

From Good Pedagogy to Racial Equity: Experimenting with what works in Engineering Classrooms

Dr. Atota Halkiyo, Florida International University

Dr. Halkiyo is a Postdoctoral Associate at the School of Universal Computing, Construction, and Engineering Education at Florida International University. Dr. Halkiyo graduated in Education Policy and Evaluation from Arizona State University and uses mixed methods but largely qualitative inquiry to study his primary research interest: enhancing higher education equity for all students, particularly those from international and/or underrepresented backgrounds (e.g., women and/or Black students in engineering). He envisions researching and removing possible systemic learning barriers from the curriculum, pedagogy, assessment, and learning environment to make education more responsive to all learners. Halkiyo taught and worked at a university in Ethiopia, where he was also a principal investigator of the "Engendering Higher Education Curricula" research project. Dr. Halkiyo is a Fulbright-Hays Fellow, where he conducted his dissertation research on global education policy transfer from the global West/North to the global South/East, specifically Ethiopia, Africa.

Dr. Stephen Secules, Florida International University

Dr. Stephen Secules is an Assistant Professor in the School of Universal Computing, Construction, and Engineering Education at Florida International University. Secules holds a joint appointment in the STEM Transformation Institute and a secondary appointment in the Department of Mechanical and Materials Engineering. He has bachelor degrees in engineering from Dartmouth College, a master's in Architectural Acoustics from Rensselaer Polytechnic Institute, and a PhD in Education (Curriculum and Instruction) from the University of Maryland. Prior to his academic career, Stephen was an acoustical consultant for 5 years in both London, UK and Silicon Valley, CA. His research has focused on culture and equity in engineering education, particularly undergraduate contexts, pedagogy, and student support. Through his work he aims to use critical qualitative, video-based, participatory, and ethnographic methods to look at everyday educational settings in engineering and shift them towards equity and inclusion. He also leads the Equity Research Group where he mentors graduate and undergraduate students in pursuing critical and action-oriented research.

From “Good” Pedagogy to Racial Equity: Experimenting with What Works in Engineering Classrooms

Atota Halkiyo^a & Stephen Secules^b

^{a,b}, School of Universal Computing, Construction, and Engineering Education, Miami, Florida, USA

Correspondence

Atota B. Halkiyo, 10555 W Flagler St, Miami, FL 33174 | Florida International University, U.S.A

Email: ahalkiyo@fiu.edu

Abstract

The issue of race-based disparities in higher education, particularly in engineering, is a pressing concern in the United States. Many faculty developers are actively seeking ways to bridge this gap and foster racial equity, including workshops for culturally responsive pedagogy. Faculty development workshops and seminars are inherently constrained by limited time, limited connection to and responsiveness to each faculty's context, and limited ability to explore effective interventions. This paper presents insights from a semester-long collaborative classroom ethnography that embedded in three engineering faculty classrooms and allowed for exploration of what worked to help them learn.

The study draws on a broader project with multiple data sources including an embedded classroom ethnography, student survey responses, faculty weekly reflective meetings, and faculty pre-post interviews; we used the project as an intervention to guide engineering faculty in transforming their pedagogy and creating racially-equitable learning environments. Theoretically, we draw on a few conceptual frameworks, including good pedagogy (e.g., Ladson-Billings's 1995 "good teaching"), learner-oriented pedagogies, equity pedagogy, and pragmatism.

Our three faculty participants exhibited varying degrees of engagement with good pedagogy, each with corresponding implications for racial equity. Our two key arguments are (1) Good pedagogy can pave the way for equity, including racial equity, and (2) An improvement in general pedagogy and efforts to improve racially-equitable pedagogy can happen concomitantly. While good pedagogy may not guarantee (racial) equity, bad pedagogy is more likely to perpetuate (racial) inequity.

We saw that when faculty members actively engage in good pedagogy that encourages student participation, e.g., even utilizing simple active learning techniques like "think-pair-share" (as seen with Faculty 1) and involving students in class activities (as demonstrated by Faculty 2), they are more likely to promote racially-equitable pedagogy compared to those who rely on traditional slides and lecturing only. Therefore, to foster the transformation of engineering faculty and their classrooms towards racially-equitable, we advocate for simultaneous exposure of general and racially-equitable pedagogies or the initial emphasis on a good pedagogy. We also note that for some professors, lessons on pedagogy will still come before a full understanding of racially equitable pedagogy, and particulars such as faculty seniority, years of pedagogical experience, identity/positionality, and classroom context can influence the faculty learning trajectory and most likely strategy for promoting equity.

Introduction

The issue of race-based disparities in higher education, particularly in engineering, is a pressing concern in the United States. Some educators are actively seeking ways to bridge this gap and foster racial equity. One avenue is to enrich curricula by integrating perspectives and experiences from diverse racial and marginalized groups. Another approach is to innovate pedagogy. Yet another strategy, but not limited to, is enhancing the responsiveness of the learning context and environment for all students by, e.g., fostering a stronger sense of belonging and improving the overall campus climate. A major question guiding our inquiry and analysis was: How can engineering faculty learn and engage in racially-equitable pedagogy, and what facilitates that journey: learning and transformation? More broadly, how do educators learn about race, diversity, and racially-equitable pedagogy and transform their engineering classroom into spaces that promote equity and inclusivity? Our two key arguments are (1) **Good pedagogy** can pave the way for equity, including racial equity, and (2) An improvement in general pedagogy and efforts to improve racially-equitable pedagogy can happen **concomitantly**. While good pedagogy may not guarantee (racial) equity, bad pedagogy is more likely to perpetuate (racial) inequity.

Theoretical frameworks: Discussing "good pedagogy"

We drew on a few conceptual frameworks, including good pedagogy (e.g., Ladson-Billing's 1995 "good teaching"), learner-oriented pedagogies, equity pedagogy, dimensions of classroom practice, and pragmatism. We recognize that "good pedagogy" can be conceptualized in many different ways (Ladson-Billings, 1995). Compared to the traditional, teacher-centered methods such as lectures, effective pedagogy embraces student-centered pedagogies (SCP), which incorporate a variety of Active Learning Methods (refer to Figure 1 for an extensive list of these methods). It's important to note that "student-centered pedagogies" do not have a universally accepted definition either. Instead, it is often referred to in different terms, including learner-centered learning, child-centered instruction, Active Learning Methods (ALMs), and "Classroom-based pedagogies of engagement" (Smith et al., 2005). Despite these varying names, SCP embodies key features that foster equitable learning experiences. Two central aspects are active engagement and an epistemological shift in knowledge construction: moving away from the domination of behaviorist paradigms towards a model that emphasizes the social construction of knowledge. This shift inevitably involves changes in the methodology of teaching. While behaviorism was a dominant educational theory during the 1960s and 1970s, its relevance has declined in instructional design. However, it still persists as a "behavior management strategy in schools, especially when working with special populations" (Newstetter & Svinicki, 2014, p. 33; Johri & Olds, 2014). When implemented effectively, SCP can personalize learning, decenter teachers' authority as the only/main source of knowledge, and democratize learning (Halkiyo, 2023).

We admit that SCP is critiqued on several grounds, including its tendency to be more of a philosophical principle than practical action (Brooke, 1982), its naivety to be framed as a “one-size-fits-all” and a magic bullet to address many educational problems (Schweisfurth, 2011). We also acknowledge that the teacher-centered approach has several benefits. However, SCP (over teacher-centered pedagogy) has a feature of “good pedagogy” and is closer to “equitable” pedagogy. Traditional lectures cater to the privileged and academically prepared students while SCP provides an opportunity to analyze/observe learners' needs and tailor the pedagogy accordingly. It is a “student-centered” instructional approach after all. Effective pedagogy involves all students, including marginalized and students of color, and prioritizes “how much [all] students learn.” On the other hand, ineffective pedagogy tends to cater to privileged and academically-prepared students. Although we framed pedagogies as a binary opposite (teacher-centered vs student-centered pedagogy), we recognize that there are recent developments towards alternative pedagogies such as culturally responsive/relevant pedagogy, Indigenous pedagogies, critical pedagogies, and multi-cultural education. These alternative pedagogies are even more “equitable” pedagogies. To engage in more equitable learning, engineering education needs to move in the direction of using more student-centered pedagogies and then progress toward employing alternative pedagogies. Thus, as a more logical and pragmatic step (also based on our experience with classroom observation and faculty engagement), we argue that SCP is relatively closer to and promotes “good pedagogy.”

We acknowledge that student-centered pedagogy (SCP) has faced criticism on various fronts. Critics argue that it can sometimes be perceived as a philosophical principle rather than a practical solution (Brooke, 1982), and that it seeks to be viewed as a “one-size-fits-all” remedy for a multitude of educational challenges (Schweisfurth, 2011). While we recognize some advantages of teacher-centered approaches, we highlight that SCP embodies key characteristics of “good pedagogy” and aligns more closely with the principles of equity in education. Although we have depicted pedagogies as a binary opposition—teacher-centered versus student-centered—it is important to recognize the emerging landscape of alternative pedagogies. Approaches such as culturally responsive/relevant pedagogy, Indigenous pedagogies, critical pedagogies, and multicultural education represent advancements toward even more equitable teaching practices. To foster an equitable learning environment, we argue and encourage that engineering education effectively adopts student-centered pedagogies and subsequently evolves toward these alternative pedagogies. Drawing from our classroom observations and engagement with faculty, we assert that SCP (hence, “good pedagogy”) serves as a logical and pragmatic step forward in the journey of enhancing learning equity in engineering education. At the project level, Faculty 1 tried simple ALM--“think-pair-share” and engaged more students. He also provided more opportunities for diverse students to reflect in the classroom. Additionally, he created more opportunities for diverse students to voice their reflections in the classroom. Meanwhile, Faculty 2 involved more students through engaging demonstrations. As learning contexts are different, there were different ways that “good teaching” and SCP were enacted; thus, we do not seek to list blanket ALMs that are universally applied.

In our study, we define "good" pedagogy as an evidence-based and active learning pedagogical practices: a student-centered teaching-learning approach characterized by active student engagement, active learning methods (ALMs), and frequent formative assessments to ensure students grasp the lesson. Utilizing a student-centered approach, e.g., ALMs, relies in part on the dedication and personality of each faculty member. Unfortunately, disciplines like Engineering often experience low implementation of ALMs due to time pressure on faculty (Halkiyo, 2023), and many faculty members mistakenly conflate equality with equity and continue justifying the use of a uniform pedagogy for all students (Halkiyo et al., 2023). Nevertheless, it's crucial to recognize the impact of our teaching methods on promoting racial equity in education. Embracing diverse perspectives and implementing student-centered approaches can lead to meaningful change and create a more inclusive educational environment. Good pedagogy (characterized by active student engagement, ALMs, and frequent formative assessments) is more likely to lead to effective pedagogy. Effective pedagogy involves all students, including marginalized and students of color, and prioritizes "how much [all] students learn." On the other hand, ineffective pedagogy tends to cater to privileged and academically-prepared students, disregarding the engagement of all students and focusing primarily on course coverage and "how much teachers teach."

Borrowed 101 ALMs (HDL Handbook, 2011)		
Goldfish bowl	Alphabet Game	What am I going to draw?
Hot seating	Are you telling the truth?	What's my job?
Diamond method	Back to the Board	Who am I?
Scavenger Hunt	Charades/Hints	Word Game
Balloon games	Chinese Mime	Demonstration
Buzz group	Fact Finding Game	Case Studies
Solomon Says	Question & Answer	Role-plays
Flash review method	Group Resume	Debates
Crossover groups	HDP Dictionary	Brainstorming
Pyramiding	Make Groups of the Same...	Project works
Decision line	Making a Group Story	Gapped lecture
Four corner method	Memory	Problem-based learning
Simulation	Mingle, Mingle, Mingle	Reflections
Drama	Name Game with the first letter of	Cooperative learning
Games	your name	Panel discussion
Just-in-time teaching	Name Game with the ball	Seminar
Bingos	Riddle	Pair work
Jigsaw group	The Change Game	Story telling
Think-pair-share	Observation	Ice breaker
Learning cycles	Walking Warmer	Competitions

Figure 1: List of examples of ALMs (Halkiyo, 2023: modified from HDP Handbook, 2011)

Methodology

Study and institutional context

The data in this paper comes from a larger study that investigates racial inequity patterns in undergraduate engineering classrooms: PROJECT_NAME_REDACTED_FOR_REVIEW. It was conducted at the Engineering College (EC) in one of the largest public universities in the United States during the fall of 2023, anonymized as Large Public University (LPU). LPU is a public research-intensive Hispanic Serving Institution (HSI) comprising a diverse student body including 66% Latinx, 12% Black, 9% White, 5% Asian, and 8% from other groups. Most of the faculty at LPU are white (46.7%), followed by Latinx (28.3%), Asian (10.2%), and Black (8.3%). LPU is in a suburb next to a large metropolitan city and ranks among the first in the nation in the number of Hispanic engineering students (Gamarra, 2019), and among the top 15 in the number of Black engineering students it graduates (Diverse Issues in Higher Education, 2020).

Data and participants

This paper presents a case study of three engineering faculty members as they strive to incorporate racially-equitable pedagogy into their teaching. It draws on a broader project with multiple data sources including an embedded classroom ethnography, student survey responses, faculty weekly reflective meetings, and faculty pre-post interviews—which we used as an intervention to guide engineering faculty in transforming their pedagogy and creating racially-equitable learning environments. Our motivation to research and intervene to expand participation in engineering is driven by a realization that progress in diversifying the field has been limited. Engineering education and profession are still not as diversified, and persistent racial disparities exist. We recognize the various structural and specific challenges that contribute to this issue and seek to tackle one of its key facets—pedagogy: transforming engineering education pedagogy into a racially equitable pedagogy. To accomplish this, we employed a comprehensive research project utilizing multiple data collection methods, including extensive classroom observations conducted throughout a semester. Classroom observations, which took place twice a week, were systematically documented using a researcher-developed checklist that focused on critical insights around the subject of our interest: racially-equitable pedagogy. Additionally, we conducted pre- and post-interviews each semester to evaluate faculty members' baseline knowledge, views, and skills related to racially equitable pedagogy at the start, and their learning and progress at the semester's end.

We consider our research project to be both research and intervention. It serves as both an inquiry into the challenges of implementing racially equitable pedagogy and an active intervention through weekly classroom observation feedback provided during faculty debrief sessions. These meetings, which included the two researchers and three faculty participants, fostered a space for critical reflective discussions. Faculty members were presented with classroom observation data and encouraged to reflect on their practices individually, followed by

collaborative reflections with their colleagues and researchers. Through these weekly engagements, we prompted faculty participants to question their assumptions and practices, offering them alternative pedagogical strategies, such as "think-pair-share" techniques to experiment with in their classrooms. We, thus, view this facet of our project as an intervention, as we assessed its impact through post-interviews and extensive and summative semester-long classroom observation data collected over the semester. Ultimately, this research project has provided some insights regarding the pathways for faculty development: How the educators learn about race, diversity, and racially-equitable pedagogy and transform their engineering classroom into more racially-equitable pedagogy.

Analysis

This paper's analysis focused on classroom observation data and pre-post interviews. However, our engagement and experience with the faculty-participants during the weekly faculty debrief meetings and student surveys also informed our analysis and interpretation. Our analysis adopted an inductive approach, capturing emerging insights through open and iterative coding and analysis. This process was supported by the ongoing critical co-reflections of the two authors throughout the semester-long research project. These reflections included several Zoom meetings, where we collaboratively discussed and summarized our insights following our weekly faculty debrief sessions. We also engaged in rigorous critiques of each other's interpretations, both in writing and during our conversations, ensuring a deep and nuanced understanding of our findings.

Findings

The findings reveal that the three faculty members exhibited varying degrees of engagement with good pedagogy, each with corresponding implications for racial equity: Faculty 1 demonstrated intentional evidence-based and active learning pedagogical practices, leading to racially-equitable pedagogy, while Faculty 2 unintentionally practiced ineffective pedagogy, indirectly affecting racially-equitable pedagogy. Faculty 3 fell somewhere in between, with partly evidence-based effective pedagogy and no apparent impact on racially-equitable pedagogy. This study offers valuable insights into the complexities of engaging with and transforming engineering classrooms toward racially-equitable pedagogy and faculty learning of racially-equitable pedagogy.

This paragraph offers a backstory into the learning journeys of the three faculty-participants. Our engagement through pre- and post-interviews, weekly engagement meetings, and classroom observations reveals that each instructor navigated unique pathways to enhance—or not enhance—their pedagogical practices. As they transitioned from the traditional mindset of "I learned it this way, and it worked for me" to adopting more dynamic and active pedagogies, their experiences reflected a learning journey specific to their individual contexts, positionality, commitment, and personal characteristics, such as openness. For instance, Faculty 1 joined the project with a foundational understanding of contemporary pedagogical methods, e.g., some

active learning methods, but lacked the skills to implement them fully. Utilizing our research project as a formal platform, he validated his pedagogical ideas through the insights of experts actively engaged in the field. He also embraced the project as an opportunity to reassess his beliefs and assumptions, some of which deficit, e.g., regarding the engagement of marginalized students in engineering classrooms. By experimenting with innovative ALM techniques like "think-pair-share" and refining his already effective strategies to better support underrepresented students (e.g., providing more opportunities for students from underrepresented backgrounds to reflect during the classroom instructional process), he demonstrated curiosity, intentionality, and a commitment to embracing new teaching methods and insights. Conversely, Faculty 2 began with limited teaching experience and a constrained understanding of participatory pedagogies. His initial approach relied heavily on slides and lectures, with minimal student engagement. However, as the project progressed, some growth occurred. His knowledge of key concepts related to race, diversity, and equity (e.g., the difference between equity and equality) improved. He increasingly recognized the value of racially-equitable pedagogy in engineering education and began implementing some recommendations from the project team, such as incorporating more engaging questions during lectures to foster student participation. In contrast, Faculty 3, an experienced senior professor, initially showed resistance to addressing issues of race in education. Despite enrolling in a project centered on racial inequity in engineering, she often dismissed the relevance of race, stating ideas similar to "I can't still see how race matters here." Her hesitance to embrace change and commitment to adopting new pedagogical approaches limited her growth. Nonetheless, over time, she began to acknowledge that race is one of the critical dimensions in achieving equity within engineering. Her gradual shift in perspective, while modest, highlights the importance of continued dialogue and efforts to address systemic issues such as racial inequity in the field.

Faculty 1: Intentional use of ALM pedagogy and racially-equitable pedagogy:

Faculty 1 is a white masculine-presenting nonbinary person who grew up, was educated, and worked in the U.S. He taught a mechanical engineering course on an introduction to programming using Python as the programming language. Upon meeting Faculty 1, they already prioritized engaging students and promoting participation. However, initially, their engagement tended to be through open-ended questions typically answered by a few students (primarily privileged demographics) in the first few rows of class. Through our intervention (i.e., weekly engagement meetings bringing in classroom observation data and student survey responses), we further inspired the faculty to be more critically reflective and experimental in their teaching methods and explore new pedagogical techniques that enhance active learning, e.g., implementing "think-pair-share" exercises. We observed a noticeable shift from teacher-oriented pedagogy to learner-oriented one, particularly through implementing ALM—"think-pair-share," and encouraging students to stand up and share their reflections (see photo 1), walk to the front of the classroom and write their answers on the board (see photo 2), and move around every corner of the classroom (see photo 3).



Photo 1

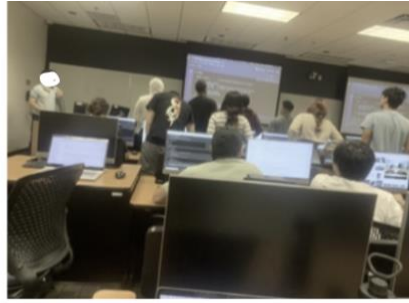


Photo 2



Photo 3

This shift in pedagogy increased the participation of all students, including students of color. In photo 1, an African American male student stood up in front of his peers and reflected on his answers to the assignment. The researcher-observer observed similar three times throughout the semester, where the faculty invited African American students to reflect in front of their peers. Additionally, this faculty increasingly involved students sitting on each row and classroom location, for example, calling: "At the back,"; "Center," "2nd row," "What about the 3rd row?" "Somebody at the center-- why the letter "B"?" "Someone in the last row...?". This faculty would also call on the names of specific students at random (so that all students got ready and were on standby to engage) and intentionally included the names of students of color. In general, across the semester, the faculty was observed to increasingly expand his engagement from students immediately adjacent to calling on a wider room location of students and using student names to engage specific students in the class discussion.

During the post-interview, the researcher-interviewer asked the faculty to reflect on the dilemma some perceive that equitable teaching could amount to unfair and discriminatory teaching against mainstream students. The faculty responded that equitable teaching levels the playing field, reduces the domination of some sets of students over others, and does not single out members of the underrepresented groups:

Hmm, I would say, based off of the discussions we're having, I think if my hypothesis is that everyone has to believe that there is a common goal that they agree with, it's incumbent on me not just to let the students have a conversation about what they want, but also to make sure that that conversation is equitable. I call on or I let students just volunteer their opinions, the assertive students, the ones that feel comfortable in the space that I haven't established a culture in yet are going to bring in their assumed culture of classroom about programming...The students with the most self-confidence, racialized [and] on gender lines, are going to dominate the conversation, more likely than not. If I come up with a weird way of having the conversation, something that's new, something that throws the people who have a lot of self-confidence a little bit more off balance, maybe it helps reduce that bias in the conversation. Maybe it becomes possible for equitable discussion to occur? This idea of "think-pair-share" right, where I'm calling on

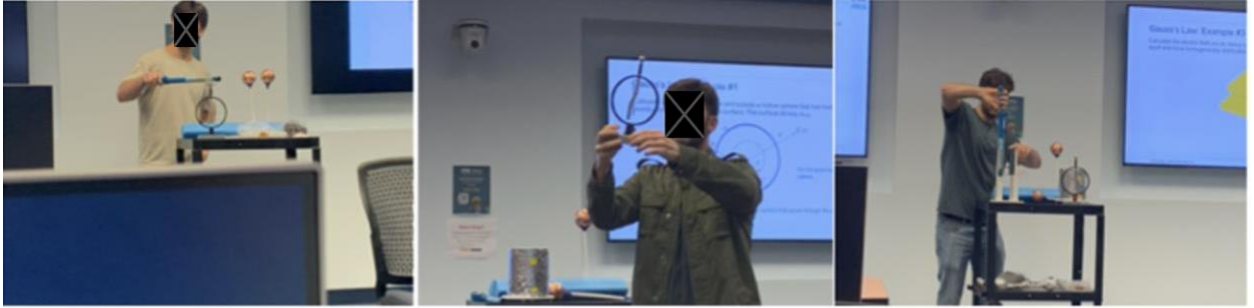
people at random, but I'm having everybody discuss it, so that no one feels singled out... I think that's something that I can try to take advantage of, because I think right from the outset, the goal that I have is to make everybody have the same level of confidence, or [a] more equitable level of confidence.

Their conceptualizations around the function and utility of ALM pedagogy for creating both equity and understanding show a fluidity with the concepts and not merely parroting the researchers' favored ideas back to us or going through the motions in class. Ultimately, by moving away from traditional teacher-dominated lectures (where the teacher and a few outstanding students drive the lesson and instruction), this faculty member noticeably enhanced the involvement of all students in the learning process, which contributed to equity in learning.

Faculty 2: Limited use of ALM pedagogy, demonstrated growth, and an indirect effect on racially equitable pedagogy.

Faculty 2 is a white heterosexual male who grew up and was educated in Europe—with around 99% white population: *"Because...English, you have only Whites; I mean, there is 99%; in Italy, it is the same,"* and was teaching engineering courses in the United States. He had limited teaching experience when the interview was conducted.

Faculty 2 initially relied heavily on lectures with minimal student engagement. Any student participation was limited to those who sat at the front left next to the podium/professor. Classroom space usage was primarily limited to the front left/podium, and the instructor rarely assessed students' understanding in a meaningful way. However, Faculty 2 made noticeable improvements after implementing the targeted pedagogical and racial-equity strategies we suggested during our weekly engagement meetings. These changes included enhanced student engagement, more frequent checks for students' understanding, a personal touch with humor—*"This experiment even blows up your mind!"*, and addressing students by name. Faculty 2 went from using a lecture-dominated teaching approach to making significant strides toward more engaging pedagogy. The following photo depicts the professor's early pattern (where he engages himself only in demonstrations) and late semester pattern (where he calls up the whole class to the front and engages all students, including a student with a mobility disability, women, and students of color).



Early in semester



Late in semester

We want to point out that the faculty did not make substantial progress toward conceptualizing racially-equitable pedagogy. However, our classroom observations documented some instances of classroom practices that we assessed as productive towards racial equity. For example, this faculty engaged in demonstrating classroom experience with a student of color, who was partially indifferent, put his hand in his pocket and stood at the back of other students (early pattern) and being directly involved in the demonstration with the professor (late pattern) (see photo 4).



Early Pattern

Late Pattern

Photo 4

We also documented growth in his knowledge and views regarding racially equitable pedagogy; however, this growth was sometimes partial. The post-interview with him shows that he expanded his knowledge of racially equitable concepts such as "diversity," "equity," and "equality"-- "Now... *I understand much better*" (Faculty 2). He also expressed a positive shift in his attitude and now recognizes the importance of diversity and providing equal opportunities for everyone: "*Definitely, this is very important...I think this is what all people should do...Why would you like to have an outcome where everything is unbalanced? I don't see why to promote one over the other..., everybody should be given such opportunities such that you can reach the same level. It's unfortunate that this is not how life works, but this is what we should aim for*" (Faculty 2). While our observed shifts in classroom practice were encouraging, Faculty 2 also shared, "... *I'm not sure if I have identified any changes in the teaching in respect to equity and diversity.*" Thus, we interpreted Faculty 2 as still working towards connecting his new understandings and his conceptualizations of racially equitable classroom practice (i.e., the sorts of connections we saw Faculty 1 make in his final reflections).

Faculty 3: Partly less effective use of ALM pedagogies—with no clear effect on racially-equitable pedagogy

Faculty 3 is a South Asian woman who immigrated to the US over a decade ago, taught a project-based class on transportation systems and was recently appointed full professor, with several years of teaching experience.

Faculty 3 exhibits some clear use of ALM pedagogies. Her course has two parts: lecture and project-based (see photo 5), and her ALM pedagogy, especially in the project-based component, keeps her students actively engaged. She intentionally but subtly encourages female engagement—contributing to gender equity. Despite our intervention, Faculty 3 did not try to enact insights to affect her teaching toward racially-equitable pedagogy: "*I don't worry in race, but gender...My objective is to increase female students [in engineering]... I do gender equity things in subtle way, I don't overdo it.*" In our engagement experience and from post-interview, Faculty 3 justified her inaction on factors such as cognitive load and workload and the HSI institutional context: "*Another reason... in my class,... almost...the minority is a majority. That's why, ...I don't see a lot of inequity...In X [the state the university is located],..., I don't see that inequity, because 90% are Spanish. I mean, the minority is the majority.*"



Part 2: project-based class



Part 1: Lecture class

Photo 5

Despite her resistance to the significance of racial inequity in engineering education during the early semester—during the pre-interview (partly due to lack of awareness), this faculty now—late in the semester—during the post-interview, believes that racial diversity also matters in students' learning:

I said in my pre-interview, or the beginning of the semester, I usually make a conscious effort to bring the females to the top, giving them more opportunities, asking them questions, asking them to go up to the board and do the problem, or stuff like that. But what I'm realizing, realized, is that in addition to asking or putting the focus on females alone, I will also put the focus more on other races, who are a minority and who are maybe introverts for whatever reason...Earlier, that [race] was not one of the variables I paid attention to, but now I have one more variable in my model.

In the course of this faculty's engagement with the project intervention, which included classroom observation feedback, student survey responses, weekly faculty engagement meetings, and pre-post interviews, we noticed that she was negotiating her initial conceptualizations and reasonings regarding the existence and significance of racial identity on race-based disparity. While classroom observation indicates no noticeable actions aimed at addressing racial inequity, the post-interview indicates shifts in understanding, views, and stance, insights gathered from post-interviews indicated a notable shift in understanding, perspective, and stance. This evolution underscores a growing recognition of racial identity as a significant factor within engineering education: "Now I have one more variable in my model." This commitment to deepened awareness is a positive step toward fostering a more inclusive and equitable learning environment for all students.

Discussion

The evidence presented above shows that two of the three faculty members responded to our intervention towards the deliberate practice of effective general pedagogy and racially-equitable pedagogy. We saw that when the faculty members actively and intentionally engaged in “good” pedagogy that encourages student participation, e.g., even utilizing simple active learning techniques like “think-pair-share” (as seen with Faculty 1) and involving students in class activities (as a group and as individuals, as demonstrated by Faculty 2), they are more likely to promote racially-equitable pedagogy compared to those who rely on traditional slide-based lectures with only a few students involved.

We oriented this paper by thinking pragmatically about what works for improving racial equity in engineering classrooms. A few findings have emerged from our first research site:

1. *Using classroom data to show faculty about the patterns in their own classes.* A numerical approach sometimes works better for these engineering faculty than qualitative examples. However, given the small numbers and nuanced scenarios of racial diversity in some classes, we found photos helped to triangulate scenario descriptions and experiences with faculty views of the classroom.
2. *Adapting the observation focus to faculty classroom contexts.* Rather than emphasize a specific kind of pedagogical structure that was feasible or developmentally accessible to the faculty at that time, we tried to meet faculty where they were in their teaching and adapt our focus towards meaningful representations of equity and pedagogy. This creativity in the redefinition of classroom equity meant a shifting focus on student participation, classroom movements, team dynamics, or other factors, respectively, and helped our pedagogical advice stay relevant and immediately actionable.
3. *Allowing faculty to express their logic, confusion, resistance, or disagreement.* We aimed not to correct the faculty and tell them how to think or teach; we engaged in dialogue and allowed faculty like Faculty 3 to disagree or resist even the central idea (racially equitable pedagogy). We think this resulted in more meaningful and nuanced reasoning (e.g., Faculty 1) and more genuine wrestling through confusion (Faculty 2) and resistance (Faculty 3) than other more didactic approaches.
4. *Considering positionality and expertise when offering advice.* We have found that positionality impacts the way our pedagogical advice or equity observations are listened to. This has involved conferring privately among the research team to strategize who will share or reiterate which observations, interpretations, and intervention strategies to the participants. Collaborating in this strategic way helped our team’s advice land with more impact and not be discounted based on an impression of it as racially biased or coming from inexperience.
5. *Promoting general pedagogy helps advance equity in engineering education.* It is unreasonable to expect a pedagogically-beginner engineering faculty to engage in the praxis of racially-equitable pedagogy, a relatively advanced skillset. Instead, our focus should be on guiding these educators from traditional lecture-based methods to learner-

centered approaches, which serve as a foundational step. Given that many engineering professors come from a background rich in subject-matter expertise but lack formal training in educational strategies, it's crucial to introduce them to general pedagogy alongside racially-equitable practices—particularly for those with more experience. For beginner faculty, starting with general pedagogy is a vital first step toward fostering a more inclusive and equitable educational environment.

Conclusion and implications

To foster the transformation of engineering faculty and their classrooms towards racially-equitable, we do not call for or promote a clean linear approach, where faculty can first master a good pedagogy and then engage in the praxis of racially-equitable pedagogy. Considering the complexity of learning and our stance of embracing multiple, subjective, and simultaneous pathways for improvement, we advocate for simultaneous exposure of general and racially-equitable pedagogies or the initial emphasis on a good pedagogy.

Additionally, engineering faculty are at different stages of learning trajectories regarding racially equitable pedagogy. Thus, we should tailor interventions and meet them where they are. More meaningful professional development would be individualized to each set of faculty members: beginners, moderate, and advanced. We thus advocate and call for simultaneous exposure for more senior faculty, and for the beginner faculty, starting with general pedagogy and progressing to racially equitable pedagogy would be more logical and beneficial. We note the challenge this may present for faculty developers who need to make workshop structures that fit larger populations. Thus, we advocate and call for simultaneous exposure (understanding good pedagogy while also engaging in praxis on racial equity), while noting that for some professors, lessons on pedagogy will still come before a full understanding of racially equitable pedagogy. We recognize that this is a small-scale case study, but our focus is not on identifying universal faculty learning strategies applicable to larger populations. Instead, we are committed to exploring effective pedagogical methods that can transform engineering education into a more racially equitable experience, and to contribute to the broadening participation efforts.

References

- Author 1. (2023). *Radical Policy Borrowing: An Intensive Inquiry into the Higher Diploma Program, Reform of Instruction Methods in Ethiopia* (Doctoral dissertation, Arizona State University).
- Au, A. B., Hailu, M. F., & Lott, B. E. (2023). Gender-based pedagogical inequity: Exploring faculty perspectives in Ethiopia. *Cogent Education*, 10(2), 2249668.
- Brooke, N. (1982). Relevance in pedagogy and the problem of educational quality in Latin America. *International Journal of Educational Development*, 2(1), 73-79.
- Higher Diploma Program for Teacher Educators. Handbook. (2011). Ministry of Education, Addis Ababa, Ethiopia.
- Johri, A., & Olds, B. M. (Eds.). (2014). *Cambridge handbook of engineering education research*. Cambridge University Press.
- Ladson-Billings, G. (1995). But that's just good teaching! The case for culturally relevant pedagogy. *Theory into practice*, 34(3), 159-165.
- Matsumoto, K. (2017). A review of Jerome Bruner's educational theory: Its implications for studies in teaching and learning and active learning (secondary publication). 名古屋学院大学論集 社会科学篇, 54(1), 129-146. <https://core.ac.uk/download/pdf/130322006.pdf>
- Newstetter, W. C., & Svinicki, M. D. (2014). Learning theories for engineering education practice. In *Cambridge handbook of engineering education research*, Chapter 2, 29-46.
- Schweisfurth, M. (2011). Learner-centered education in developing country contexts: From solution to problem?. *International Journal of Educational Development*, 31(5), 425-432.
- Smith, K. A., Sheppard, S. D., Johnson, D. W., & Johnson, R. T. (2005). Pedagogies of engagement: Classroom-based practices. *Journal of engineering education*, 94(1), 87-101.