

WiDS Initiative

Barriers Literature Reference List

Undergraduate Research Experiences

In 2021, the Women in Data Science (WiDS) Worldwide initiative (WiDS) embarked on a new nine-month research initiative to test and analyze strategies and solutions focused on increasing the representation of women to 30% by 2030 in DS/AI relevant MS/PhD programs in the U.S. One of the main goals of that initiative was to understand what relevant research had indicated were potential interventions that can overcome women's reluctance to continue for graduate studies related to DS/AI. Ten studies relate specifically to undergraduate research experiences (REU).

Annotated List

Bangera, Gita, and Sara E. Brownell. "Course-Based Undergraduate Research Experiences Can Make Scientific Research More Inclusive." Edited by Graham Hatfull. *CBE—Life Sciences Education* 13, no. 4 (2014): 602–6. <https://doi.org/10.1187/cbe.14-06-0099>.

This article argues that UG research experiences are expected in highly competitive graduate programs, however they are not evenly distributed amongst UG universities. They state that barriers for students to participate in such experiences include: awareness of opportunities, awareness of the benefits of participating, lack of awareness of cultural norms and expectations placed on students participating in scientific research, interactions with faculty, and financial and personal barriers. They also found barriers to who faculty select to participate in such opportunities, these included assessment of mentorship and selection of "rising stars" and unconscious societal bias. They argue for more structured and required research opportunities.

Daniels, Heather A., Sara E. Grineski, Timothy W. Collins, and Angela H. Frederick. "Navigating Social Relationships with Mentors and Peers: Comfort and Belonging among Men and Women in STEM Summer Research Programs." *CBE—Life Sciences Education* 18, no. 2 (April 26, 2019): ar17. <https://doi.org/10.1187/cbe.18-08-0150>.

This study interviewed 17 undergraduate students from a Hispanic majority institution regarding their participation in STEM-focused summer research programs at nine universities. They found differences in levels of comfort in relationships with mentors when comparing men and women. They found that women students expressed comfort in relationships with mentors who provided psychosocial mentoring, were available to answer questions, and were of the same gender; they expressed some social discomfort in informal interactions with mentors. Men

students felt comfortable with mentors who provided limited guidance, little psychosocial mentoring, and opportunities for informal interactions. In terms of peer relationships, women sought out the confidence of a few similar peers, while men were comfortable with a wide variety of peers.

Hurtado, Sylvia, Nolan L. Cabrera, Monica H. Lin, Lucy Arellano, and Lorelle L. Espinosa. "Diversifying Science: Underrepresented Student Experiences in Structured Research Programs." *Research in Higher Education* 50, no. 2 (2009): 189–214. <https://doi.org/10.1007/s11162-008-9114-7>.

This paper argues for the importance of UG research opportunities to keep students engaged in STEM. They state that "scholars consistently identify undergraduate research experiences as one way to attract and retain science majors, enhance the educational goals of science undergraduates, and serve as a pathway toward scientific careers." The study examines the effectiveness of these opportunities in engaging URM students to develop scientific career research goals. They conducted site visits and held student-level focus groups at the following institutions: Massachusetts Institute of Technology (MIT); University of Texas, San Antonio (UTSA); University of New Mexico (UNM); and Xavier University of Louisiana. They found that the students who had high degree of scientific identity that included a sense of competence, ability to perform, and recognition and were subsequently best positioned to be successful in science, who engaged in structured research programs either through engagement in research on campus, research in another institution, or research in industry were challenged and each success they experienced further reinforced their performance and competence as scientists. However, they also found that students across all the campuses also described a range of experiences with social stigma specifically associated with being a minority in science.

Monarrez, Angelica, Danielle Morales, Lourdes E. Echegoyen, Diego Seira, and Amy E. Wagler. "The Moderating Effect of Faculty Mentorship on Undergraduate Students' Summer Research Outcomes." *CBE—Life Sciences Education* 19, no. 4 (December 1, 2020): ar56. <https://doi.org/10.1187/cbe.20-04-0081>.

This study focused on undergraduate summer research experiences by examining the results of a single program. They found that faculty mentorship was a contributing factor to student success in the program.

Pender, Matea, Dave E. Marcotte, Mariano R. Sto. Domingo, and Kenneth I. Maton. "The STEM Pipeline: The Role of Summer Research Experience in Minority Students Ph.D. Aspirations." *Education Policy Analysis Archives* 18, no. 30 (December 2010): 1–36. <https://stanford.idm.oclc.org/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=eft&AN=508134693&site=ehost-live&scope=site>.

This study focuses on the Meyerhoff Scholarship Program, which provides students with an apprentice-style summer research internships (SRI), to understand the role of these opportunities on URM students' doctoral aspirations. They compared a sample of 452 students in the program, looking at the difference between those who participated in the research experience and those who did not. Their findings suggest that research experiences encourage participation in Ph.D. programs in STEM fields, and this relationship is stronger for those students who participate in research experiences for more than two summers compared to students who do not engage in research experiences.

Rodríguez Amaya, Laura, Tania Betancourt, Kristina Henry Collins, Orlando Hinojosa, and Carlos Corona. "Undergraduate Research Experiences: Mentoring, Awareness, and Perceptions—a Case Study at a Hispanic-Serving Institution." *International Journal of STEM Education* 5, no. 1 (April 2, 2018): 9. <https://doi.org/10.1186/s40594-018-0105-8>.

This study was about the impact of research experiences on 35 undergraduate students at a Hispanic-serving institution (HSI). They found that classification and ethnicity were the strongest predictors of participating in UREs. They found that first-gen and Latinx students were aware of opportunities, but there was no statistical significance by gender. Students did express misconceptions about reasons to participate in UREs and were unable to find mentors.

Rorrer, Audrey, Breana Spencer, Sloan Davis, Sepi Hejazi Moghadam, Deborah Holmes, and Cori Grainger. "Understanding Immersive Research Experiences That Build Community, Equity, and Inclusion." In Proceedings of the 52nd ACM Technical Symposium on Computer Science Education, 149–155. SIGCSE '21. Virtual Event, USA: Association for Computing Machinery, 2021. <https://doi.org/10.1145/3408877.3432523>.

This study specifically examines CS research experiences looking at how Google's exploreCSR encourages pursuit of graduate education for undergraduate women. They examine this intervention across 29 institutions, with 1,983 mostly female students. The intervention provides funding, evaluation, and a community of practice to faculty who design and execute research-focused workshops throughout the academic year that expose undergraduates who identify as AAHN and/or women to CS research methodologies, career pathways, and exploratory problems focusing on UG research and collaborative learning. They found that students prefer direct experiences in research over formal faculty talks about research, the value of near peer support, and access to faculty.

Tamer, Burçin, and Jane G. Stout. "Understanding How Research Experiences for Undergraduate Students May Foster Diversity in the Professoriate." In Proceedings of the 47th ACM Technical Symposium on Computing Science Education, 114–119. SIGCSE '16. Memphis, Tennessee, USA: Association for Computing Machinery, 2016. <https://doi.org/10.1145/2839509.2844573>.

This study is focused on increasing URM and women's interest in computer science through increasing engagement of URM and women in faculty positions. The study focused on 101 students who participated in a structured summer REU at one university. The study found that for URM and women students specifically, REUs where students that experienced greater collaboration, learned more about the social impacts of a career in computing, learned more about the graduate school admissions process, and became more familiar with graduate student life during their REU showed greater interest in becoming a computing professor.

Whittington, Dawayne, Latricia E. Wallace, and Cherilynn R. Shadding. "Proxies for Success: How the Application Process Correlates to PhD Pursuit for a Small Diversity Research Program." *SAGE Open* 7, no. 3 (July 1, 2017): 2158244017727040. <https://doi.org/10.1177/2158244017727040>.

This study evaluates the success of two different Opportunities in Genomics Research (OGR) at the National Human Genome Research Institute (NHGRI), 1) Undergraduate Scholars (OGR-US) an 8-week summer program and 2) Extensive Study (OGR-ES) a 1-year, postbacc program for

recent college graduates. Both programs include independent research with investigators and activities directed toward graduate school readiness and STEM career success. This study focused on the application process for participation to better understand how changes in the process shapes the outcomes of interest of students interested in doctoral degrees.

Willis, David A., Paul S. Krueger, and Alice Kendrick. "The Influence of a Research Experiences for Undergraduates Program on Student Perceptions and Desire to Attend Graduate School." *Journal of STEM Education: Innovations and Research* 14, no. 2 (March 26, 2013).

<https://www.jstem.org/jstem/index.php/JSTEM/article/view/1717>.

This study evaluates an eight-week Research Experiences for Undergraduates (REU) program in the Department of Mechanical Engineering at Southern Methodist University to determine how the program influenced participants' perceptions of engineering research and their desire to attend graduate school. Using pre/post measurements on 26 participants, they found that while students increased their knowledge of engineering and skills, they decreased their desire to attend graduate school.