Board 93: Toward a National Agenda for Broadening Participation of African Americans in Engineering and Computer Science: A Systematic Review of Workforce Barriers

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Abstract

The overarching goal of this project is to critically evaluate the research-to-practice cycle as it relates to broadening participation of African Americans in engineering and computer science, and develop a national agenda grounded in existing literature and subject-matter experts' perspectives. To address this purpose, our research team is carrying out a three-phased project that includes systematically reviewing the literature, interviewing subject-matter experts, and conducting a Delphi study, aiming to reach consensus on the key issues and gaps in our understanding. Combined, these efforts will reveal significant questions and areas of opportunity to enhance the relationship between research and practice in this area. We are currently in Year 2 of the project. In addition to providing an overview of the project to date, this paper presents salient findings that emerged from a systematic literature review nineteen articles on barriers to African American's participation in the engineering and CS workforce (i.e., academia, industry, and government). Although the barriers manifest in unique ways based on the workplace context, they can be organized by the three major paradigms that usually shape broadening participation literature as either pipeline barriers, ecosystem barriers, and/or pathway barriers. Most of the studies in this review revealed barriers experiences by individuals within the work environment (i.e., ecosystem barriers). This paper concludes with possible directions for future research that stem from gaps in the literature, and recommendations for addressing existing challenges.

Project Update

While broadening participation of underrepresented groups in engineering and computer science is a national problem, most efforts to date tend to respond with local solutions. Though valuable, such efforts—in the form of research and practice—are insufficient and have only led to incremental progress in the national demographic trends of engineers and computer scientists. If the goal is wide-scale improvements and impact that is evident at the highest levels of society, we argue that there is a need to take a step back, reexamine what has been done in terms of research and practice, and develop an integrated strategy that outlines a national agenda to the national problem. In short, the purpose of the overarching study is to: critically evaluate the research-to-practice cycle as it relates to broadening participation; and set a national agenda for broadening the participation of African Americans in engineering and computer science that is informed by existing literature and subject matter experts. To address this purpose, our three-phase project includes:

(1) a series of systematic reviews of the literature on barriers to participation and proposed solutions for each juncture of the education-to-workforce pathway;

(2) interviews with subject-matter experts to discuss their professional experiences regarding broadening the participation of African Americans, and what can be done to gain momentum in this regard; and

(3) a Delphi study to reach consensus on the key issues, gaps in our understanding, significant questions, and breakdowns in the Innovation Cycle of Educational Practice and Research (Jamieson, Lohmann, 2010).

To date, the first phase of the project is nearly complete and the second phase is well underway.

As previously statement, the focus of the first phase is synthesizing what existing scholarship already says about the barriers African Americans face as they try to participate in engineering and/or computer science at the K-12 education, undergraduate education, graduate education, and workforce levels. Before delving into the systematic literature reviews (SLR), we performed a different kind of review by systematically mapped the literature to understand the landscape based on categories like methods used, segments focused on (K-12, undergraduate, graduate, and the workforce). Highlights of the mapping review were discussed in a previously published article (London, Lee, Watford, Holloman, Halkiyo, Jew, Hawkins Ash, Phillips, 2018), and the complete set of results are in a manuscript that is was recently accepted (London, Lee, Phillips, Van Epps, Watford, Accepted). One example of an insight that emerged from the mapping review was which segment of the education-to-workforce pathway existing scholarship focused on African Americans has focused on the undergraduate years. By extension, the least amount of scholarship has focused on graduate education, the workforce, K-12 education, and cross-segment studies, respectively. The order of conducting the series of SLRs was informed by this magnitude. More specifically, the graduate education SLR is complete and currently under review (Holloman, London, Lee, Pee, Hawkins Ash, Watford, In Review); the salient insights from the scholarship on the workforce are included in this paper; and SLRs focused on K-12 education, undergraduate education, and the role of assessment in scholarship on broadening participation are in preparation. The overarching question guiding all systematic literature reviews associated with this phase of the project is:

> *What is the current state of research and practice on broadening participation of African Americans in engineering & computer science (E&CS), according to scholarly literature & national reports?*

Insights from Workforce Scholarship

Research Aims

The purpose of this study to synthesize existing literature on barriers to participation faced by African Americans pursuing careers opportunities in the engineering and CS workforce, and identify opportunities for future research. While the overarching question guides this and all SLRs in this project, the sub-questions associated with this review are:

1. What topics are being studied, and how are they motivated?
2. What are salient characteristics of the research designs guiding these studies?
3. What are the most salient barriers to participation experienced by African Americans in the engineering and computer science workforce?
4. What are some of the most promising opportunities for future research?

Data Collection & Analysis

A systematic literature review is a type of study that enables researchers to systematically search for, appraise, and synthesize existing scholarship that addresses a research question (Grant & Booth, 2009). The details associated with the search and appraisal of articles associated with this project have been described elsewhere (Holloman, London, Lee, Pee, Hawkins Ash, Watford, In Review), and many of the details will not be repeated here. As a result of the exclusion of these important details and lack of transparency in this article, it is more fitting to refer to this work as a different kind of review (Grant & Booth, 2009)-- namely an "Systematic Overview". According to Grant and Booth (2009), a systematic overview is a summary of the literature that attempts to survey the literature and describe its characteristics. What makes it "systematic" is the comprehensiveness of the search and quality appraisal processes. Some things that distinguish it from a SLR is the lack of transparency about the detailed search process, quality appraisal, comments about how issues of bias, reliability and validity were addressed (Borrego, Foster, Froyd, 2014; Petticrew & Roberts, 2006). Regardless of if it is a systematic literature review or systematic overview, it will include an analysis based on chronology, concepts, or themes and a narrative describing the salient features.

This review of studies on the workforce is based on 19 articles that met the inclusion criteria and passed the quality appraisal described elsewhere (Holloman, London, Lee, Pee, Hawkins Ash, Watford, In Review). All of the studies included in this review were published after 1975 and focused on African Americans in the engineering and/or computer science (E&CS) workforce. (See mapping review for breakdown of all articles; London, Lee, Phillips, Van Epps, Watford, Accepted). More specifically, nine of the articles were focused solely on the academic sector of the workforce (Bernadin, Atuahene, 2007; Berry, Cox, Main, 2014; Crawford, 2014; Crawford, 2015; Cruz, Hasbun, Adams, Banks-Hunt, Barabino, 2016; DeCuir-Gunby, Grant, Gregory, 2013; Mondisa, 2015; Rios, Stewart, 2015; Ross, Fletcher, Cox, Main, 2015); seven were focused on the industry sector (DeRamus-Suazo, 2013; Gatchair, 2008; Gibbs, 2009; Miller, 2014; Ross, Godwin, 2016; Smith, DiTomaso, Farris, Cordero, 2001; Stanton & Lin, 2003); two were focused on government (Hofacker, 2014, 2015); and one quantitative analysis was not specific to one sector of the workforce (Oh & Lewis, 2011).

Each article was reviewed by at least two researchers who extracted relevant data from the articles that answered the sub-questions. If there was a discrepancy among the researchers about what information should be extracted, a third member of the research team reviewed the article and made the final determination. The remainder of this section describes the themes resulting from this analysis.

Salient Findings Organized by Sub-question

What topics are being studied, and how are they motivated?

There are many similarities among the topics in research on barriers to participation in engineering and computer science careers in academia, industry, and government. (See Table 1 for summary.) Not surprisingly, studies focused on career development and career advancement were common across all three sectors (Cruz, Hasbun, Adams, Banks-Hunt, Barabino, 2016; DeCuir, Grant, Gregory, 2013; Gibbs, 2009; Hofacker, 2014, 2015; Smith, DiTomaso, Farris,

Cordero, 2001). Questions specific to women of color and the joint effect of racism and sexism (i.e., "the double-bind") are commonly investigated among these studies. Similarly, studies on pay equity are common across all sectors of the workforce as well (Gatchair, 2008; Oh & Lewis, 2011). Studies focused on academia and industry centered on other topical themes like: recruitment, retention (Bernadin, Atuahene, 2007; Gatchair, 2008; Stanton & Lin, 2003); representation (Berry, Cox, Main, 2014; Gatchair, 2008; Oh & Lewis, 2011); mentor/ing (Crawford, 2014; 2015; Gibbs, 2009; Mondisa, 2015), and workplace experiences (DeRamus-Suazo, 2013; Rios, Stewart, 2015; Miller, 2014; Ross, Fletcher, Cox, Main, 2015). Lastly, two studies focus on constructs that are prevalent in engineering education literature related to career choices --namely identity (Ross, Godwin, 2016) and self-efficacy (Hofacker, 2014, 2015)-- are the topics shared among studies on industry and government.

Academia	Industry	Government
Mentoring		
Workplace Experiences		
Recruitment, Retention, & Representation		
	Engineering Identity	
		Career Self-Efficacy
Career Development & Advancement		
Pay Equity		

Table 1. Topical Themes Among Workforce Studies

There is last observation regarding the topical emphasis that is worth mentioning before discussing trends in the rationale motivating these studies. This provides insights on what the authors of the study perceive is the reason for conducting the inquiry. Figure 1 shows the distribution of disciplines represented among the studies. For this figure, the studies on government were grouped with industry to represent all non-academic careers. In short, at least half of the studies in this review focused exclusively on engineering. On the other hand, none of the studies –including those with an emphasis on academia or industry-- focused exclusively on computer science. This was a disappointing outcome given the purpose this study, but is a recurring theme among studies associated with this phase of the project (Holloman, London, Lee, Pee, Hawkins Ash, Watford, In Review; London, Lee, Phillips, Van Epps, Watford, Accepted). Instead, the remaining studies focused on what the authors called science and engineering or STEM, broadly. We acknowledge that computer science is not excluded from these studies (focused on "science and engineering" or "STEM"), but it is still worth noting this observation since it is difficult to investigate and/or address barriers to participation in a particular context if its unique challenges are not well documented in the literature, and by extension, well understood.

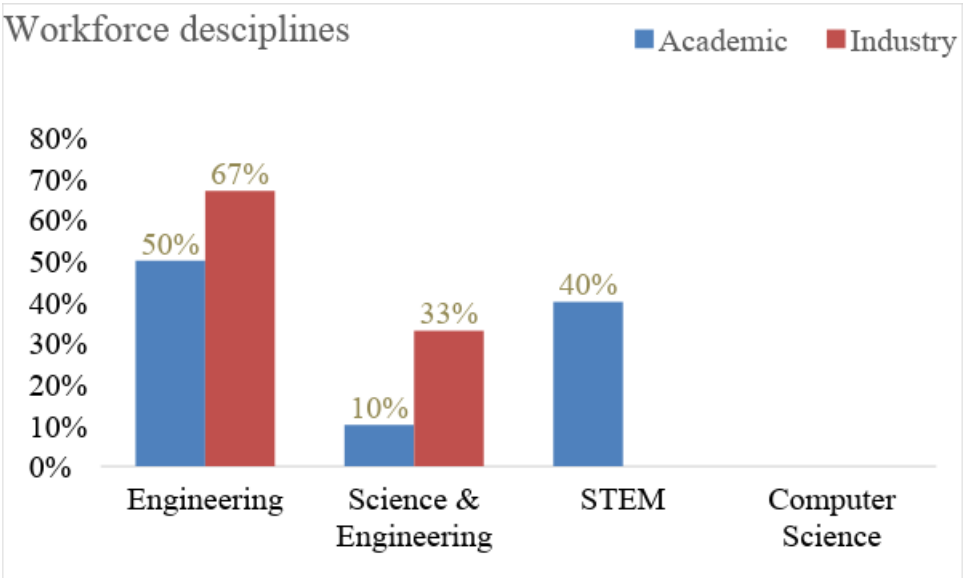

Figure 1. Disciplinary Focus of Workforce Studies

While the topics tend to vary across contexts, the motivations for the study did not range as widely. In short, studies were largely motivated by three types of arguments: arguments about underrepresentation and the need for parity with national demographics; arguments about shifting demographics in the U.S.; and the need to fill gaps in our understanding. One motivating rationale that was unique to some of the academia-focused studies was the need for more technical talent in the workforce as part of maintaining global competitiveness (Bernadin & Atuahene, 2007; Miller, 2014; Mondisa, 2015). Lastly, one rationale that was unique to industry-focused studies was related to race and gender disparities in career attainment (Hofacker, 2014; Gatchair, 2008).

What are salient characteristics of the research designs guiding these studies?

The design characteristics of most interest in this study are methodological choices regarding frameworks, participants, and methods of data collection and/or analysis. (See Table 2 for summary.) The majority (70%) of the articles focused on the academic workforce used qualitative methods, whereas the majority (67%) of the industry articles used quantitative method. Mixed methods are rarely used to investigate research questions associated with either sector of the workforce: only 11% of industry and 20% of academic workforce articles used mixed methods. There are also differences in the theoretical frameworks used to guide studies in the different workforce contexts. The majority (70%) of academic workforce scholarship used an established theory and intersectionality. On the contrary, the majority (78%) of industry workforce scholarship only used an established theory, but did not take an intersectional approach.

Research Design Characteristics	Workforce Sector		
	Academic	Industry	Government
Participants' race/ethnicity	Primarily people of color	Primarily African Americans	African Americans
Participants' sex	Primarily women	Mostly unspecified	Women & Men
Participants' occupation	Primarily (80%) faculty	Varies Widely	Practicing Engineers
Data Type	Primarily qualitative	Primarily quantitative	Quantitative
Sample size	Relatively small	Relatively large	Relatively large

Table 2. Research Design Characteristics

What are the most salient barriers to participation experienced by African Americans in the engineering and computer science workforce?

There are similarities and differences among the barriers to participation in the E&CS workforce, all of which can be organized into three types: pipeline barriers, ecosystem barriers, and pathways barriers. This organizing framework is adopted from one of the author's recent publication on the three dominant paradigms that drive broadening participation scholarship (Lee, 2019).

More specifically, barriers related to the "pipeline" are usually focused on work systems, highlight barriers to participation via traditional routes, and tend to measure progress by retention over time. The studies in this review highlighting pipeline barriers in the academy include an emphasis on tokenism (Bernadin & Atuahene, 2007; Crawford, 2015; Rios & Stewart, 2015); and challenges faced during the promotion and tenure process (Ross et al., 2015; Bernadin & Atuahene, 2007). Similarly, the industry focused studies revealing pipeline barriers related to challenges to career advancement and/or leadership opportunities (e.g., unclear promotion guidelines, effects of the "glass ceiling" (Gibbs, 2009).

The second category of barriers, ecosystem barriers, were also manifested among the barriers to participation. This category represented the majority of the barriers identified in this review. Key elements of the ecosystem paradigm include an emphasis on the work environment, highlight barriers to participation via interpersonal relations and culture, and tend to measure progress by individual's experiences and a better climate. The ecosystem barriers to full participation in the academia include: lack of/ineffective mentoring (Crawford, 2014, 2015; Mondisa, 2015; Ross et al., 2015); chilly climate (Bernadin & Atuahene, 2007; Berry, Cox, & main, 2014; Crawford, 2015; Rios & Stewart, 2015); feelings of isolation or exclusion (Crawford, 2015; Rios & Stewart, 2015; Ross et al., 2015); and lack of support or information (DeCuir-Gunby, Grant, and Gregory, 2013; Miller, 2014). The industry focused studies highlighted ecosystem barriers related to monitoring policies, friendships among coworkers, and challenges in relationships with supervisors (Hofacker, 2014, 2015; Stantone & Lin, 2003).

The third category of barriers relates to pathways. Key components of this paradigm include an emphasis on individuals, highlights barriers related to one's agency, and measures of progress relate to their persistence and/or the smoothness of their path. No studies focused on the workforce include barriers that mapped directly to the pathway paradigm, but one study focused on employment discrimination was found among the industry-focused studies (Gatchair, 2008).

Lastly, some studies identified barriers that touched on more than one of the three paradigms. For example, some studies talked about barriers like implicit bias, ramifications of stereotypes, discrimination, and pay disparities (Cruz et al., 2016; Oh & Lewis, 2011). These are

the kinds of barriers that impact work systems, individuals, and the environments in which they work.

What are some of the most promising opportunities for future research?

The following table summarizes the most salient gaps in the literature and corresponding recommendations.

Table 3. Gaps & Opportunities

	Gap in the Literature	Possible Future Directions
1	There is a tendency to focus on one form of supporting mechanism, namely mentoring.	Expand practice, policy and research to focus on other forms of support.
2	There is a tendency to focus on group of people in the faculty--namely, tenure-track faculty.	Expand practice, policy and research to focus on other groups of people in the academy (e.g., postdocs, staff, administrators).
3	There is a tendency for studies that include an emphasis on gender to study women on color.	Expand gender-focused studies to add an equal focus on men of color in the workforce.
4	There is a tendency for industry-focused studies to exclude the use of a guiding lens.	Design more industry-focused studies that include the use a lens (i.e., theory, framework) that is grounded in existing literature.
5	Despite the use of terms specifically focused on computer science, no studies emerged with this singular focus.	Significantly advance the body of scholarship on African Americans in the computer science/computing workforce. Similarly, report on engineering and CS separately, unless the guiding research question demands otherwise.
6	There is a tendency to focus solely on structural *diversity* rather than *diversity and inclusion*. There is also a tendency to use qualitative or quantitative research designs, but mixed methods are rarely used.	There is a need for more work on this topic, in general. The barriers to participation discussed in the findings of this study highlight the need for more balanced efforts and research that equally focus on diversity *and* inclusion. Design more workforce studies that rely on mixed methods as part of overcoming the limitations associated with using a singular methodological approach.
7	There is a tendency to study and report on barriers to participation in isolation.	Given the complexity and multi-faceted nature of the barriers to participation, there is a need to conceptualize, investigate and address these challenges from a more comprehensive perspective.

Summary & Recommendations

This study provided a review of scholarship on barriers to participation that African Americans face as they pursue engineering and computer science careers in industry and academia. The topics of articles in this body of work relate to a limited number of topics, and tend to be motivated by similar arguments. The research designs framing the studies tend include a combination of qualitative and quantitative studies, but very few mixed methods designs. Lastly, the there are three types of barriers discussed in the literature—namely pipeline barriers, ecosystem barriers, and pathway barriers; ecosystem barriers are the most common. Provided are few concluding recommendations for stakeholders in the workforce and researchers.

Recommendations to Workforce Stakeholders:

- **Prioritizing hiring more African Americans.** This helps reduce barriers related to chilly or hostile social climate, isolation, tokenism, stress, loneliness, exclusion and lack of information.
- **Create better support structures.** For example, this may include the establishment or improvement of formal mentoring programs. This may include making need-based, flexible, mutual/reverse, network-based, horizontal and robust enough to address professional, emotional and psychological dimensions of a mentee's mentoring needs.
- Provide training on topics like stereotype threat, implicit bias, and culturally responsiveness.
- **Revise tenure, promotion and performance evaluation criteria** to incorporate changing needs. The nation needs to improve the participation of minorities, but unfortunately tenure, promotion and performance evaluation criteria does not render equal weight/value for minority-related research agenda. This is self-contradicting and breeds two problems: African Americans in the workforce (ex. faculties) do not effectively participate, perform and thrive, and minority-related topics and/or minority students will be less served.

Recommendations to Researchers Studying the Workforce:

- **Study barriers holistically** by reimagining and exploring how one barrier can be related to and/or breed another and form cyclical challenges.
- **Study groups separately,** unless it is dictated by study questions and/or for comparison purpose. In this, participants may be grouped by identifiers like: race/ethnicity, gender, discipline, role within a sector, etc.

References

Borrego, M., Foster, M. J., & Froyd, J. E. (2014). Systematic literature reviews in engineering education and other developing interdisciplinary fields. Journal of Engineering Education.

Grant, M. J.; Booth, A. (2009). A typology of reviews: an analysis of 14 review types and associated methodologies. Health Info Libr J., 26. https://doi.org/10.1111/j.1471-1842.2009.00848.x

Holloman, T., London, J.S., Lee, W., Pee, C.M., Hawkins Ash, C.D., Watford, B.A. (In Review). Underrepresented and Overlooked: Insights from a Systematic Literature Review about African American Graduate Students in Engineering and Computer Science.

Lee, W.C. (2019). Pipelines, Pathways, and Ecosystems: An Argument for Participation Paradigms. *Journal of Engineering Education, 108*(1), p. 8-12.

London, J., Lee, W.C., Phillips, C.r, Van Epps, A., Watford, B. (Accepted). A Systematic Mapping of Scholarship on Broadening Participation of African Americans in Engineering and Computer Science.

L. Jamieson and J. Lohmann, "Creating a Culture for Scholarly and Systematic Innovation in Engineering Education: Ensuring U.S. Engineering has the Right People with the Right Talent for the Global Society," *Online for free at http://www.asee.org/about/board/committees/CCSSIE/,* 2010.

London, J., Lee, W.C., Watford, B., Holloman, T., Halkiyo, A., Jew, G.,Hawkins Ash, C., Phillips, C. (2018). Toward a National Agenda for Broadening Participation of African Americans in Engineering and Computer Science: Insights from Year One.*Paper presented at the 2018 American Society for Engineering Education Annual Conference, Salt Lake City, UT*

Petticrew, M., & Roberts, H. (2006). Systematic reviews in the social sciences: A practical guide. Malden, MA: Blackwell Publishing.

Articles Included in the Review (19)

1. Bernadin, S., & Atuahene, F. (2007). Influential factors affecting the attraction and retention of minority faculty in engineering and technology programs BT - 114th Annual ASEE Conference and Exposition, 2007
2. Berry, C. A., Cox, M. F., & Main, J. B. (2014). An examination of the numbers: African American female faculty in engineering BT - 121st ASEE Annual Conference and Exposition
3. Crawford, D. K. (2014). Considerations for the Effective Mentoring of Stem Women of Color Faculty at a Striving Private Technical University Bt - 44th Annual Frontiers in Education Conference
4. Crawford, D. K. (2015). Tailor-Made: Meeting the Unique Needs of Women of Color Stem-Sbs Faculty through Mentoring Bt - 2015 Ieee Frontiers in Education Conference
5. Cruz, J. M., Hasbun, I. M., Adams, S. G., Banks-Hunt, J. M., & Barabino, G. A. (2016). Perceptions of Treatment for Underrepresented Minority Faculty in Engineering Bt - 46th Annual Frontiers in Education Conference
6. DeRamus-Suazo, N. L. (2013). The Influence of College Choice on the Success, Ethnic Identity, and Professional Sense of Belonging of African American Engineers. (73), ProQuest Information & Learning, US. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=psyh&AN=2013-99070-001&site=ehost-live
7. DeCuir-Gunby, J.T., Grant, C., Gregory, B.B. (2013) Exploring career trajectories for

women of color in engineering: The experiences of African American and Latina engineering professors. *Journal of Women and Minorities in Science and Engineering, 19*(3), p. 209 - 225

8. Gatchair, S. D. (2008). Representation and Reward in High Technology Industries and Occupations: The Influence of Race and Ethnicity. (68), ProQuest Information & Learning, US. Retrieved from: http://search.ebscohost.com/login.aspx?direct=true&db=psyh&AN=2008-99111-025&site=ehost-live
9. Gibbs, T. S. (2009). From Retention to Detention: A Phenomenological Study of the African-American Engineer Experience. (69), ProQuest Information & Learning, US. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=psyh&AN=2009-99051-095&site=ehost-live
10. Hofacker, S. (2014). Career Self-Efficacy of the Black Engineer in the U.S. Government Workplace Bt - 121st Asee Annual Conference and Exposition
11. Hofacker, S. A. (2015). Career Self-Efficacy as a Means of Understanding the Gap between Career Attainment and Opportunity for the U.S. Government Black Engineer. (75), ProQuest Information & Learning, US. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=psyh&AN=2015-99010-414&site=ehost-live
12. Rios, D., & Stewart, A. J. (2015). Insider and outsider-within standpoints: The experiences of diverse faculty in science and engineering fields. *Journal of Women and Minorities in Science and Engineering*, *21*(4).
13. Miller, B. A. K. (2014). The Experiences of Panamanian Afro-Caribbean Women in Stem: Voices to Inform Work with Black Females in Stem Education. (75), ProQuest Information & Learning, US. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=psyh&AN=2014-99230-309&site=ehost-live
14. Mondisa, J.-L. (2015). Increasing Diversity in Higher Education by Examining African-American Stem Mentors' Mentoring Approaches Bt - International Conference on Interactive Collaborative Learning
15. Oh, S. S., & Lewis, G. B. (2011). Stemming Inequality? Employment and Pay of Female and Minority Scientists and Engineers. The Social Science Journal, 48(2), 397-403. doi:10.1016/j.soscij.2010.11.008
16. Ross, M. S., & Godwin, A. (2016). Engineering Identity Implications on the Retention of Black Women in the Engineering Industry Bt - 123rd Asee Annual Conference and Exposition
17. Ross, M. S., Fletcher, T. L., Cox, M. F., & Main, J. B. (2015). African American Women in the Academe: A Comprehensive Literature Review through the Lens of Intersectionality, American Society for Engineering Education Annual Conference
18. Smith, D. R., DiTomaso, N., Farris, G. F., & Cordero, R. (2001). Favoritism, Bias, and Error in Performance Ratings of Scientists and Engineers: The Effects of Power, Status, and Numbers. Sex Roles, 45(5-6), 337-358. doi:10.1023/A:1014309631243
19. Stanton, J. M., & Lin, L. F. (2003). Effects of Workplace Monitoring Policies on Potential Employment Discrimination and Organizational Attractiveness for African Americans in the Technical Professions. *Journal of Black Psychology, 29*(3), 257-274.