and progress related to the SDGs.

This document was a pivotal starting point for students, many of whom knew little about the country. While students were encouraged to conduct thorough research into the region and relevant SDGs (as discussed in greater detail below), giving them some foundational material helped orient them to the kind of work we were asking them to do. They were free to craft an entirely novel project, or they could build upon any of the existing projects discussed in the "Tanzania and HRCO Overview" document. For example, there had already been a fundraising project to secure bicycles for rural Tanzanian schoolgirls. Our students could opt to extend this work, with one student group in the Fall 2021 semester proposing to develop an easy-to-follow instruction manual for basic bicycle repairs.

Implementing a Socially Just Community Engagement Project

In this section of the paper, we discuss our methodology, or the way in which we implemented the social justice framework outlined earlier. In each section, we discuss our methods (including class activities, Partner Meetings, and required deliverables) and reflect on challenges and successes.

Fostering Conversations with Community Partners

Before Partner Meeting #1: The Team Contract

The cornerstone of our proposal project is fostering a critical dialogue between students (the "technical experts") and community members (the end users and experts on local challenges and goals). We should note, however, that given both time constraints of the semester and conducting the project remotely, students have structured meetings with one pivotal community member, the director of the NGO.

Accordingly, we scheduled two Partner Meetings to take place over the course of the project. Before attending the meetings, we wanted students to think through the general parameters of the project and possible approaches to community challenges so that they could ask informed questions during the meetings.

To this end, the first deliverable associated with the project was a Team Contract. The contract was divided into an Internal and External Contract. The Internal contract prompted students to establish expectations (meeting attendance, communication frequency, group roles, etc.) and policies for their collaborative work together. The External contract was designed to prepare students for the first Partner Meeting. The assignment was, in part, reflective, prompting students to discuss their assessment of the Tanzania and HRCO Overview document, and the findings that they believed would have the greatest impact on their approach to the project. The assignment also asked them to draft the questions they would like to raise at the first Partner Meeting with the Director of the ELN.

The primary goal for the Team Contract was to prompt students to conduct preliminary research into the region and the HRCO's work toward a specific SDG. We hoped this would lead the students to compose informed questions that could facilitate a productive discussion during the Partner Meeting. While having questions prepared in advance undoubtedly made for a livelier meeting, the quality of questions (reflective of their early research processes) varied across student groups, as will be discussed in greater detail below.

Partner Meeting #1: Meeting with the Director of the ELN

In the first Partner Meeting of the semester, students met with the director of the ELN. Given that the director had established our university's connection with the HRCO and had taken students on a study abroad trip to Tanzania in the past, she was a vital source of information for the students.

In terms of logistics, the meeting was held via Zoom, and while all students were invited to attend, attendance was not mandatory (although each student group was asked to send at least one representative). After opening remarks from the ELN, we devoted approximately ten-to-twelve minutes of discussion time to each SDG, encouraging students to ask questions relevant to their projects during this time. After the meeting, both a recording and transcript of the session were made available to those who were unable to attend.

There were several successes related to the first Partner Meeting, including attendance, with approximately sixty students (out of almost 250 students) joining the meeting. Conversation was

lively throughout the session, with many students eager to ask questions and discuss their project plans.

So, too, were there challenges. Despite the best efforts of the Team Contract assignment, many questions raised during the meeting were vague or under researched. For instance, students would ask about the Mara region's general proximity to Lake Victoria, something easy to find through a quick online search. More troubling were those questions that failed to demonstrate the students' grasp of positionality and privilege. Many student groups were interested in SDG #4: Quality Education, for example. Their questions and comments related to this topic often suggested that a viable solution to challenges related to educational access in Tanzania would be to impose a US education model on the country, which obviously neglects the complex economic and social factors that might impact educational access in the rural Mara region. This experience showed us that, moving forward, we need to dedicate additional time to unpacking complex topics likes positionality so that students will have the critical vocabulary necessary to construct productive and respectful questions for the partner meetings.

After Partner Meeting #1: Ethics Memo Assignment

Following the first Partner Meeting, students were asked to compose an Ethical Reflection Memo. The memo asked them to: 1) Reflect on the first Partner Meeting, discussing their most important realizations, 2) Outline their proposed project deliverable, and 3) Construct a plan for the rest of their work on the proposal. As part of meeting this final requirement, we asked them to identify different forms of expertise that might guide their work. In addition to reaching out to engineering faculty working in sustainability, for instance, who else might they turn to for advice? Students were encouraged to think about different departments (education; women's, gender, and sexuality studies, etc.) and staff on campus (librarians, the ELN). With this project, we hoped to encourage their appreciation for diverse forms of knowledge and expertise by finding valuable consultants across the campus.

Throughout the project we reminded students to remain flexible by incorporating new information into their project and letting that information guide their approach to resolving community challenges. In other words, while they may come up with an interesting initial "deliverable" or solution, they should avoid locking in on that singular concept as it may actually hinder their ability to develop a solution that works for end users. One success of the Ethics Memo assignment was the fact that several student groups discussed their decision to change or alter their initial project idea after the Partner Meeting. This suggested that they valued the expertise of their local partner (the Director of the ELN) and were willing to take her advice and information into consideration.

While students readily accepted the Director of the ELN as a subject-matter expert, they still struggled with their approach to identifying other relevant forms of expertise. Most groups identified experts and potential consultants within the school of Engineering, and were hard-pressed to identify why other forms of expertise might matter.

Students also encountered challenges with thinking through the ethical complexities of their work. In corresponding blog material, students had been introduced to their field's code of

ethics, ethical data collection, and how to ensure the public good is central to their projects. However, they had a hard time articulating how they would take the public good into account in their own work. Put another way, while they were quick to support the concept, they struggled to apply it to their actual work process. This moment also highlights some of the difficulties of delivering this project remotely. Many of the challenges we discuss in this piece are actually valuable teaching moments that could spark constructive dialogue in class. Given that much of our instruction happened asynchronously, it was often difficult to respond in real time to student struggles. As we begin to transition back to in-person instruction, we believe we'll be able to foster more robust conversations with students around the complex topics highlighted in this paper.

Partner Meeting #2: Meeting with the Director of the HRCO

As we currently have over 200 students (representing 11 sections of our technical communications course) working on this project, we are conscious of not overwhelming the NGO director with questions and requests. We mediate this by providing them structured time to interact with him, and they have direct access to our ELN director via email or requested meetings. Thus, the second Partner Meeting of the semester mirrored the first in terms of set up, but this time students met with both the director of the ELN and the director the HRCO, who was able to join the Zoom call from Tanzania.

A unique success of the second meeting was the opportunity to interact with and learn from the Director of the HRCO. Students were able to gain the perspective of a community insider, someone able to provide information and feedback they would be unlikely to find elsewhere. This was also a learning experience for us as instructors. To give one illustration, a particular student group had been developing a plan to collect and donate laptops to the students at the HRCO. While we feared this would be a challenging and fruitless endeavor (given shipping costs and the lack of reliable Internet access in the rural Mara region), the Director of the HRCO expressed interest and excitement about this idea. If the laptops could be pre-loaded with educational resources, then they would be an asset to the local students. In addition, the Director of the HRCO was planning to expand upon the HRCO facility with the hopes of building an Internet café. Thus, if local students had access to laptops (an expense that they could not currently afford) then they could take advantage of the WiFi and gain valuable digital literacy skills.

The ability to talk with and learn from our global partner proved invaluable for those who listened carefully and incorporated feedback into their projects. As mentioned above, however, many students remained resistant to changing their original idea, despite meeting with their end user. We attempted to push students to pivot when necessary and refine their approach through the research process.

<u>Conducting Contextual Research and Engaging in Critical Reflection</u>

Researching Background and Context

Our second method of implementing a social justice framework involved guiding the students through the research process by placing an emphasis on investigating the contextual factors that would influence any proposed solution they might devise. Most notably, this work played a pivotal role in constructing the Background section of the report.

The Background required students to conduct research into the social, economic, and environmental factors that would have an impact on their project. For many, this required that they look beyond the regular databases and journals that they turned to in their engineering and CS work. Indeed, they would need to widen the scope of their research and gather sources and information from a diverse array of sources, including scholarly journals in sociology, education, geography, etc., as well as reliable first-hand accounts.

Notably, the Background section also asked students to articulate the benefits of the project. More specifically, they had to explain the benefits they would derive, but they also had to discuss the benefits that their global community partner would receive. As mentioned earlier in this paper, ensuring that the HRCO received some tangible benefit from the project guided much of our work, and we wanted to see this concern reflected in student writing as well.

Composing the Progress Memo

As students were drafting the Background section of their reports, we also had them compose a Progress Memo. The assignment asked them to reflect on their work thus far, identifying the project's strengths and weaknesses. For any weaknesses they identified – confusion about how to narrow the scope of their work, lack of research into specific contextual elements, etc. – they were asked to draft a plan for resolving the issue. Who would they turn to for help? What group members would take the lead on a given task? What kinds of sources did they need to seek out? We hoped that this metacognitive thinking would enable students to better direct their own revision process and empower them to become more actively engaged in the project.

The extended focus on drafting the Background section and reflecting on its strengths and weaknesses did result in several successes. Some of our local partners, including the Director of the ELN and our Engineering Librarian on campus, reported that they were contacted by several student groups. In other words, students were actively seeking out diverse forms of expertise and knowledge. In addition, the quality of research in the proposal reports was improved compared to previous semesters.

A lingering challenge, though, was the continued student resistance to changing direction or narrowing the scope of their projects. To give one illustration, a student group was interested in the problem of eutrophication (an influx of nutrients causing massive algae blooms) in Lake Victoria. While the students had identified a critical problem, any realistic solution was beyond the scope of what they or their community partner could hope to accomplish given the size of Lake Victoria and the fact that it is bordered by three different countries (Tanzania, Kenya, and

Uganda). Despite an extended conversation with the instructor during conferences, in addition to feedback provided by classmates during the peer review process, the student group did not change course or narrow the scope of their project. While this represents a fairly extreme example of an unrealistic approach to the project, it illustrates how students can attach to a specific technical solution at the expense of social or environmental consequences. Often, once they had settled on a topic, additional research, or dialogue with local and global partners, did not cause them to adjust the scope of their work or their proposed plan of action.

Summary of Final Results: Successes, Challenges, and Reflections

The following summarizes our challenges, goals, classroom strategies implemented to achieve the goals, and an overview of outcomes. Informed by the work of scholars in engineering education and technical and professional communication, we have strived to create a project that helps students to develop ethical and socially just communication and engineering practices. It's a project that evolves each semester as we learn what activities and elements of the assignment work best (and which ones have failed). Additionally, as our colleagues join us to implement the project in their classrooms as well, they bring new ideas to further improve it. We'll harken back to the three project goals we presented to students to organize our concluding comments.

Goal 1: Recognize your own positionality as engineering and CS experts

Challenge	Implementation Strategy	Outcome
Students do not see or reflect on their own positionality as members of the technical professions	Student reflections on their own perspectives and the perspectives of people who may be impacted by their work	Increased acknowledgement of the value of the community's perspective and attention to the community's desires, but lack of awareness of how their own worldviews impact their work

The first iterations of this project had students reflecting on their positionality in a low-stakes and less-structured manner through their blog discussion posts. While this gave us some insight into their thought processes, a more robust and structured assignment explicitly focused on exploring positionality, privilege, and power as well as the "small cultures" [20] that they are a part of would be more effective. We think that a combination of individual self-reflection combined with team reflection on their ethics memo assignment will allow students to explore these ideas in more depth.

Goal 2: Value the diverse knowledge and expertise of others

Challenge	Implementation Strategy	Outcome
Students struggle with understanding the role and importance of varied and non-technical perspectives during problem solving	Partner Meetings Expertise, or "consultant" identification	Increased initiative to consult with local partners and experts (ELN director, librarians, etc.), but difficulty in in identifying expertise outside engineering/CS
Students are detached from end users / report recipients	Partner Meetings	Increased awareness of their audience, but continued struggle to meet audience needs

Preparing students to meet our community partner is an area that we think could be improved. Anecdotal feedback tells us that students genuinely value these meetings and see them as an important part of the process in refining their project ideas. So, while the meetings have been successful in terms of student engagement, we continue to think that further guidance on how to compose useful questions is merited. Our theory is that even though students prepare questions in advance, they tend to assume that regardless of their question quality, the information they need will be revealed (similar to a lecture). However, the meeting is driven by their questions, and a key skill we are hoping to cultivate is their ability to determine what information can be found through their own research and what information they need from the community directly. We imagine this could take the form of a workshop where students prepare potential questions ahead of time and offer each other feedback on them. We also think a more explicit inclusion of the Design Justice Principles as our guiding principles will further embed a community-centered approach.

Goal 3: Find a solution to a technical challenge that works for the end users

Challenge	Implementation Strategy	Outcome
Students struggle with understanding the importance of context in engineering and CS work	Partner Meetings Increased time dedicated to researching context for Background section of report	Increased awareness to contextual issues and how they related to engineering solutions, but difficulty in applying it to their specific project

Students struggle to define meaningful report topics / identify community challenges	The UN's SDGs as assignment framework Focus on a specific community (Mara region of Tanzania)	Continued struggle to define a realistic scope, but more projects were related to engineering challenges

Valuing the product over the process is a common issue in community development projects [14]. The context of the classroom brings with it a constant tension between having to produce something at the end of the unit and remaining open to changing ideas as new information comes in. Students are ever-conscious of their workload and changing their ideas can feel like punishment, the result being "more work." We hope to reduce this tension in the next iteration of the assignment with a restructuring of the written proposal guidelines. Instead of asking students to decide upon one solution and create a plan of work for it, we intend to ask them to spend more time in the report demonstrating their understanding the needs of the community, how those needs are/have been addressed, and then propose two or three solutions in less detail than previously required. Then, should they pursue their project after our course ends, they would necessarily begin with consulting with the NGO regarding which proposed solution merits further exploration.

All that said, as we review informal end-of-project feedback from students, the most common comment was how meaningful they found the project due to the "real world" implications. Knowing that they or another group of students could actually put their proposal into action gave their work more weight and value. Students mentioned feeling more confident in their skills and better equipped to complete a project that has real applications. One student mentioned this project as being the first in their engineering education to ask them to consider finances, climate, and social well-being in addition to calling on their engineering skills.

Advice for Implementing a Similar Project:

Having outlined our personal challenges and success, we'll now move to offer more universal advice for those interested in implementing a similar project.

- **Seek out organizations on campus that can help to facilitate community partnerships**. At our university, we worked closely with the Experiential Learning Network, but Offices of Sustainability or Service Learning might also be well-equipped to help locate viable partnerships and provide students with guidance on how to work effectively with partners.

- **Assemble a team of interdisciplinary consultants.** While the ideal form of this project might involve co-teaching between Engineering and Humanities or Social Science faculty, limitations of time and resources do not always make this possible, and, in our case, the project only spanned one unit in a larger course. Putting together a team of interdisciplinary consultants is an excellent alternative. Realizing that we did not have all of the answers to questions that students might ask, at the start of our project we provided students with contact information for the Director of the ELN as well as the Head

Engineering Librarian on campus. We encouraged students to reach out to these relevant consultants for guidance and support throughout the process. We recommend assembling a list of potential consultants from across departments and divisions on campus, including relevant faculty members.

- **Think expansively about the possibilities for working with community partners.** When collaborating with a community partner, we recommend working with the partner to shape how they prefer to communicate and engage with students. In scaling up this project to include over 200 students, we strived to be mindful of our partner's time and resources. Structured meeting times helped to keep this manageable, but we later learned our partner sometimes preferred responding to questions periodically through a shared Google document. We also recognize that it's not necessary to look to other countries to do this work. While we took advantage of the ELN's work with global partners, this project could also work just as well with a local partner.

- **Encourage students to write reflectively on their work.** In a project like ours, where the end-goal is a stronger appreciation for context and diverse perspectives, providing students plentiful opportunities to reflect on their own learning, on what worked and ultimately didn't work, and how they can take these factors into account in their future projects is essential to achieving that learning goal. These metacognitive assignments might take the form of periodic progress reports where students self-assess their work and make a plan for moving forward, as well as end-of-project reflections that take into account the course learning goals and how they will apply what they learned to their future work.

Conclusion:

We hope this description of the frameworks that have guided us, as well as our assignment's successes and challenges, proves useful for those exploring community development projects in their classrooms. We hope it is especially helpful for educators who are working under constraints of time and resources, or don't have the benefit of being on-site with the community. Ultimately, we think that constant self-reflection on both our part and the students' part is an integral part of cultivating a problem-solving process which values diverse perspectives and factors in contextual factors. Our cross-campus collaboration with the ELN has provided us a unique opportunity to connect students directly with their community partner and practice listening skills not often emphasized in the technical communication classroom or throughout the engineering curriculum. As we move forward with our project, we hope to assess student learning more formally through a qualitative and quantitative study in the upcoming academic year.

Acknowledgments:

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Appendix A

Overview of Proposal Project Schedule

	In-Class Work	Student Deliverable(s)
Week 1	Introduction to project Context setting	Team Contract
Week 2	Conducting research Partner Meeting #1 Considering ethical implications of community development projects	Ethics Memo
Week 3	Conducting research	Drafting Background section of report

	Partner Meeting #2	Progress Memo
Week 4	Continued research and drafting	Full Report Draft and Peer Reviews
Week 5	Group conferences with instructor	
Week 6	Presentations	Final report

Appendix B

Assignment Guidelines:

The Proposal Project: A Collaborative Assignment

For this project, you will work in a team to write a proposal for a real organization that partners with the Experiential Learning Network (ELN) at UB. As a genre, proposals are often relevant for engineers and computer science professionals in the workplace, and this project will allow you to explore the impact of engineering solutions in global contexts.

This project also offers any interested students a unique opportunity to continue this work in undergraduate research with the ELN once our course is finished. Some of your projects may be used by the ELN as work that future students can build on. You can, of course, simply complete the assignment for our course; however, the "real" nature of this project has exciting implications for any who are interested.

The Genre
A proposal is a genre that requires research and planning. In order to get approval (and possibly funding), a clear plan that demonstrates the authors are knowledgeable is essential. Your task will be, more specifically, to propose a project to the Hope Revival Children's Organization, an NGO located in the Mara region of Tanzania. Your proposed project should contribute to their work in one of the UN's Sustainable Development Goals relevant to them in a practical and meaningful way. The Background Document will outline more details about the organization and the SDGs of highest concern.

Once you have explored the NGO and the SDG of interest, you should think about what your project's deliverable will be (what will you propose to produce for them). Bear in mind that a proposal is essentially *a plan,* a very detailed plan which breaks down the steps one needs to take in order to produce something, calculates a budget needed to do the project, creates a timeline for the project elements, and gives the reader a sense of the writers' qualifications.

The Audience
The primary audience for your proposal is Stephen Marwa, the co-founder and executive director of Hope Revival Children's Organization. The Background Document will provide you with more information about his organization and how student projects can provide practical and meaningful contributions to their work.

However, most reports in engineering have multiple audiences. This is also true of this assignment: in addition to thinking about HRCO and Stephen Marwa, you need to consider two other audiences: **(1) The Experiential Learning at UB**. The ELN would be providing any students who pursue this project the support and funding to do so. **(2) The next students** who will take your project and bring it into fruition. These students might be you or other engineering/CS students working in the ELN to extend your ideas and framework. You'll want to keep in mind how important a specific proposed plan is to their success as well.

Panel of Experts
As you put together your proposal, you will have questions concerning your research or about the HRCO. We have a panel of experts available that you can consult with as you complete this project.

Mara Huber**,** *Director of the Experiential Learning Network, Associate Dean for Undergraduate Research and Experiential Learning*
> ➜ Contact Dr. Huber for questions specific to the NGO, the region, or the ELN.

Erin Rowley**,** *Head of Science and Engineering Library Services, Engineering Librarian*
> ➜ Contact Ms. Rowley with questions related to research.

Amy Baird/Lauren Kuryloski*, Course Instructor*
> ➜ Contact your course instructor for questions related to the proposal genre, elements of the assignment requirements, or if you're unsure who to contact.

Overview of Project Elements
This project includes multiple assignments to help your team successfully collaborate and communicate with your primary audience, in addition to producing the formal written proposal and final presentation. These include:

> ➜ Team Contract
> ➜ Ethical Considerations Memo
> ➜ Progress Report Memo
> ➜ Written Proposal

➔ Formal Presentation

Written Proposal Content Requirements

1. Letter of Transmittal
   This letter will be the very last piece you write. This is a cover letter which addresses what may happen next with your proposal. Address it to Dr. Mara Huber. Do any of your team members intend to continue this work by working with the Experiential Learning Network after this? If so, say so here. If not (or if you're not sure), you'll want to assume that another group of engineering students may pick up your project to further develop it by working through the ELN. In one to two pages, give a summary of the project, describe the current gaps in your design or knowledge, describe the strengths of your project, and make recommendations for the next steps.

2. Title page
3. Table of Contents
4. List of Tables and Figures (if more than four)
5. Summary
   The summary is crucial, because it might be the only item that some read in their initial review of the proposal. The summary covers the major elements of the proposal, including the total cost, but devotes only a few sentences to each. Define the problem in a sentence or two. Next, describe the proposed program and provide a brief statement of your qualifications and experience. The executive summary should be approximately one page in length.

6. Introduction
   Begin with a brief statement of the purpose of the proposal, providing a brief summary of your project and the sustainable development goal you plan to address.

   Following this, provide a preview of your proposed plan by including your list of proposed tasks your team will perform.

   Conclude this section with an advance organizer for the rest of your proposal. (You might use the structure such as, "In the following sections, we provide……").

7. Background
   In the background section, you should be sure to address the following:

- A description of the SDG that your project works to move forward. What targets does your project address specifically? Remember that the NGO has outlined the SDGs which are most applicable. Choose **one** to focus on.

    - SDG 4: Quality Education
    - SDG 5: Gender Equality
    - SDG 6: Clean Water and Sanitation
    - SDG 7: Affordable and Clean Energy
    - SDG 9: Industry, Innovation, and Infrastructure
    - SDG 17: Partnerships for the Goals

- A description of the NGO. Demonstrate you understand their goals and the work they've already done in your area of interest. Connect their work to the SDG of focus.

- A description of your proposed project idea (hereafter referred to as the "deliverable"). In addition to describing what it is, explain how your project aligns with the SDG goal and how it addresses one of the NGO's needs.

- A description of the context (social, economic, and environmental) which influences your approach to this project. Cite credible research here.

- Project Impacts. Describe the benefits of your project for the NGO and the benefits for your own academic or professional goals. Your project should provide a practical and meaningful contribution to the work of the NGO.

8. Proposed Tasks/Plan of Work
   In this section, building off of what you already know (citing credible sources where applicable), you will describe your plan for completing your project.

   You should divide your plan into clear tasks that you will accomplish. Be specific, and justify why each task is necessary. Every word you say—or don't say—will give your readers evidence on which to base their decision as to whether to fund your proposed project.

   What information will you need to gather? Justify why you need this information, and how it will help inform your project.

   ➔ Will you need information from community members? Does it make sense to propose a survey or interview with community members or those who work at the HRCO?
   ➔ Will you need to gather research from journals, books, newspapers, or other online sources?

➔ What preliminary research have you done that informs these tasks?

Who might you consult along the way? Be specific: who, and why them?
   ➔ Faculty experts at UB?
   ➔ Staff experts from the ELN or the library?

What other tasks will need to be completed? How can you break down the process of putting together your deliverable? What preliminary research have you done that informs these tasks?

Conclude the section with the discussion of the deliverable of your proposed project. After you have completed the research you describe, what do you **anticipate producing** for the HRCO?

9. Schedule
   You will need to create a schedule demonstrating how long this project will take to complete. Is this something that could be completed over the summer? Will it take an entire semester or more? Choose a timeframe that you think is reasonable. Present your schedule logically and clearly, showing when you plan to complete each of your proposed tasks. Use a **table** or a **Gantt chart** to organize your tasks visually for the reader.

10. Budget
    You may be granted funding up to $750 by the ELN. If you need these funds, you will need to put together a budget for your proposed project. What will you need in order to effectively complete your plan of work and create your deliverable? Briefly justify why any items are necessary and provide citations for where you estimated costs from.

    If you think your project will require fundraising efforts, you can detail that activity and include it within your proposed tasks because it is not money you are requesting.

    Present your budget clearly and visually (such as in a table).

11. Qualifications
    After you have described how you would carry out the project, show that you can do it. Summarize each person's background and highlight past experiences doing research, collaborating, volunteering, and anything else that may demonstrate your ability to successfully complete this project.

12. <u>Conclusion</u>
    Sum up your proposal and provide readers closure by restating the main points of your proposal one last time. Reaffirm why your proposal should be selected and authorized to perform the work, and the benefits that the project, when completed, will yield.

13. <u>Glossary (if needed; indicate glossed words in text by an *)</u>
14. <u>References in APA format</u>
15. <u>Appendixes (if any)</u>

Written Proposal Evaluation Metrics

Proposals will be evaluated according to the following criteria:

<u>Audience Awareness</u>: The proposal is clearly tailored for its primary audience. The background section clearly describes how the proposed project takes the audience's local context into consideration.

<u>Genre Conventions</u>: The proposal demonstrates the authors' understanding of the proposal genre by providing clear descriptions of their proposed work, a clear and reasonable budget and schedule, and relevant qualifications to succeed with a student project. The writing is professional and high-quality.

<u>Ethical Impact</u>: The proposed project plan demonstrates a clear understanding of the value of diverse perspectives and community engagement. The deliverable is a meaningful contribution to the NGO's work.

<u>Document Design</u>: The paper is well-designed, resulting in a user-friendly and readable document with clear attention to the principles of design: descriptive headings, active white space, consistent alignment, effective use of visuals, etc.

<u>Credible Research</u>: All sources are correctly cited within the text and on the reference page. The research used is credible, sufficient, and appropriate for the context.