A Critical Reflection on the Challenges of Implementing Culturally Sustaining Pedagogy

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***Abstract*—This work-in-progress is a critical reflection on our first offering of an energy course that reimagines what we teach and how we teach using a lens of culturally sustaining pedagogies (CSPs). As our interdisciplinary team developed and taught this class for second-year engineering students, we encountered challenges about how to best address systemic inequities in energy education in ways reflective of our own positionalities. In this WIP, we describe several missteps, illustrate how our differences in identities led to productive conflict, and reflect on our progression through deeper understanding of how to implement CSPs successfully. We conclude that critical self-reflection and acknowledging the pervasiveness of White, colonial, and masculine knowledge sources in engineering education is a necessary first step to taking an anti-racist position as an educator.**

Keywords—critical pedagogy, critical reflection, cultural schemas, socio-technical thinking, multiculturalism, inclusivity

I. Introduction

This work-in-progress is a critical reflection on our first offering of a new energy course that reimagines both what we teach and how we teach in engineering science courses. This course was developed under a National Science Foundation project that aims to modernize energy education in engineering using culturally sustaining pedagogies (CSPs) as a pedagogical lens that resists systemic inequities in engineering curricula. CSPs are an educational approach that seeks to "perpetuate and foster", or sustain, cultural pluralism as a democratic project of schooling [1]. The details of the course, as well as students' reactions, can be found in [2]–[7]. As our interdisciplinary team developed and taught this class, we encountered challenges about how to best address these systemic inequities through our use of CSPs in ways reflective of our own positionalities. This paper describes our reflection as instructors on decisions made behind the scenes in how to roll-out the course.

Even for a diverse team—in terms of both positionality and disciplinary backgrounds—this work is hard. As we rolled out the course, we encountered tensions in the content as well as within the team on what it meant to "do CSPs". This paper details our team's journey from understanding the theoretical framework of CSPs to grappling with how our own positionalities played a role in the actualization of the course. While this work is complex in nature, we argue that any type of initiative intended to challenge the dominant discourses of engineering requires effort, reflexivity, and a critical positioning to prevent essentializing culture.

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II. Theoretical Framework: Culturally Sustaining Pedagogies vs. Assimilist Pedagogies

Culturally sustaining pedagogies draw from student-centered approaches to teaching that connect students' life experiences with instruction. CSPs build on research emphasizing asset-based approaches to education that counter deficit-based models, decenter Whiteness of the curriculum, and shift the conversation to a more comprehensive and inclusive "multiethnic and multilingual present and future" [1, p. 95]. CSPs are informed by work on funds of knowledge [8], hybrid spaces [9], culturally responsive pedagogy [10], and culturally relevant pedagogy [11].

The engineering classroom—a space that has been tied to cultivating "Whiteness and manhood" [12]—is a promising space where CSPs should be implemented, as a high degree of homogeneity exists within engineering [13], leading to rigid and hegemonic values, beliefs, and assumptions. As noted by Ladson-Billings [14] and Puzio and colleagues [15], CSPs are rooted in the instructors' ability to connect with their students and their communities. Not only do CSPs allow for the incorporation of mainstream and diverse worldviews, but also provide a space for students to develop "a critical consciousness through which they challenge the status quo of the current social order" [11]. As the demographics of our engineering student body (mostly White, male, and wealthy) closely aligns with engineering in the USA, our goal was not necessarily to highlight engineering concepts in students' own cultures, but to illustrate that engineering is not owned by a particular culture (the default being White, Western, colonial knowledge).

Ladson-Billings states that the success of culturally relevant teaching requires an awareness of one's presence and actions in the classroom—not just an ability to develop students academically, but also a "willingness to nurture and support cultural competence, and the development of a sociopolitical or critical consciousness" through first understanding our own positionalities as educators [11]. Critical consciousness is an individual's ability to critically reflect and act upon their sociopolitical reality, and deeply question how and why power relations are structured and maintained [16, p. 445], [17]. While CSPs have been successfully implemented in K-12 settings [10], [18]–[23], there have only been limited applications of CSPs in engineering higher education.

A major obstacle for implementing CSPs in engineering is that faculty typically receive little pedagogical training, let

alone support in developing critical consciousness. Successfully implementing CSPs requires that faculty not only teach the content but also engage in questioning the teaching and learning processes. This involves questioning traditional problematic aspects of engineering education (i.e., military-oriented, sexist and even exclusionary curricula [8]) and pushing the boundaries to reimagine how to create a space that validates and welcomes a variety of ways of being, knowing, and doing. Academics in general, but particularly faculty in technical fields, too often have given little consideration to the question: what is the project of *education* about? As engineering faculty we often talk about training students to "be engineers", and even assign textbooks that teach them how to "think like an engineer" [24]. Not surprisingly, the success of a student in engineering is often tied to whether or not they have developed an "engineering identity" [25], [26].

Szech describes how assimilationist pedagogy has historically framed public education in the USA [27]. Szech positions assimilationist pedagogies as at the opposite end of the spectrum from CSPs and makes explicit connections between assimilation and Whiteness. Engineering culture exemplifies assimilation, as demonstrated by the pipeline model [28] and the lack of multiple pathways to success (e.g., an engineering student who becomes a STEM teacher is typically not considered as successful as a Software Engineer for Intel Corporation). Because our educational systems are built within an assimilationist framework, educators must learn to recognize our own privileged positionalities to avoid perpetuating these systemic forces even while we believe we are practicing CSPs.

III. An Integrated Approach to Energy: Determining what we teach & how we teach

Our course, *An Integrated Approach to Energy*, reimagines energy education within engineering both in content and in pedagogy. In many engineering programs, students first see energy concepts in "Introduction to Thermodynamics" [29], which emphasizes fossil-fuel based energy production and centers on examples from the Industrial Revolution grounded in White colonial mindsets. Students typically learn about the 19th century Rankine cycle used in coal, nuclear, and oil-fired power plants [30]–[32], but energy sources such as wind and solar receive limited discussion or are left to elective courses. Consider the common grouping of solar and wind as Alternative Energies (as in: alternatives to fossil fuels). This categorization, rather than the use of the term Renewable Energies, inherently prioritizes fossil fuels over other options – however this bias is rarely discussed with students. While there are some examples of textbooks [31] and programs (e.g., Berkeley, Purdue, Penn State) that take a more holistic approach to teaching energy, the typical ethnocentricity and masculinity of engineering curricula can be discouraging to women and students of color.

There is an unquestioned assumption that mathematical procedures and scientific processes are race-, gender-, and culture-free. In reality, education inherently prioritizes certain bodies of knowledge while marginalizing and excluding others. As educators we are the gatekeepers—we decide which topics to include in our classrooms. Within engineering, colonial, White, and masculine knowledge has historically been privileged over other ways of knowing [33]–[35]. By designing the course from scratch, our team developed energy curricula using a CSPs-informed framework to highlight the diversity of where energy generation and transfer is observed and utilized. For example, instead of reiterating the functions of a power plant, the same energy transfer concepts were taught using electricity-independent innovations from non-European cultures, such as the pot-in-pot invented by a teacher in rural northern Nigeria [36].

As an interdisciplinary and diverse team, our goal was not just to point out the biases in engineering content, but to challenge the dominant discourse by highlighting and celebrating a variety of what is considered engineering and who does engineering. One of our early discussions, prior to the launch of the course, considered if we should inform students that we were using a CSPs approach as a part of a research project. Based on our experiences teaching content related to social justice, we decided this explicit mention could discredit the course in the eyes of the students, as pointing out that CSPs were not mainstream in engineering reinforced the dominant discourse. Instead, our team worked to deconstruct the dominant discourse in our research meetings and reconstruct them in a way that was useful to students' learning in class.

When we started this project, our team intentionally selected our sole White man to be the instructor of the course. (The rest of the PIs consist of an Asian-American woman, a Latino man, and a White woman.) Our reasoning for this was: 1) this instructor had experience teaching *Thermodynamics*, and 2) based on student resistance in course evaluations to teaching content related to social justice [37]–[39], as well as literature on students' race and gender biases (e.g., [40]) we believed a White man as the instructor would provide the most credibility for the course and mitigate the pushback we might receive from both students and other faculty. In hindsight, our first reason reveals that we were still operating from within the dominant paradigm—that experience teaching *Thermodynamics*, as the class that we were pivoting from, would provide a foundation for the framework of the course content. This initial framework ultimately contributed more obstacles for us to overcome, as we needed to first break free of our preconceptions and inertia against change. For example, one group discussion came to a head when our mechanical and civil engineering team members continued to emphasize the need for students to learn "the laws of thermodynamics" while the other two, with expertise in electrical and metallurgical engineering, contended that the lessons should start from a place of cultural relevance rather than an abstract theory.

Our second reason for choosing our White man to be the primary instructor was also problematic. Of the four PIs, he was the least prepared to grapple with his positionality in the classroom, having the least experience due to his privilege. The example above about the laws of thermodynamics illustrates a disciplinary tension, but our discussions also frequently included one or more of us identifying a deficit-based, masculine, Eurocentric, or oppressive course example that needed to be addressed. The hard work in this research surfaced

during these discussions, where we constantly challenged each other to consider whether we were honoring other cultures as exemplars or unintentionally suggesting they were "lesser than" other content in the class. For example, we realized after the fact that our modules on engineering units and ancient windmills still inadvertently privileged Western, colonial ways of knowing, even though we included them to do precisely the opposite. Our efforts and/or delivery may have sent the message that these other viewpoints exist but are "wrong", outdated, or not as important as what is used in White/Western cultures.

The following excerpt from one of our publications and discussion below illustrates one of the larger conflicts our team wrestled with as we leaned into this work:

> "The first step we took in countering this dominant discourse and approaching a CSPs-based curriculum was to present more human examples to demonstrate typical engineering concepts. In particular, we tried to be intentional in directly confronting the Whiteness of engineering. Not only did we replace kinetic energy examples of bullet projectiles with kids on swings, but we also intentionally searched for diverse faces to include on our class slides." [2]

While the paper draft initially applauded ourselves for having "achieved" CSPs, the final publication emphasizes that simply including human faces of color is only an *initial step* towards contextualizing engineering content, but doing so does not inherently change the content and its knowledge sources. To truly liberate engineering concepts from its hegemonic framework, we need to interrogate the source of the authority of knowledge and value knowledge creation from diverse sources (e.g., ethnomathematics provides one model for this [41]). Throughout our discussions, trust and vulnerability were essential. Teammates needed to be willing to be honest, and others had to be open to accepting different perspectives. It would not have been possible to push towards liberative pedagogies if our team had willingly accepted that replacing a bullet with a kid on a swing was a deep level of CSPs, just because it was not trivial to find a photo of a person of color. We continually pushed each other to dig deeper and worked together to develop and model a critical consciousness to students.

IV. Reflections on Progression

As we began this project, our initial focus was on identifying "CSPs examples" which we planned to insert and replace the traditional technical examples with. As we stated in our grant proposal,

> "Our first Research Objective is to identify noncanonical energy examples that can be used to develop CSPs for engineering. Our focus is on identifying examples that are NOT colonial, White, and male. The identification of these examples is not a trivial task. … This work will help to develop the PIs' expertise in identifying appropriate examples to teach engineering that come from outside of the engineering canon."

After the first offering of the course, we discussed our progress and hesitations with our advisory board. In particular, we presented the missteps we had made regarding "othering" the very cultures we aimed to highlight and discussed if there was a different name for our approach than culturally-sustaining pedagogies, because we felt as if we were sustaining our students' lived experience, but not particularly their culture (as our engineering student population is largely White and male). We asked questions such as: How is culture conceptualized? Whose culture are we sustaining? Should CSPs reflect our students' *own* identities to promote student engagement, expose them to diverse worldviews to develop a critical consciousness, or a combination of both? And, what role does the positionality of the instructor(s) and/or course developers play in implementing CSPs? Our advisory board pushed us to challenge how knowledge is constructed in engineering, and that just using a few new examples in class, that were different and separate from the rest of the material, would not allow us to successfully address systemic racism and inequities in the engineering curriculum.

As we write this paper in the third year of this grant, we state the obvious that this work is harder than we thought. We went into this grant looking for examples, and we are now emerging talking about the importance of positionality. We have come to our own deeper awareness that engineering educators need professional development to understand our own identities and develop our own critical consciousness first in order to challenge the dominant discourse. Engineering faculty are not typically taught how to teach in a way that is different from how we learned as students, which reflects an engineering identity that does not question what it means to be an engineer, and what counts as engineering.

The work needed to deconstruct and analyze our own positionalities and the dominant paradigm in engineering was particularly challenging for our primary instructor, a White man. In expecting that he would get the least pushback and most credibility from students, we reinforced the idea that he was the expert. Perhaps not surprisingly, he had the least experience doing this self-reflective work and deconstruction of the dominant discourse for himself and for the students. Our progress thus far is attributed to a team effort; the perspectives provided particularly from those with minoritized backgrounds have given our team an advantage of seeing things from a different perspective and from outside the dominant engineering culture. Even for a diverse group as willing and knowledgeable and interested as we are, we acknowledge this work is still hard.

V. Results & Implications for Practice

Engineers have a tendency to look for the takeaway bullet points. Unfortunately, "how to practice antiracism in engineering" and "how to overturn the dominant engineering paradigm" are not simple items easily added to a to-do list. Rather, faculty must begin by developing their own critical consciousness and seeing for themselves the way in which Whiteness is a pervasive theme within engineering curricula. Understanding our own positionalities as educators needs to be front and center. As educators we all hope to find "plug and play" lessons that we can quickly deploy within our own courses. However, we are now skeptical that the solution is simply a revised collection of textbooks with CSPs informed

examples. The impact of any such curricula would be minimized if the instructor, intentionally or unintentionally, used it while still teaching from a deficit perspective. This type of pedagogy cannot be successful without first understanding our own identities and positions of privilege. This work is both particularly important and uniquely challenging for White faculty, especially men [42], who are the dominant demographic in engineering.

Critical reflection and self-reflection of positionalities is difficult but important work [43]. We have to engage in the process of examining what belongs in the curriculum and how we are perpetuating certain practices, because we are products of our own education that promotes a certain ideology. Deconstructing and challenging the curriculum requires an ability to critically see race and culture in these spaces, and surface them alongside the technical content.

Antiracist pedagogies have received more media attention recently, due in part to the racial justice protests throughout the USA [44], [45]. This is important work, but what effect will new curricula have if the power-holders and educational gatekeepers are still racist? As Lorde writes, "What does it mean when the tools of a racist patriarchy are used to examine the fruits of that same patriarchy? It means that only the most narrow parameters of change are possible and allowable. … For the master's tools will never dismantle the master's house." [46] Engineering education is one microcosm of society; parallels can be drawn between our reflection on our work and the aftermath of the Black Lives Matter (BLM) protests one year after the murder of George Floyd. In the same way more training has not fixed the problem of White police officers shooting unarmed Black men [47]–[49], faculty development workshops and anti-bias and anti-racism trainings will do little to fix engineering curricula if we as educators fail to critically examine and dismantle our own racist pedagogies [50], [51]. It is hard to see outside of the framework and critique it, when we are firmly planted within it. Cross (2020), whose work challenges the engineering dominant discourse, states [52]

> "Taking an antiracist position in engineering education… requires engineers to invest in the psychology of how they view, think about, and conduct themselves with people of another race. This requires first shifting from simple empathy to self-reflection and identification with one's own racialized identity and second, actively disengaging with the Whitening of the lived experiences of Black engineers."

Again, this work is hard and happens in slow increments. We recognize that we have had a unique opportunity to design a course from scratch, pair White men with women and people of color, and grapple with our own positionality within the context of an NSF funded grant. However, this is not the only path forward towards a more inclusive engineering pedagogy. We encourage readers looking to start down this pathway to engage with a diverse community of practice, as our own research group has been important for challenging each of us and helping us to see outside of our own lens. As we have discovered the difficulty of doing this for ourselves, we have begun developing and offering workshops for faculty who are seeking to integrate antiracism in their engineering courses. We draw on our team experiences to offer guidance on practicing introspection before implementing action in the classroom, and turning a critical eye to *what we teach* and *how we teach*. Change is possible, and everyone can take steps towards a new engineering education paradigm, but we must do so in a trusting and supportive community. A community provides resilience to the constraints and resistance encountered when challenging the dominant discourse.

Anti-racist change is an ongoing process. The slow and arduous processes of change reflect the nature of "systemic", and many of us are complicit in our passivity [44]. We point readers towards a call for action for engineering education scholars in research [53], [54], and towards Black scholars who have written about how to do this work in engineering classrooms [55]. We have experienced backlash as we integrate other ways of being, knowing, and doing into the curriculum [39] because backlash is rooted in "ideological and institutional structures" that seek to "maintain privilege, access, and control" [56] of the engineering curriculum. We recognize that the actions we have taken so far in implementing this course are not the radical changes to the engineering curriculum we hoped they would be, but we believe they are a necessary *first step*. We have only begun the difficult journey of recognizing the hierarchy of knowledge and its relationship to power.

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