INTRODUCTION

TO SPECIAL SECTION ON

DIVERSITY

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Diversity is vital and integral to the greater success of the engineering profession. Several key publications and organizations have called for improvements in diversity of all engineering disciplines.[1-3] Finding solutions to problems in the 21st century requires engineers who can bring a variety of perspectives and thoughts through their gender, ethnic backgrounds, and life experiences. It is important that we seek not only to recruit individuals of diverse backgrounds but we must promote best practices within our departments to retain and nurture these individuals whether they are students or faculty. It is through intentional practices of inclusivity we will be able to build a diverse and sustainable chemical engineering profession.

The term diversity has different meanings to different individuals. For the purpose of this special issue we have adopted the definition provided by the American Society for Engineering Education's Diversity Committee which states diversity is "the inclusion of individuals that represent variations in gender, race, ethnic background, disability, sexual orientation, age, socio-economic status, nationality, and other non-visible differences."[4]

Although there has been a lot of work within chemical engineering over the past two decades to improve diversity, we are still observing very minimal changes in the representation of underrepresented minorities within chemical engineering. A recent review of the diversity trends within chemical engineering performed by the co-editors of this special section and other colleagues showed that although gender diversity within chemical engineering at the bachelor level is better than engineering as a whole (32.3% compared to 19.1%), it is still well below the general working population of the United States at 44.5%.[5] Examining ethnic diversity within chemical engineering programs showed that the percentages of black, non-Hispanic, and Hispanic students graduating with bachelors in chemical engineering is less than the percentages of these students graduating from engineering programs as a whole. These results demonstrate that despite the considerable work that is being done in the field to improve diversity within chemical engineering, more needs to be done to make the discipline truly diverse and inclusive.

This special section is developed with the intent to close the knowledge gap on diversity-related research and to inform the chemical engineering community of the opportunities, challenges, and efforts to promote diversity within the discipline. There were two central themes in selecting papers for publication in this special section. The first theme related to papers that discussed the field of chemical engineering as a whole and how we can improve our diversity. The second theme related to specific programs or practices for improving diversity with a focus on three distinct subpopulation categories: PK-12 education, undergraduate education, and post-graduate education.

Refereed papers that discuss improving diversity in the field of chemical engineering as a whole include:

- *A perspective paper titled "**The Stealth of Implicit Bias in Chemical Engineering Education, Its Threat to Diversity, and What Professors Can Do to Promote an Inclusive Future,**" discusses the impact of implicit bias on diversity and inclusion, and how engineering educators can reduce bias both inside and outside the classroom. This paper explores five illustrative factors of implicit bias that can lead to inequality in engineering education and corresponding strategies that educators can use to remove implicit biases.*
- *A Teaching Tip on **"Addressing a Diverse Population"** catalogs several actions that educators can take to address the needs of a diverse student population. Most of these actions take minimal time and can be quickly implemented in the classroom. This article also points out that student experiences on diversity and inclusion may not mirror those of educators, and hence educators need to eliminate assumptions and take deliberate actions to be inclusive of a diverse student body.*
- *An analysis of diversity in chemical engineering baccalaureate programs at historically black colleges and universities (HBCUs) is discussed in **"HBCUs and Chemical Engineering: Analysis of Baccalaureate Programs."** This paper provides a historical perspective of diversity and graduation statistics of chemical engineering programs at HBCUs. It further explores the*

reasons why students choose to attend an HBCU, and the factors important for student success at HBCUs.

Refereed papers that describe studies conducted or best practices that could be implemented to address diversity within the PK-12, undergraduate, or graduate chemical engineering populations comprise the other theme of the special issue:

- *The paper **"Creating an Equitable Learning Environment"** discusses the criteria for creating an equitable environment for inclusive learning based on successful K-12 and university programs developed by the authors. The paper presents evidence of an equitable learning environment resulting in higher enrollment of women and underrepresented minorities in chemical engineering at a research university. The study further presents a set of 11 formal and informal educational programs that create equitable learning environments.*
- *The STEM identities, sense of belonging in engineering, and motivation of first-year engineering students who expressed interest in chemical engineering were explored as part of the paper "**The Intersection of Gender and Race: Exploring Chemical Engineering Students' Attitudes."** This research uses a mixed-methods approach to determine how these constructs varied based upon race/gender and observed significant differences between women's attitudes and their peers.*
- ***"Building LGBTQ-inclusive Chemical Engineering Classrooms and Departments"** provides background on why LGBTQ+ inclusion hasn't progressed as far as other forms of diversity and inclusion. The paper provides meaningful and concrete strategies for how faculty members could support LGBTQ+ inclusion within their classrooms, including but not limited to the use of appropriate terminology, learning about student experiences, and setting a proper inclusive tone within the classroom.*
- *Another facet of diversity is discussed in the paper **"Rurality as an Asset for Inclusive Teaching in Chemical Engineering."** This work describes the inclusion of asset-based design challenges as an alternative to service learning in first- and second-year courses, and how these approaches led to different design justifications. The authors observed that students leveraged their rural peers' experiences to assist them when making design decisions and had a greater appreciation for the value that their classmates could bring to a project.*
- *In the paper **"Differences in Chemical Engineering Student-Faculty Interactions By Student Age and Experience at a Large, Public Research University,"** the authors explore differences between adult students who have had work experience and traditional-age students without engineering work experience. In this qualitative study, the authors observed the student populations differed based on their level of intimidation and embarrassment when interacting with faculty members as well as their classroom engagement behaviors. The results demonstrate the need for diverse practices when engaging students with different backgrounds.*
- *The process of changing culture within an undergraduate chemical engineering program is highlighted in the paper **"Towards a Stronger Covalent Bond: Pedagogical Change for Inclusivity and Equity."** This paper applies a design-based implementation research methodology to allow for continual data collection and analysis leading to informed decision making throughout the change process. The authors describe how this approach was applied to their design-based studio and what changes were made throughout the process to create a more inclusive culture.*
- *Another paper focused on undergraduate chemical engineering education is "**Towards Chemical Engineering Student Diversity: The Case of International Students' Experiences at Tuskegee University."** This study examined the experiences of international students within an HBCU environment through the use of surveys and focus groups. The authors found that some international students experience issues with multicultural classrooms. These issues were resolved early on within the program through a supportive environment that valued students' backgrounds and experiences.*
- *Fostering inclusivity through peer mentoring is discussed in "**The Power of Peer Mentoring in Enabling a Diverse and Inclusive Environment in a Chemical Engineering Graduate Program."** The paper provides details of a peer mentoring program for first-year doctoral students along with quantitative and qualitative assessment of the program, and its impact on diversity and inclusion. Demonstrated benefits of peer mentoring include increased department inclusivity, stronger peer social bonds, and improved academic outcomes for all students.*

Some papers may appear in later issues. We thank all the contributors. It was inspiring to see how well this topic has been supported within the ChE community.

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