# Integrating Environmental Justice into Civil and Environmental Engineering Curricula

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Abstract

It is well established that communities of color experience disproportionate exposure to environmental contaminants producing negative health outcomes and undue environmental justice challenges. Many of the exposures and infrastructure inequalities are legacies of residential racial segregation, such as redlining and underbounding. While the environmental justice movement has made great strides in incorporating public health research into these issues, there has been less effort focused on integrating environmental engineering training into the movement. This paper describes research on developing and implementing a suite of integrated, interdisciplinary, community-engaged, anti-racism training opportunities for civil and environmental engineering undergraduates to build capacity for addressing environmental justice challenges. For this project, we integrate environmental engineering, applied anthropology, and Science Technology Engineering and Mathematics (STEM) education to redesign existing civil and environmental engineering courses to include equitable development within a particular community. The redesigned curriculum provides broader educational training to address environmental engineering challenges, meets community identified needs, and considers the impacts of structural racism. Collaborations between university researchers and community leaders and members led to an expansion of community-based research in civil and environmental engineering. This project studies the impacts of the new curriculum on student perceptions of racism and justice and on faculty interest and capacity for catalyzing additional curricular and co-curricular change. Initial collaborations from the community-based research have included diverse communication tools to share information with and about the community.

## 1. Introduction

The U.S. Environmental Protection Agency (US EPA) was established to, among other things, ensure that: 1) all Americans are protected from significant risks to human health in the environment where they live, learn, and work; and 2) enforce federal laws protecting human health and the environment. Despite this effort, low-income communities, particularly those of color, still experience disproportionately negative impacts from environmental contaminants when compared to low-income white communities (Cutter, 1995; Taylor, 2000; Bullard, 2001; Maantay and Maroko, 2009) due to unequal exposures to environmental stressors such as soil, air, and water pollution (Bullard, 2001; Wilson et al., 2008; Fan et al., 2019). Environmental justice emerged in the 1980s as a movement and a framework to address these challenges, especially in communities with a history of residential racial segregation (Holifield, 2001).

More recently, professional societies are increasingly aligning research aims with Environmental Justice Principles (Van Horne et al., 2023). Within academia, there has been increased efforts to engage communities to address local challenges related to environmental injustices. The National Academies of Science Engineering and Mathematics' (NASEM) *Environmental Engineering in the 21st Century: Addressing Grand Challenges* states, "A new model for environmental engineering education is needed to support the development of more innovative, creative, and

effective problem solvers" (NASEM, 2019). That model demands a "broader approach to education" recognizing that "interdisciplinary, experiential learning equips students to consider how myriad factors such as budget constraints, historical context, public acceptance, and regulatory frameworks affect the design and implementation of technological solutions to societal challenges" (NASEM, 2019). There is also a resurgent awareness among American and global youth of careers that positively address the connectivity of the environment, the economy, and society (Moore, 2014, Deloitte, 2020). Environmental and civil engineering creates innovative tools to address local, regional, and global environmental problems (ABET, 2022).

In 2006, the University of South Florida (USF) was one of the first universities to earn classification as a Carnegie Community Engaged University (Driscoll, 2008), a designation that relied heavily on the partnerships between USF, the City of Tampa, and the historically Black East Tampa community. East Tampa is a 7.5 square mile Community Redevelopment Area in Florida comprised of multiple historically predominantly African American neighborhoods with approximately 40,000 residents. It is characterized by low incomes, high unemployment rates, and high rates of food insecurity (EJ Screen, 2024). Redlined during the 1930s, a long legacy of housing discrimination persists. Researchers and filmmakers have quantified and visualized the importance of the narrative of Black lives in East Tampa, and their spirit of resistance, resilience, and survival against the backdrop of deprivation from the loss of businesses, homes, communities, and schools (Rodriguez, 1998; Shircliffe, 2002; Alishahi, 2003; Bell, 2017; Rodriguez and Ward, 2018). A study by USF geographers (Chakraborty and Bosman, 2010) reported that inequities in the social and spatial distribution of environmental hazards and risks adversely impact the health of East Tampa residents. The study demonstrated that East Tampa residents are unevenly exposed to abandoned hazardous waste sites, wastewater discharge facilities, air pollution from stationary and mobile sources, and industrial toxic emissions. Brownfield challenges include eight former landfills, 411 historical auto stations, and 263 historic dry cleaners. In 2007, the Environmental Program Management Division of the Solid Waste Department declared that 36 of the City's 52 most problematic dumping sites are in East Tampa. This equates to tens of thousands of cubic yards of trash dumped illegally in East Tampa neighborhoods each year. Finally, the U.S. EPA's EJScreen tool shows that the community is at or above the $90^{th}$ percentile (both statewide and national) for all environmental justice indicators, including wastewater discharge, diesel particulate matter, and hazardous waste proximity.

Our National Science Foundation IUSE grant entitled "Working to Eradicate Racism in Science and Engineering" (WeRISE) is dedicated to addressing the gap in sustainable engineering, community-based research, environmental justice, and civil and environmental engineering education. The primary focus is to transform civil and environmental engineering (CEE) undergraduate education and community-engaged research in East Tampa into a tool for environmental justice and community-based change. This research integrates Civil and Environmental Engineering (CEE) faculty at USF and the University of California, Berkeley (UCB) with other faculty from the departments of Anthropology, Educational and Psychological Studies, Curriculum, Instruction and Learning, the Institute on Black Life, and the USF Office of Community Engagement. Our community partners are organizations and residents of East Tampa, the Corporation to Develop Communities of Tampa Inc., the East Tampa Community Revitalization Partnership, and the City of Tampa. These organizations are committed to training individuals for workforce development in the Tampa Bay Region, establishing community

gardens, and supporting a local government agency to plan and organize community revitalization projects. The goal of this research is to develop and implement interdisciplinary, community-engaged, anti-racism training opportunities for civil and environmental engineering undergraduates at USF and UCB to build capacity for solving the complex and interconnected challenges of our time. The research questions associated with this work are:

1. How can civil and environmental engineering courses and curricula effectively focus on equitable development within historically marginalized Black communities while providing broader educational training to address grand environmental engineering challenges and meet identified community needs?
2. In what ways do CEE students perceive environmental justice and building sustainable communities in partnerships with Black communities?
3. What are CEE educators' and community leaders' perspectives of professional development focusing on anti-racism in STEM, and how do they utilize the knowledge gained within their enacted curriculum?

## 2. Methodology

### 2.1 USF Community Engagement Model

Long-term relationships have been established with the East Tampa community and the faculty at the University of South Florida in the Department of Civil and Environmental Engineering and the Department of Anthropology for close to two decades. These long-term relationships have increased and expanded community engagement for researchers, students, faculty, and staff (Figure 1). At this level of engagement, faculty and staff can sustain long-term relationships and partnerships with communities based on their longevity. These partnerships (community members and faculty) work intensely on issues over years which lead to economic opportunities and resources that flow into the community through grant funding. The next level of university engagement with the community is through postdoctoral, graduate, and undergraduate researchers. This level of engagement can span over years but has a more definitive timeline that reflects the researcher's tenure at the university. At this level, faculty members can tailor meaningful projects for researchers over a set period. The last and broadest level of participation is short-term engagement through undergraduate and graduate courses. For short-term engagement, students participate in community-based class projects for one semester or can take elective courses that offer community-based research. With short-term engagement, students apply concepts of community-based research. This participatory approach serves as an opportunity for students to conduct research and advance into mid-term engagement opportunities (Figure 1). These levels of engagement provide a more diverse audience that is engaged in community-based research and students gain a greater understanding of contextualized environmental injustices. This model purposefully draws together environmental justice tools and community-based research. Collaborative work between communities and universities integrates academic ("authoritative") and community ("local") knowledge, with an emphasis on community experience and perception (Lehigh et al., 2020). Other research has shown that place-based learning helps students to engage in environmental research on a deeper level (Haywood, Parrish, and Dolliver; 2016; Raphael and Matsuoka, 2024). Long-term engagement in communities through coursework has also aided in students' comprehensive understanding of infrastructure problems and inequities (del Puerto et al., 2019).

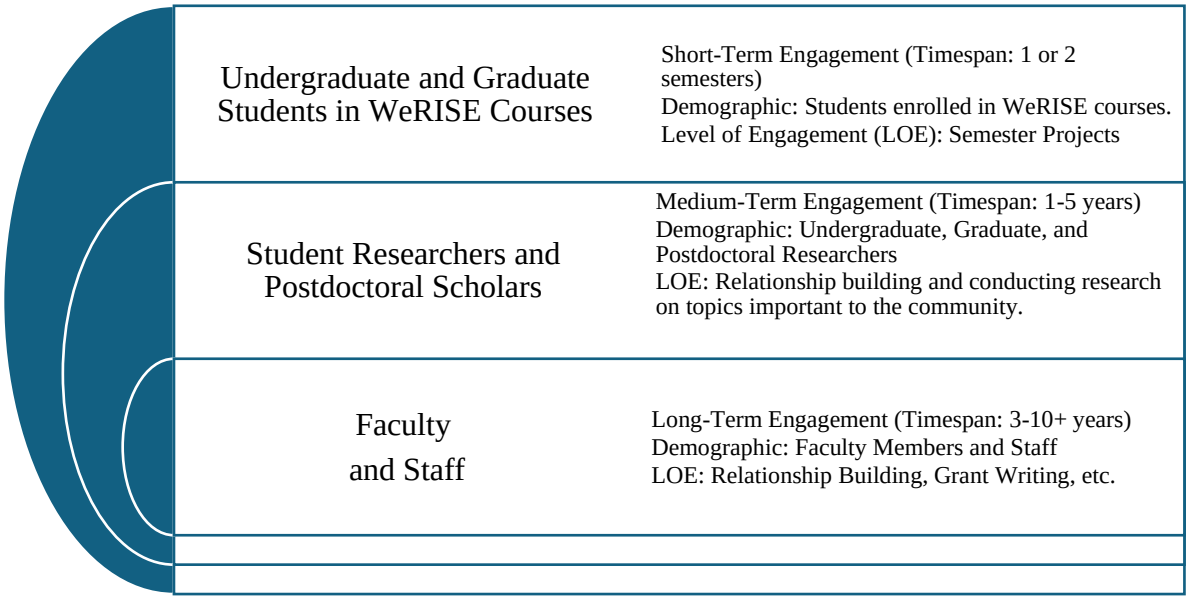


Figure 1. CEE Model for University Levels of Engagement in Community Based Research.

2.2 Student and Faculty Reflections

Envision Sustainable Communities was the CEE course and Environmental Justice was the Anthropology (ethnographic) course offered within the WeRISE program. Both WeRISE courses were co-lectured by a tenured faculty and a postdoctoral researcher. These courses introduced students to ideas of environmental justice through the lens of structural racism and experiential learning through community-based projects. Students participated in an Institutional Review Board (IRB)-approved study throughout each semester in each WeRISE course. Students were surveyed about their perceptions of environmental justice, community engagement, and structural racism, as well as their overall professional development. As part of the WeRISE focus, a faculty workshop was held to introduce environmental justice and community-based research to CEE faculty. At the workshop, faculty reflected on environmental justice and the potential of inclusion in their respective course curricula.

## 3. Results and Discussion

3.1 University and Community Partnerships

WeRISE community council members provided guidance at the inception of the project. Community council members are leaders from local organizations (Corporation to Develop Communities of Tampa Inc. (CDC of Tampa Inc), East Tampa Community Revitalization Partnership (ETCRP), and a wastewater treatment plant operator that partnered with the WeRISE grant. The community council recommended that the university project team listen to and capture the oral histories of people from, and/or living in, East Tampa. The elders from East Tampa were identified as an important demographic. Oral histories were then incorporated into the Environmental Justice course. These histories became an integral part of the short-term student involvement projects in the Environmental Justice course.

3.2 Environmental Justice Seminar

Environmental Justice (EJ) is an anthropology-based course where students were able to delve deeper into case studies and community-based research projects throughout the semester. The primary goal of the course was for students to learn about environmental justice with practical experiences through community-engaged research. In the past, the EJ course worked alongside other communities in Florida such as the University Area Community in Tampa and Tallevast (Lehigh et al., 2020; Alexander et al., 2021; Caballero et al., 2024; Vidmar et al., 2023). In this course, students considered how race, class, and politics intersect in the unequal distribution of environmental hazards across communities, how communities of color often experience a disproportionate burden of environmental pollution and its negative health consequences, and how these factors impact — and are impacted by — Federal and State environmental laws and policies. The course sought to cultivate among students a critical environmental justice perspective — a holistic view of how social differences and power shape human-environmental relations. In developing this critical lens, students interrogated the structural and historical processes that lead to environmental crises as well as their own positionality.

To facilitate this awareness, the course centered around a "university/community-engaged" project (pairing a lesser-resourced community with a more well-resourced academic institution), which aligned student learning outcomes with the needs of a community. Learning outcomes were for the students to: 1) learn the history, terms and concepts in the environmental justice movement locally, nationally and globally; 2) learn about environmental injustices in East Tampa; 3) learn how to use investigative methods for environmental justice research; 4) learn how to use archival data, literature, and other resources to interpret local and authoritative knowledge; and 5) create visual ethnographies of environmental justice issues surrounding stormwater ponds in East Tampa.

Environmental Justice was a hybrid undergraduate and graduate course offered in the Anthropology department and listed as an elective for other majors (engineering and urban planning). Throughout the semester, 22 students studied environmental justice from an ethnographic perspective. Students engaged in a seminar style class and learned about history, definitions, case studies, and anthropological methods for environmental justice research. Early in the semester, students interviewed the group of seniors from East Tampa to hear their perspectives on their history of living in East Tampa. Students interviewed 25 residents from East Tampa that were members of the local senior community group, the Jazzy Seniors.

The WeRISE team elicited the assistance of a professional photographer for the first meeting with the East Tampa seniors and students. The photographer created headshots that would later be included in a book with their interviews and given to the seniors. Students also conducted research and made short films on the past, present, and future of stormwater ponds in East Tampa. Following the interviews and their investigative research, students created culminating videos that visualized their research process. The Jazzy Seniors and other community stakeholders in East Tampa were invited to a film screening where students presented their findings. At the film screening, each student group was given feedback from stakeholders on their videos. Following the feedback from stakeholders during the screening event, students updated their videos that were subsequently uploaded to the WeRISE YouTube channel and made available for public viewing (WeRISE YouTube, 2023). An additional outcome from the Environmental Justice course was a professional video detailing the overall goals and objectives of the WeRISE grant and a description

of how the courses and community-engaged class projects were conducted. The following semester, a photo compilation was made of the oral history of the Jazzy Seniors. The photobook contained the Jazzy Seniors from East Tampa portraits with selected quotes from their interviews. The book was well received by the seniors and was issued an ISBN enabling it to be featured and distributed to various libraries.

3.2.1 Pre and Post Class Assessments for the Environmental Justice Course

The majority of students in the Environmental Justice course were anthropology students; however, two engineering students were also enrolled. Overall student assessment responses indicated a basic knowledge of environmental justice and how it pertains to communities, people, organized movements, and the environment (Table 1). At the end of the semester, students were again asked to define environmental justice and reflect on their experiences. Student responses highlighted their comprehension of EJ movements and EJ methods used in communities (Table 1).

Table 1. Themes and Supporting Quotes from Pre- and Post-Class Student Assessments from the Environmental Justice Course.

| Highlighted Themes from Student Responses | Pre or Post Class Response | Student Quotes |
|---|---|---|
| **Student EJ Definition** | Pre-class Response | *When people are marginalized, their voices aren't heard when it comes to being exposed to environmental hazards and risks put forth by corporations and the state. This is environmental injustice. Environmental justice is a movement that attempts to put a stop to environmental injustices and provide for acceptable and comfortable environmental conditions for impoverished and marginalized peoples."* |
| **Methods used in EJ communities** | Post-Class Response | *I learned about underbounding for the first time and came to better understand redlining, methods of EJ (bucket brigades, photovoice etc.), and was encouraged by the work of activists, communities, and anthropologists in creating tangible small-scale change in local communities.* |
| **Historical and Present Environmental Injustices** | Post-Class Response | *I learned about how environmental justice was started with protests in a predominantly [sic] African American town in the 1970s. Despite the fight starting decades ago, there are still many current issues with corporations placing their waste facilities in predominantly black areas. A lot of the [sic] historical areas that faced environmental problems have not been compensated to date.* |

3.3 Envision Sustainable Communities

The Envision Sustainable Communities course covers materials required for the Institute for Sustainable Infrastructure (ISI) Envision Professional (ENV SP) credential. The course covers indicators for five criteria under themes of quality of life, leadership, resource allocation, natural world, and climate and resilience (ISI, 2018). The course objectives were to: 1) review the ISI's Envision Sustainable Infrastructure Framework (ISI, 2018); 2) detail how the Envision guidelines help to meet the Sustainable Development Goals, Environmental Justice, and Environmental Engineering Grand Challenges (NASEM, 2019); and 3) introduce students to community engaged infrastructure projects. The main learning outcomes were for students to: 1) comprehend and adapt ideas on others' perspectives; 2) work within local community contexts; 3) integrate discipline specific knowledge into the contextualized classroom experience; and 4) consider the impact of engineered solutions in local, national, global, economic, environmental, and societal contexts.

The Envision Sustainable Communities course originated during a proposed highway expansion project in Tampa that was criticized for its lack of community engagement (Rodriguez and Ward, 2018). Course expectations were for CEE students to think more sustainably about infrastructure projects, as many CEE students will be responsible for creating such projects in the future. Over the years, the course has changed from focusing on larger infrastructure projects already being implemented by either the county or city, to more community-driven conceptual projects that better speak to stakeholder engagement under Envision's Quality of Life criteria (ISI, 2018). In Fall 2023, the class focused on a local stormwater pond in East Tampa, originally targeted for redevelopment by the community in the mid-2000s. Research and videos from the anthropology course, Environmental Justice, related to the Jazzy Seniors and stormwater in East Tampa was integrated into the Envision Sustainable Communities course. Students were asked to review stories from East Tampa residents and discuss links to built infrastructure. They role-played and led discussions using three stories featured in the book, *WeRISE Jazzy Seniors*. Given the demographics of the Jazzy Seniors, class discussions identified the transportation needs for seniors, accessibility of spaces (especially for persons with limited abilities), the importance of encouraging active sports for both the youth and the elderly, and the need to reconnect community members using public spaces and community buildings to host community events, concerts, and athletic events, all while ensuring the spaces are child-friendly with childcare included.

Instructors also took students on tours of stormwater ponds in East Tampa to demonstrate the differences between accessible beautified ponds and inaccessible fenced ponds. During the tour, students met with a community leader who contextualized the history and vision of the pond. Later in the semester, students were prompted to create conceptualized designs for a stormwater pond on 22nd Street based on community needs that would also enhance safety, accessibility, and space for community gatherings. Students formed groups to develop conceptual designs and then worked on individual project reports to qualify their designs. An environmental justice framework that explores the dimensions of environmental justice was woven into the Institute for Sustainable Infrastructure Envision guidelines (Figure 2) (Raphael & Matsuoka, 2024).

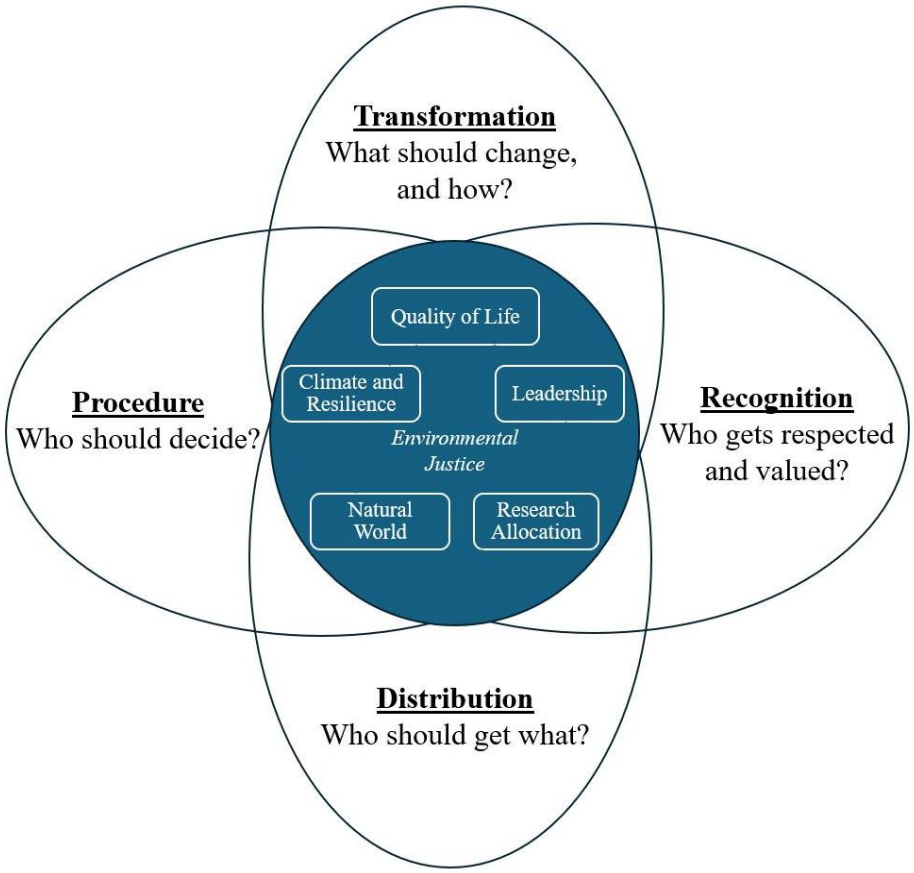


Figure 2. Schematic Detailing How the Four Dimensions of Environmental Justice (EJ) Framework Converge with the ISI Envision Sustainable Infrastructure Categories.

3.3.1 Pre- and Post Class Student Assessments for the Envision Sustainable Communities Course

At the start and end of the semester, students were given assessments asking them to define environmental justice. Their definitions of environmental justice were focused on environmental protection rather than protecting people from harm related to the environment. The concept of justice was applied to the environment, not the people living in it. When students were asked what they learned about environmental justice through the course, the responses noted the techniques they learned in class, environmental justice through an infrastructure lens, and how environmental injustices impact local communities. Students also emphasized the fair treatment of people within environmental justice and infrastructure (Table 2). Students were also able to identify the role engineers play in enforcing inequities with built infrastructure. Student responses reflected their comprehension of the learning objectives, deeper understanding of environmental justice, and infrastructural environmental injustices. Further analysis of the students' assessments will be reported in a separate publication.

Table 2. Pre- and Post-Semester Student Quotes from the WeRISE Envision Sustainable Communities Course Survey.

| Highlighted Themes from Student Responses | Pre or Post Class Response | Student Quotes |
|---|---|---|
| **Environmental Protection** | Pre-class Response | *The process or processes which help protect all environments from unjust, unethical, or damaging practices by implementing and enforcing laws and regulations* |
| **Recognition in Decision Making** | Post-class response | *The importance of defining who is recognized, listened to and awarded power to make decisions is key to achieving EJ.* |
| **Environmental Justice in Infrastructure** | Post-class response | *We learned different ways that built infrastructure can contribute to environmental justice and injustice, and how we as engineers can watch for injustice in our industry.* |
| **Environmental Justice and People** | Post-class response | *Environmental justice can be defined as the idea that all individuals and their communities [sic] deserve equal access to spaces, clean and healthy environments, reliable infrastructure regardless of their race or ethnicity.* |

3.4 Faculty Training Workshop

One of the three objectives around WeRISE is faculty training and curriculum development. A faculty training workshop was held after the first year of the grant. The workshop was aimed specifically at training CEE faculty and consisted of 10 faculty participants from the following CEE concentrations: water resources, environmental, structures and materials, transportation, and geotechnical. The workshop laid the foundation to foster a collaborative environment with faculty on the development of curriculum that focuses on fair treatment and equitable involvement of communities in planning and design of infrastructure. Team members included faculty from University of South Florida, University of California, Berkeley and members of the East Tampa community. The vision upheld through the study and workshop was to design a path that will educate the next generation to re-imagine a future where there are no disparities in infrastructure quality, or environmental pollutant exposure that emphasizes an enhanced quality of living for all. Faculty were introduced to the overall goals for WeRISE and worked through a foundational understanding of anti-racism and how to partner with communities from anthropological and engineering perspectives (Table 3). Following the faculty training, CEE faculty were tasked with incorporating environmental justice into their course curriculum. When participants were asked how they benefited from the workshop, community leaders and faculty stated that they benefited from learning opportunities, empowerment, and networking (Table 4).

Table 3. Faculty and Community Training Workshop Schedule and Associated Goals.

| Workshop Session | Goal |
|---|---|
| **Project Overview** | Initiate knowledge exchange between Civil and Environmental Engineering faculty and members of the East Tampa community. |
| **Anti-racism** | Establish shared understanding amongst participants through definitions, implications, and strategies to promote anti-racism in CEE. |
| **Partnering with Communities** | Increase understanding of some approaches, oral history in particular, to build partnership with community members |
| **Case Studies** | Highlight opportunities for integrating community engagement |
| **Syllabi Updates** | Identify synergies between community led initiatives and Civil and Environmental Engineering curriculum |

Table 4. Faculty and Community Leaders Responses.

| Highlighted Themes from Workshop Participants | Participant Role | Participant Quote |
|---|---|---|
| **Empowerment** | Community Leader | *I didn't think I had anything to offer now I realize I'm [sic] voice is my power and I'm using it hoping we are able to help the community economically.* |
| **Networking Opportunities** | Faculty Member | *It has established a new network for me to connect with in thinking about how to build community-engagement into my teaching and research.* |
| **Activism** | Community Leader | *I'm ready to become a full-time activist believing I can help others get in the field.* |

## 4. Conclusions

Sustained community engagement from the University of South Florida has strengthened collaborative partnerships with residents of East Tampa. These relationships have served to build community capacity for continued interactions with faculty, staff, students, and researchers from USF. With increased funding of infrastructure projects across the U.S. federal government that must address #justice40 requirements, community engaged research and projects can help academic institutions mainstream the types of long-term relationships needed to envision and build sustainable infrastructure. The classes discussed in this paper highlight how Civil and Environmental Engineering students are gaining new capacities to address issues of inequities in design and infrastructure. Future recommendations from this work are to expand sustainability and environmental justice into civil and environmental engineering curriculum throughout all engineering courses, not just courses geared towards sustainability. Environmental justice and sustainability can also be taught and applied to other engineering disciplines with an emphasis on the social justice issues that are relevant to each discipline.

Acknowledgements

This research was funded by NSF Division of Undergraduate Education Grant (#2142714) and NSF American Society of Engineering Education grant (#2127509). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of these agencies. We gratefully acknowledge the Jazzy Seniors of East Tampa for their participation.

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