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Transgressing Sustainability Norms: A breakdown of how we teach sustainability in engineering through a bell hooks lens

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Introduction

A review of the characteristics of classroom dynamics is presented in contrast to a specific course designed to act as an introduction to sustainability for multidisciplinary engineering design students.

Correlating pedagogy to presence

Interdisciplinary collaboration and innovative teaching methodologies can effectively bridge theoretical sustainability concepts with practical engineering applications, ultimately preparing future engineers to address complex global environmental challenges and design more sustainable technological solutions [1]. Reviews of this topic highlight that to effectively transform engineering education, institutions must develop adaptive curriculum frameworks that emphasize systems thinking, ecological literacy, and holistic problem-solving approaches [2]. By integrating sustainability principles across technical disciplines, universities can cultivate a new generation of engineers who are not only technically proficient but also ethically conscious and environmentally responsive. This paradigm shift requires ongoing pedagogical innovation and institutional commitment to reimagining engineering's societal role.

Realist review, or a realist synthesis, is a method for studying complex interventions in response to the limitations of conventional systematic review methodology as it examines the differences, intended or unintended, between contexts, mechanisms and outcomes for individual programs [3]. This nuanced approach of 'realist review' methodologies offer a more dynamic lens for understanding the complex interactions within sustainability education. By acknowledging the contextual and cultural dimensions that shape educational interventions, researchers can develop more sophisticated analytical frameworks that capture the multifaceted nature of sustainability learning, ultimately providing deeper insights into the transformative potential of interdisciplinary educational strategies [4,5].

Unmentioned in these sustainability in engineering education reviews, likely due to out-of-discipline context, is the works of bell hooks on transformative changes by transgressing educational norms [6]. While unmentioned, her work is in alignment with suggestions of Du et al. and Sivapalan et al. to investigate whether values, beliefs, and attitudes in engineering education actively position and engage students as social agents [7,8]. Social responsibility, including examination of racial and gender inclusivity have been the subject of extensive examination in engineering education in general. Based on an Ethic of Care, theses holistic engineering practices build relationships focused on shared virtues and express these virtues in a number of ways such as catering to aid in Humanitarian Engineering or catering to empathy in Design Thinking [9-11]. Canney and Bielefeldt presented a framework that centers around creating a tool called the Engineering Professional Responsibility Assessment (EPRA) operationalizing the Professional Social Responsibility Development Model (PSRDM), with care

formalizing the aspects of social responsibility when used with the Personal and Social Responsibility Inventory (PSRI) to assess the institutional climate which could foster the development of social responsibility in students [12]. Social justice, the acts that undo social injustice, can be employed by engineers and serve not to encourage building virtues, but to uncover structural conditions that represent the normalization of these inequities [13,14]. Connecting social responsibility to compassion not as an individual focus but as an engineering community focus is facilitated by breaking down the barriers between technical and social aspects of the field. Further sociologically, an examination of racial and gender inequity in engineering as presented by A.E. Slaton parallel the foundations of critical theory presented in bell hooks' work, helping to highlight the complexity of diversity in engineering education. This work concludes with an argument that cosmopolitanism is inherently a constructivist problem and there is not a clear demarcation of 'knowledge' and 'non-knowledge' with the only difference laying in the authority to challenge this distinction [15]. Epistemic commitments to changing these practices perhaps could be seen through increased sustainability education, and studies have shown that deeper social and ethical impacts in understanding these complex systems arise but need to be reinforced [16,17].

Epistemologically, progressive teaching methodologies in sustainability-focused engineering education include experiential learning approaches such as project-based learning, collaborative design studios, field research experiences, and real-world problem-solving workshops. These methods actively engage students in hands-on sustainability challenges, encouraging critical thinking, systems analysis, and interdisciplinary collaboration but all prioritize learning through experience, student-centeredness, and community engagement [18-20]. By simulating complex environmental and social scenarios, these pedagogical strategies help students develop adaptive skills, innovative mindsets, and a deeper understanding of sustainable technological solutions. Although claiming student-centeredness, many of these teaching methodologies are still subject-centered as dictated by examples chosen in the literature by educators in alignment to traditional relevancy to the engineering profession.

Methodologically, engagement with students have evolved to take many forms, and can be described in terms of human-centric, techno-centric, enviro-centric options to name but a few. Human-centric methods challenge traditional competitive educational models by prioritizing collaborative learning, empathy, and holistic student development. By integrating social-emotional learning with technical skills, educators can create transformative educational experiences that prepare students to navigate complex global challenges [21]. Such approaches recognize that sustainable innovation requires not just technical expertise, but also deep interpersonal understanding, cultural sensitivity, and a commitment to collective well-being and systemic change. Examining this choice from a skills-based focus, care must be taken to not reinforce exploitative labor practices and instead connect with emancipatory practices in alignment with the works of hooks and Freire [22]. Techno-centric educational platforms have traditionally explored automation of learning [23]. More recently, emphasis has shifted also to a value-based examination as it re-examines interconnection of human-centricity [24]. Arguments presented therein show that techno-centric ecosystems introduce significant systemic vulnerabilities, potentially undermining long-term societal resilience. By prioritizing technological efficiency and profit maximization, current paradigms risk marginalizing human

and environmental considerations. Emerging research suggests a more nuanced approach that balances technological innovation with holistic social responsibility, integrating ethical frameworks that consider broader ecological and human-centric impacts beyond mere techno-economic metrics [25,26]. Place-based education involves direct experience that is more engaging, promotes civic participation that contributes to democratic institutions, promotes an ethic of environmental stewardship and sustainability, and responds to local economic, social, and environmental pressures [27]. These methods share commonality in that their shared evolutions return to humanistic models.

Consideration of these social-spatial relationships of learning, these integrated communities can be ontologically modeled by a Students as Partners (SaP) relationship. A review of SaP relationships identify four cross-cutting themes that outline this approach: reciprocity, realities of partnership outcomes, context of practices, and inclusive, partnered learning communities [28]. The interconnectivity of results and implications of SaP as both an ethos and a practice can correlate the complex, nuanced, and multifaceted nature of these partnerships. Typically, partnerships are predominantly occurring between students and academic staff. In exploring partnerships of students and other students, and students and stakeholders external to universities in their extended communities, we can hope to move toward a more inclusive understanding of community partnerships and extend this partnership beyond the walls of our classrooms. Active learning methods for increasing student-student engagement form a cornerstone of community SaP practice and guiding active learning classrooms from a student's perspective allow for socially conscious frameworks leading to patterns of community mindfulness that may benefit connection between students [29]. Interactions with students and their existing social communities external to the classroom should allow for examples of proximal developmental learning correlating to their lived experience [30]. In extending SaP communities to form more holistic networks we can hope to explore more authentic connectivity and transcend traditional power dynamics in SaP community models.

The intersection of the above humanistic approaches involving relational, spatial, and temporal criticality. bell hooks work in Teaching to Transgress specified from her personal perspectives relational power balances relative to her reality. Martin Heidegger referred to this relation to place and time 'dasein', but existentialism does not typically correlate social interactivity in this model of lived experience [31]. Places where we give people a voice for others to hear allow for shared social experiences and these interactions then define externalized personal interpretations. Expansion of dasein to explore the othering of the self, while sometimes uncanny, leads to a truer understanding of reality.

Multidisciplinary Sustainability Courseware

A course was created by an audit of a selection of introduction to sustainability and data literacy courses from across the globe. Components were incorporated from the University of Alberta (UofA), Fulbright University Vietnam (FUV), the University of Waterloo (UW) and Olin College (Olin) to align with the program learning objectives, most notably the pillars of the program: EDI, Flexibility, Leadership, Sustainability, and Partnerships. The goal is to create an

inclusive and personalized learning experience that inspires students to become change-makers with global perspectives.

The course is split into two sections; a ‘mini-project’ in which select skills are scaffolded by an epistemologically driven group inquiry into the student’s own zeitgeist, and a major group project that examines specific energy technologies to examine how they fit into our currently understood definitions of sustainability and what is understood by society about them. Zeitgeist here refers to the specific cultural and lived reality of our student body, not homogenous yet together and representative of our shared existence.

The ‘mini-project’ is broken down into four components: a personal audit, quantitative analysis, qualitative analysis and ideation synthesis. The personal audit creates an artifact where students examine their own lives and where they examine if and when they have choices in the day-to-day energy use in their lives. They compile this data in the form of a collage that highlights the visual signifiers of these usages and control mechanics, and they also differentiate how their choices correspond to how they act, what they are thinking, and what they feel when reflecting on these choices. The information is presented the following lecture in form of an online tableau as facilitated by the program Miro in order to facilitate group awareness in the breadth of activities in the multigenerational and multidisciplinary cohort, and also to serve as a dataset to analyze in the subsequent quantitative lecture. The quantitative lecture followed the approach of FUV and utilizing methodologies similar to Olin, to selectively choose an individual statistical method and the examine a discrepancy in a sustainable technology. The most common poll has been “Transit in the City: Who Walks, Drives and Transits” as everyone travels to class. After this instruction the students organized their initial inquiry from a choice of surveys or online data collection to form some analysis of where they see a potential difference in an interpersonal behavior in society with respect to how we choose to engage in our major energy use interactions.

Once data has been collected from observational and interpersonal quantitative metrics have been taken, further discussion of culture and identity centered around ethical frameworks and how choices present in society differ in this regard. To further explore this concept, students are taught about interviewing with empathy and are requested to explore their own social networks to examine how intergenerational and international experience may vary and why. The realist review offered by allowing students to explore their own lives is then utilized to explore the critical nature of sustainability. The students are introduced to the UN Sustainable Development Goals and asked to reflect upon how choices made in their communities may have impact outside of their own lives. This reflection, as well as further re-analysis of the quantitative and qualitative data is then synthesized by the student teams into larger overarching themes and presented as an artifact of learning.

The course continues building upon the technical skills of sustainable analysis by introducing the framework of ISO 14040: Life Cycle Assessment [32]. This framework is utilized to explore ubiquitous examples of technology found in common amongst the class such as computers or cell phone devices. The students are then assembled into new teams to explore the main inquiry of their coursework, an investigation into energy supply and sources. The teams self-select and choose a technology that they find interesting. Guidance is given by the educational staff to

ensure a division of topics that are non-repetitive as well as facile to find both technical and social information about. Students are tasked with beginning their investigation to look at impacts that their process/device have had on society from both primary and secondary sources. This forms the basis of their literature review, and common questions are posed to probe how sustainability is embodied. This inquiry helps the students to scope where they find interest in how the technology they have chosen can be examined.

With the scope of their projects chosen, the next lecture discusses data analytics. Rather than pursuing more technical tools such as Power BI, students are trained to examine storytelling and to reflect on their data from human-centric ways. The interconnective analysis of their data is supported at this time by introduction to Donella Meadows 'Thinking in Systems' and they are shown how the interconnected causal relationships in their data analysis form loops not lines. This technique is practiced with the groups to help support their tasks of building balancing and reinforcing feedback loops in their inquiries to further examine their systems, and the homework presented in the following class is examined as a group to see where the commonality of their system maps interconnect.

The next subset of class activities build upon the intersectional awareness of the class. Concepts of environmental justice and environmental racism are presented and supported by international, national and local examples and are examined using a breakdown of stakeholders and partners in clean energy development as exemplified by expansion of natural resource extraction and processing. There is an invited speaker from one of the indigenous groups from the area and an opportunity to explore how both historically and at the present time these injustices are still occurring. The students are then tasked with compiling their inquiry, system maps and clever ways of visualizing these stories to a poster for presentation. The posters are presented for feedback internally the following class as a poster critique, while new content is added to examine political economics. A following class builds upon this iterative development and introduces the students to sustainable design principles such as the Sandestin declaration, as well as Donella Meadows' Theory of Change from "Thinking in Systems" and "Leverage Points: Places to Intervene in a System" [33-35]. The students continue their research efforts, investigating the environmental injustices and political influences their projects have demonstrated and theorize the ways in which their systems can be influenced to change. Before the next class a final draft of their posters are submitted and printed.

The posters on their independent research are presented not to the class again, but to the community at large. Students are invited to put their posters up around campus to explore feedback from the student body. The students have the opportunity to engage in both critique of their analysis as well as to educate their fellow students about what they have learned in class. After one hour the students return to share their observations with the class and we reflect about the commonality and differences of our experiences for further expansion of our system network.

There is a class in which a review is performed with students selecting what topics they had the most challenge with. This has typically been the statistics and political economics lectures, as the mathematical background is varied amongst the international 1st year student body. The class is then divided into three groups and flipped to allow for students to self-select which topic they

found the most challenging and re-invent a way of teaching it that is more comprehensible to their zeitgeist. The students give three 15-minute activities to reinforce their chosen areas of reinforcement and these activities are kept for future cohorts.

The final assignment and class presentation is the creation of 5-minute videos that act as a path for achieving true sustainability in their chosen energy system. The students have use of online AI assisted tools to create videos that outline the systemic challenges and five concrete actions that align with the leverage points discussed in class to influence change. Donella Meadows features centrally upon the examination of systems thinking and this examination of a Theory of Change, with the power of critical observational thinking directed to their lives and communities compliment the desired power shift that bell hooks describes. This is only true, provided, the information is complementary to the skill and background to the student body. We provide them with a future vision/mission and then work backwards to a tentative approach. Connection to the student zeitgeist, eros to their lives, and empowering them with the skills and path to change it is the design by which we hope to accomplish this.

Methodology

The purpose of this examination is to critique an example of the developed undergraduate sustainability curriculum and SaP teaching pedagogy in relation to the works of bell hooks.

The data in the results and discussion is generated through the use of a modified constructivist grounded theory. As it stands in scholarly literature, the are many approaches to educational practice, constrained by scholastic curricular demands, and further examined with pedagogical scrutiny. A bell hooks approach is presented from a comparison of close reads of several reviews of bell hooks texts centered around Teaching to Transgress [6, 36-38]. The discussion details more opportunities for expansion of this analysis to shed critical light on further innovations or gaps in practical deployment of these frameworks. The courseware was not planned with bell hooks in mind, but in reflection to her work we can hope to develop more just practices from our observed faults and triumphs.

Grounded theory is utilized to conduct the methodology and execution of this study as a qualitative research measurement that generates theory from empirical data rather than existing literature. Analysis occurs from substantiating research, confirming and enhancing the emerging project to situate it within current knowledge and practices [39]. This dataset represents one point in time with the biases and *apriori* knowledge forming observational remarks in reflection apropos of examination through a bell hooks lens. There are three methodological aspects of grounded theory: classical, Strassman, and constructivist [40]. Constructivist grounded theory emphasizes the social contexts, interactions and understanding of the role of participants and researchers in the methods and data collection and are only captured by observations when there is no intent to record or otherwise digitally capture records of in-class observations [41]. In this study the observations encompass both in-class activity but also a revised reflection with a bell hooks lens, hence the modified constructivist approach. Using this modified constructivist interpretation there is insight gathered from the primary observations through the growth of the instructor as well as the initial experiences. It is rare to include the instructor's reflection as a

data set, but constructivist grounded theory affords the admission that the observer is also a member of the in-class environment yet is also growing alongside the student body.

The observation are made throughout the term and are compiled from three separate instances of the course offering, from the winter of 2022, fall of 2022 and winter of 2024. The first two instances of the course were offered as a prototype course which allowed for any engineering student to join as a special elective, whereas the 2024 offering was part of required courseware for the initial cohort of students in a bachelor of multidisciplinary design program.

Further reflections are gathered from an innovation that was applied to how we facilitate curricular course improvements in the School of Engineering Design and Teaching Innovation at the University of Ottawa. A read-out is organized by both a GAPA presentation breakdown as well as more holistic feedback on the relationships formed and success of the term after each semester is complete [42]. The reflections and questions are provided by the instructors and course designers to better capture points by which improvements can be made.

Finally, quotes from anonymous course reviews from the student cohorts are included in the analysis to showcase instances where the student voices echo the observation found in this grounded theory examination.

Analysis

The analysis is broken down in accordance with extracted quotes from Teaching to Transgress that correlate with the central themes of the literature. Observations of the delivery of the described courseware and reflections from peer educators and students are introduced alongside references from the introductory background. Connections to pedagogical practice and correlation to previous examinations in engineering education research interconnect the student, instructor and previously found classroom experiences.

1. *Promoting student centricity in the classroom*

"Professors who embrace the challenge of self-actualization will be better able to create pedagogical practices that engage students, providing them with ways of knowing that enhance their capacity to live fully and deeply." – bell hooks

Pedagogical transformation as modeled by Freire and hooks recognizes the dynamic interplay between learner agency and systemic knowledge construction. By centering critical reflection and dialogic learning, students develop a nuanced understanding of their positionality within complex social and ecological systems. The methodology encourages students to become active knowledge producers, challenging traditional hierarchical educational models and fostering a collaborative, transformative learning environment that empowers individual and collective agency. The demonstrated course empowers learners by utilizing the Students as Partners methodology as described and is in alignment with challenging existing narratives in socio-technical education [14,15]. Culturally there still remains the tension between dialectic truths, yet

explicit discussion of the normative injustices that we experience in environmental racism and socio-political systems allows for student reflection.

"The part of the class I liked the most is how interactive it was, always giving each other constant feedback on the activities and evaluating my peers." – Anonymous Student

This transformative approach necessitates ongoing dialogue and institutional reflexivity. By creating spaces for critical engagement, educational institutions can dismantle hierarchical knowledge structures and cultivate environments that honor diverse epistemological perspectives. The challenge lies in sustaining momentum for systemic change, requiring continuous commitment from educators, administrators, and students to deconstruct traditional power dynamics and create more inclusive, responsive learning ecosystems that empower marginalized voices and promote holistic understanding. By sharing this experiential learning platform it is hoped that similar programs can be constructed and likewise shared.

Too often we prioritize skill development for realizing economic opportunity. Recognizing the complex interplay between educational systems and labor markets, researchers advocate for more holistic approaches to skill development [23]. These strategies emphasize contextual learning, social capital, and adaptive competencies that transcend narrow technical training. This also parallels the work by Leydens & Lucena to blur the lines between the technical and social, and invites transcending traditional educational hierarchies [13,15]. By reimagining education as a dynamic ecosystem of knowledge co-creation, institutions can better prepare learners to navigate increasingly fluid professional landscapes, where resilience, critical thinking, and interdisciplinary collaboration become paramount success indicators. When skill formation is separated from occupations and the social relations in which these arise, other socio-political factors affect who has access to decent jobs [43]. Data literacy, qualitative meeting quantitative analysis are interdisciplinary tools that allow for critical analysis of fact and the limitations of that knowledge. System mapping as informed by Meadows' is adaptive to known information and can highlight the questions that the students still feel are needed. Leverage points in a system highlight that there is an unequal distribution in techno-centric changes that affect the solutions to wicked problems and the social systems that ultimately control them [35].

"At the very beginning, I wondered where we were going, but with the simple and very experimental logic of small group work in class, it was easy for me to understand the analytical, constructive and elaborative side of the culture of sustainability in design" – Anonymous Student

When examining lived experiences of students' lives, an evolution of this process has grown to alternatively examine celebrities' lives – this practice was established as some students were not comfortable sharing their personal life, especially so early in the course. The examination of a curated social media feed had a secondary benefit of helping to reinforce the data analysis questioning the veracity of a shared life and examining questions about authenticity. It is preferred that the student has the opportunity to see with their own eyes from their own lives, yet it can be the barrier of shame the prevents sharing. Closer interpersonal relationships should help break this barrier, and we saw students share more with others as their team relationships increased. Having students in the class share their lives can inspire more to do the same when we

offer them that opportunity. It is unsure as to how much code-switching and authentic self-representation exist in the captured experiences, and these still exist a factor in the systemic change in relation to adopted cultural norms that this practice did not approach.

From an educator's perspective, listening to one another with an objective but still providing choice is how we influence an education while still honoring personal comfort. Normalization of this style of education may be a way of increasing authentic self-representation if the experiences themselves are authentic, in alignment with an Ethics of Care.

2. *Reframing our perspectives for a shared experience*

"All of us in the academy and in the culture as a whole are called to renew our minds if we are to transform educational institutions-and society." – bell hooks

The pursuit of multicultural transformation demands radical empathy and structural accountability. Educational institutions must actively deconstruct systemic barriers by centering marginalized narratives, creating inclusive pedagogical frameworks that challenge dominant epistemological paradigms. This requires intentional curriculum redesign, hiring practices that amplify diverse perspectives, and ongoing institutional self-reflection. By embracing complexity and recognizing the interconnected nature of knowledge production, universities can become catalysts for meaningful social change. The ways in which centering marginalized narratives is exhibited is by the explicit discussion of environmental racism and inclusion of a paid guest indigenous speakers to present lived truth to the classroom. The way for embracing complexity is embodied by systems thinking from a student centric lens and including their lives in the analysis. The ways to recognize our interconnected nature is by sharing the interconnections of the educational experience and recording them for all to see. Miro is an online whiteboard used extensively in this course to record and present the submitted homework, and every class the feedback is shared communally [44]. This allows for equitable reflection regardless of background but does not ensure Vygotsky zones of proximal development. There exists a gap here that is unsolved. This is where hooks' emphasis on building personal relationships is required, to not dehumanize this connection.

"Retained a lot more information because all students had to participate and improve. Especially Miro which is built overtime and shows class progress." – Anonymous Student

Critical pedagogical approaches demand continuous evolution and intentional disruption of traditional power structures. By fostering spaces of genuine dialogue and critical consciousness, educational institutions can transcend mere representational diversity and cultivate substantive, systemic transformation. This requires persistent commitment to dismantling hierarchical knowledge production, creating dynamic learning environments that honor complexity, intersectionality, and the lived experiences of marginalized communities. The work in engineering education has strived for this standard, with the aforementioned examples reinforcing these practices through examples in injustice, particularly through a sustainability lens [13,14,16]. In her work, hooks implores instructors to utilize critical race theory to deconstruct xenophobia to thwart exploitation in education [6]. Utilizing an interdisciplinary way

to understand systematic racism, namely in sustainable practices, we are better equipped to challenge impressions that propagate the institutional muting of race discourse in sustainable education from both environmental and social inequities.

The opportunity to renew our minds is not universal across the mixed cohort of our classes. A mandatory attendance is enforced in the classroom to afford a more homogenous community experience versus choice in community to irregularly participate actively – it is an unequal burden for those students with complexities in their lives or schedules that may draw them away from our physical learning spaces. Facilitating flex time for student meetings can afford time for the students to meet according to their own schedules, and access to the class content 24/7 could create more opportunities for the complex lives of our modern student bodies, but still the class content is difficult to capture as much of the shared learning is through oral discourse.

3. *Challenging existing perceptions*

"Authority of Experience" have already been determined by a politics of race, sex, and class domination." – bell hooks

Existential reflection requires embracing personal narratives and becomes a radical act of self-discovery and collective healing. By acknowledging the intricate layers of individual experience, educators can create transformative spaces that transcend traditional epistemological boundaries, provided the student is willing to have an open mind.

"Get rid of the personal part of this course. We just don't care about that stuff and people will make stuff up for marks. Focus on the engineering aspects of sustainability. Engineers are not the swiss army knives of society and we should not try to be." – Anonymous Student

This approach demands vulnerability, courage, and a profound commitment to understanding the complex intersections of identity, power, and lived realities. Through authentic dialogue and critical introspection, learning becomes a dynamic, reciprocal journey of mutual empowerment and radical understanding. Personal experience by incorporating student networks into the class scholarship at every opportunity must be safeguarded by allowance of limits to personal social culture. It is understood that this still remains a challenge in these classrooms, and this will only happen in smaller cohorts. Unfortunately, this echoes a much larger systemic challenge of what engineering represents in society, but may prove a path for localized perspective shifts moving forward [15].

The reciprocal journey of mutual empowerment and radical understanding exists not only for students of different cultures but also for the instructors. The wealth of diversity in our student cohorts bathes me with transcendent information that begets description when allowed to share freely. Courseware deepens as time and the populace evolves, due to increased comfort from the students in assuming personal authority of their projects as well as the freedom afforded in the classroom to express critical thought. In addition, practicing this modified constructivist grounded theory approach there exists an opportunity for institutional change when awareness of neo-liberal norms are realized and transgressed.

4. *Embracing differences & acknowledging unresolved challenges*

"Contemporary discussions of relations between black women and white women (whether scholarly or personal) rarely take place in integrated settings." – bell hooks

As a bilingual institution, the African contingent of students coming from ex-colonial French nations sometimes afforded radically different personal reflections to North American student perceptions. One particular student voiced a preference for feedback to requiring beratement, highlighting the particular differences in intrinsic motivation and respect dynamics. This difference opens questions as to how much an educator must changed their schema and pedagogy to comfort the individual in a perceived harmful and less intrinsic practice.

"I'm a French speaker, and it's often quite difficult to find a teacher who takes this factor into account, but the teacher took the trouble to give the course in fairly fluent and simple English in the pronunciation and development of ideas, always reassuring if we had the quintessence of what he was saying." – Anonymous Student

The complexity of navigating institutional spaces demands continuous negotiation of identity, power, and representation. bell hooks describes that women of color in academia must constantly balance personal agency with systemic expectations, creating intricate narratives of resistance and survival. Their scholarly work becomes not just an intellectual pursuit, but a profound act of reclaiming narrative space, challenging dominant paradigms, and reimagining transformative possibilities within inherently restrictive institutional frameworks that have historically marginalized their experiences and perspectives. Inclusion of the works of Benjamin Chavis in the explanation of environmental justice, and the works of Meadows' systems analysis helps, but needs to be further highlighted in acclaim – There is an opportunity to examine the sources of primary and secondary information as found by the student researchers to challenge if the narrative space in their studies is being just and balanced, further identifying structural conditions and acknowledging political agency and power to help engineer justice.

Queer, black and other racial groups were represented in our classroom but it was not observed that they existed there without transgression. There was still bravado of heteronormative voices from traditional viewpoints or toxic male-presenting voices. Community interactions representing these conflicts were not always directly intervened, but by the instructors challenging the comments versus censoring them seemed to reduce the frequency of their distractive asides. It is unknown if any reports were filed as formal complaints to the administration, but none are recorded by the university. Unfortunately, given the stigma between other stereotypical challenges in engineering culture, the expectation that such remarks go unchallenged still remains a problem.

5. *Building inclusivity and awareness*

"To begin, the professor must genuinely value every one's presence. There must be an ongoing recognition that everyone influences the classroom dynamic, that everyone contributes. These

contributions are resources. Used constructively they enhance the capacity of any class to create an open learning community." – bell hooks

Teaching communities serve as catalysts for profound personal and collective growth, fostering environments where critical dialogue transcends traditional educational boundaries. By creating spaces of mutual vulnerability and shared exploration, instructors and students collaboratively deconstruct existing power dynamics. These intentional learning ecosystems encourage radical self-awareness, challenging participants to interrogate their assumptions, embrace complexity, and develop more nuanced, empathetic approaches to understanding diverse human experiences. SaP deconstructs power dynamics in itself, albeit in limited fashion as restricted by the authority of the university. We can't just do 'anything', usually as mandated by university policy, and further in lock-step to cosmopolitan causes [15].

Self awareness by 'journey map' use in examining their lived experience allows students to interrogate assumptions by separating question from fact from multiple perspectives, embrace complexity by learning systems theory, and as such, the final remaining tenet is to build empathy in our communities. This unfortunately for the students will tend to come when their efforts to help others are in vain. We cannot teach loss, it has to be experienced, and in sustainability as examined from a systems approach showcases how we are failing society in many regards. In the student reflections there are many examples of how this course is changing their perspective on the plight of others, but again, the authenticity of these reactions cannot be verified at this time. In alignment with a Personal and Social Responsibility Inventory (PSRI) there is congruence in this experience with 'Contributing to a Larger Community' and 'Taking Seriously the Perspectives of Others', but unmeasured development of 'Competence in Ethical and Moral Reasoning and Action' [12]. If warranted, reinforcement of an examination of ethical and moral reasoning could be captured as a further reflection from this activity if directed.

6. *Affording a range of personal experience through shared learning spaces*

"Shifting how we think about language and how we use it necessarily alters how we know what we know." – bell hooks

Language emerges as a powerful tool for dismantling systemic barriers and creating more inclusive academic environments. By centering linguistic diversity and recognizing multiple modes of expression, educational institutions can transform evaluation frameworks. This approach demands continuous reflexivity, challenging traditional metrics that privilege dominant communication styles. The course allows for student voice utilization, and at times when deemed 'unprofessional' by specific vocational standards, these truer representations allow for closer alignment to peer proximal development.

Ultimately, language-conscious practices become a radical methodology for acknowledging and valuing the rich, complex narratives of our students. Teaching at a bilingual institution with a multilingual cohort benefits a multilingual expression that can produce truer content provided it is translatable to the other students. We are fortunate as a community of learners that is afforded by the bilingual peers and instructors employed.

A question arises as to if this enhances code-shifting if we fail to value each expression in its original form if we translate it for all to share. If facilitated by educators that span both communication paths and translate to the best of our ability it's all we can do. Unfortunately personal experiences with language are more difficult to convey. I can't understand a past I haven't experienced, nor be triggered by context that I do not know, but the freedom of self expression is what affords the critical nature of discussion, so planning for these times of discomfort in discussion is afforded in this course structure by design.

"We all learned a lot, but we all learned different things, so it would be nice to have some more advanced theoretical aspect to the course that would teach us new things about sustainability beyond the research we did for the projects. Regardless, this was a great course and I am glad I took it." – Anonymous Student

Allowing for individualized learning also means that there is a difficulty in 'everyone learning the same thing', but this may be the part to further unlock in our educational institutions – homogenization is good for evaluation of homogenization, but not good for range, or greater understanding of complex problems. Of course, this can be partially overcome by the open-classroom concept and sharing at each class to share experiences. Institutional flexibility in how the learning objectives are written in a similarly open-format can facilitate this freedom. Although beyond the scope of this discussion, further examination of how accreditation of our programs is evolving may also shed more light on this subject, with opportunities affording the same transgressive examination as our epistemological and pedagogical study.

7. *Letting love in*

"Understanding that Eros is a force that enhances our overall efforts to be self-actualizing, they it can provide an epistemological grounding informing how we know what we know, enables professors and students to use such energy in a classroom setting in ways that invigorate discussion and excitement critical imagination." – bell hooks

Love becomes the transformative catalyst that transcends traditional pedagogical boundaries, inviting educators to embrace vulnerability and emotional intelligence. By recognizing love as a profound educational practice, instructors create holistic learning environments that honor students' full humanity. This approach challenges mechanistic educational models, positioning empathy, compassion, and genuine connection as essential elements of meaningful academic engagement. This is a step further than brought forth from the ethics of care or other separations of socio-technical content [9,14]. Such pedagogical reimagining demands courage, radical openness, and a commitment to healing through education.

"I appreciate the prof's approach– what I can only describe as involved learning. I think this being a smaller class (less than 50) really benefited the class as we got to know each other and the prof." – Anonymous Student

Love and caring can follow. Bertrand Russell had some predictions amiss in his 19th century text "Icarus, or, the future of science" but one conclusion in that text is as true as ever: "the greatest importance (is) to inquire whether any method of strengthening kindly impulses exists" [45]. In what we do as engineers the primary thing we need to demonstrate is care. To discuss how to care for another to students who are remiss of personal examples in their lives leaves barren zones of proximal development. We need to demonstrate caring. This was demonstrated time and again in the courseware where exemptions were made to allow for the complexity of personal student challenges to be overcome through flexibility. In a previous study a community of care was cited as a need to solve the epidemic of self-harm present in our engineering communities [46]. As a recommendation for how this is to be achieved at a greater scale than personal allowances afford it is recommended that a GAPA framework incorporate this in a correlation of higher priority than the technical learning objectives and demonstrated in each course activity.

Conclusions

Using a modified constructivist grounded theory in the manner presented in this study provides for not only capturing a snapshot of the current state of sustainability education in engineering but also provides for a method of auditing this practice. The modification of the constructivist approach to include a reflection of bell hooks work can shed transformative light reshaping the audit in correlation to observations made from the original experience.

The review for this course highlights that more change is still needed, particularly in challenging existing perceptions and embracing our differences. These changes, as managed through the application of assessment tools, such as EPRA and PSRDM or other socio-ethical framework into a GAPA system to correlate educational interventions between all experiences in the classroom could provide for a path forward. Care must be taken however, as an institutional tool can disconnect from the true Eros needed for helping each other find the time and space needed for cultural evolution.

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