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How Diversity Matters in the U.S. Science and Engineering Workforce: Integration and Inclusion in Teams and Departments

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Scientific Workforce Diversity Seminar Series Proceedings

How Does Diversity Impact Science?

May 17, 2022

NIH National Institutes of Health
Office of the Director
Chief Officer for Scientific Workforce Diversity

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1. Executive Summary

This document summarizes the proceedings of the **Scientific Workforce Diversity Seminar Series** (SWDSS) virtual seminar "**How Does Diversity Impact Science?**" The National Institutes of Health (NIH) **Chief Officer for Science Workforce Diversity** (COSWD) office hosted the seminar on May 17, 2022. Approximately 675 people from NIH and other organizations attended. Marie A. Bernard, M.D., COSWD, moderated a panel discussion on the evidence regarding the impact of diverse, inclusive teams on creativity, innovation, and productivity in science. Six invited speakers with workforce diversity expertise shared perspectives and presented their research, including how to measure the impact of diversity and potential areas for future study. Presentations by the panelists were followed by a question-and-answer session moderated by Dr. Bernard. This document details the main points from the invited speakers' presentations and the ensuing discussion on what diversity brings to the scientific endeavor. The **seminar recording** and **panelists' presentation materials** are on the COSWD website.

2. Opening Remarks

Marie A. Bernard, M.D., NIH COSWD

Dr. Bernard welcomed attendees to the seminar and introduced the discussion topic: The outcomes of scientific workforce diversity and their impact on creativity and innovation in science, including how to measure these impacts. Dr. Bernard noted that scientific workforce diversity relates to social justice and equity issues, but a growing body of research suggests that workforce diversity positively impacts fact-based decision-making, preparation and perspective taking, and information diligence. Evidence from the business sector is abundant.[1] For example, one study found that members of racially diverse mock jury panels exchanged more information, cited more facts, and made fewer errors than

The seminar featured the following panelists:

- **Richard B. Freeman, Ph.D.**, Herbert Ascherman Professor of Economics, Harvard University
- **Jedidah Isler, Ph.D.**, Principal Assistant Director for STEM Opportunity and Engagement, White House Office of Science and Technology Policy
- **Jennifer Kuan, Ph.D.**, Deputy Director of Innovation and Research, California State University, Monterey Bay
- **George Santangelo, Ph.D.**, Director, NIH Office of Portfolio Analysis
- **Laurel Smith-Doerr, Ph.D.**, Professor of Sociology, University of Massachusetts Amherst
- **Shirley M. Tilghman, Ph.D.**, President Emerita, Professor of Molecular Biology and Public Affairs, Princeton University

homogeneous panels.[2] Diversity can also increase individuals' perception of, preparation for, and anticipation of others' perspectives, leading to improved decision-making performance.[3] And ethnically diverse market traders had fewer pricing errors than homogenous traders, receiving a greater return on their investment.[4]

3. The Impact of Diverse Representation in Science and Technology

Jedidah Isler, Ph.D., Principal Assistant Director for STEM Opportunity and Engagement, White House Office of Science and Technology Policy

Dr. Isler spoke about the White House Office of Science and Technology Policy's (OSTP's) efforts to ensure that all Americans can participate in, contribute to, and benefit from science and technology. OSTP works to advance equity across the entire science and technology ecosystem, including the people, places, and structures that drive global innovation. A truly diverse science and technology ecosystem must include a broader diversity of thinkers, scientists, researchers, lab managers, and more. To address the nation's science and technology challenges, science needs to invite contributions from individuals and communities who have historically been excluded from federal decision-making, invest in their success, and ensure their inclusion in all aspects of science. As such, OSTP is creating a national equity strategy to identify and act on ways to increase STEM participation in the United States.

Dr. Isler noted that researchers from underrepresented groups in science and technology produce more innovative solutions than their counterparts. For example, recent research suggests that underrepresented groups have higher rates of scientific novelty than their counterparts, yet that novelty is often discounted.[5] As such, a central question is how we steward existing innovation, not whether the promise of innovation exists in the first place. In closing, Dr. Isler said that as a scientist and policymaker, she hoped that the seminar would result in clear, actionable evidence highlighting that innovative work is already being done by some of the best and brightest researchers in the United States.

4. How Diversity Matters in the U.S. Science and Engineering Workforce: Integration and Inclusion in Teams and Departments

Laurel Smith-Doerr, Ph.D., Professor of Sociology, University of Massachusetts Amherst

Dr. Smith-Doerr summarized the mixed evidence for demographic diversity; some studies demonstrate that diversity is associated with innovation, while others find that diversity has no beneficial or adverse effects on team outcomes.[6] Dr. Smith-Doerr and her colleagues examined the organizational context of team diversity and found that equity is a necessary condition for diversity to produce innovation. Thus, organizations, workplaces, and lab contexts must support diverse voices. To demonstrate the benefits of gender diversity in science, Dr. Smith-Doerr cited a study on the health and financial costs of excluding women scientists from leading clinical translation efforts, for example, withdrawing drugs from the market that pose more significant risks for women than men. A second study from the life sciences found that teams led by women inventors were more likely to patent technologies that improve women's health.[7]

Research on creating inclusive university department climates found that women and faculty of color are more likely to feel included in more diverse departments.[8] Such departments are more likely to see themselves as inclusive, include collegial, informal mentoring, and address conflict rather than ignore it. Dr. Smith-Doerr concluded her presentation with a call for additional qualitative research that delves into the work context of science. This research informs understanding of social processes and strategies for creating inclusive, healthy ecosystems for science where everyone can flourish; such investments in inclusion benefit all faculty members and the entire scientific endeavor.

5. The Effect of Mentee and Mentor Gender on Scientific Productivity of Applicants for NIH Training Fellowships

George Santangelo, Ph.D.,
Director, NIH Office of Portfolio Analysis

Dr. Santangelo discussed NIH's efforts to measure scientific productivity, a critical part of assessing the impact of workforce diversity, and research on mentee and mentor gender. He summarized the evidence on the barriers that women pursuing careers in biomedical science face, including research suggesting that their work accrues fewer citations than that of their male colleagues and that subtle gender bias by NIH R01 application reviewers may result in male and female applicants being held to different standards.

To explore whether female mentors help female mentees overcome barriers to success early in their careers, the NIH Office of Portfolio Analysis examined the effect of mentee and mentor gender on the scientific productivity of applicants for NIH fellowships.[9] Their findings suggest that after normalizing for the funding level of mentors, female mentors with female mentees are as productive as other gender combinations in most metrics and are more productive than other gender combinations in clinical metrics. The initial appearance of lower productivity of female mentees might result from the documented funding gap between independent female and male investigators. Dr. Santangelo noted that the study demonstrates the importance of a multifaceted, data-driven approach to measuring the return on research investments and that high-quality data is essential to matching research outputs and doing analyses that result in clean answers.

6. Discrimination and Diversity

Jennifer Kuan, Ph.D., Deputy Director of Innovation and Research, California State University, Monterey Bay

Dr. Kuan introduced the economic theory of discrimination to explain the data-generating processes that result in a lack of diversity in science.[10] The theory posits that employers may consciously discriminate based on customer preferences, for example, leading to underrepresentation of some groups. In such scenarios, individuals from the discriminated against group perform better, on average, than their counterparts from the in-group. Dr. Kuan gave the example of Tokyo Medical School, which reduced the test scores of female students so it could admit a higher number of men.[11] As a result, the school accepted more men with lower scores, while the women who were accepted had higher-than-average scores. Economists use marginal analysis—which looks at what happens in borderline situations—to examine the outcomes of such decisions. Dr. Kuan explained that Tokyo Medical School's actions demonstrate that discrimination results in lower standards for the undiscriminated against group and higher standards for the group discriminated against, countering the claim that enhancing diversity by including underrepresented groups means lowering standards.

Other examples of the negative impact of discrimination on individuals and the entire economy are found in research that suggests higher rates of unemployment for Ph.D.

individuals from underrepresented groups.[12,13] In addition to discrimination, these talented individuals—termed "lost Einsteins"—may not have access to the resources needed to pursue scientific careers. The career pathway of biochemist Katalin Karikó, Ph.D., who co-invented the technology for mRNA COVID-19 vaccines, illustrates this point. Dr. Karikó could not secure a tenure-track position and was therefore ineligible for outside research funding. As a result, she was at risk of leaving her research career, which focused on a topic outside the mainstream that saved millions of lives and trillions of dollars in lost economic activity.[14] In conclusion, Dr. Kuan noted that what is lost to discrimination and what economists might estimate is lost in scientific contributions is vastly underestimated when considering what individuals with diverse perspectives and backgrounds bring to science.

7. Diversity in Scientific Teams Researching COVID-19

Richard B. Freeman, Ph.D., Herbert Ascherman Professor of Economics, Harvard University

Dr. Freeman discussed diversity and homophily, the tendency for any group to associate with people of that same group. In science, homophily manifests as researchers more frequently collaborating with and citing researchers like themselves.[15] More recently, Dr. Freeman and his colleagues used large datasets to examine optimal diversity in teams researching COVID-19 to understand diversity versus homophily in inputs for research outcomes in terms of raising the social value of research.[16] They found substantial diversity among these researchers, especially in terms of national origin, name ethnicity, and gender.

Their examination of COVID-19 publications revealed homophily in citations. For example, a paper written by a man is more likely to be cited in the future by other men. Likewise, a paper written by a woman is more likely to be cited by other women. Due to these self-citing networks, members of smaller groups are cited less frequently, in what Dr. Freeman termed "minority scale bias," or the bias in citations due to citation homophily among groups differing in numbers of papers. Minority scale bias likely harms women, other underrepresented groups in science, and researchers from smaller countries because hiring and promotion decisions are linked to citation metrics. In conclusion, Dr. Freeman noted that future research could estimate the effect of gender citation homophily on careers. He similarly explained that optimal diversity remains challenging to determine and may differ with the topic, team, type of diversity, and networks. Regardless, science must find ways to encourage diversity to reduce the negative effects of homophily on underrepresented groups.

8. Reaction to Panel

Shirley M. Tilghman, Ph.D., President Emerita, Professor of Molecular Biology and Public Affairs, Princeton University

The seminar focused on the central question of whether a diverse workforce affects the quality and impact of science. Dr. Tilghman explained that she has argued that it is deeply unethical to exclude any group, either consciously or unconsciously, from experiencing the joys of scientific discovery. More pragmatically, she argued that science is compromised when researchers are selected from a restricted group. Her third line of argument is the likelihood that including underrepresented groups in science will expand the range of research explored.

Throughout the COVID-19 pandemic, the United States witnessed tragic examples of the consequences of underrepresentation in science. One example is vaccine hesitancy among some Hispanic/Latino/Latina and Black/African American individuals. Some of this mistrust is derived from mistreatment and neglect by the medical profession, while other mistrust comes from being unable to relate to who scientists are and what scientists do. Until we address the lack of diversity in science, underrepresented groups will continue to be underserved by scientific advances.

Dr. Tilghman noted that rationales for the inclusion of underrepresented groups in science were historically qualitative and intuitive, and less based on rigorous evidence. However, that landscape is shifting. As the seminar speakers demonstrated, researchers now use powerful qualitative and quantitative methods to study, test, and experiment to clarify how diversity benefits science. The value of this research is its ability to inform inclusive policies and create cultural norms that maximize the impact science is intended to provide to society.

9. Question and Answer Session

Q. If audience members are interested in contributing to the growing body of evidence on the impact of workforce diversity, what metrics should they be considering?

Dr. Smith-Doerr: We need to understand the intersectional aspect of inequalities to know what is going on and to implement changes that can expand diversity and economic effects. When we look at race and gender separately, we are missing the impact of systems of privilege and oppression.

Dr. Kuan: A starting point is looking more closely at the processes inside of organizations, such as the culture and active policies that work against underrepresented groups in these settings.

Dr. Freeman: Ensure that the group measuring the impact has diverse representation in terms of gender, race and ethnicity, and field of study.

Dr. Santangelo: To measure productivity and impact effectively, look beyond simple citations and include clinical impact, technological impact, and patents, and capture indicators such as regular reproducibility of data sharing and transparency. These values are critical to creating a comprehensive assessment of productivity impact and understanding how different scientists and areas of science are based on research investments.

Q. What if making a material difference to diversity, inclusion, equity, and justice in science meant changing how we do science?

Dr. Santangelo: Evaluation is critically important in understanding what we have now and if we need to change the way we invest in science, the way we shape different areas of research, and the way we pursue research goals. If we are looking for ways to improve diversity and change the way we do science, we must understand the approaches we might be missing.

Dr. Freeman: We have a responsibility to listen to different ideas, to researchers from other disciplines, to early-stage investigators in a discipline, and to those from underrepresented groups; listening and being open will improve science.

Dr. Kuan: When people talk about different ways of doing science, the implication or fear is that there might be worse ways of doing it. But if doing science differently means innovating and including areas considered unconventional, the sooner we do that, the better.

Dr. Smith-Doerr: We need to expand how we think about knowledge production in science and understand the knowledge of many people, not just those formally labelled as scientists.

Dr. Tilghman: We are starting to see the value of doing science differently. Incentives are changing; researchers are more willing to work in teams instead of getting individual credit. Universities must change too because their incentive system is still largely focused on accrediting the individual, whether through hiring or promotion. This change will benefit a more diverse group of people in science. Returning to the discussion of how to measure productivity, we often don't know how to measure it, particularly with deep and fundamental science, until years after the discovery. Addressing this topic can open doors rather than maintain closed ones.

Q. What is one action you suggest our audience members take away from today's seminar to optimize the benefits of scientific workforce diversity?

Dr. Smith-Doerr: It is critical to consider the impact of COVID-19 on scientists. Times of crisis can exacerbate inequalities. We can lose gains easily. We know that the work of women faculty and faculty of color was more disrupted by COVID-19 than that of other scientists. I want to say to the NIH community: Something you can do now is to consider how investigators are doing and how they should receive NIH support, given the differential impacts of the pandemic on women, caregivers, and investigators of color.

Dr. Kuan: The point of the economic theory of discrimination was to get people to realize that not only is it a bad idea to discriminate, but that you can take advantage of other people discriminating and profit from that. So, let's bring more people into science and do things differently—there is a dual goal in doing that.

Dr. Freeman: Science is done in teams nowadays, so the accreditation to particular people is not correct. Science needs to rethink what it means to be a person working on a team and how to measure productivity.

Dr. Santangelo: We must understand how what we are measuring relates to actual achievement and productivity, the way we want to measure it, in terms of the commission and the place of NIH in advancing knowledge and improving human health and understanding that full pathway. And as we move toward that holy grail of measuring effectively across the entire pathway to discovery, we can still provide information that helps us understand current policies and how changes can improve science for underrepresented groups.

10. Closing Remarks

Tara A. Schwetz, Ph.D., Acting Principal Deputy Director of NIH

Dr. Schwetz explained that the science of diversity is a critical topic for NIH. Scientific workforce diversity ensures that the most creative minds address national research and health goals. It also ensures investigation of a broad spectrum of topics through varied techniques and approaches; scientific workforce diversity expands the application and generalizability of research findings, treatments, and innovations. Dr. Schwetz noted that NIH is working more diligently than ever to incorporate diversity, equity, inclusion, and accessibility (DEIA) principles into its daily work and decision-making. For example, NIH is developing an agencywide DEIA strategic plan, while UNITE addresses structural racism in biomedicine. Both efforts—and many others—are contributing to a more diverse workforce at NIH and in the NIH-supported community and are broadening our understanding of why diversity is critical to science.

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References

1. Phillips, KW. How Diversity Makes Us Smarter. *Scientific American.* October 1, 2014; 311(4): 42–47. doi:10.1038/scientificamerican1014-42

2. Sommers SR. On racial diversity and group decision making: Identifying multiple effects of racial composition on jury deliberations. *Journal of Personality and Social Psychology.* 2006;90(4):597–612. doi:10.1037/0022-3514.90.4.597

3. Loyd DL, Wang CS, Phillips KW, Lount RB. Social Category Diversity Promotes Premeeting Elaboration: The Role of Relationship Focus. *Organization Science.* 2013;24(3):757–772. doi:10.1287/orsc.1120.0761

4. Levine SS, Apfelbaum EP, Bernard M, Bartelt VL, Zajac EJ, Stark D. Ethnic diversity deflates price bubbles. *Proceedings of the National Academy of Sciences.* 2014;111(52):18524–18529. doi:10.1073/pnas.1407301111

5. Hofstra B, Kulkarni VV, Munoz-Najar Galvez S, He B, Jurafsky D, McFarland DA. The Diversity-Innovation Paradox in Science. *Proceedings of the National Academy of Sciences.* 2020;117(17):9284–9291. doi:10.1073/pnas.1915378117

6. Smith-Doerr L, Alegria SN, Sacco T. How Diversity Matters in the US Science and Engineering Workforce: A Critical Review Considering Integration in Teams, Fields, and Organizational Contexts. *Engaging Science, Technology, and Society.* 2017;3:139. doi:10.17351/ests2017.142

7. Koning R, Samila S, Ferguson JP. Who do we invent for? Patents by women focus more on women's health, but few women get to invent. *Science.* 2021;372(6548):1345–1348. doi:10.1126/science.aba6990

8. Misra J, Mickey EL, Kanelee ES, Smith-Doerr L. Creating inclusive department climates in STEM fields: Multiple faculty perspectives on the same departments. *Journal of Diversity in Higher Education.* 2022; advance online publication. doi:10.1037/dhe0000402

9. Yu H, Willis KA, Litovitz A, et al. The effect of mentee and mentor gender on scientific productivity of applicants for NIH training fellowships. bioRxiv: 2021.2002.2002.429450. doi:10.1101/2021.02.02.429450

10. Becker GS. *The Economics of Discrimination.* The University of Chicago Press; 1957. Note: Despite the age of this publication, it is the basis for the author's 1992 Nobel Prize in Economics and included for this reason.

11. Ramzy A, Ueno H. Japanese Medical School Accused of Rigging Admissions to Keep Women Out. *The New York Times.* https://www.nytimes.com/2018/08/03/world/asia/japan-medical-school-test-scores-women.html. Published August 3, 2018. Accessed October 14, 2022.

12. Cook LD, Gerson J, Kuan J. Closing the Innovation Gap in Pink and Black. *SSRN Electronic Journal.* Published online 2021. doi:10.2139/ssrn.3940042

13. Bell A, Chetty R, Jaravel X, Petkova N, Van Reenen J. Who Becomes an Inventor in America? The Importance of Exposure to Innovation. *The Quarterly Journal of Economics.* 2018;134(2):647–713. doi:10.1093/qje/qjy028

14. Nair P. QnAs with Katalin Karikó. *Proceedings of the National Academy of Sciences.* 2021;118(51). doi:10.1073/pnas.2119757118

15. Freeman RB, Huang W. Collaborating with People Like Me: Ethnic Coauthorship within the United States. *Journal of Labor Economics.* 2015;33(S1):S289–S318. doi:10.1086/678973

16. Liu M, Bu Y, Chen C, et al. Pandemics are catalysts of scientific novelty: Evidence from COVID-19. *The Journal of the Association for Information Science and Technology.* 2021;73(8):1065–1078. doi:10.1002/asi.24612

Appendix A:

Topics Most Commonly Found in Audience Questions

Seminar attendees submitted 35 questions for the panelists. This visualization shows the most common topics that emerged from an analysis of their questions; the larger words are those that appeared with greater frequency.

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