EQUITY-ORIENTED PHYSICS EDUCATION RESEARCH

GERALDINE L. COCHRAN
ASSOCIATE PROFESSOR OF PHYSICS
THE OHIO STATE UNIVERSITY

IRIS-HEP SOFTWARE INSTITUTE RETREAT
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TRADITIONAL PHYSICS EDUCATION RESEARCH (PER)?

- "PER focuses on understanding how students learn physics at all levels and developing strategies to help students with diverse prior preparations learn more effectively" (Singh, 2014).
- Discipline-based Education Research in Physics (Docktor & Mestre, 2014)
  - It's only ~50 years old
  - Covers a variety of topics
    1. Conceptual understanding
    2. Problem solving
    3. Curriculum and instruction
    4. Assessment
    5. Cognitive psychology
    6. Attitudes and beliefs about learning and teaching

EQUITY-ORIENTED PHYSICS EDUCATION RESEARCH

- Equity-oriented PER
- **PER - applying education research methods to problems with a physics context.**

- Equity - a redistribution of power and access to make situations and circumstances more just or fair (Atwater, 1999)
  - Things aren't currently fair in physics.
  - Equity-work spans a variety of topics.
    - Curriculum development
    - Course transformation
    - Assessment
    - Access, success, flourishing at all levels and spaces in physics!

EQUITY-ORIENTED PHYSICS EDUCATION RESEARCH

- Documentation of inequities in…
  - Identifying representation
  - Uplifting lived experiences
- Changing policies, practices, and culture in physics
  - Sense of belonging within a department, division, or unit
  - Transparency in regard to promotion
- Mitigating the negative impact of injustice
  - Creating programs
  - Understanding how people are successful in physics despite injustice so that we can better support people until …

HOW ARE TOPICS IN EQUITY-ORIENTED PER DETERMINED?

- Graduate Students
  - McDermott: neurodivergent physicists
    - McDermott, L. G., Mosley, N. A., & Cochran, G. L. (2024). Diverging nonlocal fields: Operationalizing critical disability physics identity with neurodivergent physicists outside academia. *Physical Review Physics Education Research*, 20(1), 010111.
  - Sargsyan: oral candidacy exams
    - Sargsyan, L., & Cochran, G. (2024). Oral candidacy exams: An investigation of student perspectives. Bulletin of the American Physical Society.
- Undergraduate Students
  - Learning Assistants
    - Cochran, G. L., Troncone, B., Evangelista, B. R., Vera, P. J. C., Tajudeen, G. O., Mosley, N., ... & Ptak, C. (2021, July). Understanding the Impact of Inequity on Student Learning Experiences During a Time of Multiple Crises. In *2021 ASEE Virtual Annual Conference Content Access.*
- RHIC&AGS Users Executive Committee within the Diversity Workshop Group
    - Determining gender representation in the field of heavy-ion collisions
- My Experience
- What barriers have you overcome to succeed in physics?

GRADUATE ADMISSIONS IN PHYSICS

- Cochran, G. L., Hodapp, T., & Brown, E. E. (2018, March). Identifying barriers to ethnic/racial minority students' participation in graduate physics. In *Physics Education Research Conference*.
  - Content Analysis
  - 9 Semi-structured interviews
  - Barriers to Applying to Graduate Programs
    - GRE results
    - Lack of Research Experience
    - Undergraduate GPA or Grades
    - Deadlines or Timescale for Applications
    - Finances

GRADUATE ADMISSIONS IN PHYSICS

- Posselt, J. R., Hernandez, T. E., Cochran, G. L., & Miller, C. W. (2019). Metrics first, diversity later? Making the short list and getting admitted to physics PhD programs. Journal of Women and Minorities in Science and Engineering, 25(4).
- Multivariate Statistical Analysis
  - GRE Scores Have Positive, Significant Relationships with Odds of Being Placed on a Short List
  - On average, women on the short list have 3 times the odds of being admitted compared to men ($p < 0.01$) and 4.5 times the odds of being admitted when PGRE is considered and held constant.
  - Latinx applicants on the short list have 3.3 times higher odds than white applicants of being admitted ($p < 0.05$) when controlling for GPA and GRE general scores.
  - By contrast, Black/African American applicants on the short list **do not** have statistically significant different odds of being admitted compared to white applicants when controlling for GPA and GRE general scores

CLIMATE, CULTURE, AND REPRESENTATION MATTER!

- Gender representation in the heavy-ion collision community (RHIC&AGS Users Executive Committee within the Diversity Workshop Group)
- Nuclear Science
  - Gaspar, M., & Dubertrand, M. (2018). Toward closing the gender gap in nuclear science. IAEA Bulletin, 21.
- Particle Physics
  - Towers, S. (2008). A case study of gender bias at the postdoctoral level in physics, and its resulting impact on the academic career advancement of females. arXiv preprint arXiv:0804.2026.
  - Bernstein, R. H., Macy, M. W., Williams, W. M., Cameron, C. J., Williams-Ceci, S. C., & Ceci, S. J. (2022). Assessing gender bias in particle physics and social science recommendations for academic jobs. Social Sciences, 11(2), 74.
  - Report of the 2021 U.S. Community Study on the Future of Particle Physics (Snowmass 2021)

EQUITY-ORIENTED THEORIES AND FRAMEWORKS

- Critical Race Theory
- Feminist Standpoint Theory
- Community Cultural Wealth
- Intersectionality Theory

GRADUATE EXPERIENCES IN PHYSICS

- Tempkin, J. P., Cochran, G. L., & Boone, T. (2023, September). Using Community Cultural Wealth to Understand Experiences in Physics Bridge Programs. In Proceedings of the Physics Education Research Conference (PERC) (pp. 368-373).
- Interviews Using a Community Cultural Wealth (CCW) Framework
- Yosso*, T. J. (2005). Whose culture has capital? A critical race theory discussion of community cultural wealth. Race ethnicity and education, 8(1), 69-91.
- This framework identifies 6 forms of capital:
  - Aspirational
  - Linguistic
  - Navigational
  - Social
  - Familial
  - Resistant

INTERSECTIONALITY THEORY

- Less concerned with the failures of feminist theories, Afrocentric theories, Marxist theories or theories on economic inequality. Developing a theory grounded in the thought, scholarship, and lived experiences of working class Black women. (Collins, 2022)
- "Rather than examining gender, race, class, and nation as distinctive social hierarchies, intersectionality examines how they mutually construct one another" (Hill Collins 1998)
- Interlocking systems of oppression rather than axes of identity (Hill Collins, several works)

  - Collins, P. H. (1998). It's all in the family: Intersections of gender, race, and nation. Hypatia, 13(3), 62-82.
  - Collins, P. H. (2022). Black feminist thought: Knowledge, consciousness, and the politics of empowerment. Routledge.

Understanding the Terms

- Diversity - Representation. Who is at the table?
  - Most of the research is in this area.
  - Efforts in this area can often be implemented much faster and more easily than efforts in the other areas.

- Inclusion – Climate. Are those at the table, in the classroom, in the position surviving and thriving?
  - Research in this area has increased over the last decade.
  - Many organizations utilize climate studies that may or may not be a part of published research.

- Equity – Defined in multiple ways
  - Educational equity and CRT (Gloria Ladson-Billings)
  - Elimination of access and opportunity gaps
  - Equity models in research
    - Equity of parity
    - Equity of fairness
    - Equity of individuality

CHANGING CULTURE BASED ON RESEARCH

- Self-Efficacy Theory
  - Self-efficacy Theory: a theory for behavioral change
  - Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. *Psychological review*, *84*(2), 191.

  - Predicts a students' task persistence
  - Cervone, D., & Peake, P. K. (1986). Anchoring, efficacy, and action: The influence of judgmental heuristics on self-efficacy judgments and behavior. *Journal of Personality and social Psychology*, *50*(3), 492.

  - Predicts a students' performance in math
  - Pajares, F., & Miller, M. D. (1994). Role of self-efficacy and self-concept beliefs in mathematical problem solving: A path analysis. *Journal of educational psychology*, *86*(2), 193.

  - Men and women draw on different sources of self-efficacy
  - Sawtelle, V., Brewe, E., & Kramer, L. H. (2012). Exploring the relationship between self-efficacy and retention in introductory physics. *Journal of research in science teaching*, *49*(9), 1096-1121.

  - Zeldin, A. L., & Pajares, F. (2000). Against the odds: Self-efficacy beliefs of women in mathematical, scientific, and technological careers. *American Educational Research Journal*, *37*(1), 215-246.
  - Women in mathematical, scientific, and technical fields
  - Self-efficacy beliefs resulted in perseverance and resilience

CHANGING CULTURE BASED ON RESEARCH

- Stereotype Theory/Identity Threat
  - Stereotype threat is anxiety caused by a fear that you will fulfill a negative stereotype about a social identity group with which you identify
  - Steele, C. M., & Aronson, J. (1995). Stereotype threat and the intellectual test performance of African Americans. Journal of personality and social psychology, 69(5), 797.

  - Stereotype threat impacts women in science and math
  - Spencer, S. J., Steele, C. M., & Quinn, D. M. (1999). Stereotype threat and women's math performance. Journal of experimental social psychology, 35(1), 4-28.
  - Beilock, S. L., Rydell, R. J., & McConnell, A. R. (2007). Stereotype threat and working memory: mechanisms, alleviation, and spillover. Journal of Experimental Psychology: General, 136(2), 256.

- Ambady, N., Shih, M., Kim, A., & Pittinsky, T. L. (2001). Stereotype susceptibility in children: Effects of identity activation on quantitative performance. *Psychological science*, *12*(5), 385-390.
- Gonzales, P. M., Blanton, H., & Williams, K. J. (2002). The effects of stereotype threat and double-minority status on the test performance of Latino women. *Personality and social psychology bulletin*, *28*(5), 659-670
- Aronson, J., Lustina, M. J., Good, C., Keough, K., Steele, C. M., & Brown, J. (1999). When white men can't do math: Necessary and sufficient factors in stereotype threat. *Journal of experimental social psychology*, *35*(1), 29-46.
- Stone, J., Lynch, C. I., Sjomeling, M., & Darley, J. M. (1999). Stereotype threat effects on Black and White athletic performance. *Journal of personality and social psychology*, *77*(6), 1213.
- Harrison, L. A., Stevens, C. M., Monty, A. N., & Coakley, C. A. (2006). The consequences of stereotype threat on the academic performance of White and non-White lower income college students. *Social Psychology of Education*, *9*(3), 341-357.

CHANGING CULTURE BASED ON RESEARCH

Self-affirmations as an intervention

- Steele, C. M. (1988). The psychology of self-affirmation: Sustaining the integrity of the self. In *Advances in experimental social psychology* (Vol. 21, pp. 261-302). Academic Press.
- Cohen, G. L., & Garcia, J. (2008). Identity, belonging, and achievement: A model, interventions, implications. *Current directions in psychological science*, *17*(6), 365-369.

Self-affirmations and value affirmations work

- Improved grades of African American Students and reduced racial achievement gap by 40%
  - Cohen, G. L., Garcia, J., Apfel, N., & Master, A. (2006). Reducing the racial achievement gap: A social-psychological intervention. *science*, *313*(5791), 1307-1310.
- Gender in introductory physics courses
  - Miyake, A., Kost-Smith, L. E., Finkelstein, N. D., Pollock, S. J., Cohen, G. L., & Ito, T. A. (2010). Reducing the gender achievement gap in college science: A classroom study of values affirmation. *Science*, *330*(6008), 1234-1237.
  - Kost-Smith, L. E., Pollock, S. J., Finkelstein, N. D., Cohen, G. L., Ito, T. A., & Miyake, A. (2012, February). Replicating a self-affirmation intervention to address gender differences: Successes and challenges. In *AIP Conference Proceedings*(Vol. 1413, No. 1, pp. 231-234). AIP.
- Women college students drinking coffee
  - Reed, M. B., & Aspinwall, L. G. (1998). Self-affirmation reduces biased processing of health-risk information. *Motivation and Emotion*, *22*(2), 99-132.

IMPLICIT BIAS THEORY

- Implicit Bias - relatively unconscious, relatively automatic features of prejudiced judgement and social behavior
- "30 years of findings from neurology and social and cognitive psychology showing that hidden biases operating largely under the scope of human consciousness influence the way we see and treat others, even when we are determined ty be fair and objective"
  - Staats, C., Capatosto, K., Wright, R. A., & Contractor, D. (2015). *State of the science: Implicit bias review 2015* (Vol. 3). Kirwan Institute for the Study of Race and Ethnicity, The Ohio State University.
- Many names
  - Implicit bias
  - Unconscious bias
  - Implicit social cognition
- Our unconscious mind takes in trillions of bits of information each second. Our conscious mind can handle only 40–50 of those bits, maybe only 16 bits each second. That leaves the bulk of the mental processing to the unconscious. (Kozak; Lewis, 2011; H. Ross, 2008).
- F. Trix & C. Penska, Exploring the color of glass: Letters of recommendation for female and male medical faculty, Discourse & Society, 14, 191-220, 2003
  - Systematic differences in letters of recommendations
  - Letters for women are shorter & contain fewer standout words (outstanding, groudbreaking, superstar) & express more doubt and contain adjectives such as diligent, hardworking
  - More likely to mention women's personal lives & compare women to other women
- In the hiring process and other decision-making occasions, allowing adequate time to make decisions is vital. Time pressures create an environment in which unconscious biases can flourish (Bertrand, et al., 2005).

IMPLICIT BIAS THEORY – WHAT DO WE KNOW?

- Once an implicit association is activated, it is difficult to inhibit (Dasgupta, 2013). Despite what may feel like a natural inclination, attempts to debias by repressing biased thoughts are ineffective. Due to rebound effects, suppressing these automatic associations does not reduce them and may actually amplify them by making them hyper-accessible (Galinsky & Moskowitz, 2000, 2007; Macrae, et al., 1994). A great way to debias is to openly acknowledge biases and then directly challenge or refute them.

- Our implicit biases are not permanent; they are malleable and can be changed by devoting intention, attention, and time to developing new associations. Implicit biases are malleable; therefore, the implicit associations that we have formed can be gradually unlearned and replaced with new mental associations (Blair, 2002; Blair, Ma, & Lenton, 2001; Dasgupta, 2013; Dasgupta & Greenwald, 2001; Devine, 1989; Kang, 2009; Kang & Lane, 2010; Roos, Lebrecht, Tanaka, & Tarr, 2013).

STRATEGIES FOR DEBIASING

- **Counter-stereotypic training** in which efforts focus on training individuals to develop new associations that contrast with the associations they already hold through visual or verbal cues (see, e.g., Blair, et al., 2001; Kang, et al., 2012; Kawaka- mi, Dovidio, Moll, Hermsen, & Russin, 2000; Wittenbrink, Judd, & Park, 2001)

- **Expose to counter-stereotypic individuals.** These counter-stereotypic exemplars possess traits that contrast with the stereotypes typically associated with particular categories, such as male nurses, elderly athletes, or female scientists (see, e.g., Dasgupta & Asgari, 2004; Dasgupta & Greenwald, 2001; Kang & Banaji, 2006).

- Engaging in **deliberative processing** can help counter implicit biases, particularly during situations in which decision-makers may face time constraints or a weighty cognitive load (Beattie, et al., 2013; D. J. Burgess, 2010; Kang, et al., 2012; Richards-Yellen, 2013). Medical professionals, in particular, are encouraged to constantly self-monitor in an effort to offset implicit biases and stereotypes (Betancourt, 2004; Stone & Moskowitz, 2011).

STRATEGIES FOR DEBIASING (CONTINUED)

- **Having a sense of accountability**, that is, "the implicit or explicit expectation that one may be called on to justify one's beliefs, feelings, and actions to others," can decrease the influence of bias (T. K. Green & Kalev, 2008; Kang, et al., 2012; Lerner & Tetlock, 1999, p. 255; Reskin, 2000, 2005).

- **Taking the perspective of others** has shown promise as a debiasing strategy, because considering contrasting viewpoints and recognizing multiple perspectives can reduce automatic biases (Benforado & Hanson, 2008; Galinsky & Mos- kowitz, 2000; Todd, Bodenhausen, Richeson, & Galinsky, 2011).

- **Education efforts aimed at raising awareness about implicit bias** can help debias individuals. The criminal justice context has provided several examples of this technique, including the education of judges (Kang, et al., 2012; Saujani, 2003) and prospective jurors (Bennett, 2010; Roberts, 2012). These education efforts have also been embraced by the health care realm (Hannah & Carpenter-Song, 2013; Hernandez, Haidet, Gill, & Teal, 2013; Teal, Gill, Green, & Crandall, 2012).

STRATEGIES FOR ADDRESSING IMPLICIT BIASES

- **Stereotype replacement** requires addressing our own biases related to stereotypes head-on. We first must recognize that the thought we had or a statement we made was related to a stereotype and not reality. Then, we must think about where this thought or the ideas we stated actually came from. This helps us to avoid biased stereotypical thinking and comments in the future.
- **Counter-stereotypic imaging** is a tool for addressing our own implicit bias. Faculty can engage in counter-stereotypic imaging by imagining or reflecting on people who do not conform to negative stereotypes. For example, one might imagine, or reflect on, a group of women physicists presenting their research at a national conference to counter the stereotype that women are not good in physics.
- **Individualism** is the practice of intentionally seeing others as individuals rather than as part of a larger group. For example, if we are assessing an African American student's potential for success in our research group, we can intentionally think about what we know about that student as an individual and what that says about their potential for success rather than evaluating them based on what we might think or feel about African Americans engaged in research.
- **Perspective taking** can be accomplished by engaging in any activity that presents someone else's perspective on an experience. This could be reading a novel about someone from a different background or thinking about how someone from a different background might experience a situation.

PEARL - COCHRAN LAB

Physics Equity and Access Research Lab

https://sites.google.com/view/pearl-cochran-research-group?usp=sharing

Investigating Student Experiences in Physics Bridge Programs

Transforming Introductory Physics Sequences to Support All Students (TIPSSS)

Inclusive Graduate Programs

Using Social Network Analysis to Understand the Impact of Communities on Engineering Majors

Documenting Gender Disparities in the Heavy Ion Collision Community

Transforming Introductory Physics Courses to Support All Accepted Students

THANK YOU AGAIN!