Getting Started with Equity

A Discipline Brief for Equity in Chemistry: Kimberly N. White, Ph.D.

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Contents

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About the Contributor

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About the Supporting Organizations

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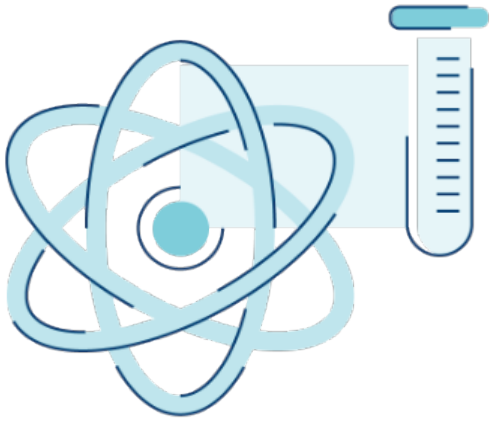
Discipline Brief: Equity in Chemistry

Kimberly N. White, Ph.D., an Associate Professor of Chemistry at Humboldt State University, shares how asset-based instruction, fostering student belonging, active learning, and flexible and differentiated coursework can reduce equity gaps in chemistry.

Summary of equity areas of concern



Fostering diversity in the field of chemistry is not only a social justice imperative, it is also the intelligent path forward. Diversity is defined broadly to include variations in age, gender, gender identity, race/ethnicity, national origin, socioeconomic status, sexual orientation, and more. Racially minoritized students choose STEM majors at equal rates to their White peers, but are awarded only 14.7% of STEM Bachelor's degrees in the United States (Estrada, 2015). This stunts the advancement of racial diversity in the field of chemistry and highlights one of many equity gaps in which minoritized students achieve lower grades, retention rates, and graduation rates from post-secondary institutions than their more privileged counterparts (Bok, 2017).

Significant equity gaps in chemistry courses create barriers within the academic pathway. This is especially true in general and organic chemistry, which are foundational courses for many majors and careers. As a result, the chemistry field experiences a critical loss of potential talent, as evidenced in data from the United States: In 2019 only 6.2% of chemists and materials scientists, chemical engineers, and chemical technicians identified as Black or African American and only 7% identified as Hispanx or Latinx. These percentages are far lower than the representation of these racial groups' total U.S. population percentages of 13.4% and 18.5%, respectively (US Bureau of Labor Statistics, 2019).

What is the role of chemistry educators in increasing the attainment of chemistry degrees and the pursuit of chemistry and STEM careers by minoritized students? Targeted modifications to the undergraduate chemistry curriculum, instruction, and instructor attitudes can reduce and even eliminate equity gaps so that students from all backgrounds can thrive in undergraduate chemistry courses. Departments and colleges should offer professional development opportunities for faculty to evaluate the effects of their behaviors and mindset on student performance. In addition, faculty should adopt evidence-based pedagogies and practices that will create more equitable learning environments and subsequently improve equitable outcomes in undergraduate chemistry courses.

Suggestions for change

Adopt Asset-Based Instruction

Educate and train chemistry faculty to adopt asset-based language and attitudes in undergraduate chemistry courses.

- Encourage faculty to affirm the efforts and abilities of all students.
- Frame the cultural wealth (Yosso, 2005) that students bring with them to the chemistry classroom as a tool for success.
- Dismantle the persistent narrative that introductory chemistry courses are designed to "weed out" unacceptable students.
- Combat the mutual disaffect that occurs when students' own insecurities are reinforced by negative instructor narratives.

Foster Student Belonging and Scientific Identity

A sense of student belonging at four-year colleges is positively associated with persistence, use of campus services, and mental wellbeing, all of which enhance student success and retention (Gopalan, 2020).

- Promote the formation of meaningful student-student relationships.
  - Support student chemistry club meetings and outreach activities.
  - Provide ample opportunities for students to work collaboratively towards common goals, both in and out of the classroom.
- Cultivate meaningful instructor-student relationships.
  - Conduct a survey at the beginning of the course so that students may share their name, pronouns, relevant personal information, and any obstacles that may interfere with their learning experience (e.g. family or work obligations, learning barriers, etc.).
  - Learn all students' names and review students' survey responses before one-on-one meetings
  - Initiate conversations with students when they fall behind or miss assignments, before students withdraw.
  - Use deliberate strategies to encourage attendance at office hours.
  - Employ Hammond's "trust generators" in the chemistry classroom (Hammond, 2015).
- Actively build students' scientific identities.
  - Call students in the classroom chemists or scientists to actively include them in the scientific academy.
  - For example, "As chemists, we can use our understanding of…"

- Provide ample examples of female-identifying chemists, racially minoritized chemists, and other diverse chemists to dismantle the persistent narrative that chemists can only be white men.
- Combat insecurities and stereotype threats by affirming to all students regularly that they are capable chemists and scholars.
- Offer opportunities for students to be the expert and assist their peers (e.g. group quizzes, peer feedback, group homework).

Employ Active Learning and Collaborative Learning in the Chemistry Classroom

Traditional lecture-based methods of teaching chemistry often discourage and disadvantage minoritized, first-generation, and poverty-affected students in chemistry.

- Adopt active learning and promote social interactions in the classroom that may be especially instrumental for students from collectivistic or high-context cultures.
- Employ student-to-student learning strategies so that group work is meaningful, productive, and benefits all students.
- Use Process-Oriented Guided Inquiry Learning (POGIL) exercises in introductory coursework. (Spencer, 1999; Moog, 2008)

Create Flexible Coursework and Multiple Pathways for Student Success in Chemistry Courses

Students of today are experiencing more barriers to college education and degree attainment than previous generations: 25% of college students work full time and 40% work at least 30 hours a week (Carnevale, 2015), 33% of students are first-generation college students (US Department of Education, 2018), and many students experience food and housing insecurity. The changing student population necessitates strategic change from chemistry faculty.

- Employ “care and push” strategies to simultaneously maintain high standards and meet the needs of students. (Hammond, 2015) When students trust an instructor they are more confident to engage in challenging and deeper learning activities because they do not fear being considered “not smart enough” or “not good enough”.
- Offer specifications grading in undergraduate chemistry courses by increasing the number of credit/no credit assignments and provide a clear set of requirements for students to earn specific letter grades. (Nilson, 2015)
- Offer multiple low stakes formative assessments instead of, or in addition to, high stakes summative assessments.
- Allow students to drop lowest score(s) on exams or assignment sets.
- Give students choices of assignments to complete.
- Establish mechanisms for students to make up missed work.

- If synchronous online work is required, create asynchronous pathways for satisfying the same requirements.
- Use free or low-cost course materials.

Offer Professional Development Opportunities for Chemistry Faculty on Cultural Humility and Implicit Bias

- Cultural humility training helps instructors understand and appreciate cultures that differ from their own.
- Prompt instructors to critically examine how their pedagogies and practices may be a mismatch for students from different cultural backgrounds
- Encourage ongoing self-reflection and instructional improvement (as opposed to cultural competency, in which learning ceases when "competency" is achieved). Cultural competency posits that one can essentially take a course and then be competent in another culture. It was made as a requirement that could be met - take the course and you are done. Cultural humility theory proposes that you can never fully understand another's culture and that you must commit yourself to lifelong learning so that (in this case) instructors can best serve students with cultural backgrounds that differ from their own.
- Provide opportunities for Implicit Bias education.
- Encourage instructors to examine how they may inadvertently offer different supports, attention, and criticisms to different groups of students.
- Encourage faculty to examine the unconscious decisions they make that may affect their students. Implicit bias can offer unfair advantages to students whose cultural and physical identities are most similar to the instructor.

Further reading

Relevant Books for Supporting Culturally Diverse Students in STEM

Chasteen, S. *Talking About Leaving Revisited. Persistence, Relocation, and Loss in Undergraduate STEM Education*; Springer Nature: Switzerland AG, 2019.

Hammond, Z. *Culturally Responsive Teaching and the Brain: Promoting Authentic Engagement and Rigor among Culturally and Linguistically Diverse Students*; Corwin Press: Thousand Oaks, CA, 2015.

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Websites Relevant to Promoting Equity in STEM Education

Name	Acronym	Website
American Association for the Advancement of Science's Entry Point!	AAAS	https://www.aaas.org/programs/entry-point
American Chemical Society's Women Chemists Committee	WCC	https://acswcc.org
American Indian Science and Engineering Society	AISES	https://www.aises.org
Association for Women in Science	AWIS	https://www.awis.org
Great Minds in STEM	GMIS	http://www.greatmindsinstem.org
Latinas in STEM	-	http://www.latinasinstem.com
Maximizing Access to Research Careers	MARC	https://www.nigms.nih.gov/training/MARC
National Organization for the Professional Advancement of Black Chemists and Chemical Engineers	NOBC-ChE	https://www.nobcche.org/home
National Organization of Gay and Lesbian Scientists and Technical Professionals	NOGL-STP	https://www.noglstp.org
Scientista	-	http://www.scientistafoundation.com
Society for Advancement of Chicanos/Hispanics and Native Americans in Science	SAC-NAS	https://www.sacnas.org
The Society of Asian Scientists and Engineers	SASE	https://www.saseconnect.org
Women of Color Research Network	WoCRN	https://womeninscience.nih.gov/women-of-color

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US Department of Education, Feb 2018. Stats in Brief, First-Generation Students College Access, Persistence, and Postbachelor's Outcomes National Center for Education Statistics https://nces.ed.gov/pubs2018/2018421.pdf (accessed March 2021). Yosso, T. J. Whose Culture Has Capital? A Critical Race Theory Discussion of Community Cultural Wealth. Race Eth. & Ed. 2005, 8 (1), 69– 91, DOI: 10.1080/1361332052000341006