“All learning begins when our comfortable ideas turn out to be inadequate.”
- John Dewey

Abstract
Under-representation on many levels is endemic in STEM fields, and STEM instructors have a unique opportunity and responsibility to address this. The Underrepresentation Curriculum offers those instructors a powerful resource with which to do so.

Scientists have long recognized that their ranks do not match the broader population; specifically, science in America is skewed more male and more white than the country as a whole. Numerous explanations have been offered to explain this disconnect and, while research has discredited the possible explanation of a lack of aptitude in underrepresented groups[1], the problem remains complex and enormously consequential.

Implications include:

- A lack of diversity in portrayals of science contributes to a lack of diversity in the students who pursue the field; as the saying goes “you cannot be what you cannot see.”. Research has shown more diverse groups do more impactful scientific work[2], and so science indirectly suffers as a result of this limited diversity. Our charge, in the words of the American Association of Physics Teachers, is **“**making [science] more inclusive and supportive of women and people of color is required for doing excellent[science].[3]
- The equitable access to science for all is, in the powerful words of Chanda Prescod-Weinstein, a matter of "fundamental human decency.” The current reality, in which this access is not fully realized, is a moral problem as much as a pragmatic one.
- In both society and science, the ability to recognize and work in diverse settings is increasingly valuable. By talking about diversity (or the lack thereof) as it pertains to science, we will be better preparing our students for their lives as scientists or as engaged citizens.
- When students are implicitly taught that science can only be done by a select few, science may be inadvertently portrayed as inaccessible or even irrelevant to

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[1] Brickhouse, Nancy W. “Embodying science: A feminist perspective on learning.” Journal of Research in Science Teaching, vol. 38, no. 3, 2001, pp. 282–295.
[2] Richard Freeman and Wei Huang, “Collaboration: Strength in diversity,” Nature 513, 503 (Sept. 2014)
[3] Statement on Fisher v. University of Texas. (2016). The Physics Teacher, 54(6), 326-328.

> "normal" people. A population that regards science as outside their reference is unlikely to fund it and may even come to fear its power.

This is a problem for science instructors to help solve and, happily, we have many effective ways to do so. One powerful option is to engage students in an exploration of the lack of proportional representation in science, and to explore the societal forces that might cause this. In doing so, students will be using and practicing scientific skills, while gaining a deeper understanding of "science as a human endeavor"[4]. What's more, learning about underrepresentation has been shown to deepen the formation of scientific identity, belief in the value of science, and science self-efficacy in students from underrepresented groups[5,6], and learning about affective factors which keep students out of science has been shown to reduce their effect on those students[7,8]. Learning about underrepresentation is both an important part of scientific learning for all our students and a powerful solution to the challenges listed above

By creating this resource, we hope to help science instructors to facilitate these challenging conversations about who does science and why. We have undertaken this project because we love science and want it to be better, because we believe all students can learn and deserve to fall in love with science if they choose, and because we recognize that the history of science teaching has ignored many students and misled nearly all. Considering the demographics of who does scientist is not only relevant but, rather, represents our recognition that science is, by its very nature, a human endeavor.

After years of doing this work with students, we have seen its transformative potential in our own classrooms and beyond, and heard it from our students:

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[4]NGSS Lead States, "Appendix H – Understanding the scientific enterprise: The nature of science in the Next Generation Science Standards" in Next Generation Science Standards: For States By States (2013)

[5]Erica Weisgram and Rebecca Bigler, "Effects of learning about gender discrimination on adolescent girls' attitudes towards and interest in science," Psychol. Women Quart. 31, 262–269 (Sept. 2007)

[6]Zahra Hazari et al., "Connecting high school physics experiences, outcome expectations, physics identity, and physics career choice," J. Res. Sci. Teach. 47, 978-1003 (Oct.2010)

[7] Michael Johns, Toni Schmader, and Andy Martens, "Knowing is half the battle: Teaching stereotype threat as a means of improving women's math performance," Psychol. Sci. 16, 175–179 (March 2005).

[8] National Center for State Courts, "Strategies to reduce the influence of implicit bias," http://www.ncsc.org/ibeducation

> "[Race] does relate to what we learn. By discussing it in physics, we are able to connect what we have learned to other things in 'real life.' By learning about it, I feel less discouraged from perhaps pursuing a course in math or science."

These conversations are not only for the benefit of students from underrepresented demographic groups. Students who identify in the majority will benefit as well. Being able to work in diverse groups and participate comfortably in conversations about society and representation is an important skill for graduating students, according to employer surveys.

Scholars generally agree that the problem with under-representation of specific groups in science stems not from any characteristic of these individuals, but rather from the culture of science itself[9]. Given this origin, any solution to rectifying the lack of diversity in science must find a way to change the culture of science to be more welcoming and inclusive.

It is our strong assertion that this change cannot and should not be the responsibility of individuals with one or more of these under-represented identities or by helping them achieve particular experiences to better prepare them for careers in science. Instead, we believe change happens through learning for all students - including those who are over-represented in science. Education, and the Underrepresentation Curriculum, is one means of accomplishing this change.

Yes, change is hard, but scientists solve hard problems all the time. Our goal, in simple terms, is to equip the next generation of scientists with a broader sense of who should do science, and what societal supports and obstacles impact the achievement of that goal, so that they can challenge and, thereby change, the culture of the field.

As secondary instructors, we are in a unique position to influence our students[10] and, by extension, society. Though many of us were not trained to bring conversations about representation and equity and society into our classroom, we recognize that by not doing so, we suggest that these things do not matter in science. In the words of Na'ilah Suad Nasir, "To not discuss or address issues of race, culture, and inequality is to accept the

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[9] Leslie, Sarah-Jane, et al. "Expectations of brilliance underlie gender distributions across academic disciplines." Science, vol. 347, no. 6219, 2015, pp. 262-265., doi: 10.1126/science.1261375

[10] Hazari, Zahra, et al. "The Importance of High School Physics Teachers for Female Students' Physics Identity and Persistence." The Physics Teacher, vol. 55, no. 2, 2017, pp. 96–99., doi:10.1119/1.4974122.

current patterns of inequality and marginalization." [11] Moreover, our students are living in a world in which these topics are discussed more and more widely; bringing the conversation into the science classroom is a matter of continuation, not insertion.

Our students will exist in society, as scientists or otherwise, and this unit offers a way to better prepare them both for a life in the lab (so to speak) and a life in society. We hope these resources prove useful to our science teaching peers, and that with your help, this work will continue to expand and evolve.

[11] Nasir, N. S. (1996). Why Should Mathematics Educators Care About Race and Culture? Journal of Urban Mathematics Education, 9(1), 7-18.