Board 269: Equity-focused Goals of Humanitarian Engineering Students: Addressing Systemic Oppression, Amplifying Community Cultural Wealth, Developing Social Justice Self-Efficacy, and Elucidating Career Concerns

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Emma Stine is pursuing a Ph.D. in Civil Engineering from the University of Colorado, Boulder, where she is researching student experiences before, during, and after attending a graduate program in humanitarian engineering, focusing on how these experiences influence career goals and outcome expectations. She is interested in how these goals align with social justice movements, including if and how students and practitioners are addressing global inequality and the SDGs in career pathways, especially now, when activists are calling for the development sector to implement decolonized and anti-racist structures. Emma graduated from the California Polytechnic with a B.S. in Mechanical Engineering in 2019 and an M.S. in Irrigation Engineering in 2020.

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How Decolonial and Anti-Racist Mindsets Shape the Career Aspirations of Humanitarian Engineers

Introduction

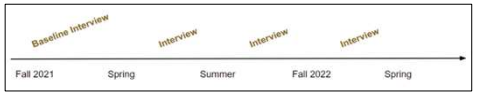
Humanitarian Engineering Graduate Programs train students to improve infrastructure service provision disparities in marginalized and low-income communities. As these programs are growing in popularity across the country it is important to:

Offer guidance to Humanitarian Engineering programs, on how pedagogy can empower students in achieving their career aspirations through nurturing self-assurance, realism, and adaptability in the HE field

Highlight the capacity, pathways, and support mechanisms enabling students' to address infrastructure equity by challenging systemic oppression and cultivating allyship with marginalized communities

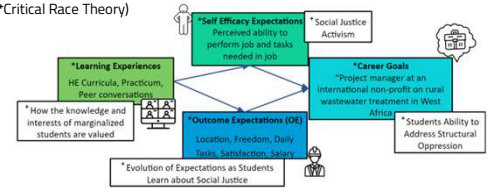
Data Collection

To fill these gaps in knowledge, 47 graduate students from 7 different Humanitarian Engineering programs, were interviewed one to four times over 2 years, totaling 167 interviews. Recruited students carried varying racial and ethnic identities, ages, and nationalities and were at different stages of their graduate education.



Frameworks Used

Data was analyzed using frameworks to understand career goal development (*Social Cognitive Career Theory), and frameworks that center social justice (*Critical Race Theory)



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Overview of Studies and Examples of Preliminary Findings

HE Student's Equity-Focused Career Concerns

Research Questions
- How are graduate students questioning their HE career expectations throughout their graduate program?
- How are HE academic and experiential learning experiences prompting students to question these career expectations?

Data Collection

Four interviews with all 47 students responding to questions like:
- What aspects of a career are important to you? (types of tasks, freedoms, items, work environment, topic)
- Please tell me a story of what led you to your current career goals.
- How did your classes influence your HE career expectations?,

Data Analysis

Deductive Codes:
Themes of negative career expectations, such as:
- Worrying about ethics in working in marginalized communities as an outsider
- Worrying about lack of work-life balance

Inductive Codes:
Categories of learning experiences in Social Cognitive Career Theory that have a high degree of influence on career expectations (Bandura, 1997):
- Mastery • Emotional Distress • Vicarious (Role Models) • Verbal Persuasion

Findings

Students perceived an imbalance in learning experiences that helped visualize successful performance in future careers, instead noting that they learned a lot about ineffective HE projects. As one student indicated, *"Right now, we've just been learning about projects that have failed. So, I kind of have a pessimistic outlook right now, but I'm trying to learn that there are ways to be successful."* Consequently, HE programs may benefit from providing students with more positive vicarious examples, or in other words, relevant role models, to increase student confidence in their ability to address equity and resilience through engineering.

Status

Paper submitted to Journal of Civil Engineering Education

Supports and Barriers in HE Students Resisting Systemic Oppression

Research Questions
- What factors influence students' ability to 1) critique social oppression and/or 2) maintain a motivation for social justice

Data Collection

Four interviews with all 47 students responding to questions like:
- What power could you see you or another engineer having to change any form of systematic oppression?
- How would you define (de)colonialism and/or anti-racism (social justice) at this moment in the program?
- What is your process of deciding whether a future job aligns with your values or understanding of social Justice?

Data Analysis

Inductive Codes:
Categories of resistance to systemic oppression as defined by Transformational Resistance (Solórzano and Bernal,2001) which are identified by a student either:
- Critiquing social oppression and/or
- Maintaining motivation for social justice

Deductive Codes:
Supports to students' resistance, such as:
- Classes that taught social justice theory

Barriers to students' resistance, such as:
- Learning environments that encouraged prioritizing personal growth and personal benefits over the impact HE projects had on marginalized communities

Findings

We found that when students with high social dominance (i.e., white students from the imperial core) are encouraged to define social justice concepts or practices by relying upon their personal experiences and engaging in discussions with similarly privileged peers, they have difficulties resisting systematic oppression. Instead, these students benefit from learning environments that encourage them to seek guidance from peers and mentors with lived experiences of oppression as well as literature, theory, and frameworks on social justice created by marginalized scholars and activists.

Status

Data analyzed and article currently being written

Learning Environments Conducive to HE Students' Growth as Activists

Research Questions
- How are HE students practicing social justice activism?
  - What learning environments are aiding students in different forms of activism?

Data Collection

Four interviews with all 47 students responding to questions like:
- How have you learned about topics such as racism, colonialism, power dynamics, or ethics in your classes or research over the past semester?
  - Did any of these experiences align with or challenge your own worldviews?
- Did you do or are preparing to do any HE-related work with a specific community?
  - How are you trying to make this work successful? Specifically, by being ethical, anti-racist, or decolonial?

Data Analysis Plan

Inductive Codes:
Categories of Social Justice Self-Efficacy (Miller et al. 2009), which highlights the spheres of influence students can practice activism to subsequentially grow as activists (seen in the figure to the right)

Deductive Codes:
Learning environments that students perceived aided them in their attempts and longitudinal growth as an activist

Status

Data analysis has not begun

Perceptions of Supportiveness in HE Education Among Students of Color and Students from Low- to Middle-Income Countries

Research Questions
- What sources of cultural capital are marginalized HE students bringing to their Humanitarian Engineering education?
- How are HE students perceiving their HE educational programs support (or lack thereof) this cultural capital?

Data Collection

Four interviews with 19 students of color or from low and middle countries responding to questions like:
- What barriers to an HE education and career have you faced or observed others facing?
- When was a time when you found parts of your home culture that helped you navigate graduate school?
- How do you believe your HE program will help you achieve your career goals?

Data Analysis

Inductive Codes:
Categories of Community Culture Wealth (Yosso,2005), which highlights the cultural capital of marginalized students, such as:
- Familial • Aspirational • Social • Linguistic

Deductive Codes:
Themes in students' sentiments or feelings regarding the supportiveness of their learning environments.

Findings

Students' sentiments regarding the supportiveness of their cultural and social capital revealed learning environments that were 1) unreceptive, 2) receptive but not investing, and 3) receptive and investing. Students reacted to these learning environments differently. Specifically, when students sometimes perceive learning environments as unresponsive, defined as feeling restrained or discouraged from expressing their capital, and/or the expression of capital is more of a burden than an aid and expressed sentiment like "Yeah, (my professor), is the one who I feel undermined working in (the region I am from) the most. They brush it away." Here, students often expressed low self-esteem, frustration, and feeling misunderstood or misplaced within their HE program.

Status

Currently in process of data analysis

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Equity-focused Goals of Humanitarian Engineering Students: Addressing Systemic Oppression, Amplifying Community Cultural Wealth, Developing Social Justice Self-Efficacy, and Elucidating Career Concerns

Abstract

Humanitarian Engineering (HE) programs, aimed at training engineers to address infrastructure and public service inequality, have gained popularity and are drawing diverse and passionate students, including those from historically underrepresented minority groups in STEM. However, comprehensive data on how these students' career aspirations and capabilities evolve within HE programs is lacking. Furthermore, the HE field is undergoing a transformation with calls for decolonization as it grapples with its colonial legacy, which has contributed to perpetuating disparities through infrastructure and environmental racism. This research explores how these changes influence students enrolled in HE programs. Specifically, we collect and analyze data from longitudinal interviews and surveys with 47 graduate students enrolled in seven HE graduate programs in the US. Through this research, we explore and characterize HE students' evolving (1) self-efficacy and outcome expectations in the HE sector; (2) social justice activism, including their critiquing of social oppression and motivation for social justice; and (3) self-efficacy in social justice activism, tying changes to learning experiences throughout the program. Further, we (4) examine how the cultural capital of marginalized students adds value to HE education and the support provided to and barriers encountered by these students in their programs. As a result, this study longitudinally documents how social justice influences engineering pedagogy and student growth, pushing students to challenge colonial narratives and engage in equity-oriented changes. Overall, this research contributes to understanding how HE students navigate their evolving career aspirations, activism, and the decolonization of the HE field.

Research Problem Statement

Graduate educational programs aimed at training engineers to address national and global infrastructure and public service disparities, often referred to as Humanitarian Engineering (HE) programs, are growing in popularity and prevalence [1]. These programs advertise explicit commitments to diversity, sustainability, and partnerships with marginalized communities. For instance, these programs often prioritize the needs and desires of marginalized communities in engineering design and focus on modern-day engineering initiatives such as sustainable development goals [2], [3], [4]. In addition, HE programs attract students of diverse backgrounds who are passionate about advocating for the well-being of marginalized communities [5]. In part, this diversity of students may come from the mission of HE programs, as female students and students of color rank wanting to help people as a significant reason to pursue engineering [6], [7], [8] and engineering courses with humanitarian design projects have stronger retention rates

of students from underrepresented groups [9]. Thus, universities are creating HE educational programs, in part, to increase the recruitment and retention of these students [5], [10]. However, a dearth of studies investigates the career aspirations and outcomes of these diverse and passionate cohorts of students or how learning experiences, including the HE educational experience, influence HE students' aspirations and capabilities. Research is needed to understand what training and career opportunities are valuable in retaining this diverse and socially minded cohort of engineers in the engineering industry.

Further, the career aspirations of HE students are likely currently being influenced by ongoing social justice activism in the HE field. HE has a colonial history from imperialism in the 18th and 19th centuries to today, where marginalized communities have minimal sovereignty in their development [11]. By not addressing how colonial structures in America were unjust and inequitable, engineers have isomorphically implemented infrastructure (e.g., wastewater treatment centers, bridges, transportation, and energy supply) whose placement and quality perpetuate institutional and environmental racism [12], [13]. Thus, there are ongoing social justice activism movements to reform the HE field by identifying and dismantling the field's remnant ties to colonialism and addressing racism. More broadly, social justice activism is defined as advocating for a fair and equitable division of resources, opportunities, respect, and privileges in a society [14]. This can be seen in opinion pieces, such as "Foreign Aid is Having a Reckoning" [15] and "Black Lives Matter is also a reckoning for foreign aid and international NGOs" [16], which illustrate how decolonization and antiracism movements are advocating for changes in HE. However, to decolonize the field, aspects of HE careers, such as the needed skills, daily tasks, salary, flexibility, location, and scope of impact, are being challenged and reshaped, including who should have these careers [17], [18]. Consequently, research is needed to understand how the training and preparation of HE students may need to shift to keep up with the social justice shifts in the larger field.

During this time, HE educational programs are transforming their pedagogy towards social justice activism and drawing in students who desire careers in activism. For instance, HE programs are creating missions such as to graduating engineers who carry a "concern with the unequal and unjust distribution of access to basic services (...), and (who) emphasize identifying the drivers, determinants, and solutions toward increasing equitable access to reliable services" [19]. However, in pursuing an educational system that trains students for social justice activism, HE education programs themselves are in the ongoing process of reforming. This provides an opportunity to document the student experience, including how their career expectations of a career evolved during a period of social justice activism. This will add to scholarship on how activism can/is shaping the development of engineering students.

Finally, the colonial structures in HE educational programs themselves are also being re-examined for oppression or unequal cultures, policies, and norms. For example, common HE teachings that students can address the engineering disparities for others are being criticized for

reinforcing colonial narratives such as “white saviorism” in student value systems [20], [21], [22]. Other scholars have argued that HE spaces may be relying on the false deficit narrative, a narrative that attributes the disparities faced by communities to internal or presumed deficiencies of their families and cultures, to give their field value and purpose to “fill” those educational and cultural deficits [18], [23], [24]. Further researchers caution that activities in HE programs, such as fieldwork, can quickly shift into neo-colonist voluntourism and risk unhelpful and harmful partnerships with communities [25]. This research will longitudinally document how calls for social justice may permeate the pedagogy HE students are exposed to. Further, as this research uses frameworks that recognize students not as passive victims of inequitable or colonial systems but as whole individuals who struggle against unjust norms, policies, and practices, we will also track how students enact activism in their own educational spaces [26]. As HE programs are in flux, this research examines how various learning experiences push students towards archaic colonial tropes and, at other times, challenge them to participate in equity-oriented change.

To fill these gaps in knowledge, this research study aims to longitudinally collect and analyze data on how career aspirations and self-confidence to enact social justice change over time and the factors influencing this change. This will include not only how and why HE career aspirations and expectations change over a graduate education but also how HE educational spaces support and inhibit the success of HE students in advocating for social justice in infrastructure and public service equality during and post their graduate educations. Thus, this research intends to employ robust, detail-rich, and multi-modal research on the HE graduate student experience.

Data Collection Methodology Overview

Our primary form of data collection includes longitudinal interviews with HE students supported by survey questionnaires. We recruited 47 students from seven HE graduate programs (six to ten students per program. These HE programs consist of either a HE certificate or a degree. Each program has a similar goal to the Mortenson Center in Global Engineering and Resilience (MCGER): “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” [27]. Further, all HE programs enrolled attended a 2021 NSF-funded workshop, “Defining the emerging pedagogy in the field of Global Engineering”, where participants discussed and aligned on common learning objectives and approaches to meet these learning objectives [3]. Finally, using IRB 21-0207 processes, students were recruited through email advertisements from program directors and professors to their respective HE cohorts.

Of the 47 students recruited from the seven HE graduate programs, 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). Recruited students carried varying racial and ethnic identities, ages, nationalities, and

privileges and were at different stages of their graduate education. In addition, students self-identified as students of color or students from low and middle-income countries through interviews.

Table 1: Numbers of Students Enrolled from Each HE program for Interviews

School	Enrolled	Interview 1	Interview 2	Interview 3	Interview 4
University A	5	5	4	5	5
University B	5	5	3	2	3
University C	8	8	8	5	7
University D	11	11	10	10	10
University E	7	7	6	5	6
University F	6	6	6	6	6
University G	5	5	3	3	4
Total Students	47	47	40	36	41

Recruited HE graduate students participated in longitudinal interviews across two years. These interviews captured students' evolving career and activism goals, experiences, and reflections. Interviews were semi-structured and conducted in an ethnographic style (Spradley, 1979), containing questions relevant to all four sub-projects of this work. Interviews began in the Fall of 2021 and were conducted every following semester and summer for two years for a total of four interviews. Audio recordings were transcribed using Trint [28] and imported into the qualitative coding software NVivo [29].

Sub-projects Data Analysis and Findings

The following section outlines the four subprojects of this study, including the motivations, data used, data analysis, and, when available, findings specific to each study. The four studies look into 1) unpacking students' HE career concerns and influential learning experiences, 2) characterizing students' activist goals within the lens of critiquing social oppression and being motivated for social justice, 3) collecting patterns in how students are practicing, succeeding, and consequently gaining confidence or self-efficacy in social justice activism; 4) and highlighting how the cultural capital of marginalized students is inhibited supported and invested in during HE education pathways

1) Exploring Concerns in Equity-Focused Career Goals Among Humanitarian Engineering Students: Investigating the Influence of Graduate Education

Humanitarian engineering (HE) programs aim to train engineering students to improve infrastructure equity and resilience and prioritize the well-being of marginalized communities. However, scholars have found that students involved in HE activities question their ability to

improve equity through an engineering career and are at risk of dropping out of engineering [30]. By characterizing student career concerns and the learning experiences influencing these concerns, this study aims to pinpoint ways HE programs can better support aspiring engineers committed to prioritizing equity, resilience, and the welfare of marginalized communities within their careers, thereby fostering a more inclusive and impactful engineering industry.

To characterize students' career concerns and influential learning experiences, we use social cognitive career theory (SCCT). SCCT posits that students' career expectations, including the expected benefits students associate with a career and their confidence to perform specific tasks needed for a career [31], influence career goals. Further, SCCT posits that four types of learning experiences influence students' career expectations: experiencing personal successes (mastery), receiving verbal encouragement (verbal persuasion), having access to relevant models (vicarious), and encountering low levels of negative emotions (emotional distress) [32]. 165 Interviews of 47 students were analyzed by 1) inductively coding for themes when students expressed negative expectations of their initially desired career and 2) deductively coding for the types of learning experiences students associated with these negative career expectations. We determined the relative frequency of students, out of the 47, who expressed each theme of negative career expectations or influential learning experiences at various points during the longitudinal study.

One finding of this study was that students perceived an imbalance in learning experiences that helped visualize successful performance in future careers, instead noting that they learned about ineffective or failed HE projects. As one student indicated, "Right now, we've just been learning about projects that have failed. So, I kind of have a pessimistic outlook right now, but I'm trying to learn that there are ways to be successful." Consequently, HE programs may benefit from providing students with more positive vicarious examples, or in other words, relevant role models, to increase student confidence in their ability to address equity and resilience through engineering.

2) Exploring Transformational Resistance in Humanitarian Engineering Education and Fostering Learning Environments Conducive to Students Addressing Systemic Oppression
Research has found that HE students and the larger HE field want to address the systemic causes of infrastructure inequity. However, the limited scholarship on this topic focuses on the barriers and failures of HE students and He practitioners to do so. This study aims to support Humanitarian Engineering students' growth in transforming unjust systems of oppression by delving into the learning environments that are (un)conducive to students identifying, resisting, and transforming oppressive norms, policies, and cultures.

We use the Transformational Resistance Framework (TRF) to characterize moments when students address systemic oppression and influential learning environments. In short, the TRF deduces that students are acting as agents of systematic transformation when they are able to: 1)

critique social oppression and/or 2) maintain motivation for social justice. Moreover, rooted in Critical Race Theory principles, the TRF framework offers literature to contextualize findings within the pervasive normalization of racism, settler colonialism, and white supremacy [26]. We analyzed 165 Interviews of 47 students for moments when students identified, resisted, or transformed oppression by deductively coding to identify moments of students successfully and falling short of addressing systemic oppression. Next, we inductively coded to identify learning experiences that either encouraged or discouraged students from doing so.

Through these methods, we found that when students with high social dominance (i.e., white students from the imperial core) are encouraged to define social justice concepts or practices by relying upon their personal experiences and engaging in discussions with similarly privileged peers, they have difficulties addressing systematic oppression. Instead, students benefit from learning environments that encourage them to seek guidance from peers and mentors with lived experiences of oppression as well as literature, theory, and frameworks on social justice created by marginalized scholars and activists.

3) Countering Deficit-Based Teaching: The Potential of Humanitarian Engineering Graduate Education in Amplifying Community Cultural Wealth

In early 2020, activists pushed for greater representation of marginalized racial backgrounds and nationalities in leadership roles within the HE sector, leading to initiatives to boost the enrollment of marginalized community members in HE educational programs [17], [18]. However, achieving tangible progress on this initiative faces challenges within the modern university system, which is intentionally structured to cater to predominantly white upper and middle-class communities, perpetuating their values and culture [33], [34]. This research aims to assist HE graduate programs in fostering inclusivity by exploring how students from marginalized backgrounds feel HE learning experiences support and could further support their cultural and social capital.

We employed the community cultural wealth (CCW) framework to characterize marginalized students' cultural and social capital and the receptibility of HE learning environments. The CCW framework identifies six forms of capital in marginalized students often undervalued in modern university systems: aspirational, navigational, social, linguistic, familial, and resistant [34]. We analyzed 67 Interviews with 19 students of color and from low—and middle-income countries for moments of students employing their cultural and social capital. We deductively coded these moments to the six forms of CCW and inductively coded them to identify themes in students' sentiments or feelings regarding the supportiveness of their learning environments.

This work found students' sentiments regarding the supportiveness of their cultural and social capital revealed learning environments that were 1) unreceptive, 2) receptive but not investing, and 3) receptive and investing. Students reacted to these learning environments differently. Specifically, when students sometimes perceive learning environments as unresponsive, defined

as feeling restrained or discouraged from expressing their capital, and/or the expression of capital is more of a burden than an aid and expressed sentiment like “Yeah, (my professor), is the one who I feel undermined working in (the region I am from) the most. They brush it away.” Here, students often expressed low self-esteem, frustration, and feeling misunderstood or misplaced within their HE program.

4) Social Justice Self-Efficacy Growth in Humanitarian Engineering Students: Longitudinally Tracking the Learning Environments Conducive to Students' Success at Activism in Graduate School

While HE educational programs are intended to train students capable of advocating for engineering and infrastructure equality, there needs to be more studies surrounding how students succeed and fail at activism throughout their HE education. This is particularly important as a student's successes and failures, or Mastery Experiences, are the most significant influences on a student's self-efficacy or judgment of their capacity to accomplish a certain level of performance [32]. This study aims to increase the number of engineers confident in their social justice activism capacity by tracking when and through what supports students' success at activism attempts.

To better understand students' success in activist attempts, we employ Social Justice (SJ) Self-Efficacy, which is associated with a student's increased confidence and motivation to partake in activist activities. Specifically, SJ self-efficacy highlights the importance of student growth as activists in a person’s ecological spheres of influence, i) the person's individual thoughts (personal activism), and outwards to ii) their conversations with others (interpersonal activism), iii) contact with communities (community activism), and iv) power over institutions (institutional activism). 167 Interviews with 47 students will be analyzed longitudinally for individual students’ self-efficacy growth. I will deductively code interview responses regarding activism attempts to the four forms of activism and then inductively code these attempts by themes (e.g. had a personal worldview shift to realize their own compliance in oppression) and learning environments that students perceived aided them in their attempts. Analysis plans are under formation for this paper and findings are forthcoming.

Conclusion

In conclusion, this research endeavors to shed light on the evolving landscape of Humanitarian Engineering (HE) education, particularly focusing on the career aspirations, activism, and experiences of graduate students within HE programs in the United States. By delving into the longitudinal journey of 47 diverse graduate students across seven HE programs, this study offers valuable insights into how the field of HE is adapting to calls for decolonization and social justice activism. This research examines the nuanced shifts in students' self-efficacy, career goals, and engagement with social justice issues over time.

Ultimately, this research contributes to a deeper understanding of how HE programs can better support students in their aspirations to effect positive change in infrastructure and public service equality. By documenting the intersections of career development, activism, and decolonization within HE education, the study provides valuable insights for educators, policymakers, and practitioners aiming to foster a more inclusive, equitable, and socially conscious engineering industry. As HE programs continue to evolve, this research serves as a critical foundation for guiding future initiatives and interventions aimed at nurturing the next generation of socially responsible engineers.

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