

**Expanding the Pathways to Science, Technology, Engineering, and Mathematics (STEM)
Education and Careers for Underrepresented Students: Emerging Excellence in Key
National Priorities**

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The Urban Education Collaborative
Department of Civil and Environmental Engineering
Department of Electrical and Computer Engineering
College of Engineering
Center for Science, Technology, Engineering, and Mathematics (STEM) Education
Department of Special Education
Department of Educational Leadership

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Target Category
Existing and Emerging Excellence

Keywords: *STEM, College Readiness, Underrepresented*

Executive Summary

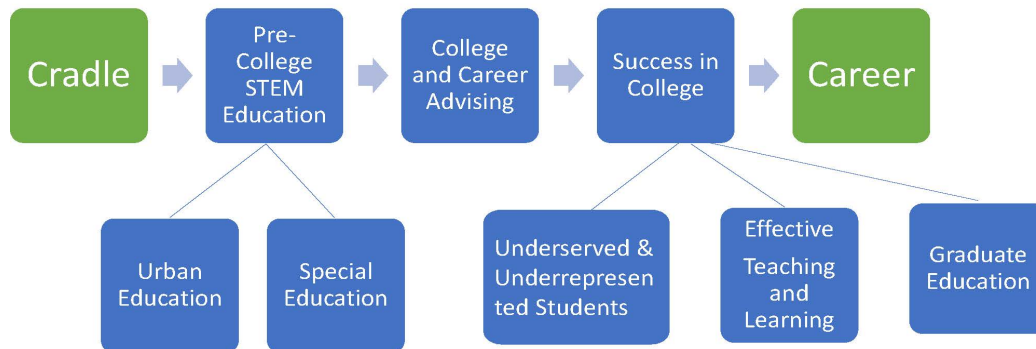
This core/thematic area broadens participation to new stakeholders in current Science, Technology, Engineering and Mathematics (STEM), supports federal, state and local priorities, and uniquely positions UNC Charlotte as a national leader and institution of excellence in this area. Most notable, this Emerging Area of Excellence Team of nationally and internationally recognized faculty provide evidence of new underrepresented populations (i.e., special education students, LGBTQ students, women and minoritized students) that must be considered for inclusion in emerging opportunities in STEM. As a result, our team of faculty have demonstrated an ongoing commitment to receiving external funding and expanding the knowledge-base in this emerging area of research that warrants greater collaboration across academic disciplines to fully address this national crisis.

To expand the future landscape of national priorities in STEM, it is inevitable that the definition of the stakeholders that will be encouraged to participate in this area will expand with the *significant financial commitment* of federal, state, local and foundation agencies. Future funding projections on broadening participation will open more opportunities for these stakeholders that have been traditionally excluded from STEM higher education and career opportunities. To align with these national priorities, our interdisciplinary team will be at the forefront of this national priority by expanding opportunities to special education students, LGBTQ students, women and minoritized students. By expanding these pathways to STEM fields and career opportunities, our interdisciplinary team will focus on four fundamental components for these stakeholders: (1) student success; (2) success of underrepresented students; (3) postsecondary transition; (4) pre-college preparation; and (5) graduate education. As a result, this proposal will position UNC Charlotte as a national leader in expanding pathways to STEM by positioning the university to receive significant external funding, to add to the increasing opportunities for these stakeholders, support doctoral student research, and add significant value to the existing knowledge base on this topic.

Our team of nationally and internationally recognized faculty has published 580 papers, received a total citation impact of 13,806 (Google Scholar), and received over \$7.5 million dollars in external funding. Additionally, our team has successfully chaired 66 completed dissertations and published 157 papers with students. This level of commitment is noteworthy given the need to provide more opportunities for the next generation of students to be able to have a pathway to careers that will position the United States as a global leader in the area of Science, Technology, Engineering and Mathematics (STEM).

Evidence of Strength and Excellence

This area of research excellence is focused on understanding the Pathway that students follow from cradle to careers in science, technology, engineering and mathematics. Although this type of research is underway at several prominent institutions in the US, this team is unique for being an interdisciplinary group that includes researchers of primary, secondary and post secondary student achievement in STEM fields. The team is also particularly interested in topics of equity and the goal of expanding opportunities for students from underrepresented and underserved populations. The team members are highly focused on action research built around engagement with the regional community of public school districts, community-based organizations and directly with students. The degree of community engagement in our approach to STEM education research has differentiated us from many other research teams in the US. The capacity for outreach has enabled the team to seek funding from an extremely broad variety of sources, including institutional funds, private foundations, and state and local grant makers, in addition to federal agencies. The following visual encompasses the depth and breadth of the team's expertise and the ability to synergize our collective work to achieve local, regional, and national priorities.



The team members have achieved national excellence in research and received external funding to improve: (1) student success; (2) success of underrepresented students; (3) postsecondary transition and (4) pre-college preparation; and (5) graduate education. The strength of each collaborator is illustrated by the impactful and sustained activities related to this proposal. Dr. Foxx has published 40 papers with 440 citations (Google Scholar) and received over \$2 million in external funding from the National Science Foundation (NSF) and Office of Special Education (OSEP). Due to her work on college and career readiness, she was invited two Reach Higher White House Convenings. Dr. Lewis has published 117 research articles with over 5,657 citations (Google Scholar) and received over \$7 million in external funding, including multiple invitations to participate in White House and U.S. Department of Education initiatives on expanding opportunities in STEM fields for underrepresented students. Dr. Tempest has published 17 papers with 257 citation impacts (Google Scholar) and received \$2,299,527 in external funding. Dr. Galloway has received \$1.2 million in funding from the NSF and is currently leading several STEM research projects with three of the team members. Dr. Blat has published 14 articles with Google Scholar citation impact of 407. She is a recipient of national awards such as the Latin-American Student Organization Latina Woman Award. Dr. Smith-Orr has published 20 articles and received funding from NSF. Dr. Pugalee has published 210 articles with 2022 Google Scholar citations, secured millions in external funding, and his work has been recognized by outlets such as the *Charlotte Business Journal*. Dr. Miller has published 35 papers

with 304 Google Scholar citations and received \$25k in external funding. His work has been quoted in national outlets such as the *Wall Street Journal*. Dr. Dika has published 44 papers with 3,522 Google Scholar citations and been awarded \$100k in funding from Belk Foundation, Institute of Education Sciences (IES), and NSF. With over \$6 million in external funding for agencies such as IES, NSF, and OSEP, Dr. Pennington has published 65 articles with citation impacts of 1115 (Google Scholar). Finally, Dr. Bross has published 15 papers with 58 Google Scholar citations and has collaborations with Charlotte-Mecklenberg Schools.

When considering the collective impact, cohesion of the group, and the success in collaborative teams, the team has published 580 papers with citation impacts totaling 13,806 (Google Scholar). The collaborators have been successful collaborators on research papers and grant teams. Dr. Dika has published 12 articles with Dr. Tempest and two with Dr. Miller. Drs. Pennington and Bross have co-published as well as Dr. Pugalee and Blat. Drs. Foxx and Lewis have served as guest editors of a special issue on urban school counseling. Finally, Drs. Tempest, Lewis, Galloway and Foxx are collaborators on an S-STEM grant and have research publications in progress.

To build upon the success of our current S-STEM grant, Developing Engineering Academic Pathways for Low Income Students, we see the need to expand major aspects of the activities to a wider audience that extends beyond recruitment of low-income students to STEM. The focus of this collaboration is to provide STEM pathways to a broader audience of underrepresented students. This includes special education, LGBTQ, women, and minoritized students in urban settings. Additional resources could support the training of STEM education teachers, special education teachers, school counselors, and college counselors. Resources are also necessary for recruitment and retention, college and career advising, mentoring, and establishing partnerships with the community and school partners.

Each of the team members has a history of specific synergies that will enable the collaboration to have greater impact. Dr. Foxx has experience as a school counselor in urban settings, conducts research on school counselor STEM advocacy, and has relationships with district, state, and national school counseling leaders. Dr. Lewis is a national/international expert in urban education and has been successful in developing strategic K-12 partners. Dr. Tempest is focused on the preparation, recruitment and collegiate success of engineering students from all backgrounds. Dr. Blat's expertise includes student success in STEM majors, particularly underrepresented groups. Dr. Galloway's expertise is in the areas of assessment and student engagement among historically underrepresented populations in STEM. Dr. Smith-Orr brings expertise in engineering education and the mentoring of African American women in engineering. Dr. Pugalee brings a wealth of experience in mathematics, STEM education, and has a sustained record of obtaining funding from NSF. Dr. Dika's scholarship relates to participation, engagement, and success in STEM higher education, particularly of underrepresented students. Related to special education, Dr. Pennington is a nationally distinguished scholar in special education and has over 25 years of experience working with individuals with disabilities, their families and teachers and Dr. Bross has research and teaching expertise in autism and transition. Dr. Miller has national expertise related to LGBTQ students in STEM. Most of the collaborators on this team have a solid record of contributions to student education and research training. The team has chaired a combined 66 completed dissertations, served or are serving on 71 dissertation committees, and published 157 articles with graduate students. These activities are clear indicators of our commitment to graduate students, particularly those at the doctoral level.

Alignment with Regional and National Priorities

The mission of UNC Charlotte includes a commitment to addressing the cultural, economic, educational, environmental, health, and social needs of the greater Charlotte region. One major factor in addressing these concerns is narrowing the educational and career opportunity gaps faced by low-income and minority students. According to the National Science Foundation (NSF, 2019) the United States invests a large amount of resources and time in science and engineering education. Underutilization due to underemployment could negatively affect the labor force. Over the next decade, science, technology, engineering, and mathematics (STEM) careers are projected to grow faster, have increased earning potential, and are likely to have lower unemployment rates than non-STEM jobs (Fayer, Lasey, Watson, 2017).

Careers in STEM offer promising futures for America's youth. Individuals employed in science and engineering occupations tend to have higher earnings and lower rates of unemployment than other occupations (National Science Board [NSB], 2018). However, the number of U.S. students choosing to pursue STEM related college degrees and occupations is relatively low with STEM majors comprising only 24% of all bachelor's degrees awarded (National Center for Education Statistics [NCES], 2014). And, of those students who graduate with a degree in STEM, most will end up employed in a non-STEM field (NCES, 2014). Further disparities exist with the attainment of research doctorates. Despite comprising 30% of the current labor force, only 11% of degrees were awarded to underrepresented minorities. Future projections are also similar as the Census Bureau estimates that by 2060 minorities will make up 56% of the population, however the proportion of these individuals in STEM fields will only increase 2% points from 13% to 15% (NSF, 2019).

According to the NSF (2019) and Freeman (2020) minorities such as African Americans, Hispanics or Latinos, and American Indians or Alaska Natives, women, persons with disabilities, and lesbian, gay, bisexual, transgender, and queer (LGBTQ) people are underrepresented in science and engineering. LGBTQ students are 8% less likely to persist in STEM than heterosexual peers (Hughes, 2018) and evidence outlines negative climates, hostility, and invisibility LGBTQ students often face in STEM majors and classrooms (Cech & Waidzun, 2011; Linley et al., 2018) and in the STEM workforce (Mattheis et al., 2019). To that end, NSF has identified specific priority areas of funding. In particular, the NSF strategic plan includes a broadening participation focus to ensure that underrepresented groups participate more fully in STEM. The funding portfolio includes three categories: (1) programs that are primarily focused on broadening participation, (2) programs that have broadening participation as one of several emphases, and (3) Dear Colleague Letters expressing interest in specific aspects of broadening participation. Furthermore, in 2018, NSF made a formal announcement of its interest in supporting proposals that build research capacity for persons with disabilities. Such examples included EHR Core Research (ECR): STEM Learning and Learning Environments, Broadening Participation, and Workforce Development ([NSF 19-508](#)) and Improving Undergraduate STEM Education: Education and Human Resources ([NSF 17-590](#)). Additionally, the U.S. Department of Education, Office of Postsecondary Education, has priorities such as Talent Search, TRIO, GEAR UP, and Upward Bound Math-Science to fund programs that identify and provide services to low-income individuals, first-generation college students, and individuals with disabilities to progress through the academic pipeline from middle school to postbaccalaureate programs (U.S. Department of Education, 2021). Given these priorities, it is evident the area aligns with both the university's mission and national priorities.

Supporting Documents

Collaborator	Area of Expertise
Sejal Parikh Foxx, Ph.D Professor and Chair, Department of Counseling	Equity and Access to College and Careers, Urban School Counseling, STEM Advising, Advocacy
Chance W. Lewis, Ph.D. Carol Grotnes Belk Distinguished Professor of Urban Education Director, <i>The Urban Education Collaborative</i>	Urban Education, Equity and Access to College, Academic Success of Underrepresented Populations and Teacher Recruitment of Male Teachers of Color in STEM fields
Brett Tempest, Ph.D. Associate Professor Department of Civil and Environmental Engineering	Engineering education, success of students from low-income, underrepresented, and first-in-family backgrounds.
Stephanie Galloway, Ph.D. Director of Assessment and Advising, College of Engineering	Assessment of student learning, STEM education, underrepresented students in STEM.
Cathy Blat, Ph.D. Assistant Dean for Student Experiences and Director of OSDS The William States Lee College of Engineering	Student Success in in STEM Majors, Student Mathematics Performance, and Underrepresented groups in STEM
David Pugalee, Ph.D. Director and Professor, Center for Science, Technology, Engineering, and Mathematics (STEM) Education	Mathematics and STEM education
Ryan A. Miller, Ph.D. Assistant Professor, Department of Educational Leadership Director, Higher Education Programs	LGBTQ students in STEM, LGBTQ issues in education, Disability in higher education, Diversity and equity initiatives in higher education

<p>Robert Pennington PhD BCBA-D Lake & Edward J. Snyder, Jr. Distinguished Professor in Special Education Department of Special Education and Child Development</p>	<p>Working with individuals with disabilities, their families and teachers. His primary research interests are in the application of behavior analytic principles and procedures to the development of written communication repertoires and the improvement of educational programming for students with intellectual disabilities and autism spectrum disorder. Special education intersections with STEM, communication intervention within robotics</p>
<p>Leslie Ann Bross, Ph.D., BCBA-D Assistant Professor of Special Education Program Director, Graduate Certificate in Autism Spectrum Disorder Department of Special Education and Child Development</p>	<p>Transition and autism- transition to adulthood for individuals with disabilities and also supporting individuals with autism across the lifespan, single-case design research methodology, and evidence-based practices for learners with autism.</p>
<p>Sandra L. Dika, Ph.D. Associate Professor and Graduate Program Director Educational Research, Measurement, & Evaluation Department of Educational Leadership</p>	<p>Higher education access, engagement, and success, particularly: Persistence and attainment of underrepresented and marginalized groups in higher education, Participation, engagement, and success in STEM higher education, Contexts of middle and high school success, and Research, evaluation and assessment support</p>
<p>Courtney S. Smith-Orr, Ph.D. Teaching Assistant Professor Electrical & Computer Engineering</p>	<p>Engineering Education, Active learning pedagogy in engineering, Mentoring of African American women in engineering, qualitative methods</p>