Getting Started with Equity

A Discipline Brief for Equity in Biology:

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Discipline Brief: Equity in Biology

Holly J. Swanson, PhD, Graduate Researcher at the Science Education and Society (SEAS) Research Program in the University of Rhode Island, explores how pedagogical, content, and mindset changes can reduce obstacles for minoritized students in STEM programs

Summary of equity-related areas of concern

Underrepresentation is an important issue in STEM fields. In biology specifically, while binary gender representation (men and women) has become more balanced, a continued disparity remains for other minoritized groups, including students and professionals holding diverse racial, ethnic, and socioeconomic backgrounds. Biology education researchers have made progress in understanding how to address this issue, but their findings need to be further disseminated to the academe to provide additional faculty the means to ensure equitable opportunities and outcomes for all biology students, and particularly for those who are racially minoritized, poverty-affected, and/or first-generation.

Several obstacles present themselves to minoritized students which may discourage them from continuing to pursue an education or career in the field. These include the high cost of science textbooks, lab supplies and lab fees, the limited use of active learning, the absence of diverse perspectives and representation in the curriculum, and the use of traditional grading systems. Active learning and inclusive curricula have been shown to increase student engagement and improve their sense of belonging. However, some of these pedagogical transformations require departmental support, including adopting an assessment structure that does not perpetuate inequity and promoting the use of open-access resources to reduce student expenses.

Finally, science takes place within a social context. It is important that students are explicitly taught how society can influence scientific research and how these advancements could be used to exacerbate inequities. Examples can be used to address the interdependent impacts science and society can have. For example, craniometry studies of the late 1800s and early 1900s linking skull capacity and intelligence were used to support racial differences (Samuel Morton) but also to disprove them (Friedrich Tiedemann). A more recent example was the use of men of color, beginning in 1932, to study the progression of syphilis, including the withholding of proven effective medical treatment. This continued until 1972 when the study was found to be unethical and immediately halted. Another example is the contested use of genetically modified mosquitoes in the control of the Zika virus and the less objectionable use of Wolbachia. A current example is the disproportionate impact COVID-19 has had on people and communities of color and their hesitation towards receiving vaccinations based on previous medical mistreatment.

Suggestions for change

Pedagogical changes

- Increase utilization of open-access resources to reduce the cost of taking STEM courses that often require the purchase of textbooks with large price tags and additional lab supplies/fees
- Adopt active learning opportunities and activities to create a more equitable learning environment
- Adopt an inclusive curriculum and provide opportunities to create and support a sense of belonging
- Reflect on the assessment structure of the course and how traditional institutional systems, like grading, perpetuate inequity.

Content changes

- Explain that science exists within a social context (the Nazi science program, Tuskegee syphilis study, CRISPR, COVID-19, etc.) that impacts which findings are presented and how they are portrayed in the media, which populations are being studied, and which research questions are being asked to begin with.
- Include diverse voices and perspectives in course-related readings, videos, assignments, lectures, labs, etc.

Mindset changes

- Remind students that there is no such thing as “science people,” and that science understanding requires effort and practice.
- Honor students’ hard work in substantive ways, like including teamwork and participation as part of students’ grades.

Further reading

Burrus, L. W., Parangan-Smith, A., Riggs, B., & Samayoa, C. (2021, January 6). A rapid response to racism in STEM. *Inside Higher Ed*. https://www.insidehighered.com/advice/2021/01/06/teaching-science-through-social-justice-and-racially-inclusive-lens-opinion

The authors describe how they recently made curricular changes to their biology labs in the wake of anti-Black racism and a global pandemic. Over nine weeks, more than 60 administrators, faculty, staff, and graduate teaching assistants created ten new lab manuals including a total of 120 new activities. The activities were designed to include positive representations of diverse communities, build a sense of community for students, and spotlight their voices. Several examples of these activities designed with a social justice aspect are provided. They discuss difficulties they faced during the process and describe their continuing assessment of the activities' impact on students, especially Black, Indigenous, and people of color.

Canning, E. A., Muenks, K., Green, D. J., & Murphy, M. C. (2019). STEM faculty who believe ability is fixed have larger racial achievement gaps and inspire less student motivation in their classes. *Science Advances*, 5(2). https://advances.sciencemag.org/content/5/2/eaau4734.abstract

Official Abstract: An important goal of the scientific community is broadening the achievement and participation of racial minorities in STEM fields. Yet, professors' beliefs about the fixedness of ability may be an unwitting and overlooked barrier for stigmatized students. Results from a longitudinal university-wide sample (150 STEM professors and more than 15,000 students) revealed that the racial achievement gaps in courses taught by more fixed mindset faculty were twice as large as the achievement gaps in courses taught by more growth mindset faculty. Course evaluations revealed that students were demotivated and had more negative experiences in classes taught by fixed (versus growth) mindset faculty. Faculty mindset beliefs predicted student achievement and motivation above and beyond any other faculty characteristic, including their gender, race/ethnicity, age, teaching experience, or tenure status. These findings suggest that faculty mindset beliefs have important implications for the classroom experiences and achievement of underrepresented minority students in STEM.

Colvard, N. B., Watson, C. E., & Park, H. (2018). The impact of open educational resources on various student success metrics. International Journal of Teaching and Learning in Higher Education, 30(2), 262-276. https://eric.ed.gov/?q=ej1184998&id=EJ1184998

Official Abstract: There are multiple indicators which suggest that completion, quality, and affordability are the three greatest challenges for higher education today in terms of students, student learning, and student success. Many colleges, universities, and state systems are seeking to adopt a portfolio of solutions that address these challenges. This article reports the results of a large-scale study (21,822 students) regarding the impact of course-level faculty adoption of Open

Educational Resources (OER). Results indicate that OER adoption does much more than simply save students money and address student debt concerns. OER improve end-of-course grades and decrease DFW (D, F, and Withdrawal letter grades) rates for all students. They also improve course grades at greater rates and decrease DFW rates at greater rates for Pell recipient students, part-time students, and populations historically underserved by higher education. OER address affordability, completion, attainment gap concerns, and learning. These findings contribute to a broadening perception of the value of OERs and their relevance to the great challenges facing higher education today.

Dewsbury, B. & Brame, C.J. (2019). Inclusive Teaching. *CBE-Life Sciences Education*, 18(fe2), 1-5.
https://doi.org/10.1187/cbe.19-01-0021

Official Abstract: Over the past two decades, science, technology, engineering, and mathematics (STEM) faculty have been striving to make their teaching practices more inclusive and welcoming to the variety of students who enter college. However, many STEM faculty, even those at teaching-focused institutions, have been educated in a traditional environment that emphasizes research and may not include classroom teaching. This can produce a deficit in training that leaves many STEM faculty feeling uncertain about inclusive teaching practices and their essential undergirding principles. This essay describes an online, evidence-based teaching guide (https://lse.ascb.org/evidence-based-teaching-guides/inclusive-teaching) intended to help fill this gap, serving as a resource for science faculty as they work to become more inclusive, particular with regard to differences in race, ethnicity, and gender. The guide describes the importance of developing self-awareness and empathy for students as a precursor to considering classroom practices. It also explores the role of classroom climate before turning to pedagogical choices that can support students' sense of belonging, competence, and interest in the course. Finally, the guide suggests that true inclusivity is a community effort and that instructors should leverage local and national networks to maximize student learning and inclusion. Each of these essential points is supported by summaries of and links to articles that can inform these choices. The guide also includes an instructor checklist that offers a concise summary of key points with actionable steps that can guide instructors as they work toward a more inclusive practice. We hope that the guide will provide value for both faculty who are just beginning to consider how to change their teaching practices and faculty seeking to enrich their current efforts.

Feldman, J. (2020, January 27). Improved grading makes classes more equitable. *Inside Higher Ed*.
https://www.insidehighered.com/views/2020/01/27/advice-how-make-grading-more-equitable-opinion

Faculty are provided little training or support in the development of their grading practices and often rely on how they were graded. In this article, Feldman calls for an overhaul of the grading practices in higher education courses and describes the process of how departments can change their grading culture. Feldman provides four benefits from newer grading practices including: (1) being mathematically accurate to validly describe a student's level of mastery; (2) evaluate students based on their knowledge, not their environment, history or behavior; (3) support hope and a growth mind-set;

and (4) “lift the veil” on how to succeed. Preliminary evidence illustrates decreases in student anxiety and shifts in focus from grade attainment to the demonstration of content mastery.

*Another good article on grading in biology: Schinske, J. & Tanner, K. (2014). Teaching more by grading less (or differently). CBE- Life Sciences Education, 13, 159-166. https://pdfs.semanticscholar.org/692c/6cdba7f25b48a9a7778a09a5e14090229895.pdf?_ga=2.63224683.537982056.1606859502-1720585751.1606859502

Gouvea, J. S. (2021). Antiracism and the problems with “Achievement Gaps” in STEM education. *CBE-Life Sciences Education,* 20(1). https://doi.org/10.1187/cbe.20-12-0291

Official Abstract: Inspired by the biology education research community’s collective reading of Kendi’s How to Be an Antiracist, I draw together recent articles related to “achievement gaps”—a construct identified by Kendi as perpetuating racist ideas. At the same time, I recognize that, for many in science, technology, engineering, and mathematics (STEM) education, the notion that achievement gaps exist is evidence of a problem that motivates reform. My hope is that this small collection of recent work can stimulate critical reflection on what we mean by “achievement” in STEM, how we can understand the causes of “gaps,” and what we might consider to be productive steps toward racial equity and justice.

Schinske, J. N., Perkins, H., Snyder, A., & Wyer, M. (2016). Scientist spotlight homework assignments shift students’ stereotypes of scientists and enhance science identity in a diverse introductory science class. *CBE—Life Sciences Education*, 15(3), ar47. https://doi.org/10.1187/cbe.16-01-0002

Official Abstract: Research into science identity, stereotype threat, and possible selves suggests a lack of diverse representations of scientists could impede traditionally underserved students from persisting and succeeding in science. We evaluated a series of metacognitive homework assignments (“Scientist Spotlights”) that featured counterstereotypical examples of scientists in an introductory biology class at a diverse community college. Scientist Spotlights additionally served as tools for content coverage, as scientists were selected to match topics covered each week. We analyzed beginning- and end-of-course essays completed by students during each of five courses with Scientist Spotlights and two courses with equivalent homework assignments that lacked connections to the stories of diverse scientists. Students completing Scientist Spotlights shifted toward counterstereotypical descriptions of scientists and conveyed an enhanced ability to personally relate to scientists following the intervention. Longitudinal data suggested these shifts were maintained 6 months after the completion of the course. Analyses further uncovered correlations between these shifts, interest in science, and course grades. As Scientist Spotlights require very little class time and complement existing curricula, they represent a promising tool for enhancing science identity, shifting stereotypes, and connecting content to issues of equity and diversity in a broad range of STEM classrooms.

Tanner, K. D. (2017). Structure matters: Twenty-one teaching strategies to promote student engagement and cultivate classroom equity. *CBE-Life Sciences Education*, 12(3). https://www.lifescied.org/doi/pdf/10.1187/cbe.13-06-0115

In this article, Tanner provides examples of teaching strategies classified under five categories: (1) giving students opportunities to think and talk about biology; (2) encouraging, demanding, and actively managing the participation of all students; (3) building an inclusive and fair classroom community for all students; (4) monitoring behavior to cultivate divergent biological thinking; and (5) teaching all of the students in your biology classroom.

“These teaching strategies are sometimes referred to as “equitable teaching strategies,” whereby striving for “classroom equity” is about teaching all the students in your classroom, not just those who are already engaged, already participating, and perhaps already know the biology being taught. Equity, then, is about striving to structure biology classroom environments that maximize fairness, wherein all students have opportunities to verbally participate, all students can see their personal connections to biology, all students have the time to think, all students can pose ideas and construct their knowledge of biology, and all students are explicitly welcomed into the intellectual discussion of biology. (From Introduction)”