Engagement in Practice: Innovating a Project-Based, Community Engaged Course for Engineering Students that Fosters Ethical Thinking

Prof. Tucker Krone, Washington University in St. Louis

Tucker Krone joined the faculty in the McKelvey School of Engineering at Washington University in St. Louis in 2017. He teaches statistics, ethics, publication writing, communication, and community engaged courses. Tucker emphasizes engineering and statistics as forces for equity and social justice. Tucker Krone's current passion focuses on integrating community engagement, social justice, equity, diversity and inclusion into both technical and non-technical engineering courses. In addition to teaching courses, Tucker is a member of the PhD Student Professional Development group within the McKelvey School of Engineering. Tucker's background as a WashU BME alumna inspires him to stay involved on campus; Tucker loves WashU so much, he decided to come back and teach! He hopes to inspire and motivate the next generations of engineers.

Prof. Seema Mukhi Dahlheimer, Washington University in St. Louis

Seema Dahlheimer is a Teaching Professor in the Division of Engineering Education and Assistant Director of the Engineering Communication Center at the McKelvey School of Engineering at Washington University. She teaches Technical Writing, Reflective Writing in Medicine and Healthcare, Engineering Leadership and Team Building, and Engineers in the Community, among other courses. She believes that education can be a force for liberation and freedom, and through engineering, we can build a more just and equitable world.

Sandra Payton Matteucci

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Abstract

The killing of Michael Brown in Ferguson, Missouri (a suburb of St. Louis) catalyzed the *Black Lives Matter* movement, underscoring the need for students to explore how privilege and systemic injustice have physically, racially, and economically impacted communities. Many undergraduate students are unaware of local disparities and develop cognitive dissonance: engrossed in academic routines, they lose sight of the real-world implications of their studies. Therefore, exposing students to the local community and illustrating their role in societal change is paramount to enriching their sense of ethical responsibility, equity, and diversity. *Engineers in the Community*, created in 2016, was an immersive spring break course that exposed undergraduate biomedical, chemical, environmental, electrical, and mechanical engineering students to systemic problems in St. Louis, showcasing how their engineering skills apply to these challenges with inspiration from speakers who embodied leadership and explored themes of ethics and (in)equity. However, the COVID-19 pandemic necessitated a shift from this community-connected approach to a semester-long project-based model where students collaborated with local partners advocating for equity, ethics, or environmental improvement. As in-person instruction resumed, we integrated the immersive spring break experience with the semester-long community-partnered project, creating a community-engaged course that builds student empathy for diverse peoples through interaction with community partners. The projects mutually benefit students and partners, help address systemic inequities, and foster ethical mindsets. Drawing from seven years of community partnership experiences, we have developed a practical framework for sustainable community engagement. We will delve into the nuances of community collaboration, including challenges, strategies for fostering long-term relationships, and methods to prevent partner burnout. It is easy for students to get comfortable in their campus "bubbles"—we have a responsibility as educators to inspire students to see beyond their immediate environment, to encourage students to creatively apply their engineering skills to real-world problems, and to promote cultural competency and equity building.

Community engaged pedagogy

Community engaged teaching and learning, an asset-based approach to what is also referred to as service learning, focuses on engaging with the community in a mutually beneficial way. Too often, educational institutions uphold hegemonic norms and the status quo. Howard et al. describe that "education has reinforced structures of disadvantage rather than challenging such structures," adding that "education appears to maintain rather than change broad social and economic structures" [1, p. 2]. Carpini and Keeter describe service learning as "a collaborative effort to address a community problem" [2, p. 635]. Building off of Gervasoni et al.'s [1] and Carpini and Keeter's [2] social justice lens—though they use the language of *service learning*—we have chosen the term *community engagement* rather than *service learning* to emphasize the mutual benefit of the community and the students and to avoid the more deficit-based perspective that *service learning* can sometimes suggest (i.e., white saviorism).

When conducting any community-engaged projects, we must consistently strive to avoid pitfalls, considering the ways our pedagogical approach might unintentionally cause harm to the community or the students. Chupp and Joseph describe some of these possible negative effects: "Some service learning experiences may actually reinforce negative or counterproductive attitudes among students. Many efforts fall short of maximizing the potential social change impact of the service and learning activity" [3, p. 190]. This illustrates harm in multiple ways—having students walk away with a deficit perspective about the community, as well as having an impact on the community partner that is either minimally helpful or not helpful at all. Further, we must consider our impact on students from marginalized communities. We approach this work with an aim to actively dismantle systems of injustice, or with a lens of what Coles-Ritchie et al. [4] describe as *critical community-engaged pedagogy*. Coles-Ritchie et al. further explain that "well-intentioned, or 'benevolent' service-learning projects can be more insidious [than] overt bigotry" [4, p. 3]. Considering Paulo Freire's idea of true dialogue [5], we approach community engagement—discussions between instructor, student, and community partner—by questioning ourselves, encouraging students to see community knowledge and ways of knowing as just as valid as traditional educational structures, and sharing in mutual learning.

In a white paper about STEM education, Harkavy et al. [6] describe the importance of community engagement in solving societal problems; they propose an iterative approach that emphasizes full inclusion, suggesting that "universal problems...are manifested locally" [6, p. 1]. Indeed, we focus on the St. Louis local community as a case study, encouraging our students to approach community-engaged projects with an attitude of skill-building. And Kezar and Rhoads, in addressing critics who suggest that community-engaged projects belong in co-curricular spaces rather than as part of formal courses, describe that education "must develop students as whole individuals," adding that universities' missions often include citizenship or social responsibility as tenets [7. p. 164]. Mbah, describing meaningful community engagement in an international context, reminds us that community engagement should be "predicated on targeted collaborative engagement frameworks, underpinned by mutual trust" [8, p. 11].

Finally, Kimball and Thomas describe four institutional prototypes: "exploitative, contingent, contributive, and transformational" [9, p. 19]. This continuum is fluid, and there are many times our students' projects or experiences fall short of transformational and are more contributive or even contingent. At the very least, we hope our students' and community partners' experiences are not exploitative. However, in this paper, we present a framework that aspires toward the transformational—for both the students and the community partners.

Course background and evolution

The first offering of Engineers in the Community centered on an intensive curriculum over Spring Break 2016 in Ferguson, Missouri, one of the flashpoint cities of the *Black Lives Matter* movement. We selected speakers that embodied leadership in the community and explored broad themes of ethics. In this course, we exposed undergraduate engineers to systemic problems in the St. Louis region, encouraging them to apply their engineering skills to these challenges. Before 2020, this course was community-connected, and students found it impactful to (1) get outside of

the “campus bubble” by visiting locations around St. Louis, and (2) meet people from our community. The Covid pandemic rendered both of these transformative aspects impossible. In response, we drastically reimagined this course as community-engaged, project-based, and more fully integrated into our broader community.

In 2021, we reimagined this course with depth in mind. In groups of 3-5, students completed semester-long projects with community partners, and presented their work at the end of the semester. The community partners included a local advocacy group focused on guiding the EPA with the West Lake Landfill nuclear waste site cleanup, a legal advocacy firm focused on reforming the justice system in St. Louis, a social-focused business incubator, an environmental organization, a housing equity organization, and an education equity group.

In 2022, we designed this class to bring together the breadth of in-person instruction during an immersive week and the depth of experience gained from projects for community partners. We learned that having our students work with community partners on semester-long deliverables deepened their investment in the community and added value to local partners. So, we brought back the immersion week to expose students to local equity issues while continuing the projects.

Because teams struggled to meet consistently, in 2023 and 2024, we added a Monday night two-hour class session to facilitate team meetings. The class sessions are broken into one hour of content delivery/guest speaker and one hour of group check-ins, where the instructors help resolve conflicts and check on teams’ progress. We cover many topics related to meaningful community engagement: conflict management, working with community partners (presented by Engineers Without Borders), team dynamics, stereotype threat, implicit bias, white saviorism vs system change (presented by a local partner), ethics through the lenses of technology as a method of humanitarian aid, and review of student work. The weekly class sessions help students develop teamwork and community engaged skills, resolve interpersonal conflicts early on, and scaffold their work and their knowledge in preparation for the immersion week and beyond.

Sustainable community engagement framework

We strive to balance our goals of exposing students to the local community, adding value to equity-focused local organizations, and not causing harm to any of the stakeholders. Mutual benefit for both the community partners and the students is the foundation of our relationship building practices, as shown in Fig. 1.

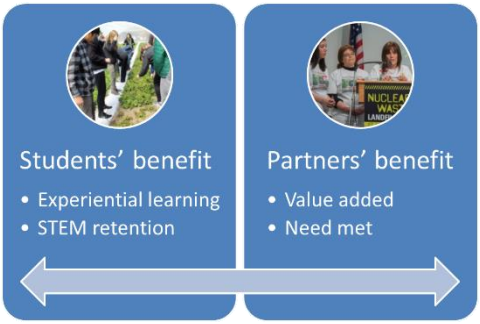

Fig. 1. Foundation of community partnership building. Community partnerships are grounded in mutual benefit for the students and community partners to enrich both parties.

Students deepen learning when they experience how their STEM education translates into the community because that allows them to embody being researchers and engineering professionals. Community partners have value added to their organization through the students addressing an unmet need. Bidirectional benefit grounds the practical framework of how we create sustainable community partnerships through the process of partner identification, communication, placement, rotation, and retention, as shown in Fig. 2.

Fig. 2. Practical framework for mutually beneficial community partnership building.

The first step to community engaged work is to **identify partners**[1] that meet the learning objectives of the course, that contribute to students' learning, and that benefit by engaging with the course.

- Benefits for students can include exposure to real-world topics outside of the classroom, experiential learning, opportunities for out of class follow up, inspiration to stay in STEM, networking, and project-based learning.
- Benefits for partners can include exposure, networking, financial compensation, and student-led projects that add value to their organization.
- We have identified partners through internet searching, cold calling, meeting at social or professional events, connecting through peers, and accessing our personal networks.

Once a partner is identified, we need to **communicate** to onboard them. Emails work well for initial introductions, but we encourage phone or video calls to be able to share more details about the course needs and the benefits we can provide. Key to this interaction is that we are partnering with our community partner, building a shared agenda and seeking to truly understand their goals and needs.

- When onboarding a new partner, we assess the partner's bandwidth (if they can mentor students or just offer an hour to speak), the partner's needs, the students' ability and skills, the partner's alignment with learning objectives, and the course timeline.
- Through partner identification and communication, we keep track of their organization, connections we have with them, contact person, preferred method of communication, mission and content area of the organization, what knowledge and cultural assets the partner brings, and whom the partner helps.

Through the onboarding communication, we then **place** the partner on the spectrum of community connection to community engagement by identifying the way they will participate in the course. Community-connected actives are one-time events that have a low demand on the partner, where the partner benefits from financial compensation and networking with the students. Community-engaged activities are sustained semester or multi-semester partnerships that involve a high demand on the partner, where the partner benefits from student-based

[1] Because we serve biomedical, chemical, environmental, electrical, and mechanical engineering students, we need to diversify our partners to represent topics that are relevant to each major.

deliverables that meet a need that the partner cannot otherwise address due to financial, time, labor, or resource limitations.

- Community connection can look like guest speaking, site visits, tours, and field trips.
- Community engagement can look like semester or multi-semester projects where the partner mentors a group of students through regular meetings and feedback opportunities as the students complete a project for the partner.

Once a relationship is built, we consider **rotating** partners among community-connected activities, community-engaged partnership, and taking time off from partnering. We balance the academic needs of our students and the realistic demands on community partners by identifying where everyone's capacity and needs intersect. Rotating community partners helps to prevent burnout by giving partners a chance to decrease the demand on their time.

- Community partners may ask to increase, decrease, or disengage their engagement.
- We may ask partners to engage in different ways based on partner and student feedback.
- We may rotate out a partner based on project success, student experience, and diversity of partners for any given semester.

We keep a record of every former partner's contact information so we can sustain communication and **retain** them, even if we do not partner over a given semester. Inviting former partners, potential partners, peers, members of the community, community connected partners, and community engaged partners to poster sessions and final presentations where we serve food builds a lasting sense of community and increases long turn support for our course.

The main challenge when working with community partners is communication. Therefore, it is paramount to keep a robust database of the partners' information from onboarding and your communication thread or meeting minutes. It is important to pick up the phone sooner rather than later if we or the students are having issues connecting with the partner. Phone calls tend to have quicker responses than emails. Similarly, having multiple connections at an organization helps to allow someone else to mentor or present to your class when issues arise.

When other issues arise, the success of this type of engagement depends on addressing these issues productively. In the past, we have had challenges such as a community partners being unable to continue mid-semester, the students in a team having differences that they cannot reconcile or feeling unsafe with their group, a student disappearing from the group and disengaging from the class, a community partner changing the parameters of a project to where it no longer benefits the students, and the students and community partner not having the same vision of the project. In all of these issues, timely communication with strong facilitation skills has been key to keeping these projects moving, partnerships positive, and relationships retained.

Flexibility is a necessity, whether you are doing an immersion week, having guest speakers, or doing community-engaged partnerships. Partners are humans; they will cancel, be late, ghost you, or life will happen (like a pandemic). It is important to have back-up partners, have alternate ways to cover course content (like movies), and keep calm in front of students. If possible, you can leverage personal connections or colleagues for last-minute replacement speakers.

For immersion experiences and sessions where you invite the community, we recommend having local food from women- or minority-owned businesses. The students enjoy being exposed to restaurants they may not readily patronize and supporting local restaurants shows the community you are invested in their success. Weaving an equity mindset into the food, products, and practices you use shows them how to engage positively with the community as a patron.

Impactful community-engaged projects

Table 1. Examples of student projects (from https://sites.wustl.edu/engineersinthecommunity/)

Community Partner	Project Description
JustMoms STL – Environmental justice	Students created a website showing EPA's levels that are defined safe for toxic chemicals in different types of sites (rural, industrial, etc.). Taking information from the EPA's documents, these students created an easy-to-navigate site. Communities around the country are now using this website so they can advocate for themselves.
Challenger Learning Center – Education	Students created a portable hovercraft for Challenger Learning Center, so that staff could transport it to K-12 schools and community centers for STEM education events.
KidSmart – Education	Students developed data models to determine centralized locations for teachers to receive free school supplies. Using data from the Department of Elementary and Secondary Education, they considered percentage of students on free and reduced lunch and population density.
Home Sweet Home – Housing	Students developed a portable and adaptable ladder to allow staff members to safely access home furnishing for recently housed individuals.
T-REX – Community spaces	Students generated the schematics of the 6^{th} through 8^{th} floors of a large downtown building that serves as a business incubator. Their schematics allow T-REX to better showcase available spaces to prospective startups.

Conclusion

When community-engaged work is grounded in mutual benefit for both the students and the community partners, the benefits for both can be very impactful. For example, a student project led to an investigative journalism piece that inspired national legislation. For students, we hear quotes like, "I think of the 'takeaways' from this class ought to be 'what can I do to effect change in my community as an engineer?'" Mutual benefit can only be sustained while the gains for the community partner outweigh the costs. Community connections, engagements, and partnerships allow students to witness the impact STEM has on stakeholders outside of the classroom. Community partners enrich student learning through experiences ranging from guest speaking to mentoring. Regular instructor communication with partners helps to evaluate where in the process (identification, communication, placement, rotation, and retention) each partner should be. We should reevaluate and adapt the way each partner can participate across semesters as organizations' needs evolve. Community-engaged work aims to expand student learning and meet the needs of the community. The goal, ultimately, is to move beyond the partnership being merely transactional, but rather, towards being transformational.

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