

Towards a National Agenda for Broadening the Participation of African Americans in Engineering and Computer Science: Insights from Year 1

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OVERVIEW

While more students are pursuing degrees in science, technology, engineering, and mathematics (STEM), representation of African Americans remain low and is not on par with national representation [1], [2]. As a result, broadening the participation of African Americans in engineering and computer science continues to be an effort that is of interest to various stakeholders in the STEM community. As part of the effort to improve diversity in STEM, the researchers engaged in this project aim to critically assess and evaluate the research-to-practice cycle [3] and set a national agenda for broadening participation of African Americans in engineering and computer science.

This three-phased study is guided by the following research questions:

1. What is the current state of research and practice on broadening participation of African Americans in engineering and computer science, according to scholarly literature and national reports?
2. What do subject matter experts perceive the engineering and computer science community should be doing—in research, policy, and practice—to broaden participation of African Americans at all levels of education and in the workforce?
3. How should the *Innovation Cycle of Educational Practice and Research* be modified to reflect a meaningful agenda for broadening participation of African Americans in engineering and computer science?

The conceptual framework guiding this study is the *Innovation Cycle of Educational Practice and Research* [3]. This model depicts an idealized, cyclical relationship between research and practice: a scenario in which practical issues drive research questions and research insights influence what happens in practice. Unfortunately, this is rarely what happens in reality—most of what happens in practice is not informed by research, nor is it properly assessed for accuracy of meeting objectives [3]. The same is often true in the reverse, as research efforts are not always driven by experiences of the practitioners in the field. In this study, this lens is being used to address the proposed research questions and achieve the following outcomes:

- A. Literature review synthesizing and highlighting the current state of research and practice around broadening the participation of African Americans;
- B. *Innovation Cycle of Broadening Participation*, a conceptual model that depicts the current relationship between research and practice in this context and outlines a national agenda for coordinating the efforts of stakeholders committed to broadening participation of African Americans in engineering and computer science.

To this end, we began a three-year, NSF-funded project in January 2017, Phases I and II well underway. The outcomes of Phase I will be a systematic mapping of the literature and a systematic review of relevant scholarship (e.g., [4], [5], [1]), or Outcome A. The second outcome (Outcome B) will be developed based on insights from Phases II and III, which will include interviews with subject matter experts (SMEs) associated with various levels of engineering and computer science education as well as the workforce, and a Delphi study. This paper includes an overview of various research activities and outcomes associated with Phases I and II.

PRELIMINARY FINDINGS

Systematic Mapping & Review of Scholarship

During Phase I, a literature mapping was conducted, revealing key insights. The results of a literature map describe and catalogue the available evidence on a topic and identify clusters and gaps in knowledge ([6], [7]. Literature maps are valuable tools for policy makers, practitioners and researchers in offering them “an explicit and transparent means of identifying narrower policy and practice-relevant review questions [8].” Table 1 includes preliminary insights from the map of literature on African Americans in engineering and computer science. Our search strategy resulted in the identification of 1,180 pieces of scholarship; 470 met our inclusion criteria, which was based on the relevance of the scholarship to the topic of interest in this study.

As Table 1 indicates, there is significantly less scholarship focused on broadening participation of African Americans in computer science (CS) than in engineering. In this case, scholarship includes books, journal articles, conference papers, national reports, etc. The results also reveal that much of the scholarship in this area has focused on undergraduate and K-12 education. On the other hand, less scholarship is focused on the community college and non-academic segments of the education-to-workforce pathways. A host of other mapping review results will be presented in the publication that is forthcoming.

Table 1: Preliminary insights from the literature map

Segment	Engineering (39.6%)	CS (8.5%)	STEM (51.9%)	Subtotal
ED: K-12	7	12	69	88
ED: Community College	2	0	5	7
ED: Undergraduate	132	17	106	255
ED: Graduate	5	1	16	22
Workforce: Academic	11	0	9	20
Workforce: Non-academic	8	1	3	12
Across Segments	18	5	28	51
Other	3	4	8	15
Grand Total	186	40	244	470

Umbrella Review of National Reports

During Phase I, we also conducted a modified umbrella review of 29 national reports from over a 40-year timespan (1976-2016) that addressed this subject. An umbrella review focuses on compiling evidence from multiple sources into one accessible and usable document on a broad topic for which there are competing interventions [8]. In doing so, its analysis aligns the findings in such a way that recommendations for practice emanates from what is known, and recommendations for research stem from what is unknown [8]. Examples of other umbrella reviews include: *Public health interventions for asthma: An umbrella review, 1990-2010* and *Systematic reviews of psychosocial interventions for autism: An umbrella review* [9], [10]. While an umbrella review primarily aggregates findings from several reviews, this aspect was modified in our study.

The 29 collected national reports were analyzed based on the range of recommendations put forth as possible solutions to help recruit, retain, or sustain the success of African American men and women in STEM. Recommendations were sorted into five categories: (1) practice, (2) policy, (3) culture & climate, (4) information & knowledge, and (5) investments & commitments. Recommendations ranged from improving K12 math and science education for

underrepresented minorities to creating organizational culture that value employees' contributions and respects all [11], [12], [13]. With a range in recommendations comes a range in stakeholders who these reports called on to implement these changes. The complete set of findings of this review were presented at the inaugural 2018 Collaborative Network for Engineering and Computing Diversity (CoNECD) conference and can be found here [14].

NEXT STEPS

Systematic Literature Review (SLR) of Scholarship

The literature map led to another research activity associated with Phase I: systematic reviews of the relevant literature. We documented the “messiness” that comes with initiating a SLR in a paper presented at the 2017 Frontiers in Education conference [15] and the first SLR that will result from this project is underway. More specifically, 249 pieces of scholarship (out of 470 mentioned in the mapping review) passed the subsequent quality check associated with the SLR method [Op. cit.], and will serve as the basis for both SLRs.

The first SLR will focus on how assessment is used in assessment- and evaluation-focused scholarship associated with programs and interventions designed to broaden the participation of African Americans in engineering and computer science (E&CS). A total of 34 pieces of scholarship passed our inclusion criteria and quality checks and are being included in this analysis. The remaining 215 documents will be associated with a research-focused SLR. The goals of each review are similar, despite the focal difference. Examples of specific questions that are of interest in the SLRs are: *What practical initiatives have been deployed and are associated with broadening the participation of African Americans in E&CS? What research methods, evaluation methods, and theoretical frameworks have been used in work surrounding the subject? What limitations have been presented/discovered while investigating these topics?* Publications associated with this research activity are also forthcoming.

Exploring the Perspectives of the Subject-Matter Experts

With a better understanding of the current scholarship on this topic, Phase II will focus on SMEs insights, experiences, and reactions to the literature on broadening participation. In this phase, SMEs will be recruited from four specific junctures along the education to workforce pathway: 1) K-12 education, 2) baccalaureate education, 3) post-baccalaureate education, and 4) E&CS workforce. A minimum of 15 SMEs will be interviewed from each of the four sectors. This will provide us with a nuanced and multi-faceted perspective on the issues, challenges, opportunities, and needs associated with broadening the participation of African Americans in engineering and computer science. The immediate next step is to develop a recruitment strategy, identify participants, develop interview protocols, and conduct the interviews. Details on our approach to this will be described in an upcoming FIE conference paper [16].

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