



THE OHIO STATE
UNIVERSITY

Environmental Injustice and the Need for Physics for and by the People

Sunday, October 13, 2024, 3:07 pm

IUPAP Inter-Commission Symposium: Physics research for a sustainable planet

geraldine L. Cochran
Department of Physics, The Ohio State University

Acknowledgements



- Thank you to the speakers in day 1 and day 2 of this Inter-Commission Symposium: Physics Research for a Sustainable Planet. This has inspired me!
- Thank you to the audience for allowing me to share my research interest and work with you.
- Thank you to the previous speakers in this inter-commission symposium as you have already established the motivation for what I would like to share.



- Environmental harm disproportionately impacts marginalized households. (Martinez et al., 2023)
- **This makes physics education incredibly important!**
 - Physics education allows for socioeconomic mobility.
 - Physics education provides an opportunity for addressing issues relevant to one's life.
- **This also makes equity-oriented physics education research incredibly important!**

Judy's Story



- Judy like me is an African American woman in the states.
- Her family was devastatingly impacted by hurricane Katrina in Louisiana.
- Judy wanted to become a physicist so that she could conduct sustainability research with a focus on energy.
- Judy was a very bright student who excelled in all of her math and science courses in middle school.
- Judy goes on to earn a PhD in physics and decides that she no longer wants to be a physicist or part of the physics community.

Judy's Undergraduate Story



- Judy doesn't have access to Algebra 1 or any advanced math courses in high school.
- Judy's high school doesn't offer physics either.
- (U.S. Dept of Education Office of Civil Rights, 2021 Report)
 - Only 53% of public high school students in the U.S. attend a public school that offers a full range of math and science courses.
 - Only 87% of U.S. public high schools offer Algebra 1
 - Only 61% of U.S. public high schools offer a physics course.
- Inequities in access to physics and math at the high school level are exacerbated by policies and practices at the collegiate level (Brahmia & Cochran, in-preparation)
- Undergraduate women in physics face sexual harassment (Ayccock et al., 2019).

Judy's Graduate Story



- Graduate admissions processes in physics exacerbate existing inequities (Posselt, et al. 2017; Cochran et. al., 2018)
- Students in bridge programs are stigmatized by faculty and resented by their peers (Gómez et al., 2023, Sachmpazidi, 2021).
- Black women are excluded from study groups in graduate physics programs (Rosa & Moore Mensah, 2016).
- Faculty hesitate to work with with students from bridge programs (Gómez et al., 2023, Sachmpazidi, 2021).
- Physics graduate students struggle to find a research group and leave their research group even when they are unhappy (Verostek, 2024).
- Physics graduate programs in the U.S. often lack policy regarding days off and vacation for graduate students (Cochran et al., in-review).
- Women graduate students in physics and astronomy face microaggressions and sexism (Barthelemy et al., 2016)



- **Goals:**

- Uncover inequities in physics education
- Develop strategies for mitigating the impact of unjust and unfair circumstances, policies, and/or systems
- Provide evidence-based strategies for modifying policies, practices, and culture to make things more just or fair



- Transforming Introductory Physics Sequences to Support all Students (TIPSSS)
 - Removing barriers to accessing calculus-based, physics courses.
 - Teaching quantitative literacy and mathematical skills in introductory physics courses.
 - Development of curriculum, support network for faculty teaching transformed courses, research on the efficacy of these transformed courses.
 - **A growing number of physics departments in the U.S. are removing the calculus pre/co-enrollment requirement for calculus-based mechanics courses.**
- Inclusive Graduate Education Network (IGEN)
 - Identifying inequities in the graduate admissions process.
 - Designed rubrics to support holistic admissions process.
 - **Made an impact! Many departments have changed to using holistic admissions. (Young et al., 2023)**
- Inclusive Graduate Programs in Physics (IGP) project
 - Continuing work on graduate admissions
 - Improving the qualifying process in graduate physics programs
 - Improving culture and climate in graduate physics programs

Selected References on Gender Harassment



- Knaub, A. V., Maier, S. J., & Ding, L. (2020). Changing Culture and Climate to Prevent Sexual Harassment in the Physics Educational Setting. *Physics Teacher*, 58(5), 352–355.
- American Institute of Physics, S. R. C., Porter, A. M., Walsh, C., & Ivie, R. (2022). Exploring Harassment and Discrimination Experiences in Astronomy: Results from the Longitudinal Survey of Astronomy Graduate Students (2007-16). Focus On. In AIP Statistical Research Center.
- Aycock, L. M., Hazari, Z., Brewe, E., Clancy, K. B. H., Hodapp, T., & Goertzen, R. M. (2019). Sexual Harassment Reported by Undergraduate Female Physicists. *Physical Review Physics Education Research*, 15(1).
- Barthelemy, R. S., McCormick, M., & Henderson, C. (2016). Gender Discrimination in Physics and Astronomy: Graduate Student Experiences of Sexism and Gender Microaggressions. *Physical Review Physics Education Research*, 12(2), 020119.

References Mentioned in this Presentation



- Aycock, L. M., Hazari, Z., Brewe, E., Clancy, K. B. H., Hodapp, T., & Goertzen, R. M. (2019). Sexual Harassment Reported by Undergraduate Female Physicists. *Physical Review Physics Education Research*, 15(1).
- Barthelemy, R. S., McCormick, M., & Henderson, C. (2016). Gender Discrimination in Physics and Astronomy: Graduate Student Experiences of Sexism and Gender Microaggressions. *Physical Review Physics Education Research*, 12(2), 020119.
- **Cochran, G.L.**, Hodapp, T., & Brown, E.A. . (2018). Identifying barriers to ethnic/racial minority students' participation in graduate physics, PERC Proceedings [Cincinnati, OH, July 22-26].
- Martinez, Y. M., & Nenger, J. (2023). Infrastructures of Harm, Communities of Knowledge and Environmental Justice. *Studies in Social Justice*, 17(3), 323–332.
- Posselt, J. Hernandez, T., **Cochran G.L.** & Miller, C., (2019). Metrics first, diversity later? Making the shortlist and getting admitted to physics PhD programs. *Journal of Women and Minorities in Science and Engineering*, 25, 283–306.
- Gámez, R., Packard, B. W.-L., & Chavous, T. M. (2022). Graduate Bridge Programs as Nepantla for Minoritized Students in STEM: Navigating Challenges with Non-Bridge Peers and Faculty. *Journal of Diversity in Higher Education*, 15(1), 37–46.
- Rosa, K., & Moore Mensah, F. (2016). Educational pathways of Black women physicists: Stories of experiencing and overcoming obstacles in life. *Physical Review Physics Education Research*, 12.R.
- Sachmpazidi, D. Investigating the Relationship between Departmental Support Structures, Self-Efficacy and Intention to Persist: An Examination of Students' Experience in 19 Physics Graduate Programs across the United States (Western Michigan University, 2021).
- Verostek, M. J., Jr. (2025). Admitting students, finding a research group, and promoting skills for research: Examining critical processes in physics graduate education to facilitate change [ProQuest Information & Learning]. In *Dissertation Abstracts International Section A: Humanities and Social Sciences* (Vol. 86, Issue 1–A).
- Young, N.T., Tollefson, K., & Caballero, M.D. Making graduate admissions in physics more equitable, *Physics Today* 76, 40 (2023).

Acknowledgements



- Thank you again for the opportunity to share with you all today!
- I acknowledge the National Science Foundation which funded the IGEN under several awards, the IGP under award #2330015, and the TIPSS Network activities under award #2403512.
- The thoughts shared in this presentation are my own and do not necessarily reflect the views of the National Science Foundation, The Ohio State University, or any other organization.



THE OHIO STATE
UNIVERSITY

Thank You!



- “**Quantitative literacy** (QL) can be described as the ability to adequately use elementary mathematical tools to interpret and manipulate quantitative data and ideas that arise in an individual’s private, civic, and work life.” (Gillman, 2005)
- Physics inventory of quantitative literacy (PIQL) is designed to assess student understanding of numbers and their applications in real-world, problems with a physics context. (Brahmia et al., 2021)

Quantitative Literacy Development



- You have a pile of pennies and another pile of dimes. The value of the pile of pennies is equal to the value of the pile of dimes. If P is the number of pennies in the pile and D is the number of dimes in the pile, then write an equation expressing a relationship between P and D . Pennies are worth one cent (0.01 USD), Dimes are worth 10 cents. (0.10 USD).
- When we ask this question to students, we generally get one of two responses:
 - $P = 10D$
 - $D = 10P$

This question comes from materials that have been modified by the TIPPS Team from originals by Suzanne White Brahmia and colleagues.

Quantitative Literacy Development



16. Consider the following statement about subatomic particles:

“There are three times as many quarks as nucleons.”

Some students were asked to write an equation to represent this statement, using Q for the number of quarks and N for the number of nucleons. Which of the following are correct?

Choose all that apply.

$3Q/N$ $3Q = N$ $3Q + N$ $Q = 3N$ None of these are correct.