The Career Experiences of African American Female Engineers

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Abstract: African American women are significantly underrepresented in engineering workplace organizations. However, the primary focus, in the field, is on the STEM pipeline in K-12 and undergraduate education. If the engineering community does not address contributing factors in workplace organizations, then the overall goal of increasing the underrepresented populations in the engineering field will not be met. As a result, this study examines the career experiences of African American female engineers to understand the challenges, which impact their development. Implications for research and practice are given to support this population and other underrepresented groups in STEM.

The intellectual capital produced by a country is connected to the innovation and advancements made in science, technology, engineering, and mathematics, commonly referred to as STEM (National Academy of Sciences, 2007; NACME, 2008; Science and Engineering Indicators, 2006). What the US produces and contributes as a country in these fields, is the measurement of progress, innovation, and leadership. Historically, the US leads the race in STEM research and advancements (National Academy of Sciences, 2007; Science and Engineering Indicators, 2006). However, due to a reduction in the number of students pursuing STEM careers, a reduction in the number of STEM research projects, and a move to international markets for engineering production and manufacturing, to name a few of the challenges, the US is faced with the dilemma of diminishing interests and advancements in STEM, which impacts the output and global leadership in a technologically-led global society (National Academy of Sciences, 2007; Science and Engineering Indicators, 2006).

To address these issues, oftentimes the field examines the talent pool and efforts to increase the pipeline for STEM occupations (National Academy of Sciences, 2007; NACME, 2008) in particular, targeting underrepresented populations. Consequently, the preponderance of literature and research addressing STEM issues is focused on the pipeline, specifically recruitment and retention of underrepresented groups in the K-12 and collegiate realm (e.g. National Academy of Sciences, 2007). For underrepresented populations (American Indian/Alaska Natives, Blacks, Hispanics, Pacific Islanders, and women) who manage to successfully navigate the K-12 pipeline and collegiate domains, there are additional challenges encountered in professional workplace organizations. As a result, if the engineering field does not address contributing factors in workplace organizations, then the overall goal of increasing the underrepresented populations in the engineering field will not be met.

Purpose of the Study

Women of color, specifically African American women, are marginally represented in engineering workplace settings. According to the National Science Foundation (Division of Science Resources Statistics, Scientist and Engineer Statistical Data System: Table H-6, 2006) only 10% of the engineering workforce is characterized by racial/ethnic underrepresented

populations. Women represent a higher percentage as a group and account for 13.5% of the engineering workforce (Table H-7, 2006). However, in professional engineering roles, African American women only represent 6% of the total number of women employed (Table H-7, 2006). Although a sample of African American women have accessed the professional engineering environment we have very little information on these women and the factors that contribute to their experiences in the field. Therefore, the purpose of this study was to examine the career experiences of African American female engineers and thereby explore the personal and structural factors which served as challenges in their career. Specifically, the research question was: *what were the macrosystem and microsystem challenges impacting the career experiences of African American female engineers*.

Theoretical Framework

The framework guiding the study was Cook, Heppner, and O'Brien (2005) adaptation of Bronfenbrenner's (1977) ecological model, which included four systems—macrosystem, exosystem, mesosystem, and the microsystem—as key elements in human development. Cook, Heppner, and O'Brien (2005) acknowledge the four subsystems yet contend that the macro and micro system interactions are most constructive when examining the career development for women of color. Moreover, they assert that the micro and macro system levels, due to race/ethnicity and gender, have a direct relationship to career intentions, pursuit, and experiences. Therefore, the ecological model framed this research by examining the macro and micro subsystems in studying the career experiences of African American female engineers.

Research Design

The underlying focus was to understand how African American female engineers processed their career experiences and what their experiences meant to them (Josselson, 1995; Merriam, 2009), as a woman and person of color. In order to gain a holistic perspective of the factors, which impacted the career experiences of the participants, a life history approach was employed (Cole & Knowles, 2001). The life history design allowed the participants to share and explore elements of their background, including early life experiences, which contributed to their career development.

Participant Selection

This research study focused on African American female engineers currently working in an engineering function. Additionally, the participants needed at least 10 years of experience in an organization (or multiple organizations) and at least one promotion, or equivalent, from an entry level position. The aforementioned tenure and promotion conditions provided a sample with experience navigating the engineering culture. Participants were identified by working with professional engineering networks and contacting professional engineering corporations directly. In addition to these resources, snowball sampling was utilized to reach the sample population, as defined. Ultimately, nine Black female engineers were purposively selected (Merriam, 2009; Patton, 2002) and agreed to participate in the study.

Data Collection

Data was obtained primarily using in-depth interviewing employing a general interview guide approach (Patton, 2002). The general interview guide approach provided limited structure to ensure that particular content was addressed during each interview; however, this approach permitted freedom in the sequence of the conversation, which allowed for a conversational design, identical to a guided conversation (Cole & Knowles, 2001). This style of interviewing

helped to develop rapport between the researcher and interviewee and relied on the interaction to discover data.

The initial interviews lasted between 90-150 minutes to delve into the participants' life history and career experiences. Points of clarification and questions related to specific experiences were addressed in follow up interviews, as needed. The individual interviews were digitally recorded and transcribed, with permission.

Data Analysis

Each interview required multiple readings of the text to allow patterns to develop and to gain a deeper understanding of the participant (Cole & Knowles, 2001). Accordingly, a case story was created for each interviewee and was sent to the participant for member checking. The interviews were initially analyzed as individual units of data and thematic analysis was utilized for each narrative (Riessman, 2008). Thematic analysis focuses on the content of the narrative (Riessman, 2008) and ultimately allowed the researcher to identify commonalities and differences amongst themes in the data holistically.

Findings and Discussion

The emergent themes were categorized into two primary areas: collegiate experiences and the professional engineering workplace. The microsystem factors discovered in the data occurred solely during their college experiences. Microsystem factors included a lack of discipline and focus, seeking assistance, and adjusting to the program rigor.

Collegiate Experience - Microsystem

The participants shared difficult transitions from high school to college as young African American women aspiring to become engineering professionals. In the literature, two of the subthemes—lack of discipline and focus and adjusting to the program rigor—had parallel connections. For example, students entered undergraduate engineering programs with a high degree of self-confidence and mismatched expectations of the required workload. This reality check, in turn caused the students to conduct a self assessment (Etzkowitz, Kemelgor, & Uzzi, 2000). Consequently, if the student persisted, then they established a more disciplined academic lifestyle and became focused. However, they also hit the virtual wall at some point during their academic career, which was due to a combination of individual factors such as incorrectly prioritizing social activities and not focusing on their studies. Additionally, an underlying trait that impeded the African American women was learning to ask for help overall. Seeking assistance appeared to be an individual trait that had rarely been utilized by the participants. Some research reports women have minimal self confidence when compared to their male counterparts (Goodman et al., 2002) and this could explain the lack of assertiveness in asking for assistance. However, examining interpersonal traits without including the impact and climate of the environment presents a one-sided view of the system.

Collegiate Experience - Macrosystem

The participant's collegiate experiences included macrosystem challenges, which consisted of limited representation, professor's lack of care and support, and an unwelcoming peer network. According to the participants, the undergraduate engineering environment severely lacked racial and gender diversity. This meant that they were keenly aware of their status as the only person of color and/or woman in the engineering classroom. This finding is consistent with other research in the field, which states that women take notice of the lack of females in engineering programs, faculty roles, and as professional engineers in the workplace (Goodman et al., 2002). To address the limited representation from minority groups, Busch-

Vishniac and Jarosz, (2004) suggested an area to explore is the engineering curriculum. The authors propose that minimal changes to the content, such as including the people tied to the theory in engineering and adding a social component that connects women and people of color, may recruit more women and students of color to pursue the field. However, curricular changes are not completed in a vacuum; in order to impact change in engineering content, one has to address the additional challenge presented by those who teach in the engineering classroom.

The African American female participants shared a common experience in the classroom; they felt that the professor did not take an interest in their success as a student. This lack of care and support served as a challenge for the participants and perhaps the challenge is explained by research that reports faculty in this realm, tend to focus on research more than teaching. Astin and Astin (1992) discovered that STEM faculty use traditional teaching methods and focus less on student needs or on creating a learning environment that is student centered. A narrowly scoped approach to teaching combined with an emphasis on research, negatively impacts the classroom and college environment for all students, and especially for the African American female students who have other negative factors contributing to the environment and adding to the unwelcoming setting.

Colbeck, Cabrera, and Terenzini (2001) found in their research on faculty teaching and classroom environment that the underlying perception was that male students typically responded to and treated females differently than males. Similarly, Estzkowitz, Kemelgo, and Uzzi (2000) determined that "Many men are well aware that they or their peers often exclude the women in their classes from their working or social groups solely because they are women" (p. 60). In addition to the hostile environment as a result of gender differences in the classroom, the African American women also had to deal with issues based on race. According to the College Board (1999):

> Because White students are still a large majority on most campuses, the negative views of some Whites can contribute to a perception that minorities are "unwelcome." Although hard to measure, this "lack of hospitality," as one member of the Task Force puts it, appears to undermine the academic performance of many minority students. (p. 16)

The collegiate experiences presented by the African American female participants noted individual and environmental challenges. Therefore, the items discovered must be examined at the interaction level. Moreover, the discussion on challenges impacting the career experiences of African American females has to include the professional workplace setting.

Professional Engineering Experience – Macrosystem

The data categorized in the participant's professional engineering workplace were identified as macrosystem factors. Those factors included a lack of diversity and the impact of age, race, and gender. Analogous to the limited representation challenge presented by the participants in the collegiate environment, the same lack of diversity carried over into the workplace setting. Based on the pipeline, it makes sense that a lack of diversity in the academic setting would extend to a lack of diversity in the professional workplace setting. The engineering community continues to note the unsatisfactory numbers for minorities in the field yet diversity goals remain unmet (Watson & Froyd, 2007). Although literature (e.g. Catalyst, 1992; Sukumaran & Jahan, n.d.) in the field includes a multitude of challenges such as few mentors, balance of work and family, and sexual harassment, to name a few, the participants in this study primarily shared challenges related to gender and the intersection of gender, race, and age.

There is limited research, which includes challenges in the engineering workplace associated with age, whether younger or older, and the intersection of this factor with race and gender (Gilla, Sharp, Mills, & Franzway, 2008; Roberts & Ayre, 2002). Moreover, literature in the field often highlights the experiences of White women; the challenges incurred by women of color are often overlooked (Richie, 1992). The experiences of White women and women of color are not synonymous, as noted in the Catalyst (2004) report, "Whereas white women frequently reference the 'glass ceiling' as blocking their advancement up the career ladder, women of color often characterize the barriers they encounter as comprising a 'concrete ceiling'—one that is more dense and less easily shattered" (p.3). The report shared a similar finding with the participants in this study, by noting the exclusion felt by the women of color as a result of their race and gender. Nevertheless, the preponderance of literature in predominantly male dominated organizations or nontraditional fields focuses on the impact of gender (Richie et al., 1997).

The participants described hostile working environments when sharing their experiences as females in male dominated organizations. Challenges presented by the participants included exclusion, racism, sexism, and general harsh treatment as defined by each participant. These elements support findings presented by research and literature in the field which addresses barriers and challenges for women (e.g. Catalyst, 1992, 2004; Gilla, Sharp, Mills, & Franzway, 2008; McIlwee & Robinson, 1992; Miller, 2004; Roberts & Ayre, 2002; Robinson & McIlwee, 1991). McIlwee and Robinson (1992) researched the impact of gender in the workplace and found that men respond negatively to professional women in the workplace culture and especially in male dominated fields. The Catalyst (1992) reported that many of the challenges experienced by female engineers is common in other professions, however the exclusion of females from the network in engineering is more harmful. Until the challenges, as presented by the African American female engineers, are addressed by organizations then the environment as experienced by the participants will remain relatively unchanged.

Implications for Adult Education

This research contributes interdisciplinary knowledge focused on adult development with a social justice component and professional education emphasis. This research seeks to make a significant contribution to the research and practice regarding adult education in engineering specifically and STEM by and large.

Research

Research and literature addressing the career development of Black women in the workplace are scant, relative to White women whose patterns of work and living are typically generalized to those of Black women (e.g. Phillips & Imhoff, 1997). Moreover, research addressing Black women in engineering is nearly non-existent. As a result of limited perspectives, researchers (e.g. Fouad & Byars-Winston, 2005; Thomas & Alderfer, 1989) made a call to include more voices from women of color in career development literature and this research attempts to answer the call and serve as a catalyst for others to answer the call by researching women of color and their career experiences.

Practice

This research attempts to impact practice in terms of increasing diversity in STEM overall and engineering organizations specifically. Moreover, this research informs STEM professionals and their leadership in corporations by providing factors, which hinder retention for African American female engineers. For adult educators, this component contributes data to

assist academic and workplace organizations in adopting strategic initiatives to support African American female engineers and other underrepresented groups in STEM, in addition to other workplace organizations where women and people of color are marginalized. Ultimately, research on the career experiences of African American female engineers makes a positive contribution toward establishing gender and race equity and diversity in engineering.

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