



Passing Along Experiential and Learned Understandings of Inequality: Marginalized Communities are Shapers of Humanitarian Engineers

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Imparting Lived and Learned Understandings of Inequality: Marginalized Communities are Shapers of Humanitarian Engineers

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Abstract

Humanitarian Engineering (HE) is quickly becoming a prevalent engineering subdiscipline, drawing an increasing number of graduate students to its study. However, little is known about the pathways of HE graduate students, including what influences their interest, admission, and resilience in these programs. In particular, while HE programs strive to recruit and create space for students from marginalized communities (students of color and students from and with ancestral ties to low or middle-income countries), we know little about the experiences influencing these students' enrollment and experience. We use the concept of Familial Capital, within the Community Cultural Wealth framework, to analyze and characterize the ties that marginalized students made between their family and childhood community and their HE aspirations. To better understand these pathways and how familial support systems and cultural funds of knowledge influenced student career paths, we conducted interviews of 47 HE students, across seven programs, of whom 28 were from dominant communities and 19 were from marginalized communities. We found testimony that students' experience with a well-supported and valued stepping stone - field-based infrastructure projects - is mediated by their sociopolitical status and their membership in historically marginalized groups. When circumnavigating this potentially gatekept stepping stone, some marginalized students instead utilized long-standing dialogues with family members for experiential and learned understandings of infrastructure inequality. These long-standing dialogues instilled marginalized students with a supply of encouraging stories and role models, a dedication to relationship building with partner communities, and encouragement to work on grassroots HE efforts.

Introduction

Humanitarian Engineering (HE) graduate programs strive to train students in increasing global infrastructure equality and these programs are multiplying across the United States. Imperative to the success of these programs is sweeping recruitment and resiliency of students across races and nationalities and consequently across the intersections of lived infrastructure instability. Students from marginalized communities carry social, navigational, technical, linguistic, and cultural capacities that enrich HE learning environments for students of all backgrounds, and their minimal presence has been identified as a learning disadvantage by past HE cohorts [1]. Further, HE activists and stakeholders are demanding the humanitarian field decolonize and implement anti-racist structures [2]. A key part of this movement is having members from marginalized communities lead these global reform efforts and organize for social change. To understand enabling conditions for this leadership, this research sought to uncover the support systems, childhood experiences, and points of inspiration that aid marginalized students in enrolling in and remaining resilient throughout their HE education. Thus, we ask:

- 1) Within this study, how does the utilization of field-based infrastructure projects differ between student populations in dominant and marginalized communities?

2) How do marginalized students utilize their family and community in expanding and deepening their knowledge of global wealth and infrastructure disparities.

3) What are some of the implications of familial capital on HE student career pathways.

Humanitarian Engineering

Humanitarian Engineering (HE) education programs are growing in prevalence from less than two accredited programs in 2000 to over 67 in 2020 [3]. HE programs train students to analyze and center infrastructure around the societal impact of engineering [4], the global and societal context of engineering [5], and provide professional skills needed in infrastructure development, such as effectively collaborating with stakeholders across levels of social, ethnic, and nationality privilege [6]. This training can be valuable in efforts to achieve modern-day engineering standards found in the United Nations Sustainable Development Goals, the National Academy of Engineering's Grand Challenges of Engineering in the 21st century, and the Build Back Better legislation [7]–[9].

The expansion of HE programs brings an opportunity to create engineering spaces that are more accessible and valuable to underrepresented groups in engineering. Female students and students of color rank wanting to help people as a significant reason to pursue engineering [10]–[12], and HE clubs, projects, and activities can help to satisfy motivations and desires for social engagement with engineering [13]. Notably, undergraduate courses with humanitarian design projects have stronger retention rates of these underrepresented groups [14], and universities are creating HE programs and design projects in part to increase the recruitment and retention of these students [15], [16]. There are signs that these spaces are becoming accessible and valuable to women; for instance, HE clubs such as EWB have a substantially higher percentage of women (40%) than typical engineering clubs, and many HE cohorts have strong percentages of women [1], [16], [17]. Further, white women have been identified as flourishing in humanitarian spaces [18].

However, scholarship suggests that students of color, and students from low and middle income countries continue to be underrepresented in Humanitarian Engineering. The humanitarian field has been identified as having a “race problem” providing drastically different financial and leadership opportunities for employees across lines of race and nationality [19], [20]. Further activists are highlighting the residuals of HE's missionary, colonial, and genocidal lineage that shape conventions common to the HE field [21], [22]. While there has been increased interest in and reflection of antiracism and social justice activism in Humanitarian Engineering, many diversity, inclusion, and equity endeavors in engineering education remain denounced as shallow and ineffective [23]. Further, HE graduate programs have reported struggling to increase the presence of students from low-income countries [1]. Given that engineering spaces can continue to be hostile environments, where students of color represent 21% and 14% of engineering and science masters and doctorates, respectively [24], we must utilize educational frameworks centered on race and racism to understand the current accessibility and value of HE to the students who continue to be underrepresented.

Introductions to Humanitarian Engineering

There is insufficient research unearthing the learning experiences that influence student pathways towards HE education. In fact, scholars have called for studies that highlight the experiences that promote engineering students' interest and dedication to social justice [25]. Studies have identified field-based infrastructure projects, in which students design an infrastructure project for a community other than their own and travel to implement that project, such as Engineers Without Borders (EWB), as one of the largest HE outlets for young engineers. For instance, EWB has been seen as an intermediate step for socially engaged engineers [26], and an important component of professional HE training [27]. Because these field-based infrastructure projects are one of the most prominent and accessible introductions in HE for undergraduate students, many HE graduate programs provide mentorship and resources to these programs [49]. Further, scholars have found that engineering students perceive community service and/or volunteer activities have increased their sense of social responsibility, such as Boy Scouts, church work, mission trips, Peace Corps, Americorps, EWB, and K-12 outreach within college, among others [28]. Three of the seven universities studied had specific scholarship and outreach programs for returning Peace Corps volunteers, and at least one required a formal profile submitted of past engineering projects for admission. In fact, frameworks used to track student social responsibility theorize that connecting one's moral obligation to help others to the engineering skills that one possess occurs through action, specifically service engagements as engineers [4].

There are reasons to believe some of these common introductions to HE are racially and internationally divided. EWB is almost entirely hosted by predominantly white institutions, with only one HBCU, Howard University, initiating a club in 2014 [29]. Further, there are no systematic processes connecting universities in low and middle-income countries to EWB. While African Americans and Latinos make up 13% and 20% of students in college, respectively, they comprise 5% and 10% percent of those participating in study abroad activities [30]. For instance, of Peace Corps volunteers, 6%, 8%, and 13% percent are from Asian, Black, and Latina backgrounds, respectively, and this opportunity is not available to non-US citizens [31]. Moreover, studies have found that marginalized students are less likely than other groups to participate in out-of-school or extracurricular activities [32], [33].

The Community Cultural Wealth Framework

Given that HE programs aspire to include a diverse student body, we sought to analyze the support systems and introductions to HE that are important to marginalized students. Within this paper, we draw upon the community cultural wealth framework, which is used to organize the cultural capital that supports marginalized student's aspirations towards, and survival in, higher education [34]. This is an assets-based theory born from Critical Race Theory tenets and is used to organize and highlight the cultural resources passed to marginalized students from their families and communities, making these students particularly valuable to engineering communities. By illustrating the cultural capital of marginalized students, we can better understand in what ways the recruiting, community, and curricula of HE programs are (or are not) hospitable to marginalized students. It is important to note that this framework recognizes the intersectional and unique experiences of students of color and students from low and middle income countries. However, recognizing some of the experiences and capital common to marginalized students is a valuable step to recognize these student experiences, especially when most of the systems were created to support the experiences and capital common to white

students from high-income countries. Community Cultural Wealth comprises six types of capital; aspirational, navigational, social, linguistic, familial, and resistant. These capitals can interact, overlap, and build on one another [34]. This research examines how marginalized students draw specifically from familial capital as a stepping stone to HE graduate education.

Familial capital refers to the education, resources, and support provided by immediate and extended family, close friends, neighbors, and other community caretakers to students [34]. This capital can include community history, cultural intuition, support to overcome difficulty, and a desire to give back to one's family and community [34]. For instance, marginalized students have described how lessons on their own family history and struggles can encourage them to overcome challenges and also give back to their own family and community [35]. Scholars have also illustrated that marginalized families support their engineering students by encouraging their persistence through hardships, celebrating their achievements, building their work ethic and respect for teachers, and providing day-to-day and curricula-related advice [36]. Analyzing familial capital in engineering can help fill a deficit in the literature on the resources marginalized STEM students bring to their education from their extended families [36].

Using the Community Cultural Wealth framework, we will analyze how familial capital supports, inspires and educates marginalized students towards careers in improving infrastructure equality and the potential implications of these forms of familial capital.

Methods

To answer these questions, we recruited 47 students from seven graduate Humanitarian Engineering programs (six to ten students per program). These HE programs had mission statements similar to “*promoting integrated and participatory solutions to humanitarian development by educating globally responsible engineering students and professionals to address the problems faced by developing communities worldwide*”. Using processes outlined in IRB 21-0207, students were recruited through email advertisements circulated from program directors and professors to their respective HE cohorts. Recruited students carried varying racial ethical identities, ages, nationalities, and privileges and were at different stages of their graduate education. Students self-identified as a student of color or a student from a low and middle-income country through interviews. Of the 47 students recruited, 28 were from dominant communities in engineering (white students from high-income countries), and 19 were from marginalized communities (students of color and students from low and middle-income countries).

We conducted ethnographic-style interviews to capture students' educational, career, and infrastructure equality interests [37]. For instance, students were asked to describe the story of their journey to their HE graduate program and their current career interests. Further, students were asked what aspects of their identity have affected their pathway to HE. When focusing on familial capital students were asked questions such as, “When is a time where you found parts of your home culture or life to help you in navigating your way in graduate school?” or, “Do you feel you are able to bring your personal knowledge, experiences, and expertise to your graduate program? If so, how?”

Audio recordings were transcribed and imported into the qualitative coding software, NVivo. We inductively coded interviews, allowing common stepping stones to HE, such as a field-based

infrastructure project, or influential relationships/conversations, to emerge. Field-based infrastructure projects were defined as traveling to or living in a community outside of your own, as part of a process of implementing or improving some piece of infrastructure in a fellowship, internship, or extracurricular activity. When marginalized students talked about the influence of their family and community in coming to their program this data was deductively coded as familial capital and then, within this code, influences of familial capital commonly found in literature, such as *keeping students motivated*, or *dedication to giving back to one's own community* were inductively coded into child nodes. The paper was sent to all marginalized students as a process of member checking and hearing feedback on the interpretations of quotes.

Findings and Discussion

First, we discuss findings that the stepping stones into HE appear to be divided by racial and global power inequalities, highlighting the common pathways for the dominant group. We then discuss how the experience of marginalized students differed, highlighting the importance of relationships with their families and the larger community to facilitate understanding of inequality through dialogue and storytelling. Finally, we discuss how familial capital from marginalized communities influences HE education outcomes for all students. Marginalized students spoke of dedication to learning about inequality through dialogue with partner communities, staying motivated in the field from familial stories of hope and aspiration, and an interest in working on infrastructure equality efforts as a member of a community instead of as an outsider. Interweaved, we offer reflection and discussion points for HE programs to consider as they evolve.

A Potentially Gatekept Stepping Stone to HE

Our findings suggested that field-based infrastructure projects are unequally accessed by students across tiers of privilege. Fifty-seven percent of all students interviewed spoke about visiting a foreign community in efforts to implement a field-based infrastructure project as an instrumental step in their enrolling in HE graduate education. Students recounted how their foreign engineering project increased their awareness of infrastructure inequality and dedication to HE, introduced them to HE career opportunities and networking, and aided in graduate school admissions. However, these stepping stones were not instrumental for all students. While 72 percent of dominant-group students interviewed used experiential learning through field-based infrastructure projects as part of their pathway to HE, this was only true for 32 percent of marginalized students.

Many students identified field-based infrastructure projects as prevalent in their HE cohort. One man identified the stereotype of students being introduced to HE through field-based infrastructure projects, deciding that project was not as valuable as they were hoping and wanting to go to HE graduate school to learn how to more effectively improve infrastructure inequality. He states,

The stereotypical path to get to this HE graduate program is to be born in a suburban city or not an inner-city, not a discriminated region, (...). Go to college as a freshman, do four years. (...) want to travel, do EWB and (then) like ‘become more woke’ about the issues and understand that EWB isn't that good or whatever project (they are working on), (...) and then wanting to. I wouldn't say, like, dedicate their career to, but wanting to get a deeper understanding of those issues. So that's why they come here. I think that they are trying to get more understanding. (...)

Further, this study found evidence that influences and learning experiences other than field-based infrastructure projects may be undervalued or under-named in spaces of HE graduate school. This is contradictory to this study's findings that many students, and the majority of students of color and students from low and middle-income countries, circumnavigated this stepping stone to HE graduate school with other learning experiences. One student reflected on how his lack of international work, or seeing the infrastructure disparities in other countries, influences his sense of imposter syndrome in graduate school:

Part of me also has hesitations (...) I don't have international experience, I actually haven't even left this country. That's 100 percent just due to the fact that my family didn't have the economic means to have me going on international trips. (...) And so in that sense, I think where the imposter syndrome comes for me is that I don't have those international experiences. And like so I think a dominant pathway in that sense for an outsider would be like, Oh, I have to have some sort of international experience. And if I haven't done something, I don't bring anything to the table. (...) I feel like all of the students that I talk to in this degree have been like, Oh, you know, I spent the summer working in (a country outside of the US)

Importantly, the reason marginalized students opted out of field-based infrastructure projects varied widely. Students spoke of not seeing evidence that field-based infrastructure projects were effective, not having the time, citizenship, interest, resources necessary to partake in these trips or being a part of organizations that did travel to low-income areas but who frowned on “trying to change a community as an outsider”. In an attempt to better balance how we value learning experiences that inform students in HE graduate programs, this study will highlight other influential and valuable learning experiences for HE students in the following sections.

Common pathways for marginalized students into HE: understanding, conversation, and familial relationships

All marginalized students who didn't discuss a field-based infrastructure project as a central step in their pathway to HE, and many marginalized students who did partake in a foreign engineering project, referred to longstanding relationships with individuals holding both experiential and learned knowledge on infrastructure inequality. Marginalized students benefited from building community with peers, cousins, uncles, parents, mentors, and individuals living with infrastructure disparity and the subsequent educational dialogues that came from these relationships. For some students, these influential dialogues were part of a process of realizing the biases in the lessons of national and international power imbalances that they learned in school, such as the history of why those imbalances exist. For example, one student described how her aunts and uncles from Latin America were instrumental to her own understanding of history being expanded from what was taught in her American education:

Then getting a real perspective from my own family because what I read was so skewed to the U.S. ... My aunts and uncles are very well-read and educated. They would smack me down (saying), no, no, this is the perspective from here and I would be like "Oh okay" It was a reality check. I was pretty naive.

Other marginalized students were introduced to HE when building community with individuals and families outside of their own family and consequently gaining insight into the infrastructure issues faced by those with different wealth, privilege, and priorities than themselves. These students benefited from relationships built without the predisposition of trying to change aspects of that person's life or infrastructure. When one student first witnessed infrastructure accessibility that differed from that in her hometown, she was taught to not be a provider for a community you are an outsider to. She uses the tenet of building relationships and understanding in her HE thesis work today.

We went to the mountains and we spent a week with the families there (but) we did not go to provide anything. The team believed that they (outsiders) should not be providers. So you can notice that I started making some bridges with that (philosophy) and what I am doing now with the humanitarian engineering program. The goal of the trip was to spend time with them, try to live through the same things they live through, try to understand what were the constraints they were facing at that time. And that completely changed my mindset

Relationships like those described above and the consequential oral education on infrastructure constraints, lived experiences, history, and philosophies often made up a lifelong and highly reflective education. Many marginalized students spoke of moving between hope for improving equality and despair in various inflexible barriers for change. While this roller coaster of self-efficacy was common among all HE students interviewed, many marginalized students benefited from relationships that put them on this reflective pathway at a young age. Further conversation through relationships were instrumental in grounding marginalized student career goals and aiding students in creating realistic goals for improving equality. For instance, Jeffry grew up hearing stories about his parents' previous lives in a Sub-Saharan country. When he first visited his extended family as a young child, he witnessed the infrastructure discrepancy between their lives and his, and he began a long process of "tie(ing) whatever I would do (in a career) towards potentially doing something there, or that could be of use there".

In this process, Jeffry described moving between spaces of overinflated impact goals and being discouraged about any ability to improve infrastructure inequality. As Jeffry reflected:

It [his self-efficacy to enact change] was definitely overinflated when I started in undergrad. A hundred percent. And people did have a small role in that. Oh, they would tell me that there's oil in your country and in my head, (I'm thinking) yeah, I can go into oil and (my community) would make money. So over time, you start to realize the world doesn't work like that. You learn about things like the resource curse on a lot of these countries that are wealthy with natural resources. And so there is an evolution that takes place. (...)there was a phase where I did feel like I couldn't really make an impact, (...)

Jeffry's story illustrates the lifetime of reflection that marginalized students are often engaged in to become valuable in the communities of people they have extended relationships with. A

childhood and early adulthood of reflection, observation, conversation, and education now reinforce Jeffries' understanding of infrastructure inequality and his career goals. By the time he visited his parent's country again in 2017, he had simultaneously improved his language skills, understanding of water resources, engineering, and community development, and had kept up with local news, this gave him the ability to begin identifying areas where he could potentially utilize his engineering skills to impact this community positively.

And then in 2017, when I went. At that point, I knew the language spoken in our country better. I understood the history more, the culture as well. ...And at that point at that age, even before I went. My parents follow the situation there closely. And so even without going there, I would interpret what I saw in 2005, I would interpret what I hear from my parents or what I see in the news. And try to understand why or how things became like that and what needs to be done. And so it was through that lens, I went and saw things in 2017.

Familial Capital Anchored HE Career Goals to Stories of Hope

As seen in Jeffry's story, for many students an increased understanding of HE comes with increased understanding of all the barriers to infrastructure equally. Many marginalized students were able to maintain drive despite the permanence of colonialism, racism, capitalistic greed, through the stories of their family and childhood community(s). While one student felt anger for global injustices and unfounded variation of privilege, the stories of economic growth in her own family and underserved populations in her own country keep her uplifted. Honestly, I'm very angry at a lot of injustices in the world. I think there are so many people that deserve better. I have a lot of privileges that I've not earned. (...) But at the end of the day? I say I'm really inspired by a lot of people's strength and resilience, and that's what makes me think that they deserve so many better things. Working in my country, working for a couple of underserved communities, and it's just people that are beautiful, that are trying to uplift their communities, that they have this amazing culture that they try to keep alive. My own family two generations ago was just dirt poor. So I find that really inspiring, and I want to see more people being able to reach levels of security that allow them to be happy and have opportunities.

Aiding in graduate school resilience, marginalized students were able to draw upon their family histories in remaining motivated through laborious jobs, classes, applications, and daily schedules. Further, one dominant student was able to utilize the stories of aspiration passed down to him from his family member of a marginalized community. This student referred to how his dad's work ethic through simultaneously working full time, attending college, and raising a child, inspired him through undergraduate workloads, aiding in his admission to HE graduate school today.

I think it's something that my dad really instilled in me (..) I always heard about his stories of working at a restaurant when he moved here, because he moved here, not really knowing any English and crossed the border (...) that got me through like really hard moments in undergrad or just moments where I have to work really hard and don't get very much sleep. Because my dad did as well. He was raising me. He was going to college, was working and raising a kid. So like, if he can do that, then definitely I can do the same thing.

Aiding in creativity as future HE practitioners, marginalized students also carried stories of community advocacy in the face of institutional barriers. Marginalized students carried stories of individuals, potentially ones with even less opportunity than themselves, finding outlets for positive social impact. When one student was asked about his hometown, and if he saw his community members struggling to enact change, or maintaining hope to enact change, he replied that he carried many examples of change-makers despite these barriers.

I've actually known so many people from those communities (his hometown included) who really think they can change the world. It's just that they think of the current state and maybe the financials are lacking or whatever. But they do try to (enact change) through capacity building programs or through mentoring to enact change, at least in their community.

Familial capital influenced student devolution to relationships, conversation, and dialogue

The influential relationships and running dialogues in marginalized students' pathways to HE graduate school instigated dedication to relationship building and dialogues with partner communities in infrastructure projects. The student below reflects on how she ties her values from her upbringing and her prioritization of listening to, and creating dialogues with partner communities in infrastructure project today.

My family's from (a latin american country). I think I've always been brought up with the idea of listening, (...) I put it in terms of - would I walk into your house and start redecorating and telling you how to live? (...) As opposed to if you contacted me and asked me for help, I would expect that I need to listen to you. I need to understand what it is you want out of the new design in your house, your decoration or whatever. And that I need to understand where you're coming from in order to be able to provide whatever it is that you're asking for. I think that's just something that I've had since a very young age.

Many dominant students discussed how peers, mentors, and professors from marginalized communities greatly influenced and benefited their experience of coming to HE education. This included passing along the importance of relationship building and dialogue with partner communities in infrastructure projects. One student talked about how friends she had from marginalized communities helped her be critical of her opportunities to be a part of a field-based infrastructure project. She learned to be uncomfortable working on an engineering project in another country that did not have structures set up to listen and learn from local engineers.

All my friends were international (...) And I think hearing them talk about the work they wanted to do in their own countries gave me a lot of perspective on the aspirations of people from these areas and how they are working to reach those goals (of development). (Her friends) would talk about politics and infrastructure. (...) I sort of saw firsthand how important that local perspective was in development work, and I really felt myself just wanting to listen and not to give information to (marginalized communities). I think that transferred to my opinions of EWB, I just felt like before I ever go to that context, I'd have to sit and listen and learn from engineers that work in that area for a long time (...) I'm very grateful that they gave me that perspective.

Familial Grassroots dedication

Somewhere along with an education that regarded relationships and dialogue, many marginalized students gained debt and interest in working on grassroots efforts. One student reflected on how she desired to work on infrastructure inequality in her own country because she is drawn to her own culture and because she feels a debt for the opportunity and resources that she perceives her country provided for her.

Even though I love going around the globe because I love meeting people, I always come to my roots. Back home we have these really strong connections with our families and friends and our culture. (...) And I think my country has a lot of things to do in order to improve, and it's a really wonderful country and region as well. So I always think that I am in debt to my country because they have provided me with a lot of stuff (referring to undergraduate education and employment in the government)

For some students, this focused interest and feeling of community debt was extended from their childhood or family's community to the towns they currently reside in. Students spoke of not wanting to take the resources and benefits of a community without giving back to it through some sort of infrastructure work, volunteering or activism. For example, the student quoted below spoke about how, while she hopes to eventually work on the infrastructure initiatives in her childhood country, she also felt a moral obligation to work on impactful projects in the college town she is currently living in.

“Eventually, I want to do some kind of work in the middle east (...) (However) I don't want to feel like I'm living in this community and I'm draining resources here and then putting my efforts and energy somewhere else. (...) I feel a moral obligation to also take care of the community that I'm living in as well. So even though I'm not from here. Like I just moved here two years ago, but (...) if I'm going to school here, if I want to live here, I feel like I should be addressing some of the issues of this community as well because we have plenty of environmental issues in this state.

For another student, his understanding of effective HE work involves working as one member of a community. Throughout his childhood his mother would stress the collective efforts of their own community in their families success. Today he believes one individual cannot and should not try to change a community made up of so many moving parts. Instead, he hopes to use his engineering skillset, alongside relationship building and a built understanding of context, in becoming a productive “cog” of a community.

One thing that I feel like every Hispanic mom has heard at some point and tells their kids is like it takes a village to raise a child. (...) It was stressed to me, at a very young age. You're not going through this alone and there are so many people that you don't even realize are having an impact on you and your growth. And so tying that to HE, I think it kind of helps you realize, like you at best are a cog (of a community). You are never and should never be like a savior

Discussion

HE education is at a critical point in its formation, where pedagogy has not yet converged across the different institutions and stakeholders [49]. Field-based infrastructure projects have been identified as one of the most accessible and influential experiences for HE orientated students before graduate school, and as one of the only learning experiences that is consistent across HE graduate programs [49]. This is despite increasing scholarship recognizing that field-based infrastructure projects may promote “thin” activism [38], may create opportunities to exploit low-income communities and neocolonialism [39], and can result in unsustainable, unfinished, or undesired infrastructure [40], [41].

This paper illustrates that while field-based infrastructure projects are valuable to many HE students, their value may be bloated for white students from high-income countries and not the HE student population as a whole. Students from marginalized communities, whose presence improves HE learning environments, and is necessary for decolonizing and consequently improving HE strategy [2], accessed field-based infrastructure projects at a much lower rate than dominant students. Further, the value of other HE learning experiences may not be consciously, nor verbally, explored enough in HE spaces. This study found evidence that by not partaking in a field-based infrastructure project, marginalized students can feel ostracized despite bringing important expertise and skillsets to HE spaces.

Where do some of the expertise and skills carried by marginalized students come from if not field-based infrastructure projects? All marginalized students who didn't partake in field-based infrastructure projects, and many who did, spoke of an education through long-standing relationships with individuals holding experiential and learned knowledge on infrastructure inequality. Yosso [34] defined familial capital as the cultural knowledge nurtured among communities through community history, memory, and cultural intuition. Within the context of HE, this capital appeared as a long-standing education that broadened students' understanding of global power and infrastructure imbalances as well as deepened contextual skills valuable to amending those imbalances. Often this education revolves around dialogue and observation, without a predisposition to change one another's lived experiences, a condition absent in field-based infrastructure projects. Individuals' understandings of infrastructure inequality, and their ability to impact it, were cultivated over entire childhoods and early adulthoods through a process of observation, dialogue, storytelling, formal education, and accessing literature and other media. Foremost, this process alludes to the need for the HE field to consciously and verbally decipher between a contextual and cultural competencies that are built throughout a lifetime of community engagement versus a limited time period.

Secondly, this competency and process of learning show an alternative pedagogy for HE programs to converge around, in addition to, or as an alternative to field-based infrastructure projects. During this developmental time, it is critical HE leadership is intentional and well researched in their valuing, funding, and advertising of different learning experiences. To aid in the literature necessary to make these decisions, this paper collects some of the impacts of familial capital on HE students summarized in the following paragraphs.

When families and communities anchor students' understanding of inequality and social justice to their own stories, students' goals of equality become anchored to stories of overcoming barriers, living through hardship, and continued aspiration. This allowed students to 1) remain

encouraged to improve infrastructure equality despite frustrating structural barriers, and undeserved distributions of privilege and 2) remain encouraged as school, work or other aspects of life become laborious. This first reinforcement is needed in HE, as the field is fraught with failed projects, community extortion, and continued inequality [2]. The strengthening of this dual understanding, a dedication to improving the world despite the feebleness of global justice, is in line with critical race theory tenets - and consequently community cultural wealth - of social justice activism despite the permanence of racism. HE programs agree on the importance of training students on historical causes and present conditions of global inequality” [42]. An in-depth understanding of the historical and present-day inequality can sometimes cause apathy, dread, or frustration in students [43]. HE programs must graduate students with an in-depth understanding of inequality and the immovable structure maintaining this inequality who are still determined and encouraged to work on equality initiatives; a duality some marginalized students are accustomed to maintaining. HE leadership may benefit from increased support, and leadership opportunities for students carrying this duality.

An understanding of inequality anchored in stories of survival and resistance also aided hard work and encouragement through individual difficulties students worked through. Our findings reinforce past scholars' illustrations of stories of family and community hardship encouraging marginalized engineering students to persevere through their own hardships in engineering education [35], [44], [45]. This is valuable because scholars have identified barriers to engineering disproportionately faced by marginalized students that require emotional, mental, and physical energy [46], [47]. Familial capital may be necessary for supporting marginalized students throughout their education and career and consequently creating HE leadership needed for the HE field to evolve towards anti-racism, decolonization, and effective engineering.

Finally, because of this childhood long education, many marginalized students carry role models of community activism and improvement in the face of limited resources and structural barriers. The literature used for HE education often involves failed case studies and lessons learned in implementing infrastructure [51]. Further, institutions and leadership that HE spaces might have once looked up to, are now being questioned for colonial or racist practices [2]. This alludes to a potential dearth of role models enacting infrastructure equality initiatives in decolonial and sustainable fashions, despite barriers to equality. The stories of aspirations and role models preserving inequality initiatives despite barriers that marginalized students are connected to may be an underutilized resource in HE spaces. While marginalized students should not be tokenized to discuss these stories and role models, HE spaces may be able to learn from the process of creating relationships and having a dialogue with marginalized communities to find role models. We must make sure HE educational spaces are not turning a blind eye to stories of grassroots community leaders and initiatives that do not match colonial archetypes of a Humanitarian Engineer.

Some marginalized students connected a prioritization of building relationships with partner communities to their family's education. This alluded to marginalized students already passing down this type of learning to their classmates. Indeed dominant students spoke of their peers from marginalized communities helping them be more critical of different infrastructure improvement strategies, including when they perceived local expertise wasn't being taken into enough consideration. In-community projects and professional development initiatives both benefit when development institutions have strong and lasting relationships with community

partners [51], [52]). By carrying a dedication to relationships and conversation from childhood, marginalized students may avoid the pitfalls of initiating alluring infrastructure projects before sufficiently understanding nor establishing strong communication lines with communities that the project hopes to aid.

Finally, some students from marginalized communities spoke of a long-lasting dedication to work on infrastructure improvement in the communities they were from or had ties to. Past studies have similarly illustrated how familial capital can promote an engineering student to give back to their own community [34], [46]. This debt and long-term focus are valuable in Humanitarian Engineering as they could be a precursor to grassroots infrastructure projects. Grassroots can be defined as projects that use the people in a given district, region, or community as the basis for infrastructure development. Community-driven initiatives have been proven to be valuable in modern-day engineering initiatives such as the United Nations Sustainable Development Goals and decolonizing development initiatives [1]. While grassroots organizations are commonly praised in HE spaces, we must also be sure the individuals dedicated to grassroots efforts are also being supported. Creating HE programs and curricula focused on supporting marginalized students potentially could be an avenue to supporting individuals dedicated to grassroots efforts and the familial capital is valuable in creating this dedication in individuals.

Limitations

This paper is believed to be the first in using Community Cultural Wealth as a framework for understanding student pathways to and experiences in Humanitarian Engineering. More work is needed to modify race-centered educational frameworks for engineering and global inequality contexts. This research was unable to decipher the intersectional experiences and unique capital of students from various racial-ethnic backgrounds, countries, or communities brought to HE spaces. Further, this paper focused on how familial capital influenced the pathway to HE graduate education, and early graduate experiences, where more work could be done to recognize how the use of familial capital changes throughout graduate education. Finally, this study only focuses on one of six forms of community capital wealth. To further understand the accessibility and value of HE education to minoritized students, additional scholarship is needed to address the deployment of all six forms of capital in HE education.

Conclusion

Marginalized students bring valuable knowledge, experiences, and backgrounds into Humanitarian Engineering spaces. However, there are reasons to believe the common pathways to HE graduate spaces may be racially divided; popular stepping stones to these programs, like foreign engineering projects, are accessed at a lower rate by marginalized students. This paper begins unwrapping the pathways and experiences of marginalized students in Humanitarian Engineering through an assets-based framework centered on race and racism: Community Cultural Wealth (CCW). By focusing on one aspect of CCW, Familial Capital, this paper highlights some of the ways marginalized students perceive their family and childhood community supporting, inspiring, and educating their pathway to HE graduate school. These findings were collected by interviewing 19 marginalized students across seven HE programs, twice throughout an academic year.

Students from marginalized communities often spoke of the influence of family and childhood community members who passed along experiential and learned knowledge of infrastructure inequality. Students benefited from relationships with individuals carrying this knowledge that was centered around dialogue and understanding each other's lived experiences. From this form of education, marginalized students spoke of being able to draw stories of inspiration from their community members and families working through hardship when they felt frustrated with the difficulties of sustainable development. Marginalized students also spoke about a dedication to building strong dialogues and relationships with partner communities in HE projects before initiating a project. Finally, for some marginalized students, the capital they gained from their community compelled them to work on grassroots efforts within their own community instead of in new foreign spaces.

This research is just one step in understanding the experience and pathway of marginalized students in HE graduate school. More research will be needed to unravel the other forms of capital that marginalized students draw on and the intersectional experiences of marginalized students from different backgrounds. By directing future research on marginalized students' experiences in HE spaces, the HE field can work to increase the recruitment of students dedicated to advancing infrastructure equality.

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