

Strengthening the STEM Pipeline for Elementary School African Americans, Hispanics, and Girls by Scaling Up Summer Engineering Experiences

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David Knight is Assistant Professor and Assistant Department Head for Graduate Programs in the Department of Engineering Education at Virginia Tech. He is also Director of International Engagement in Engineering Education and affiliate faculty with the Higher Education Program at Virginia Tech. His research tends to be at the macro-scale, focused on a systems-level perspective of how engineering education can become more effective, efficient, and inclusive.

Dr. Walter C. Lee, Virginia Tech

Dr. Walter Lee is an assistant professor in the Department of Engineering Education and the assistant director for research in the Center for the Enhancement of Engineering Diversity (CEED), both at Virginia Tech. His research interests include co-curricular support, student success and retention, and diversity. Lee received his Ph.D in engineering education from Virginia Tech, his M.S. in industrial & systems engineering from Virginia Tech, and his B.S. in industrial engineering from Clemson University.

Dr. Karl W. Reid, National Society of Black Engineers (NSBE)

Karl Reid is the newly appointed Executive Director of the National Society of Black Engineers (NSBE), a 18,000 plus student-governed association in Alexandria, Virginia whose mission is to increase the number of culturally responsible black engineers who excel academically, succeed professionally and positively impact the community. He is the author of "Working Smarter, Not Just Harder: Three Sensible Strategies for Succeeding in College...and Life."

Dr. Reid came to NSBE from the United Negro College Fund where he served as senior vice president of research, innovation and member college engagement. Prior to joining UNCF, Dr. Reid was Associate Dean of Undergraduate Education and Director of the Office of Minority Education at the Massachusetts Institute of Technology (MIT).

Dr. Reid earned both his Bachelor's and Master's of Science degrees in Materials Science and Engineering from MIT, and his Doctorate of Education from the Harvard Graduate School of Education. His research interests include exploring the relationships between racial identity and self-efficacy, and their influence on the academic achievement of African American males in higher education.

Dr. Monica E. Cardella, Purdue University, West Lafayette (College of Engineering)

Monica E. Cardella is the Director of the INSPIRE Research Institute for Pre-College Engineering Education and is an Associate Professor of Engineering Education at Purdue University.

Dr. Morgan M Hynes, Purdue University-Main Campus, West Lafayette (College of Engineering)

Dr. Morgan Hynes is an Assistant Professor in the School of Engineering Education at Purdue University and Director of the FACE Lab research group at Purdue. In his research, Hynes explores the use of engineering to integrate academic subjects in K-12 classrooms. Specific research interests include design metacognition among learners of all ages; the knowledge base for teaching K-12 STEM through engineering; the relationships among the attitudes, beliefs, motivation, cognitive skills, and engineering skills of K-16 engineering learners; and teaching engineering.

Dr. Cherie D. Edwards, Virginia Tech

Dr. Cherie D. Edwards is a Postdoctoral Associate in Engineering Education at Virginia Tech. She earned her Ph.D. in Educational Research and Evaluation from Virginia Tech. Her research and scholarship are focused on exploring the implementation of mixed methods, qualitative, and arts-informed research designs in studies examining issues of social justice and educational equity. Currently, she is on a research team examining the impacts of an out-of-school STEM summer program for racially underrepresented youth.



Dr. Glenda D. Young, Mississippi State University

Dr. Glenda D. Young is a visiting assistant professor in the department of Industrial and Systems Engineering at Mississippi State University. She completed her doctoral work at Virginia Tech in the Department of Engineering Education. Her research examines the role of university-industry partnerships in shaping student career expectations and pathways, the student to workforce continuum, and broadening participation in engineering. Dr. Young has worked as an Employer Relations Assistant for the VT Career and Professional Development office and has a B.S. degree in Industrial Engineering from Mississippi State University and Master of Industrial and Systems Engineering from Auburn University. She is a Gates Millennium Scholar.

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Abstract

With the rapid growth of science, technology, engineering, and mathematics (STEM) jobs in the United States, stakeholders are investing more resources to expand participation in these fields in terms of overall numbers as well as representation across demographics. Although there has been a steady stream of federal and corporate investments in STEM programs, reaching and engaging youth from underrepresented communities remains a challenge. Attempting to disrupt this trend, the National Society of Black Engineers (NSBE) is leveraging over ten years of experience to further develop and expand the nation-wide Summer Engineering Experiences for Kids (SEEK) program. In partnership with education researchers from Virginia Tech and Purdue University, NSBE aims to expand participation in SEEK using the research-to-practice cycle to identify and develop best practices moving forward. This paper summarizes preliminary results from the first year of the three-year project, *Strengthening the STEM Pipeline for Elementary School African Americans, Hispanics, and Girls by Scaling Up Summer Engineering Experiences*. Findings from this research suggest that over the course of the SEEK program students showed increases in their conceptual knowledge (i.e., math, science, and engineering) as well as their attitudes towards these disciplines and their overall perceptions of engineering, but there is certainly room for improvement from this baseline year as the research begins to inform practice.

Overview

Although the number of STEM jobs in the United States are growing rapidly, there is an insufficient number of students pursuing degrees and positions in these fields. There are even lower percentages of students from underrepresented racial and ethnic communities entering STEM degree programs and professions (Ntiri, 2002). Through various approaches, stakeholders from STEM disciplines continue to look for ways to diversify the population of students entering these fields, and although there has been a steady stream of federal investments in STEM programs, reaching and engaging students from underrepresented communities continues to be a challenge. One of the ways stakeholders are addressing this challenge is by developing youth out-of-school programs to pique interests in STEM fields (Valla & Williams, 2012).

With the amplification of national interest in attracting underrepresented youth to STEM fields, the presence of out-of-school programs aimed at attracting these students has grown (Perna, 2002). Building on more than 10 years of experience conducting SEEK camps in cities across the United States, NSBE has planned and implemented more than 16 camp sites with plans to expand over the course of the next few years. NSBE led the expansion process through the selection of site locations, fundraising, hiring site leaders and mentors, developing and reviewing student applications, interviewing and training site leaders and mentors, and working with community partners (e.g., schools and corporate partners). The next step of expansion will be conducted through a research-to-practice based partnership with Virginia Tech and Purdue University under the project title, *Strengthening the STEM Pipeline for Elementary School*

African Americans, Hispanics, and Girls by Scaling up Summer Engineering Experiences. The partnership is guided by two objectives:

- (1) Evaluate the proposed program's success at influencing STEM-related academic and career identity, conceptual knowledge, and interpersonal and intrapersonal skills.
- (2) Generate evidence and a greater understanding of organizational context factors that operate to enhance, moderate, or constrain SEEK's impact from site to site. Through these two objectives, the research-to-practice and practice-to-research cycle is continuously progressed.

Preliminary Results

To address the first objective, pre- and post-tests were administered during the first and next to last days of the camp. These assessments focused on analyzing the following changes within the program participants: (1) conceptual knowledge, (2) engineering identity, (3) interpersonal and intrapersonal skills, (4) perceptions of engineering, (5) attitudes toward math and science, and (6) perceptions of the SEEK experience. Across all of the sites, 654 students completed assessments and had their parents sign consent forms to allow data to be used for research purposes (out of a total of 1,375 matched pre- and post-tests). Figure 1 shows the results of the 2017 SEEK pre- and post-test assessments across two conceptual knowledge areas under investigation. Results suggest that scores increased in both of these major conceptual areas, with the largest growth in items pertaining to engineering. Our poster also displays results from the other constructs under investigation, such as engineering identity, interpersonal and intrapersonal skills, etc.

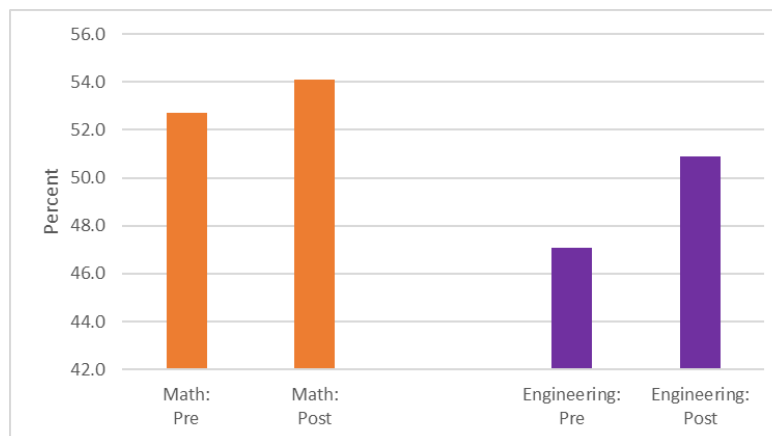


Figure 1. Math and engineering conceptual knowledge scores (statistically significant differences) before and after the SEEK experience (n=654, includes all IRB-approved students who have both a pre- and post-test).

To address the second research objective, we focused on variation across SEEK sites and triangulate information across the assessments, surveys of parents and SEEK mentors and site leaders at each site, interviews with NSBE National Headquarters staff, and interviews with mentors and site leaders at select site. As shown in Figure 2, we observed variation in outcomes across sites, and this aspect of the investigation focused on *why* we may have observed such variation. Results could point to actionable changes that NSBE can put into place as it scales up the SEEK experience to ensure high-quality experiences across sites.

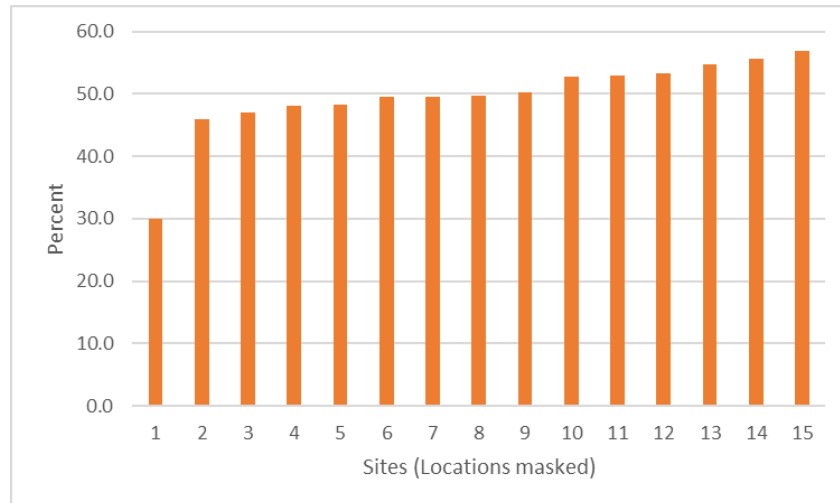


Figure 2. Average math pre-test scores by SEEK site. We are focused on understanding differences between sites for the second objective of the project.

Next Steps

Building on what we learned during this baseline year, we are developing adjusted plans of assessment for SEEK students, mentors, and site leaders. In the forthcoming SEEK cycle, student assessments will continue to measure grade-specific conceptual knowledge, motivation, and self-perception. In addition to these constructs, student collaboration and classroom culture have been added to the assessment plan. Mentor and site leader experiences are to be examined through a series of research methods that both measure mentor and site leader attitudes and capture different aspects of their experiences (e.g., motivation, self-efficacy, classroom preparation). These adjustments are the product of ongoing team meetings between the Virginia Tech, Purdue, and NSBE teams. Through these meetings, the Virginia Tech, Purdue, and NSBE team members have become better aware of the components necessary to both hold SEEK camps and assess the impact of these camps.

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