The Assessment Dilemma: Examining our practices through the lens of equity and fairness

Kerrie A. Douglas
School of Engineering Education
Purdue University
West Lafayette IN, USA
douglask@purdue.edu

Kelly J. Cross
School of Chemical Engineering
University of Nevada, Reno
Reno, Nevada, USA
kcross@unr.edu

Şenay Purzer
School of Engineering Education
Purdue University
West Lafayette IN, USA
purzer@purdue.edu

***Abstract* —The broader field of engineering education has for decades emphasized the need to broaden engineering participation. However, there have been few conversations about the role of assessment in engineering education as both gatekeeper and talent finder in the process. While national and international policies may communicate value for diverse perspectives in engineering, how those divergent ways of thinking and perspectives show on engineering classroom assessments is less clear. During this special session, our goal is to engage participants in a rich and difficult conversation about how fairness and equity for diverse learners can be represented in engineering assessment practices. We will present a framework for culturally responsive assessment applied to engineering context and engage participants in answering how can assessments capture the strengths that diverse students bring into engineering.**

Keywords—equity, assessment, broadening participation, and culturally responsiveness (*key words****)***

I. INTRODUCTION

The goal of this special session is to engage in a rich and difficult conversation with engineering educators to address ways we can assess engineering learning with a lens of inclusive and just education lens. By inclusive assessment in engineering education, we build from others' broader definition of inclusive education [1] to mean that *all* students are assessed in ways that: improve their engineering learning, increase their active participation in the educational activities, and value all students as members of the engineering community. Just education then requires a response to the deep diversity that students bring into education [2]. Following the rationale from Connell [2] on curricular justice, a just response to assessment in engineering would then mean the assessment process would be organized around the experience, culture, and needs of least advantaged groups within engineering education, rather than the majority groups. Just assessment would also mean that engineering education systems have mutual responsibility for students' assessment results, uses, and consequences. Hence, we ask: *How can we design assessments to be inclusive and just? How can assessments be designed to capture the strengths that students from diverse cultures possess? How do we commit to inclusive and just approaches to assessment?*

Globally, there are many educational initiatives designed to increase the diversity of the engineering and computing workforce. However, assessment has an important place in the diversity, equity, and inclusion conversation. Assessment is an integral part of engineering education, every step of the way to reach the desired educational outcomes, including rigor and technical competence. Unfortunately, substantial score differences between racial or cultural groups in engineering classrooms and research are commonly interpreted as though the finding is expected. The score differences between demographic groups are often referred to as an "achievement gap", as though there is something wrong with the group whose scores are significantly lower. Our community has only begun to question the validity of assessments for diverse groups of students and the way that assessment data are interpreted. We approach this problem with the understanding that the assessment questions and the testing process are not culturally or color-neutral in engineering. With that we introduce an asset-based assessment of engineering reasoning for diverse groups. We build from the Culturally Responsive Assessment (CRA) framework [3], [4] to discuss practically how engineering instructors and educational researchers can design assessment practices that better reflect what diverse students know and can do. This session will promote thought-provoking, retrospective, reflective thinking about assessment practices in engineering education. Participants will leave with a greater awareness of how to commit to inclusive and just educational assessment in their engineering classrooms. Participants will also develop awareness of how to create assessment practices (tools or instruments) that are more culturally responsive and better able to assess diverse students' competencies. We will also provide resources to support participants as they seek to develop more equitable fair assessments in their classes.

II. Background

While there is a long history of blaming students or their pre-college education for the discrepancies in scores, the tests themselves are not simply color-neutral or bias free [5]. Many assessments are designed without consideration for how diverse groups of students would have experienced the topic or how diverse students would represent their understanding. The test writers themselves (whether instructors, teaching assistants, researcher) bring with them their own culture and ways of understanding (knowing and epistemology) which then become embedded into the assessment instruments. Further complicating the problem is that most traditional engineering faculty are not trained in assessment, effective assessment, or how to be culturally responsive in assessment.

One approach that is used to reduce bias had been to strip assessment questions from their contextual features. However, this approach has two flaws. First decontextualization means we cannot assess transfer of abstract knowledge into realistic contexts. Another issue is that even a question with no contextual features still reflects the perceptive of the majority and those who are in power.

Another approach to increasing fairness of assessments is to examine the items for bias after student data has been collected through means of differential item functioning analyses (DIF) [6], [7]. However, the differences in sample size between predominant groups of students and racially minoritized groups do not meet the conditions necessary for sophisticated modeling approaches. Simply said – the sample of racially minoritized students in engineering classrooms rarely is large enough to meet the sample size requirements for the DIF tests. In addition, assessment processes can be unfair even if

III. Justification

The engineering and computing education communities have had several initiatives to increase diversity, equity, and inclusion over the span of decades[8]–[14], yet there has been a dearth of discussion in these communities regarding the role of assessment in broadening participation. For example, a review of assessment papers published in prominent engineering education journals found that none provided evidence of fairness for students of Color [15].

Though some researchers consider the fairness of assessment processes for racially diverse learners, the role of classroom assessments in creating more a more diverse, equitable and inclusive engineering education is discussed even less. Course exams and quizzes play a major role in the course grades for many fundamental engineering courses. These assessments affect GPAs, which are used to make many educational decisions and selections for opportunities like research experiences, internships, and, ultimately, jobs. Though disparities in achievement between Black and White students in engineering is evident [12] it is common that individual students are blamed as the problem. As a result, unfair assessments can shut many doors. Given this, the most qualified candidates will ultimately populate the field only if assessments effectively measure students' competencies.

If one student from a particular subgroup does poorly on one test in a course, it is plausible that the student did not prepare adequately. But if all or most students in a particular subgroup perform worse than their peers in test after test– there is something system-wide causing the problem. For change to happen, we need to begin engaging engineering instructors in the conversation about what is the real problem – the underlying assumptions that we all have the same experiences and ways of knowing.

IV. Session Description

A. Welcome and Ice Breaker

The session will start by acknowledging that discrepancies in test scores based on race is a controversial topic. The facilitators will ask participants to establish a safe place to discuss differing opinions and seek input on norms for the discussion through the RESPECT guidelines for engagement. Participants will be given pieces of paper and asked to anonymously write down what they think are the reasons for the score differences. Next, we will discuss what answers participants wrote down and discuss that score differences occur in global settings. We will present a few example questions from engineering textbooks. In small groups, we will ask participants to discuss: What is the context of the question? What type of students are likely to have had experience with or be excluded by the context of the question? How might students of different backgrounds understand this question differently? At a whole group level, we will discuss the overt racism embedded into the assessment questions and the question could advantage certain students and disadvantage others.

B. What is Culturally Responsive Assessment In Engineering?

We will present the Culturally Responsive Assessment framework [4] in the context of engineering education classrooms. According to Montenegro & Jankowski, being culturally relevant in assessment "involves assuring that the assessment process – beginning with student learning outcome statements and ending with improvements in student learning – is mindful of student differences and employs assessment methods appropriate for different student groups" p.9. We will discuss the diversity of student identities and how one's different identities can not be separated from their other identities (i.e., intersectionality is also important). In small groups, we will ask the participants to evaluate assessment questions from published engineering textbooks in terms of how culturally responsive the assessment is for a diverse group of students. Participants will then write new assessment questions that are more culturally responsive for a wider diversity of students.

C. Let's Make It Personal

Next, we will ask small groups to discuss their personal experiences with teaching persons excluded based on ethnicity or race? Example questions are: What experiences have you had with students in racial minority groups scoring **well** on tests? What experiences have you had with students in racial minority groups scoring **poorly** on tests? What do you attribute the results to? How well are your classroom assessments culturally responsive to your students? At a whole group level, we will discuss how covert racism blames students of Color.

This work has been supported by NSF ERC #XXXXX

Next, participants will reflect on their experiences in terms of how personal culture and race influence their own test writing.

D. Moving the Field Forward

The last 15 minutes of the session will be discussion of how we can implement the culturally responsiveness of assessment in engineering classrooms. For examples, *How can we design assessments to be just and inclusive? How can assessments be designed to capture the strengths that students from diverse cultures possess? How do we commit to inclusive and just approaches to assessment?*

TABLE I. SPECIAL SESSION AGENDA

Minute	**Topic**	
	Activity	***Rationale***
10	Icebreaker	Help establish environment for discussions about race in assessment
10	Introduce CRA	Introduce participants to framework that can help guide classroom assessment
15	Critique assessment	Discussion of how racism is embedded in example assessment questions
15	Personalize	Discussion of racism that is hiding in assumptions that everyone represents knowledge in the same way
20	Commit	Discussion of how we can demonstrate value for diversity of experiences and perspectives in assessment
10	Wrap-Up	Synthesize ideas and session evaluation

V. EXPECTED OUTCOMES

The goal of this special session is to engage in a rich and difficult conversation with engineering instructors and educational researchers to address ways we can assess engineering learning with an equity and fairness lens. There are three desired outcomes: 1) Participants would leave with a greater understanding of how to design classroom assessments for diverse groups of engineering students; 2) Facilitators and the participants would have a greater understanding of the challenges of implementing equitable and fair assessment in engineering classrooms; and 3) Facilitators would write a paper based on the session.

VI. FACILITATORS

Dr. Kerrie Douglas is an Associate Professor of Engineering Education at Purdue University since 2016. In 2018, she was a recipient of the FIE New Faculty Fellow award for her research on increasing the fairness of assessment in engineering classrooms. She was a 2021 U.S. NSF CAREER awardee to study improving the fairness of assessments in engineering classrooms. She has worked on the development and/or validation of more seven published assessments for engineering education research purposes.

Dr. Kelly Cross is an assistant professor in the Chemical and Materials Engineering at the University of Nevada Reno. She is a data-informed, transformational mission-focused culturally responsive practitioner, researcher, and educational leader. She is a member of the ASEE Leadership Virtual Community of Practice (LVCP) that organizes and facilitates Safe Zone Training workshops. Dr. Cross has conducted workshops on managing personal bias in STEM, online and in-person, in addition to faculty training on power and privilege. Her research interests include diversity and inclusion in STEM, intersectionality, teamwork, assessment, and identity construction. Her teaching philosophy focuses on student centered approaches such as culturally relevant pedagogy and Black feminist epistemology. Dr. Cross' complimentary professional activities promote inclusive excellence through collaboration. She is an NSF CAREER awardee, delivered multiple distinguished lectures, and has received a national mentoring award.

Dr. Şenay Purzer is a Professor in the School of Engineering Education at Purdue University. She is an engineering educator renowned for her expertise in the assessment of engineering design learning and reasoning. Dr. Purzer developed the Honeycomb of Engineering framework, demarcating diverse inquiries of engineering aligned with engineering philosophy and practices. At Purdue, Purzer teaches undergraduate courses on engineering design and analysis as well as graduate courses in engineering education. She is passionate about authentic learning and assessment.

REFERENCES

[1] A. Moriña, "Inclusive education in higher education: challenges and opportunities," *Eur. J. Spec. Needs Educ.*, vol. 32, no. 1, pp. 3–17, Jan. 2017, doi: 10.1080/08856257.2016.1254964.

[2] R. Connell, "Just education," *J. Educ. Policy*, vol. 27, no. 5, pp. 681–683, Sep. 2012, doi: 10.1080/02680939.2012.710022.

[3] A. L. Qualls, "Culturally Responsive Assessment: Development Strategies and Validity Issues," *J. Negro Educ.*, vol. 67, no. 3, pp. 296–301, 1998, doi: 10.2307/2668197.

[4] E. Montenegro and N. A. Jankowski, "Equity and assessment: Moving towards culturally responsive assessment," *Occas. Pap.*, vol. 29, 2017.

[5] J. Randall, "'Color-Neutral' Is Not a Thing: Redefining Construct Definition and Representation through a Justice-Oriented Critical Antiracist Lens," *Educ. Meas. Issues Pract.*, vol. 40, no. 4, pp. 82–90, Dec. 2021, doi: 10.1111/emip.12429.

[6] J. E. Helms, "Fairness is not validity or cultural bias in racial-group assessment: A quantitative perspective," *Am. Psychol.*, vol. 61, no. 8, pp. 845–859, Nov. 2006, doi: 10.1037/0003-066X.61.8.845.

[7] D. Y. Ford and J. E. Helms, "Overview and Introduction: Testing and Assessing African Americans: 'Unbiased' Tests are Still Unfair," *J. Negro Educ.*, vol. 81, no. 3, pp. 186–189, 2012, doi: 10.7709/jnegroeducation.81.3.0186.

[8] Broadening Participation Working Group,National Science Foundation, "A Framework for Action." National Science Foundation.

Arlington, VA, 2008. [Online]. Available: http://www.nsf.gov/od/broadeningparticipation/framework_report.jsp

[9] National Science Foundation, "Women, Minorities, and Persons with Disabilities in Science and Engineering." Special Report NSF 13-304. Arlington, VA, 2013. [Online]. Available: http://www.nsf.gov/statistics/wmpd/2013/citation.cfm

[10] National Academy of Engineering, *Colloquy on Minority Males in Science, Technology, Engineering, and Mathematics*. Washington, D.C.: National Academies Press. Accessed: Oct. 01, 2014. [Online]. Available: http://www.nap.edu/openbook.php?record_id=13502&page=1

[11] National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, "Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads," The National Academies Press, 2011. Accessed: Jan. 14, 2013. [Online]. Available: http://www.nap.edu/openbook.php?record_id=12984

[12] National Academy of Engineering and American Society for Engineering Education, *Surmounting the Barriers: Ethnic Diversity in Engineering Education: Summary of a Workshop*. National Academies Press, 2014. Accessed: Oct. 01, 2014. [Online]. Available: http://www.nap.edu/openbook.php?record_id=18847&page=1

[13] National Academy of Sciences, I. of Medicine, and National Academy of Engineering, "Rising Above the Gathering Storm, Revisited: Rapidly Approaching Category 5," The National Academies Press. Accessed: Jan. 14, 2013. [Online]. Available: http://www.nap.edu/catalog.php?record_id=12999

[14] "Diversity, Equity & Inclusion | ABET." https://www.abet.org/about-abet/diversity-equity-and-inclusion/ (accessed Apr. 22, 2022).

[15] K. A. Douglas, A. Rynearson, S. Purzer, and J. Strobel, "Reliability, validity, and fairness: a content analysis of assessment development publications in major engineering education journals," *Int. J. Eng. Educ.*, vol. 32, no. 5, pp. 1960–1971, 2016, Accessed: Apr. 15, 2022. [Online]. Available: https://dialnet.unirioja.es/servlet/articulo?codigo=6917662