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Dimensions of Diversity in Engineering: What We Can Learn from STS

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Introduction

The challenge of increasing diversity in engineering is usually framed as a problem of representation with solutions and interventions aimed at increasing the numbers of underrepresented groups. Historically, and in the present moment, the field of engineering has not been the most diverse in terms of race and gender. As of 2014, only 19.8% of all engineering undergraduate students in the United States identified as female, down 0.7% from 2004 [1]. Compared to this percentage, the University of Virginia's engineering school had a 31% female undergraduate enrollment in 2017 [2]. Yet, nationally females represent greater than 50% of all college students. Recent efforts have initiated means to strengthen an atmosphere of inclusion, but there is more work to be done to bridge the identified gaps.

Reasons for the gender gap can be found within different engineering disciplines. One of the most commonly-cited reasons for why systems and industrial engineering attracts more women than other engineering disciplines is that it is perceived as having more feminine qualities. Brawner et. al [3]surveyed 70,000 students and concluded that feelings of "warmth" and the idea that systems engineering is more generally applicable to a career led women to choose the concentration. Blosser [4]made a similar conclusion, presenting evidence that systems engineering is seen as feminine while mechanical and electrical engineering are seen as more masculine pursuits. Other research suggests that math confidence, a common explanation used by researchers to explain why women choose not to pursue engineering in general, is inadequate to explain the disparity across different majors [5], [6]. Chemical engineering serves as an example of the inadequacies of these explanations; despite its mathematical rigor, masculine perceptions and typical career paths, chemical engineering attracts a large number of women [4].

Apart from the identified issues with gender and engineering are concerns about minority retention in engineering. Computer science engineering is a field that does not have high retention rates for minority students. A resounding number of studies refer to female and minorities' perceived lack of confidence in their own computing abilities as a key factor in their decision to leave the major. Varma [7] indicated that minority students interviewed "believed that teachers perceive white and Asian students to be smart[er] and hence more likely to excel in CS classes. Such perception of the faculty prevented minority students from asking questions in class or approaching the faculty for help." (p. 131)

Additionally, Redmond's [8] case study – in which they re-structured Stanford's computer science department to become more inclusive – found that one of the largest impacts on a woman maintaining interest in computer science is how early she took her introductory computing coursework. Thus, if women and minorities are mandated to take these introductory courses earlier in their undergraduate curriculum, retention rates would likely increase. This sentiment was reflected throughout countless studies, all of which frequently refer to women and minorities' lack of early exposure to computing as crippling factors in their disinterest in the major. To address this gap, the NSF funds programmatic interventions that attempt to increase demographic representation to an "equitable" level.

A skeptical assessment of interventions of this sort is that they are really about enriching the experiences of already privileged participants in the nation's engineering schools by exposing them to alternative perspectives. On the face of it, this is an important and laudable development. Exposure to alternative perspectives for engineers are valuable in and of themselves. However, if interventions that address the diversity challenge are only limited to increasing the numbers of underrepresented groups without simultaneously creating the intellectual and institutional spaces that allow for the expression of multiple viewpoints and perspectives, engineering education runs the risk of limiting and possibly preventing the very thing we are trying to encourage.

This paper presents a range of approaches and frameworks, rooted in the field of science, technology & society (STS), that explore and sustain diverse intellectual and institutional spaces, allowing engineering students to individually and collectively explore and experience multiple dimensions of diversity in engineering pedagogy and practice. All of the authors of this paper are members of the Science, Technology, and Society (STS) program in the University of Virginia's School of Engineering and Applied Science. Science, Technology and Society (or Science and Technology Studies) is a field of critical enquiry concerned with the *inter*-actions of science, technology and society. STS draws from and contributes to various established fields of inquiry in traditional social science and humanities departments. (For more information on the intellectual and organizational roots of STS, see Jasanoff [9], Wyatt et al [10].) The STS program at the University of Virginia is the *only* STS program located *within* an engineering school at a comprehensive university in the United States. We are humanists and social scientists and also members of an engineering faculty with whom we share pedagogical goals and programs but not disciplinary cultures. Our unusual location provides a particularly interesting perspective from which to explore the many dimensions of diversity. Many of the ideas presented in this paper are explored in more depth in other papers being presented at this year's conference ([11], [12], [13]).

Disciplinary Diversity as a Structural Problem: Getting Beyond Disciplinary Egocentrism

Most discussions of diversity recognize the existence of mutable and invisible aspects of diversity such as life experience, but these aspects tend to be viewed as secondary to or consequences of the less mutable and more recognizable factors such as race and gender. Authors writing about innovation in technology-based organizations, on the other hand, tend to focus on the creative and competitive advantages of a diverse workforce. This could be because they are better positioned to (1) understand and meet the needs of a wider group of potential users and (2) gain creative insight by connecting "seemingly unrelated questions, problems, or ideas from different fields" [14], p. 2. Given the broad agreement about these principles, which are also reflected in the ABET outcome "ability to work on multidisciplinary teams," it is surprising that more attention has not been given to intellectual diversity which we argue is best understood as disciplinary diversity, and indeed may be the foundation of all other kinds of diversity in a university setting.

Unfortunately, the discipline-centric structure of higher education means that our institutional arrangements are not only not conducive to disciplinary diversity, but instead antithetical to it—and resistant to change. These circumstances suggest that our best option may be what the British sometimes refer to as "the thin end of the wedge," which in this case would mean working within these structures (as opposed to changing them radically). It is true that some institutions have taken more structural approaches to escaping disciplinary centrism, for example the University of New Haven [15]. Our institution has chosen to explore such opportunities in the context of upper-level STS courses populated by students from many different engineering majors. These courses provide the opportunity for two different kinds of interdisciplinary exposure: (1) to engineering disciplines other than the student's major and (2) to research and perspectives from the humanities and social sciences broadly and the interdisciplinary field of STS specifically.

In "Identifying Barriers to and Outcomes of Interdisciplinarity in the Engineering Classroom" [16] Richter and Paretti provide insight into the problems that interdisciplinary classrooms must overcome but also have the potential to remedy. Drawing on a distinction between "multidisciplinary" collaboration "in which little information is exchanged and participants leave the encounter unchanged" and "interdisciplinary" collaboration "in which participants work closely together to continually integrate knowledge and approaches" (p. 30), Richter and Paretti propose the term "disciplinary egocentrism" as a label for the "cognitive barriers" that stand in the way of interdisciplinary collaboration. Disciplinary egocentrism is marked by an inability to think beyond one's own perspective, a lack of understanding of the value of multiple approaches, and an "inability to integrate and synthesize differing epistemologies and value systems in addressing complex problems" (p. 38). At its foundation, disciplinary egocentrism grows out of both a "rejection of other viewpoints" and "a failure to recognize differences" (p. 38). Given this diagnosis, a logical place to begin treatment would be exposure to different perspectives in a context that makes them meaningful and relevant (as opposed to simply being exposed for exposure's sake).

Two upper level courses that provide such a context are offered at the University of Virginia as a year-long sequence—*STS 4500: STS and Engineering Practice* and *STS 4600: The Engineer, Ethics, and Professional Responsibility*. As part of these two courses, every student completes a design or research project (usually in a group and in the student's major) and an STS research paper that uses concepts and scholarship from the humanities and social sciences (broadly defined) to develop a deeper understanding of a social or ethical issue related to the development and implementation of new technology (usually the technology associated with the student's technical project).Each instructor, while drawing upon STS literature and working to support students' research papers in STS 4500 and STS 4600, takes a distinctive approach to the course. Also, see Neeley and Steffensen, ASEE 2018 [11] "*The T-Shaped Engineer as an Ideal in Technology Entrepreneurship: Its Origins, History, and Significance for Engineering Education*" for the history of a fairly recent attempt to overcome disciplinary egocentrism within engineering education, especially education for entrepreneurship and innovation.

Cross-Hierarchy Collaborations: Students as Teachers and Knowledge Producers

Educators have long viewed students as somewhat empty vessels, ready to be filled with knowledge and skills in order to make them into future practitioners. This model appears in some institutional and sociocultural norms as well as in classic studies of socialization in scientific and technical careers, which don't mention novices' existing knowledge, skills, or identities (e.g., [17], [18], [19]). Despite ongoing critiques of this mindset as inaccurate and a barrier to learning and identity formation (e.g., [20], [21], [22]), some academic communities, such as the engineering research laboratory groups that co-author Wylie studies, continue to talk about novices according to this model. This approach does great injustice to newcomers to expert communities as well as robs experts of opportunities to learn from "a wisdom of peripherality" ([23] p. 216), i.e., the invaluable perspective of outsiders. In ongoing observations and interviews of four engineering research labs (for a summary of preliminary results, see Wylie and Gorman, ASEE 2018 [12], also [24]), Wylie found that although PIs and graduate students tend to talk about undergraduates in terms of empty vessels, they do not treat undergraduates as empty vessels. Instead, experts interact with novices based on two tacit assumptions: that undergraduates are low-status, low-stakes learners and interdisciplinary, open-minded scholars. While experts' deficit thinking about novices limits novices' participation within a community, the roles that engineers assign to undergraduates enable undergraduates to actively contribute to the construction of knowledge.

Specifically, Wylie found that undergraduates serve research groups as local experts at laboratory tasks and as nonexpert outsiders who challenge the knowledge the experts take for granted. For example, at one group meeting, an electrical engineering graduate student gave a practice talk about how to lower the battery power needed by an electronic sensor to monitor a person's heart rate. Undergraduate Will asked, "Couldn't we sample only during heartbeats, for example, if we have some idea when they'll be and if we don't need to know what happens in between?" He was suggesting that matching the sensor's data collection to predicted heartbeats would reduce data collection time and, accordingly, power demands. The PI replied, “Yeah, compressive sampling is trendy right now.” He speculated about how to build compressive sampling into the project, and concluded that it would be good to try in the long term. He thanked Will for the idea, saying “good question.” Thus an undergraduate proposed a novel way to address an engineering problem. He derived this suggestion from his broad education in engineering and his hobby of reading about innovative technologies. In Wylie’s observations, undergraduates tend to excel at this open-mindedness and ability to make novel connections. In addition, the PI took Will’s suggestion seriously because Will understood the lab’s specific problem and matched his suggestion to it. Graduate students and PIs of course are also capable of open-minded, interdisciplinary thinking, but undergraduates’ current experience of wide-ranging coursework and their incomplete indoctrination in a specific paradigm particularly empower them in these abilities [18]. This conversation illustrates the value of sharing knowledge across social statuses, such as from students to faculty.

Similarly, co-author Ferguson draws upon several strategies from liberation pedagogy [25], feminist theory ([26], [27]) and democratic engagement from STS [28] for practical applications of critical pedagogical interventions among fourth year engineering students. From the first day of class, students were encouraged to share their own education needs and life experiences as sources of valuable knowledge, during which the instructor collected ideas through consensus conferences and electronic surveys in order to build a shared syllabus and community supporting diversity and equality. Yet, throughout the course, repeated encouragement for liberating oneself from assuming the instructor “knows best” became necessary as the community repeatedly defaulted to institutionalized behaviors.

Typically, faculty assume the roles of leaders and experts in the laboratory and the classroom, thereby overlooking ourselves as learners and--equally problematic-- overlooking students as leaders and experts. Instead of acting as though power and knowledge follow a single hierarchy, faculty should construct knowledge collectively, by engaging with each individual’s expertise. Institutional strategies and sociocultural norms to encourage this cross-hierarchy collaboration, including listening and distributed leadership, promise valuable epistemic and social benefits, such as increased knowledge exchange between disciplines and more inclusive communities that welcome the perspectives of more kinds of people. We have all witnessed how students’ wisdom and experiences can enrich a discussion; why then don’t we treat students as our co-instructors and co-learners? Novices can bring great wisdom and insight to communities of experts, if experts are open to learning from them.

Challenges to Teaching Diverse Analytical Perspectives: Differences in Ways of Knowing

Engineering schools are adept at teaching students how to think like positivists. Students are taught how to analyze the world using logic, particularly mathematical based logic. This “Rationalism” is a cornerstone of early courses in Engineering Analysis and Applied Mathematics. Additionally, engineering students are also taught to value “Empiricism” as a valid means of acquiring “Truth” about the physical world. Experiments that allow the experimenter to “see” for themselves and gather data about the physical world are emphasized in lab classes and in the rhetoric around the importance of data in analysis. These two ways of knowing, shorthanded here as “positivism,” are an important and essential element of what it means to be an engineer. Engineers by definition, are logical and data-driven. However, the work of the engineer as a professional and of engineering as a profession is not limited to logic and data alone. Engineering requires persuasion, dealing with citizens, engaging with policy, understanding ethical restrictions and right action, and being able sometimes, to come up with innovative solutions that can garner support from the widest constituency. These skills and others require diverse analytical frameworks. It is also true that different communities approach problems from different perspectives and that of necessity, the tidy world of problems that can be abstracted through logic and data in the walls of the Ivory Tower need to meet the messiness of the real world and be translated into useful solutions. Increasing Diversity in Engineering must also mean increasing diversity in ways of knowing, i.e. teaching different analytical perspectives to our students.

Lead-Author Odumosu’s experience of teaching a full year final year course devoted to teaching constructivism [29] as an analytical perspective demonstrates one way to increase diversity in this way. At the start of the semester, students find it difficult to take of their positivist “hats” and think like constructivists. Only through deep immersion and opportunities to practice these ways of thinking and analysis do they develop a facility with different analytical perspectives. The students learned a great deal from an assignment where they had to consider a problem from the traditional engineering viewpoint, and then again from a different analytical point of view. Sharing these viewpoints with students from other departments in the School of Engineering and also with students in the College of Arts and Sciences at the University of Virginia, further reinforced the idea that there are diverse analytical perspectives to solving any particular problem and an integrated approach that is able to consider multiple perspectives can be supremely useful in anticipating future challenges to engineered solutions. This demonstrates some of the challenges, but also the varied opportunities available to bring diverse ways on knowing into the classroom.

Opening up our understanding of diversity to include analytical perspectives requires institutional retooling. The University of Virginia, organized as it is to expose all undergraduates to a full year of this kind of training is in a rather unique position, nevertheless, much of programmatic benefit of the University’s final year STS courses can be transposed to other schools. It does require cultural acceptance of the validity of this type of training by faculty in traditional departments, and an embrace of diverse ways of knowing by the administration all the way from the Dean's office to the Undergraduate curriculum committee. However, the pay-off in student learning and ability to function in diverse environments is more than worth it.

International Standards: Exploring the Problems and Possibilities of Global Innovation

Co-author Ku designed and implemented an STS-informed STEM course curriculum, *"Standards in Action: A Global Perspective"*, which was funded by the National Institute of Standards and Technology (NIST). The curriculum was predicated on the idea that standardization provides for a concrete educational platform to address the epistemic, institutional and socio-cultural dimensions of diversity in global technology innovation. Drawing on various STS literatures, the course encourages students to conceptualize "standards" not as a set of neutral, ready-made, "ought-to" mundane rules, but a series of dynamic and constant reinterpretations, reaffirmations, negotiations and materialization of science, law and ethics among heterogeneous stakeholders from various socio-political and geographical regimes. By reckoning with standards, this curriculum brings diversity and its practice to the core of technology production, management, and governance.

Based on an empirical review of the teaching experience and students' learning results, Ku concludes that Standards education can be utilized as a tangible and reflexive platform to explore the problems and possibilities of global innovation, diversity and justice. However, to teach standards as a vehicle for bridging diversity and engineering practice requires a paradigm shift - novel research frameworks to re-conceptualize standards-in-the-making and standards-in-action within the global innovation framework; innovative pedagogical means to create an interactive classroom and out-of-classroom teaching such as mock panels, gaming, and field trips to increase students' comprehensions of the multilayer socio-technical complexities. Finally, cultivating collaborative partnerships between universities and standard development organizations such as the International Organization for Standardization (ISO), ASTM International and the IEEE Standards Organization (IEEE-SA)is necessary to sustain a critical, down-to-earth understanding of diversity and justice in real-world engineering practice.

Self-reflection, Otherness, Plurality: The Complex Relationship Between Diversity and the Cultivation of Disciplinary and Professional Identities

As students enter science, technology, engineering and mathematic (STEM) field at universities and colleges in the United States, they move away from general education towards specialized fields of study. Even with the broad field of engineering, students must declare their major concentration and follow the curricular pathway laid out by the faculty and administration and accredited by ABET. This choice seems obvious and will position the student for success in their pursuit of employment opportunities in the near-term. What co-occurs with this choice, often implicitly, is a secondary set of selections that are associated with this decision. Those co-occurrences include the pedagogical preference within the student's major (or sub-discipline), forms of rationality (ontological orientation), methods for gathering and analyzing data (epistemic community characteristics), language and communication techniques (communicative actions), behavioral expectations (performative norms), intra-organizational affiliations with particular groups and clubs (in group versus out group dynamics), and predetermined metrics for success (goal orientation and evaluation techniques). This means that along with the selection of a major comes the 'baggage' of particular ways to understand the world, forms of knowledge production, social dynamics, and normative criteria. These conditions can be described as the means for disciplines and subdisciplines to ensure shared identify. Ethics courses offer an opportunity to reflect upon such shared identities as those held within sub-disciplines and the practices and rituals of training the next generations of member. One could ask: What value is there in introducing diversity in the form of gender, race, ethnicity, or nationality, if the goal is to achieve a sameness or shared identity? How might people working within a sub-discipline react to 'non-rational' thought, alternative methods for understanding truth or validating knowledge claims, unfamiliar words (or jargon from another discipline), or alternative communication techniques or behaviors?

Teaching engineering ethics offers an opportunity to foster self-reflection among students that have started to travel down a disciplinary pathway. Engineering ethics can encourage students to encounter other ways to knowing and alternative, yet quite valid beliefs. A case study by co-author Foley and colleagues encouraged students to practice four, alternative forms of communication, i.e. journaling, peer-review, discussion boards, and twitter, that go beyond the forums and traditions practiced in their field. Students responded to the prompt, What does 'ethics' mean in the context of STEM fields? Why is thinking about ethics important for STEM students and professionals? Students then responded to discussion question in an online forum every other week for 10 weeks. The peer-review occurred between paired students that read and offered critiques of one another's writing from different engineering subfields and then met in person and shared their critiques with the professor and their peer-review partner. The fourth form of communication was publicly available on Twitter and students were required to post 10 tweets during the semester.

These encounters were designed to afford student with opportunities to engage in didactic communicative actions and subjected to multiple interpretations and responses. This project sought to 'open up' [30] and critically reflect upon relationships between their discipline and other social groups to consider issues of power, equity, authority, agency, and autonomy, as well as service, dependences, and synergistic efforts. Disciplinary training ascribes a set of values, explicitly and implicitly, which can blind a person to other beliefs and ways of knowing. One area of emphasis in engineering education has been on micro-ethical responsibility and the goodness or rightness of personal actions taken within the context of a particular engineering practice. This is, but one form, of constructing a homogenous community in which there are shared values around the responsible conduct of research (RCR), i.e. honesty, accountability, and integrity [31]. This project asked individuals to confront broader, macro-ethical questions that confront others' values and priorities, institutional factors, and social structures as a means to encourage students to reflect on the context of their decisions and how their disciplinary training often narrows the scope and boundaries of ethical decision-making.

This approach can force students out of the comfortable confines of their chosen discipline's social world and its constructs that offer clear rules and guidance on how to perform engineering. Here it is not only gender, racial, or ethnic diversity that causes consternation. Rather it is the diversity (i.e. differences) in the constructs of the social worlds and the ambiguity and uncertainty in how to perform (behave) in relation to seemingly irrational institutional pressures (rules that reward alternative values). It is in the moments of confrontation with another perspective or value that implicit biases can arise in statements about what "everyone should do" or "if only everyone was a rational person then we could fix the problem". At those times students are encountering the intersection of pluralism and collective action problems. Here is an opportunity for growth. By reflecting upon one's own values, recognizing that other people hold different values, undergraduate engineers can start to consider how they will behave and what types of behavior to expect in a pluralistic world where there are multiple ways of knowing and acting. Engineering ethics can explore the ways in which sameness (homogeneity) and otherness (heterogeneity) can spawn a deeper understanding of the macro-ethical challenges of knowing and acting in a diverse world (plurality). This research project is explored further by Foley and colleagues [13] in "Learner types a means to expand the definition of diversity and to redesign ethics modules" that will be shared at this year's conference.

Mindfulness Practices and Other Rearrangements in the classroom: Intentions of Inclusion

As mentioned earlier in this paper, diversity efforts may lead to changes in demographic representation among the undergraduate student body. They don't, however, necessarily lead to inclusivity in participation or to an authentic sense of value and belonging. Indeed, for undergraduate engineering students typically enrolled in these classes, some clearly feel empowered to actively participate, while others are obviously both hesitant and reticent, even when factoring for being an introvert. Consider this typical group of about thirty-four engineering students: Most are white, and about half are male. Some have come from abroad and others born in the US to parents who immigrated here. One has Asperger's syndrome. Another, openly homosexual, is known to be a crossdresser. All will graduate with engineering degrees, but not all will feel empowered when they leave the university: This statement reflects the observations and interpretations of the dynamics of co-author Berne's STS classroom within a school of engineering, based on who sits where and with whom, who speaks up, and who remains silent.

The built environment, as a non-human actor in engineering education, can support or suppress students becoming active or engaged. (For example, in Berne's experience, apparent are the many African American students who elect to sit together in the rear of the classroom. And the many, especially Asian students, whose English is their second or even third language, who remain silent throughout the class.) One effective way to create an environment more conducive to inclusivity of diverse voices, is to rearrange physical elements of the classroom. Most of the rooms in the school have individual desk-chairs lined up in rows that face the front of the room, where the professor stands holding a place of authority. On entering the classroom, students will generally determine for themselves which chair to sit in, and its location relative to other students. Changing this arrangement can alter a student's expectations, and also their sense of self in relation to other students.

Another way to invite and create an atmosphere which engages diversity in participation, is to incorporate mindfulness practices. Mindfulness is defined by some a "state of being attentive to and aware of what is taking place in the present" [32]p. 822. Others understand it to be the observation, description, and acceptance of whatever one is experiencing in the moment, without judgement, and with awareness [33]. There is broad acknowledgement of the efficacy of mindfulness practices in the college classroom ([34], [35], [36]). Studies point to the cultivated awareness of presence, heighted self-reflection, and ability to experience something with an open mind, generative of acquiring new knowledge. As [37]) has exclaimed, "Contemplative practices, when integrated into the college classroom, can help students develop this ability to critically self-reflect. It can also offer them tools to remain present—and embodied—in the classroom" (p. 2).

Contemplation from a subjective position within the individual student (referred to as "first person inquiry") is the conventional approach to bringing mindfulness into the classroom. For example, Berne begins each class by inviting the students to close their eyes. Then using her voice to guide them, methodically attunes their senses to the self within the immediate environment. The guidance flows from "hearing into" the space, to observing one's breathing and beating heart, to engaging the eyes in noticing "what's here" without any judgement. This is meant to heighten the students' awareness to "being present" in the present moment. For most who bring mindfulness practice into the classroom, this kind of first-person exercise serves to engage the students more deeply in the teaching that will ensue.

Berila [37] observes that mindfulness practice is critical in classrooms that teach about diversity, as it can help students "learn how their identity locations shape their reactions to course content, helping them to unlearn the effects of systems of oppression as they recognize, understand, and become accountable for their responses" (p. 3). But what about the classroom where STS is taught, unlikely to be focused explicitly on diversity, but rather on technology as a primary actor in society? Berne suggests that mindfulness practices are also critical in engineering education, but most helpful when they move students beyond a first-person perspective.

Gunnlaugson, Scott, Bai and Sarath [38] point to second-person perspectives, which involve practices "experienced from an objective position that is presumed to be outside of us" (p. viii). They suggest that second-person methods provide a distinctive learning milieu in which "collective wisdom and shared learning can begin to emerge from a participatory rather than individual-centered ethos" (p. viii). This is especially important in the STS classroom which focuses on engineering ethics. One way to encourage students to work through a range of seemingly intractable situation is by using films where the protagonist faces a significant moral dilemma without an apparent ethically correct answer. For example, in the film *7 Pounds*, Will Smith's character who crashed looking at a cell phone while driving, aims to assuage his guilt over his wife's death. He arranges to donate all of his usable, vital organs, but the result will mean for another tragic loss. Students watch a film such as this, then work through small group dialogues to determine what would have been the most ethically acceptable course of action.

This kind of "second-person" mindfulness methodology support aids students in their ability to embrace and engage the diversity of experiences, cultures, beliefs, and perspectives that are represented in the classroom. With the chairs arranged so that there is neither a front or "back" of the classroom, (making one large circle, or in smaller circles of teams) the professor effectively disappears, the inherent authority structures are diminished, and privileged voices of presumed value are removed. Student-led dialogue is used to explore problems, enhancing awareness of "self" as connected to "other." The classroom becomes a place where varied perspectives can be fostered and integrated, with students using mindfulness as a tool to remain present and non-judgmental while in conversation with their peers.

Conclusion

Equitable demographic representation remains an obdurate challenge facing engineering programs across the nation and is an important and necessary goal to strive for. We are in complete support of all efforts to improve representation in this way. What this paper argues though is that a focus on numbers without a simultaneous attention to the necessity of creating the intellectual and institutional spaces that allow for the expression of diverse viewpoints and perspectives could very well be self-defeating. The various dimensions of diversity explored here are presented as a useful first step in the necessary and difficult process of reimagining our engineering institutions, classes, spaces and research environments in order to create the room for different kinds and types of voices to speak and be heard.

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