

Broadening Participation in Engineering Track 2: The PROMISE Engineering Institute Mentor Academy – NSF EEC #2233683

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Dr. Robin Cresiski serves as the Associate Vice Provost for Graduate Student Development and Postdoctoral Affairs, as well as Affiliate Professor in Biology, at the University of Maryland Baltimore County (UMBC). She has directed and co-led numerous grant-funded programs to help broaden participation in graduate education and the professoriate. Prior to her current role at UMBC she has been a tenured faculty member, a faculty senate chair, department chair, interim provost and run a faculty development center.

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Dr. Lewis (she/her/hers) serves as Chief Strategy Officer in Inclusive Excellence at the University of California, Davis (UC Davis), leading initiatives and projects that advance the campus Inclusive Excellence strategic goals. In this role, Dr. Lewis focuses on developing and implementing approaches that centralize and align institutional initiatives and partnerships related to recruitment, retention, and advancement programs and interventions that connect to issues of inclusive excellence. Within Inclusive Excellence, Dr. Lewis also oversees the Institute for Dissemination, Engagement, and Access (IDEA) which focuses on amplifying higher education research by ensuring that evidence-based insights reach the audiences who can put them into practice. The IDEA also showcases promising practices that can be replicated and scaled to advance learning and achievement for scholars at all levels.

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Elaina Lopez is a Program Analyst at Inclusive Excellence at the University of California, Davis. She supports grant-funded programs that advance student access, success in higher education, and the education-to-workforce pipeline.

Dr. Renetta Garrison Tull, University of California, Davis

Renetta Garrison Tull, Ph.D., is the Vice Chancellor for Inclusive Excellence at the University of California Davis, and she is a past convenor for the University of California's system-wide (10 campus) Council of Vice Chancellors for Equity and Inclusion. Tull's undergraduate and doctoral degrees in electrical engineering and speech science are from Howard University and Northwestern University, respectively. She has had past faculty roles at UW-Madison, the University of Maryland College Park, and UMBC. At UC Davis, she is an Adjunct Professor in the Department of Electrical and Computer Engineering in the College of Engineering, and a faculty affiliate in the Interdepartmental Program on Human Rights Studies. As Vice Chancellor, her divisional portfolio includes the Davis-based Office of Campus Community Relations, and the Office for Advancing Mentoring and the Professoriate. The Sacramento headquarters houses the Office for Health Equity by Design for Inclusive Excellence, serving the medical school,

nursing school, and medical center. Inclusive Excellence also covers medical clinics around California, and UC Davis' locations in the Bay Area and other parts of the state. Her portfolio also includes the Avanza initiative; the Police Accountability Board; the Center for Reducing Health Disparities; the Center for the Advancement of Multicultural Perspectives on Science; the Center for the Advancement of Multicultural Perspectives on Social Sciences, Arts, and the Humanities; and the Truth, Community Healing, and Transformation Center. She credits the success of Inclusive Excellence to talented teams and a supportive university environment. She is proud to be the Executive Sponsor for the UC Davis Principles of Community university-wide campus climate campaign, which highlights the key phrase, "We affirm the dignity inherent in all of us."

Before joining UC Davis in California, Tull was in Maryland at the University of Maryland Baltimore County (UMBC) and served as Assistant Dean for Graduate Student Development (GSD), Associate Vice Provost for GSD and Postdoctoral Affairs, and Associate Vice Provost for Strategic Initiatives. She later had a detail with the University System of Maryland (USM, 12 institutions), serving as the Director for USM Pipeline Professional Development Programs, and she had Co-PI and PI roles on National Science Foundation (NSF) grants within the LSAMP, Alliances for Graduate Education and the Professoriate, and ADVANCE programs. At Davis, she is PI for the NSF-funded PROMISE Engineering Institute (PEI - UC Davis and UMBC). PEI has developed an intergenerational mentoring engineering leadership network which has engaged engineering graduate students and senior leaders from UC Davis, UMBC, UC Irvine, UC Berkeley, UCLA, Stanford, University of Maryland College Park, Virginia State University, Rice University, George Mason University, and North Carolina A&T.

An international speaker on global inclusion in STEM, Dr. Tull, a member of Tau Beta Pi, has shared Humanitarian Engineering principles and work connected to the United Nations' Sustainable Development Goals at the United Nations Headquarters, and on every continent (except Antarctica). Through the Latin and Caribbean Consortium for Engineering Institutions (LACCEI), she has given bilingual talks across Latin America on topics related to engineering for all.

Tull was a finalist for the Global Engineering Deans Council/Airbus Diversity Award (announced in Italy and acknowledged in Dubai). In addition, she has received the ABET Claire L. Felbinger Award for Diversity, the Student Platform for Engineering Education Development Global Mentoring Award, and the Electrical and Computer Engineering Department Head Association's (ECEDHA) Diversity Award. She was a PI for Puerto Rico's ADVANCE Hispanic Women in STEM, she is the past President for LACCEI, and the current Vice President of Transformative Initiatives for the International Federation of Engineering Education Societies (IFEES). Tull is currently leading the "Alianza" project for LACCEI in partnership with the Organization of American States; she sits on the Board of Directors of the American Geophysical Union (AGU), one of the world's largest Earth and space science organizations; and recently, she has been invited to serve on engineering expert teams in Chile and China. Tull was a co-author for UNESCO Engineering Report II, and she participated in the UN Women CSW66 side event on "Role of Women in STEM in Addressing Climate Change" where she joined global leaders on the importance of women in engineering for climate action, disaster risk reduction, and sustainable development. She is an author of a chapter of "Rising to the Top," an IFEES book on global women in engineering, and was a co-author for the National Academies' "Impact of COVID-19 on the Careers of Women in Academic STEM," and "The Science of Effective Mentoring in STEM." She is also co-author for the "Matilda y las Mujeres en Ingeniería" series, and her book chapter with a collaborative team of authors from several continents, "Models for International Collaborations to Nurture Students into Global Engineers," in the Springer book, "Academic Leadership in Engineering Education: Learnings and Case Studies from Educational Leaders Around the Globe," was launched in Australia. Tull enjoys her work as a global education policy strategist and champion for equity. She often travels with her husband of more than 30 years, Dr. Damon Tull, with whom she collaborates on work such as "The Success Equation," and "Dark Matters: Metaphorical Black Holes..." which creatively couples math, physics, and social science.

Dr. Janet C. Rutledge, University of Maryland Baltimore County

Dr. Janet C. Rutledge is Dean Emerita of the Graduate School at the University of Maryland, Baltimore County (UMBC) where she was also a faculty member in the Computer Science and Electrical Engineering

Department. She is currently serving as Dean-in-Residence at the Council of Graduate Schools (CGS). She has been a PI or co-PI on over \$25 million dollars in grant funding supporting research and education and has a national reputation for programs that promote inclusive excellence in graduate education. Rutledge serves on the Rensselaer Polytechnic Institute Board of Trustees. She formerly served on the Sloan Foundation Minority Ph.D. Program Advisory Committee, the CGS Board of Directors, and the GRE Advisory Board (serving as Chair 2017-18).

Dr. Maria C Sanchez, University of Maryland Baltimore County

Dr. Maria C. Sanchez is currently serving as the Director of the Engineering and Computing Education Program (ECEP) in the College of Engineering and Information Technology at the University of Maryland, Baltimore County. She obtained her B.S. degree from La Universidad de Los Andes in Bogotá, Colombia and her M.S. and Ph. D. in Mechanical Engineering from Virginia Polytechnic University in Blacksburg, Virginia. She has held faculty positions at California State University, Fresno (CSUF), University of Maryland, Baltimore County (UMBC) and University of Maryland, College Park (UMCP). She also served as Project Coordinator of the t-STEM Initiative, funded by the Bill and Melinda Gates Foundation, at UMBC. She is actively engaged in research and program development in the areas of Engineering for Social Change, increasing the accessibility of STEM education to under-represented groups, social responsibility thinking, and accreditation activities. Her technical interests are in the areas of Thermodynamics, Heat Transfer, and Energy Systems.

Mrs. Yarazeth Medina, University of Maryland Baltimore County

Assistant Director of Graduate Student Development and Postdoctoral Affairs with extensive experience in student recruitment, retention, and success initiatives in higher education, particularly for graduate students and postdoctoral scholars. Her work centers on advancing equitable access and outcomes in STEM, with a strong focus on supporting historically excluded populations, including first-generation students and women in science. She designs and delivers programs in career exploration, academic preparation, and professional development, with an emphasis on pathways to academic and research careers. She also brings expertise in grant budget development, administration, and financial oversight, having managed multi-institutional NSF-funded initiatives such as PROMISE AGEF, LSAMP, and RISE UPP INCLUDES, as well as national collaborations like the PROMISE Engineering Institute.

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Abstract

This paper describes the Broadening Participation in Engineering Track 2 program: the PROMISE Engineering Institute Mentor Academy (PEI-MA) supported by the National Science Foundation (NSF) EEC Award #2233683. PEI-MA aimed to develop future academic leaders by training engineering PhD students in core skills related to engineering excellence and leadership. This initiative addresses the persistently low levels of faculty positions and leadership roles in academia and industry for historically marginalized individuals. The main research question — “How does the development of a generational engineering leadership identity factor into PhD persistence toward a faculty and higher education leadership track?” — was explored using qualitative methods. The project had two goals: designing and piloting a Leadership Model for doctoral engineering scholars emphasizing community, skills-building, and networking; and expanding Mentorship in Engineering models with proven success. The project was externally evaluated, and the results are being disseminated to scale the model across various STEM fields, thereby strengthening the pipeline of future engineering academic leaders who will reach executive administration levels. Research shows that mentoring is crucial for degree completion, workforce entry, and career advancement in STEM fields. The PEI-MA introduced a new component: it offered one-on-one mentoring with current and former university presidents who are also engineers. Mentees, in turn, are expected to serve as mentors to nurture the next generation and grow the pool of leaders. The project also proposed innovative methods for building professional networks to adapt to the permanent shifts in work and education caused by the COVID pandemic, including in-person, hybrid, and virtual interactions. Key project activities include: 1) a three-day in-person leadership conference; 2) ongoing virtual engagement with mentor presidents; 3) networking sessions at national engineering conferences; and 4) a two-day workshop focused on higher education academic and career success. Activities #1, #2, and #3 are entirely new and complement Activity #4, which already existed. Several program activities were opened to larger audiences to extend reach beyond the cohorts.

Descriptive statistics of post-activity surveys and thematic content analysis of focus group interviews were used to further understand Fellows' experiences. Participants strongly agreed that the program content increased their awareness of careers and leadership, clarifying the pathway to becoming a faculty member and academic leader. Access to senior academy leaders and meaningful interactions with mentors and PEI program leadership were consistently highlighted as the most beneficial aspects of the program. They also valued the diversity of perspectives and experiences shared through various workshops and speaking engagements. The feedback from participants showed that the methods used by the PEI-MA project helped achieve its goal of strengthening the pipeline of future academic leaders.

Background

Decades of effort and intervention to diversify the STEM professoriate have yielded mixed results. Numerous interventions have increased historically marginalized student participation and success in doctoral degree completion [1], [2], [3], [4], such that scholars of color are an increasing proportion of doctoral degree completers [5]. However, the percentage of faculty of

color in tenure-track positions has increased incrementally since 2002 for Asian and Hispanic/Latinx scholars, but has been depressingly stagnant for Black scholars until a very recent uptick in the assistant professor ranks [6]. The sustained underrepresentation of minoritized faculty carries into university leadership as well. In 2021, a study revealed that of top university earners – which includes presidents, provosts, faculty, chancellors, and even athletic coaches- only 4.3% of top earners were Black, and 3.9% Hispanic/Latinx [7]. However, there has been some notable growth in the diversity of academic leaders in recent years. For example, in 2011, 87% of university presidents were White, 5.9% were Black, and 3.8% were Hispanic/Latinx, which shifted significantly in the next decade, such that by 2022, 72.7% of university presidents were White, 13.6 % were Black, and 5.8% were Hispanic/Latinx [8]. This creates a unique opportunity for today’s graduate students to be exposed to role models who reflect greater possibilities and to have mentors at the level of executive leadership [9]. There has not been significant research on how to prepare, motivate, and train historically marginalized students for *leadership excellence* and a sustained career in academia and university leadership, which led the authors to develop a program, the PROMISE Engineering Institute Mentor Academy, that capitalizes on this moment to connect graduate students with university leaders.

Program Description

The PROMISE Engineering Institute Mentor Academy (PEI-MA) is an NSF-funded bi-coastal collaboration between the University of California, Davis (UCD) and the University of Maryland, Baltimore County (UMBC) designed to cultivate future academic leaders by equipping engineering and computing PhD students with strong foundations in engineering excellence (innovation, scholarship, networking) and leadership (envisioning, academic structures, mentoring) [10], [11]. To address the main research question — “How does the development of a generational engineering leadership identity factor into PhD persistence toward a faculty and higher education leadership track?”— the PEI-MA intervention focuses on exposure (of doctoral students to university leaders of color), mentorship (from program staff as well as directly with university presidents), and cohort programming (to build peer networks and belonging that is sustained). These program attributes were selected because of strong literature supporting them as critical to doctoral student success and leadership development [12], [13]. For example, Arday reports that the lack of visibility of (and subsequent access to) current Black and ethnic minority leaders in higher education is a barrier for entry of younger Black and ethnic minority scholars into leadership positions [14]. This lack of role modeling is exacerbated by the consistent reporting from underrepresented doctoral scholars that they experience a lack of supportive mentoring as a challenge to their academic success [15], [16]. Notably, on the other side of the coin, quality mentoring has been shown to improve doctoral student well-being and metrics of productivity and success [10], [17]. Finally, the PEI-MA builds on the nearly 20 years of experience of the PROMISE program in building cohorts of graduate students who act as third-space communities connected to student belonging and success [18].

Objectives

The project aims to achieve two goals: 1. Design and pilot a leadership model for doctoral students that prioritizes community, skills building, and networking; and, 2. Expand a successful

engineering mentorship model by adding program evaluation and dissemination to allow scalability of the model to any STEM field. A distinctive feature of this project is its unique approach of connecting scholars with current and former university presidents at professional conferences, workshops, and online mentoring sessions.

Research Design

To understand and assess the impact of intergenerational mentoring on doctoral student persistence, the current study utilized descriptive statistics of post-activity surveys and thematic content analysis of focus group interviews. The descriptive statistics examined differences between the baseline survey from the PEI-MA orientation and various post-activity surveys collected after core activities organized by the PEI-MA. The core activities included workshops and networking meetings at in-person professional conferences throughout the grant term. The survey asked questions across four broad areas: students' career goals, leadership identity, engineering identity, and sense of belonging. Additional questions asked about the programmatic aspect of the academy, mentoring, and other perceived benefits of participation. While all Fellows were asked to complete the baseline survey during the orientation, the post-conference surveys were voluntary. As such, the resulting descriptive data included 16 responses from Cohort 1 and 8 responses from Cohort 2. To further investigate the impact of PEI-MA for Cohort 1, the researchers compared baseline survey data from May 2024 and December 2024 surveys ($n = 7$). Notable differences among respondents across the four aforementioned areas—career goals, leadership identity, engineering identity, and sense of belonging—guided the questions for the focus group interviews in January 2025.

Focus group interviews were conducted in January 2025 to gain rich perspectives from doctoral students' experiences. The interviews were conducted over two days in January 2025, with each session lasting about an hour, and used a semi-structured design comprising additional questions for clarification or elaboration. We chose focus group interviews over 1:1 interviews to elevate the synergetic and communicative aspects of focus group; by having other cohort members, the space would also create a safe, supportive space for idea generation and narrative sharing among participants. 9 out of 12 Fellows from Cohort 1 participated in the focus group interviews, during which the discussions centered around career aspirations, leadership development, highlights of the PEI-MA program, and recommendations for program enhancements. The focus group was audio-recorded, transcribed, and analyzed using thematic content analysis and inductive coding. Despite small numbers, the focus group offers valuable insights into Engineering students' experiences in mentorship, leadership development workshops, and networking opportunities that led to their anticipated career paths.

Results / Evaluation

Expanding the Intergenerational Mentoring Model

PEI-MA was established to provide Fellows with opportunities for intergenerational mentoring through engagement with university presidents and other academic leaders. Although initially conceptualized as exclusively one-on-one meetings with volunteer presidents, the PEI-MA Team

broadened its engagement model to foster meaningful interactions, accommodate leaders' schedules, and maximize Fellows' exposure to leaders. In addition to one-on-one meetings, PEI-MA hosted breakfasts at national conventions with university presidents and academic leaders, including deans, vice presidents, and associate deans. During the Summer Success Institute, a former president held individual meetings with mentees, attended the welcome dinner with all PEI-MA Fellows, and led a session on academic careers. Offering diverse engagement opportunities increased overall participation and helped address the primary challenge of limited leader availability. As an example, the PEI-MA Leadership Conference included a hybrid panel featuring University Presidents sharing their experiences and insights on mentorship (as mentors and mentees) and ways they cultivated their peer networks. Additionally, connecting these events to broader institutional activities reduced barriers typically associated with initiating new mentoring relationships. Interactions with presidents and other leaders made the experience less intimidating and created a more friendly environment. These expanded interactions still effectively fostered Fellows' vision of themselves as future faculty members. In response to an open-ended question about which activities were most impactful, one Fellow wrote about the breakfasts hosted at conferences:

"The breakfast and past breakfasts largely for the networking, but also because of great advice. It was great talking candidly and getting encouragement to become a faculty member, and I am now reconsidering what I want to do after I graduate. I'm reconsidering trying the faculty route, just need help figuring out what that will look like exactly."

Participant Impact and Identity Development

According to survey data, access to senior academic leaders and meaningful interactions with mentors and PEI program leadership were seen as the most valuable aspects of the program. The Fellows also appreciated the diversity of perspectives and experiences shared through various workshops and speaking engagements. Program elements consistently received high ratings in follow-up surveys. On a Likert scale from 1 (Strongly Disagree) to 5 (Strongly Agree), the relevance of the information was rated 4.80, and the sessions helping to deepen the Fellows' commitment to completing their degrees were rated 4.67. Being university leaders established a sense of credibility, so when the leaders openly shared their own journeys and the trials and challenges they had faced, it reinforced the idea that the Fellows could reach similar levels of success. The following quotes from Fellows highlight their key takeaways.

"It felt unprecedented to get such unfiltered feedback from such a high-ranking university official. I was most inspired by his confidence and his desire that we not give way to imposter syndrome. He stated 'do the best you can today, and do better tomorrow.'"

"Having a small workshop where we get to interact with a person who has held a presidential position is quite informative and helpful in understanding what it takes to hold such a position."

Strengthening Networking and Mentoring Skills

Specific focus was placed on developing "Mentor Maps" to help Fellows identify and organize their support systems. Follow-up surveys confirmed that these program elements strengthened

the Fellows' commitment to proactive networking. The diverse perspectives shared by leaders from various backgrounds—including deans and vice presidents from different R1 institutions—clarified the pathway to becoming a faculty member. 100% of the Fellows surveyed said that the PEI events strengthened their commitment to expanding their networking and mentoring skills.

“I greatly enjoyed listening to leaders who have worked their way to top positions. It felt great being in rooms where leaders were sharing their “secrets” to success. The mentor map activity was also very meaningful for me as it provided actionable guidance for creating my network.”

Students strongly agree that the program content has increased their awareness of careers and leadership and demystified the path to becoming a faculty member and academic leader.

Conclusions

PEI-MA established a structured intergenerational mentoring framework to combat the ongoing underrepresentation of individuals from historically underrepresented backgrounds in engineering faculty and leadership positions. Providing access to senior academic leaders, primarily university presidents with engineering backgrounds, helped demystify the pathway to becoming faculty members and leaders. Recognizing the busy schedules of university presidents, it was important to expand interactions beyond one-on-one meetings. Facilitating networking at conferences and the PEI-MA Leadership Conference helped overcome limited availability and foster meaningful interactions. Assigning specific mentees and setting clear expectations made it easier for presidents to manage their mentoring commitments. Preliminary qualitative results suggest that cultivating a generational engineering leadership identity positively impacts PhD students' perseverance in completing degrees and pursuing higher education leadership roles.

Future Plans

The focus of future plans is on ensuring sustainability and scalability. Future iterations of the program will emphasize data-driven deployment of tools (e.g., Mentor Maps and Legacy Statements) that Fellows found helpful. The PEI Team will monitor the career paths of the two Cohorts to assess short-, medium-, and long-term impacts on faculty appointments and leadership positions. The project will continue to explore innovative ways to facilitate networking and mentoring with senior academic leaders and to seek opportunities to apply this model in other STEM fields beyond engineering.

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