

Board 215: Building Capacity as an Engineering Education Researcher: First-Year Progress of an NSF ECR: BC SER Grant

Dr. Lizandra C Godwin, University of New Mexico

Dr. Lizandra C. Godwin is an assistant professor in the Electrical and Computer Engineering Department at the University of New Mexico. Her research focuses on materials development (metals, dielectrics, phosphors) for advanced manufacturing processes, process optimization for microelectronic devices, biomaterials, and broadening participation in engineering through engineering education research. The focus of her inclusive, multi-disciplinary lab is to create material solutions for a more sustainable and earth conscious future. Dr. Godwin earned her M.S. and Ph.D. degrees in Materials Science and Engineering from the University of Florida where she focused on phosphor development and degradation. Her B.S. is in Mechanical Engineering from Florida Agricultural and Mechanical University. In addition to her academic experience, Lizandra has worked for many companies including Intel Corp. and The National Aeronautics and Space Administration.

Building Capacity as an Engineering Education Researcher: First-Year Progress of an NSF ECR: BCSER Grant

Abstract

This paper summarizes the first-year progress made on a research grant funded through the National Science Foundation EDU Core Research: Building Capacity in STEM Education Research (ECR: BCSER) program. The research activity has two primary objectives. Those objectives are: (1) address the underrepresentation of Latinas in graduate engineering programs, and (2) establish an engineering education research program that focuses on the fundamental research of the experiences and support systems that foster the success of diverse students in engineering. The first objective will be investigated through a mixed-methods research approach. The second objective will be supported through specific activities that build the principal investigator's capacity to mentor and sustain a research group focused on fundamental engineering education research. This research that delves into the undergraduate interest of graduate engineering programs and their identity as a researcher would illuminate strategies for addressing the underrepresentation of Latinas in national Ph.D. programs. This paper provides the details on the initial research results, accomplishments, and next steps for the research project.

Introduction

The racial and ethnic demographics of the United States is changing, as the percentage of minority groups continue to increase [1], [2], [3]. Consequently, fundamental research that informs our institutions of higher education on how to support the success of a diverse student population has become a national priority. This is especially necessary in science, technology, engineering, and mathematics (STEM) fields, where diverse populations are underrepresented [4], [5], [6]. The author is currently an assistant professor in Electrical and Computer Engineering at the University of New Mexico- a Hispanic Serving Institution (HSI), where the enrollment numbers in engineering became the basis for this research study. The University of New Mexico is located in Albuquerque, New Mexico, Southwest United States. As recently as the 2022- 2023 academic year, only 8% of all students that earned a bachelor's degrees in the School of Engineering identified as a Latina [7]. Further, in the same academic year, there were no Latinas that graduated with a Ph.D. from any of the 10 Ph.D. programs within the UNM School of Engineering [7], despite the institution's HSI and R1 research activity classifications [8]. Nationally, the statistics are dreadfully similar. For degrees awarded between July 1, 2020 and June 30, 2022, only 1% of the doctoral degrees in engineering were awarded to Latinas [9].

These statistics led the author to submit a research proposal to the National Science Foundation EDU Core Research: Building Capacity in STEM Education Research (ECR: BCSER) program. While she always supported programs that encouraged diversity in engineering, she identified the BCSER program as an opportunity to take an active role in understanding the issues surrounding broadening participation in engineering. The objective of the ECR: BCSER program is to build a researcher's capacity and expertise in STEM education research [10]. The author's proposal titled "*An Individual Investigator*

Development Plan for Building Capacity to Study Undergraduate Latinas Interest in Graduate School” was selected for funding.

Project Approach

This NSF project incorporates capacity building through the “4 steps to Growth in Engineering Education Research” depicted in Figure 1. These steps were designed to strengthen the author’s capacity to carry out fundamental engineering education research (EER). The proposed strategy starts with Step 1: Knowledge Building. The knowledge building step outlined opportunities to gain knowledge through both formal and informal learning opportunities. As an investigator without formal engineering education training, it was important to ensure there was an adequate opportunity to engage in both short and longer duration workshops. Step 2 of the process outlined training of research protocols, necessary to steps to facilitate ethical and scientifically sound education research. Steps 1 and 2 provide the foundation and preparation for Step 3: Research Initiation of the pilot project. The pilot research project would start to understand the problem outlined in the introduction. Finally, by Step 4, the initiated research would become a catalyst for additional topics of engineering education research that examines fundamental research questions related to broadening participation in graduate engineering programs.



Figure 1: Capacity Building Plan: 4 steps to Growth in Engineering Education Research

The first phase of the pilot study focused on the following research question:

RQ: How do Latinas’ perceptions about graduate school differ, depending on their undergraduate classification, socioeconomic status, and first- versus continuing-generation status?

Research Methods/ Discussion

The principal investigator began her knowledge building by applying to the NSF funded Quantitative Research Methods (QRM) for STEM Education Scholars Program, led by scholars from the University of Maryland's Department of Human Development and Quantitative Methodology. The NSF QRM Scholars Program pairs education researchers with quantitative mentors to help researchers develop their skills in design, measurement, and analysis by offering a year-long training agenda that includes an institute on fundamental quantitative methodology and access to quantitative expertise through an assigned mentor [21]. The institute focused specifically on the data analysis skills, measurement issues, and design principles most applicable to STEM education researchers. As a result, the PI was able to apply what she learned in the program to the design and development of the initial phase of the pilot study.

Utilizing the skills learned during the QRM Scholars program, the pilot study began with an initial survey instrument that was developed, validated, and administered in all first-year engineering courses over 2 semesters at a research-intensive Hispanic serving institution. In total, 435 participants completed the survey over the 2 semesters. The next steps include using a principal component analysis on the ordinal data.

To support the pilot study research, we examined relevant frameworks in the literature. We determined that the LatCrit [22], [23], [24] and community cultural wealth [24], [25], [26], [27], [28] frameworks were most appropriate for the developing study.

Next Steps

The initial research results will be used to develop the qualitative methods for the second phase of the research project.

Further, the PI will continue to advance her engineering education research capacity by participating in additional workshops, such as the Modern Meta-Analysis Research Institute.

Acknowledgement

This material is based upon work supported by the National Science Foundation under NSF Grant Number 2225399. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

Bibliography

- [1] United States Census Bureau, "The Chance That Two People Chosen at Random Are of Different Race or Ethnicity Groups Has Increased Since 2010," Census.gov. Accessed: Feb. 19, 2024. [Online]. Available: <https://www.census.gov/library/stories/2021/08/2020-united-states-population-more-racially-ethnically-diverse-than-2010.html>
- [2] National Academies of Sciences, *Barriers and Opportunities for 2-Year and 4-Year STEM Degrees: Systemic Change to Support Students' Diverse Pathways*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/21739>, 2016.

- [3] Jonathan Vespa, Lauren Medina, and David M. Armstrong, “Demographic Turning Points for the United States: Population Projections for 2020 to 2060,” in *Current Population Reports*, Washington, DC.: United States Census Bureau, 2020, pp. 25–1144.
- [4] M. L. Miles, C. A. Agger, R. S. Roby, and T. R. Morton, “Who’s who: How ‘women of color’ are (or are not) represented in STEM education research,” *Science Education*, vol. 106, no. 2, pp. 229–256, 2022, doi: 10.1002/sc.21694.
- [5] “Diversity and STEM: Women, Minorities, and Persons with Disabilities 2023 | NSF - National Science Foundation.” Accessed: Feb. 19, 2024. [Online]. Available: <https://nces.nsf.gov/pubs/nsf23315/report>
- [6] R. F. Funk Brian Kennedy and Cary, “STEM Jobs See Uneven Progress in Increasing Gender, Racial and Ethnic Diversity,” Pew Research Center Science & Society. Accessed: Feb. 19, 2024. [Online]. Available: <https://www.pewresearch.org/science/2021/04/01/stem-jobs-see-uneven-progress-in-increasing-gender-racial-and-ethnic-diversity/>
- [7] UNM School of Engineering, “Enrollment and Graduation Data :: School of Engineering | The University of New Mexico.” Accessed: May 01, 2024. [Online]. Available: <https://engineering.unm.edu/about/enrollment-and-graduation-data.html>
- [8] NASA Minority Serving Institutions Exchange, “Institutions 1-18 of 18 Whose Carnegie Classification Description is Doctoral Universities: Very High Research Activity, Active is true and Category is Hispanic-Serving Institution Sorted By Name in Ascending Order - Minority Serving Institutions Exchange.” Accessed: May 01, 2024. [Online]. Available: https://msiexchange.nasa.gov/institutions?c%5B0%5D=name&c%5B1%5D=city&c%5B2%5D=state&c%5B3%5D=hasAttachment&i=25&p=1&f=html&q%5B0%5D=carnegieClassification_description&q%5B1%5D=active&q%5B2%5D=categories_name&q%5B0%5D=is&q%5B1%5D=is&q%5B2%5D=is&qv%5B0%5D=Doctoral%20Universities:%20Very%20High%20Research%20Activity&qv%5B1%5D=1&qv%5B2%5D=Hispanic-Serving%20Institution&b=name&o=ASC
- [9] American Society for Engineering Education, “ASEE 2022 Edition: Engineering and Engineering Technology By the Numbers,” Washington, DC, 2023.
- [10] “NSF 22-548: EHR Core Research: Building Capacity in STEM Education Research (ECR: BCSER) | NSF - National Science Foundation.” Accessed: May 01, 2024. [Online]. Available: <https://new.nsf.gov/funding/opportunities/ehr-core-research-building-capacity-stem-education/nsf22-548/solicitation>
- [11] S. C. Davis, S. B. Nolen, N. Cheon, E. Moise, and E. W. Hamilton, “Engineering climate for marginalized groups: Connections to peer relations and engineering identity,” *Journal of Engineering Education*, vol. 112, no. 2, pp. 284–315, 2023, doi: 10.1002/jee.20515.
- [12] H. B. Carlone and A. Johnson, “Understanding the science experiences of successful women of color: Science identity as an analytic lens,” *Journal of Research in Science Teaching*, vol. 44, no. 8, pp. 1187–1218, 2007, doi: 10.1002/tea.20237.
- [13] C. J. Faber, R. L. Kajfez, D. M. Lee, L. C. Benson, M. S. Kennedy, and E. G. Creamer, “A grounded theory model of the dynamics of undergraduate engineering students’ researcher identity and epistemic thinking,” *J Res Sci Teach*, vol. 59, no. 4, pp. 529–560, Apr. 2022, doi: 10.1002/tea.21736.
- [14] H. C. Contreras Aguirre, E. Gonzalez, and R. M. Banda, “Latina college students’ experiences in STEM at Hispanic-Serving Institutions: framed within Latino critical race theory,” *International Journal of Qualitative Studies in Education*, vol. 33, no. 8, pp. 810–823, Sep. 2020, doi: 10.1080/09518398.2020.1751894.

- [15] Dina Verdín and Allison Godwin, “Exploring latina first-generation college students’ multiple identities, self-efficacy, and institutional integration to inform achievement in engineering,” *Journal of Women and Minorities in Science and Engineering*, vol. 24, no. 3, 2018.
- [16] S. L. Rodriguez, E. E. Doran, M. Sissel, and N. Estes, “Becoming La Ingeniera: Examining the Engineering Identity Development of Undergraduate Latina Students,” *Journal of Latinos & Education*, vol. 21, no. 2, pp. 181–200, 2022, doi: 10.1080/15348431.2019.1648269.
- [17] M. R. Kendall, M. Denton, N. H. Choe, L. M. Procter, and M. Borrego, “Factors Influencing Engineering Identity Development of Latinx Students,” *IEEE Transactions on Education*, vol. 62, no. 3, pp. 173–180, Aug. 2019, doi: 10.1109/TE.2019.2909857.
- [18] E. Litzler and J. Lorah, “Degree aspirations of undergraduate engineering students at the intersection of race/ethnicity and gender,” *Journal of Women and Minorities in Science and Engineering*, vol. 24, no. 2, 2018, Accessed: Feb. 19, 2024. [Online]. Available: <https://www.dl.begellhouse.com/journals/00551c876cc2f027,4c37811e62eac771,359bf18817ac4bed.html>
- [19] L. N. Fleming, S. E. Burris, K. C. Smith, L. B. Bliss, I. N. Moore, and F. Bornmann, “Beyond persistence: Graduate school aspirations of Hispanic engineering students at HSIs,” in *2014 ASEE Annual Conference & Exposition*, 2014, pp. 24–228. Accessed: Feb. 19, 2024. [Online]. Available: <https://peer.asee.org/beyond-persistence-graduate-school-aspirations-of-hispanic-engineering-students-at-hsis>
- [20] M. G. Cuellar and A. M. Gonzalez, “Beyond the Baccalaureate: Factors Shaping Latina/o Graduate Degree Aspirations,” *Journal of Hispanic Higher Education*, vol. 20, no. 1, pp. 59–74, Jan. 2021, doi: 10.1177/1538192719830082.
- [21] “NSF QRM Scholars Program | UMD College of Education.” Accessed: Feb. 20, 2024. [Online]. Available: <https://education.umd.edu/academics/departments/hdqm/research/nsf-qrm-scholars-program>
- [22] C. Peralta, M. Caspary, and D. Boothe, “Success factors impacting Latina/o persistence in higher education leading to STEM opportunities,” *Cultural Studies of Science Education*, vol. 8, no. 4, pp. 905–918, Dec. 2013, doi: 10.1007/s11422-013-9520-9.
- [23] D. Gutierrez, C. Gonzalez, and G. Seshadri, “We are the unicorns: Exploring experiences of Latina graduate women utilizing an intersectional Latino/a critical theory framework,” *Peace and Conflict: Journal of Peace Psychology*, vol. 28, no. 1, pp. 130–139, Feb. 2022, doi: 10.1037/pac0000595.
- [24] T. Yosso, W. Smith, M. Ceja, and D. Solórzano, “Critical Race Theory, Racial Microaggressions, and Campus Racial Climate for Latina/o Undergraduates,” *Harvard Educational Review*, vol. 79, no. 4, pp. 659–691, Dec. 2009, doi: 10.17763/haer.79.4.m6867014157m707l.
- [25] T. Yosso and R. Burciaga, “Reclaiming our histories, recovering community cultural wealth,” *Center for Critical Race Studies at UCLA Research Brief*, vol. 5, 2016.
- [26] M. Denton, M. Borrego, and A. Boklage, “Community cultural wealth in science, technology, engineering, and mathematics education: A systematic review,” *Journal of Engineering Education*, vol. 109, no. 3, pp. 556–580, 2020, doi: 10.1002/jee.20322.
- [27] J.-P. Nuria, O. Maria, S. Christina, and M.-G. Audrey, “Women of Color Leveraging Community Cultural Wealth to Persist in Computing and Tech Graduate Education: A

Qualitative Meta-Synthesis,” *Education Sciences*, vol. 11, no. 797, pp. 797–797, 01 2021, doi: 10.3390/educsci11120797.

- [28] B. L. McGowan and D. Pérez, “ 'A Community Built Just for Me': Black Undergraduate Men Bridging Gaps to Community Cultural Wealth,” *Journal of the First-Year Experience & Students in Transition*, vol. 32, no. 1, pp. 43–57, 2020.