"I am able to have a different lens and different approach:" A Critical Examination of how Black Female Engineering Teachers Utilize and Create Counternarratives

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This research highlights the educational and professional experiences of three Black female secondary teachers of engineering. Using a lens of community cultural wealth, this research calls attention to the resources these teachers called upon during their navigation of engineering pathways and currently utilize to challenge their school's normative perceptions of engineering and engineers. Findings of this work discuss how aspirational capital functioned to support the teachers' successful matriculation through a STEM high school and undergraduate engineering and/or architecture programs, while also serving as a foundation for how they currently created opportunities for their students. Implications for future engineering education research and approaches for k-12 engineering educators acknowledging racialized and/or gendered experiences in these spaces are discussed.

Keywords: Engineering, Counternarratives, Community Cultural Wealth

"Being a Black [woman] educator [of engineering] in a predominantly Black school is very important! It's important that my students see what I've done in my own life, how I've persevered through my own struggles to really get to where I am, and in continuing to work towards where I want to be. And, so, being a Black educator is very important for me because I'm able to have a different lens or different approach that I don't think, in the general

curriculum kind of takes into account" -- Shannon[1], a Black female high school engineering teacher

Introduction

In the above quote, Shannon identified reasons for the importance of her presence, as a Black engineering educator, within a predominantly Black high school. Initially, she highlighted that her students would be able to draw upon and gain inspiration from her experiences as a Black woman who has successfully navigated an engineering pathway. In addition, she believed that her being a Black educator afforded her a *different lens or different approach* for working with her students than what generally happens within the department. Shannon's notion of looking at her students' experiences through a *different lens* was inexplicably situated within the context of Central STEM Magnet's 137 year racialized and gendered history that included decades of denying girls and/or Black children access to its specialized engineering program, while also limiting the number of Black teachers of engineering. The three women featured in this research, including Shannon, are all Central alumnae and the first, and only, Black women teachers of engineering in the school's history. Highlighting the insights of these three women, this research looks to explore how colorblind ideologies informed, and continue to inform, engineering perceptions at Central, despite its current demographic shift in becoming a predominantly Black school. We argue that the teachers' *different lens and different approaches* for conceptualizing their students' experiences offers: (a) the engineering education community perspectives into how race and gender impact students' navigation of engineering pathways and (b) practical approaches for how teachers can recognize and attend to these issues.

Using a lens of community cultural wealth (Yosso, 2005), this research study unpacks the "accumulated assets and resources" (p. 77) that three Black female engineering teachers utilized while challenging the normative perceptions of engineering along their academic pathways and currently as teachers of engineering at Central. In particular, we explore how aspirational capital functioned to support the teachers' perceptions of self along their engineering pathways, as well as how, as Black teachers in a predominantly Black school, they intentionally offer their students counternarratives (Solórzano & Yosso, 2002) of who engineers can be. We contend that this research is of particular importance because despite an emerging body of literature focused on the engineering experiences of students from historically marginalized communities (Burt et al., 2019; Gibson & Espino, 2016; McGee & Martin, 2011; Moore, 2006; Samuelson & Litzler, 2016; Wright et al., 2018), there remains a gap in knowledge specifically addressing the educational and professional experiences of Black women teachers of engineering (Wright et al., 2020) and their potential role as change agents in k-12 engineering spaces (Wallace et al., 2014).

Quite often, research that emphasizes equity in engineering education has overlooked and ignored the intersectional barriers, or double bind, faced by Black women which encompasses both their race and gender (Ong et al., 2011). At these intersections, White, Western men are most privileged and hold the power of knowledge validation (Collins, 2000). We take up Fletcher and colleagues' (2017) claim that while acknowledging the challenges and barriers that Black women face, the field of engineering education needs to "also acknowledge and seek to

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[1] For the privacy of participating schools and teachers, pseudonyms are utilized throughout the manuscript.

better appreciate the valuable experiences and knowledge that African American[2] women bring to engineering" (p. 1). In the following sections, we review literature on the Black women and girls' experiences in undergraduate engineering and k-12 science education. Next, we situate this study within a framework of critical race theory and counter-storytelling in education. Our methodological approach is described, including a specific description of the research context, participating teachers, and the procedures for collecting and analyzing data. Finally, research findings are presented followed by the presentation of a discussion and implications section.

Literature Review

This section looks to synthesize literature that foregrounds Black women and girls' experiences in engineering and science education. We specifically focus on the ways that Black women and girls have drawn upon various forms of support within their social networks and successfully navigated engineering and science pathways. Using an anti-deficit lens to examine and understand the factors that contribute to the successful navigation of engineering pathways is important because, as noted by Harper (2010), "most empirical studies amplify minority student failures and deficits instead of achievement" (p. 64). We use this review to argue for the importance of understanding the engineering pathways of three Black women and how these understandings currently inform their professional practice as secondary teachers of engineering. Initially, this section will focus on literature that unpacks the networks and support systems that Black women utilized to navigate undergraduate engineering programs. Next, and due to the dearth of research that features Black girls' experiences in k-12 engineering, we examine literature that explores the academic and identity supports within k-12 science spaces. Finally, the section will conclude with a discussion as to how findings from this review supports research focused on the experiences and voices of three Black female teachers of engineering.

Black Women's Social Networks in Undergraduate Engineering Pathways

Despite increased attention afforded to diversifying the engineering workforce, women of color still make up less than two percent of all engineering professionals (National Science Foundation, 2017). Noting systemic factors that particularly impact the number of Black women in engineering, Fletcher and colleagues (2017) identified the "lack of role models, stereotype threat, biculturalism, tokenism, and feelings of isolation" (p. 3) as particular challenges for Black women in engineering. Recent studies have looked to uncover the coping strategies that Black women have deployed within spaces of engineering learning, where perceptions of isolation and alienation often exist. Bush (2013) found that when reflecting on their undergraduate experiences, a group of Black female engineers spoke about the importance of having access to positive external resources as they strengthened internal dispositions for navigating engineering institutions. Engineers within the study acknowledged the "powerful and meaningful support" (p. 97) provided by their mothers, educators, and church communities as they personally developed internal dispositions of self-determination and self-esteem. Gaining insights into these experiences and acknowledging potential resources in Communities of Color, engineering institutions committed to contributing to a "diversified engineering workforce" could reimagine

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[2] The descriptors of Black and African American are used interchangeably throughout this manuscript in order to denote individuals with ancestral origins from the African diaspora.

the ways in which they leverage these kinds of support systems and networks. Looking at the role of institutions in supporting these types of networks, Blosser (2020) argued that engineering institutions should be more intentional in providing resources that support students from historically marginalized communities. This work included the specific recommendation of supporting and promoting "counterspaces" (p. 67), or conceptual and physical spaces that offer academic support and social refuge for Black engineering students. Opportunities to collect these stories in engineering education have been limited, especially in relation to Black women, although these types of stories could potentially impact the ways institutions conceptualize their meanings for providing inclusive engineering spaces.

Conceptualizing Support Networks in K-12 Science Pathways

Recent research has focused on the ways in which Black girls experience k-12 science learning environments (Ireland et al., 2018; Lewis-Ellison et al., 2020; Norris, 2014; Young et al., 2017) and how educators play critical roles in students' development of positive STEM-related identities. Likewise, minoritized students all together (Native Americans, African-Americans, and Latinx communities) are not well-represented in science fields including along the academic pipeline (Chemers et al., 2011). Collins, Joseph, and Ford (2020) detailed how teachers' choices of science curricula, instructional approaches, and learning environments were essential elements for nurturing STEM-scholar identities for gifted Black girls. Students, like Black girls, who have racialized and gendered experiences in STEM learning spaces (Tan et al., 2013) are not often considered in curriculum. Rather a homogenized "science for all" experience is offered as an objective alternative to attending to racialized and gendered experiences of students and teachers (Mutegi, 2011). Hierarchies within STEM education (Barton & Yang, 2000) are a result of the dominant culture as a "culture of power" (Aschbacher et al., 2010, p. 564) that determines what is expected as normal, acceptable, right, and valid. These hierarchies present Western, Eurocentric standards as STEM norms (Gardner, 2011) further promoting this idea of objectivity. The problems with this concept is such that STEM classes are not objective since they further isolate and intimidate students (Banks & Banks, 2004; Quiroz, 2001; Rosebery et al., 2016) by presenting normalities of the dominant culture as a standard. The norms and expectations, or the "set of assumptions, privileges, and benefits that accompany the status of being White… that Whites have come to expect and rely on" in many facets of daily life (Harris, 1995, p. 277) are deeply embedded in STEM education. Many minoritized students struggle to fully engage and prosper in traditional academic settings because they are less competent in the dominant culture while simultaneously their own cultural wealth is undervalued (Yosso, 2005).

Also building on the aforementioned notion of counterspaces, King and Pringle (2019) found that when afforded the space and opportunities to make connections across various contexts of their everyday lives, Black girls displayed high levels of interests and participation in science activities. This work specifically called attention to the importance of educators knowing about and understanding the challenges that Black girls encounter in STEM pathways and consciously seeking out opportunities for creating "counterspaces." Additional research has also called upon educators to specifically advocate for Black girls in science spaces by amending curricula in order to make real world connections and exposing students to Black women in STEM (Young et al., 2017). Along those lines, Black girls are losing interest in science disciplines and as a result, engagement with and persistence in STEM decreases (Ong et al., 2011). Reasons for this decline in interest in STEM are attributed to the classroom environments

and school culture (Carlone et al., 2014). Essentially, it is imperative for educators to acknowledge the challenges for navigating these pathways and to actively explore opportunities for supporting students' success.

In this study, we follow a recent trend where researchers are recognizing and foregrounding the community cultural wealth that Communities of Color bring to the table, in this case, the community cultural wealth of secondary Black female teachers of engineering. Yosso (2005) conceptualized community cultural wealth as "an array of knowledge, skills, abilities, and contacts possessed and utilized by Communities of Color to survive and resist macro- and micro-forms of oppression" (p. 77). Therefore, the current research privileges the voices of these teachers, who have both successfully navigated engineering pathways, as well as reimagined opportunities in engineering pathways that connect the historical, cultural, gendered, and daily lives of Black students. Specifically, we looked to build upon previous literature by examining what Koch, Lundh, and Harris (2019) refer to as the "interplay of social networks" (p. 243) that supported the teachers' successful navigation through engineering pathways and, in turn, their cultivation of similar networks for students within Central's engineering department.

Theoretical Framework

Critical Race Theory and Counter-storytelling in Education Research

With roots in legal scholarship, critical race theory is a theoretical framework that argues that race and racism are entrenched in United States' institutions, including political, legal, and educational structures (Delgado & Stefancic, 2017). Grounding our work in the ways in which race and racism are settled in education (Dixson & Rousseau, 2005; Ladson-Billings & Tate, 1995; Stovall, 2006), this study deployed a critical race methodology in order to highlight how race and racism often go unnoticed or unrecognized when discussing teachers' and students' experiences within engineering education. Specifically, a critical race methodology was utilized to explore how three Black women engineering teachers navigated engineering education spaces and discuss how these teachers utilized these experiences to challenge current colorblind ideologies and norms at Central. In this sense, we sought to examine these teachers' experiences and current practices through the five elements that inform the basic perspectives and insights of critical race methodologies in education (see Table 1).

Adhering to a critical race methodology acknowledges the unique racialized and gendered, or intersectional (Bruning et al., 2015; Collins & Blige, 2016; Ro & Loya, 2015; Ross & Godwin, 2015) experiences of Black women in engineering education contexts. Our intent is that by highlighting these intersectional experiences, this research would challenge the settled claims of objectivity and colorblindness in the representations of engineering education. Specifically using this framework meant that we would foreground the teachers' experiential knowledge of navigating spaces of engineering and engineering education, and call attention to the teachers' forms of resistance or disruption in the ways that engineering was being represented at Central. Situating this research within a framework of counter-storytelling, *we address the following research questions: (a) what resources do teachers highlight as contributing to their navigation of varied engineering pathways and (b) in what ways did teachers view their presence as being a contribution to conceptualizations of engineering at Central?*

Table 1. The five elements of critical race theory and methodology in education

Elements of critical race methodologies in education	Description of each element and implications for education research
Intercentricity of race & racism with other forms of subordination	Acknowledges the intercentricity of racialized oppression, including layers of subordination based on race, gender, class, immigration status, surname, phenotype, & accent.
Challenge to dominant ideology	Challenges the traditional claims of objectivity, meritocracy, colorblindness, & race neutrality in educational institutions.
Commitment to social justice	Committed to social justice & offers a liberatory or transformative response to racial, gender, & class oppression.
Centrality of experiential knowledge	Recognizes the experiential knowledge of people of color is legitimate, appropriate, and critical to understanding, analyzing, and teaching about racial subordination.
Transdisciplinary perspective	Challenges ahistoricism and the unidisciplinary focus of most analyses and insists on analyzing race and racism

Note. Solórzano & Yosso, 2002, p. 25-27

Methodology

Research Design

This study is framed within a critical constructivist paradigm, and thus a qualitative research tradition was employed due to our interest in understanding the lived experiences of the participating Black women engineering teachers. Qualitative research is concerned with how individuals make sense of their social contexts, and how these experiences are thus represented through interviews, field notes, photographs, and memos to the self (Denzin & Lincoln, 1994). In this study, the teachers' meaning making processes and knowledge construction were an important platform to explore their lived experiences at Central STEM Magnet High School.

Data collection & analysis. In qualitative research, the data collection methods are essential components of the research study. In this study, data was collected through two sets of 1-hour audio-recorded interviews with each teacher as well as 1.5 hours of participant observation at Central STEM Magnet. According to Maxwell (2013) participant observations are

useful because "they make it difficult for the observer to restrict his [her] observations so that (s)he sees only what supports his [her] prejudices and expectations" (p. 126). During this process, field notes were taken during the observations in order to provide further descriptive details about the participant's experiences within the school setting. The credibility of the findings is supported by providing thick descriptions (Altheide & Johnson, 1994) and quotes from the data. After all interviews were transcribed, we engaged in a reflexive and iterative data analysis process that allowed for fluidity in our own researchers' meaning making processes (Srivastava & Hopwood, 2009). First, we read each transcription in its entirety to gain a global impression of the holistic narrative (Lieblich et al., 1998). Then we engaged in a first layer of analysis which included open coding. The open coding analysis yielded eighteen codes (see Appendix A). After carefully reading and re-reading the data, we used open coding to identify emergent concepts, patterns and descriptions. This process of first cycle coding allowed us to "initially summarize segments of data" (Saldaña, 2016, p. 236). We created a code book, matching raw data to initial codes. We then engaged in second cycle coding, synthesizing initial codes into "a more unified scheme" representing a "smaller and more select list of broader categories, themes, concepts, and/or assertions" (Saldaña, 2016, p. 234) yielding six codes (see Appendix B). The researchers assessed intercoder reliability and engaged in the process of intercoder negotiated agreement (Campbell et al., 2013) by comparing codes and reconciling any of the coding discrepancies that emerged amongst the team (Campbell et al., 2013) after our second round of individual coding. We practiced researcher reflexivity concurrent with first and second cycle coding processes by using analytic memo writing (Saldaña, 2016), helping us to better understand the phenomena (Weston et al. 2001) and transition to the formal write-up of the study.

Setting: contextualizing race and gender at Central STEM Magnet. Central STEM Magnet is an urban intensive (Milner, 2012) STEM magnet high school (grades 9-12) located in the mid-Atlantic region of the United States. Central originally opened in the late 1800s as an all-White male manual training / vocational school which, at that time, served as the primary pathway towards an engineering career. Hence, engineering has heavily informed the school's identity from its inception. Confronted with a legal grievance that argued that the city's Black high schools did not provide access to a comparable engineering and science curriculum, Central begrudgingly admitted its first Black male students in the late 1950s. Facing a similar legal battle that argued that female students in the city were being denied access to an engineering curriculum, Central, again begrudgingly, admitted its first female student in the mid 1970s. Despite these changes in the school's demographics, Central, in many ways, has maintained the "undercurrent of White, male privilege" (Douglas, 2015, p. 40) on which the school was founded. For instance, citing the need to hire knowledgeable engineering professionals while maintaining the school's "culture and high academic tradition," Central has often hired alumni to serve as teachers within its engineering department. Until the early 2000s, these hires have primarily been White men, thus reflecting Central's racialized and gendered history and reifying White, maleness in STEM spaces.

Currently, the student body at Central consists of 70% Black, 18% White, 6% Latinx, 5% Asian, and 44% of students receive free or reduced lunch. Additionally, the student body is made up of 53% female and 47% male students. The contemporary makeup of the school's student body is significant when compared to the school's beginnings as an all-White male school for engineering. Although female students currently make up 53% of the student body, female

students are still underrepresented within the school's engineering department. It is an abnormality to have twelfth-grade engineering courses where female students are outnumbered by a 5:1 ratio.

Participating teachers. This research is a smaller component of a larger research project that looked to explore the educational and professional experiences of Black k-12 teachers of engineering. Looking to add the voices and insights of Black teachers to larger conversations regarding engineering and science teacher education (Mensah, 2019; Mensah & Jackson, 2018; Parsons & Mensah, 2010), we initially identified 1 middle school and 6 high school Black teachers of engineering. We elected to highlight the insights of Kayla, Patricia, and Shannon because they offered unique opportunities for investigating these experiences: (a) Black women in engineering and (b) alumnae of the same school they were teaching. Thus, Kayla, Patricia, and Shannon, alumnae of and current teachers at Central, served as the study's participants. As previously described, the practice of hiring alumni to teach at Central was historically valued as opportunities for maintaining the culture and traditions of the school, as 20% of the current faculty and staff were previous Central graduates. Although the hiring of alumni was a normal and well-respected practice at Central, the hiring of Kayla, Patricia, and Shannon was particularly significant because they were the first and only Black female engineering teachers hired during Central's 136 years of existence. This specific detail provides additional context for the ways in which the "undercurrent of White, male privilege" was maintained within the school's engineering department.

Kayla. Kayla was the eldest of the three teachers, having served 16 years as an engineering teacher at Central. After graduating from Central, Kayla matriculated to a historically Black college and university (HBCU) in a neighboring state. While attending college, Kayla switched her major from pre-engineering to mathematics. Despite switching majors, Kayla had access to a number of summer internships and other experiences that continued to support her interests in engineering. Upon completing her undergraduate degree in mathematics, Kayla went on to graduate school and earned a Master's degree in mechanical engineering. Kayla began working in industry but stated that, *"a large part of the reason why I left industry was because there were not enough people there that look like me."* She later received the opportunity to become a long-term substitute teacher at her alma mater and was appointed a full-time engineering teacher position the following year. She currently teaches courses in vector mechanics, 3-D visualizations, and renewable matter and energy with electricity and magnetism.

Patricia. At the time of the study, Patricia was in her 3rd year of teaching at Central. After graduating from Central with "average" grades, Patricia received a scholarship from and attended a local community college. After earning an associate degree from the community college, Patricia matriculated to a local HBCU and later earned a Bachelor of Science in Architecture and Environmental Design. Due to her participation in several mentoring experiences while majoring in architecture, Patricia knew she wanted to get into teaching and applied for several teacher residency programs. After briefly serving as a long-term substitute, Patricia was eventually appointed a teaching position within Central's engineering department. Patricia currently teaches courses in architectural design and applications of technology.

Shannon. At the time of the study, Shannon served as an engineering teacher for ten years, four of which were at a local middle school and the additional six at Central. After graduating from Central, Shannon went on to earn an undergraduate degree in mechanical

engineering from the state's flagship university, a large predominantly White institution. Upon earning a mechanical engineering degree, Shannon applied her knowledge and skills in the area of patent law. Shannon described the patent law environment as not being suited for her needs. She stated, *"I was used to working with other people and so that solitary kind of situation was not the best for me."* Thus, Shannon pursued a teaching career at a local middle school and later transferred to Central's engineering department. Shannon currently teaches the honors applications of engineering and engineering design and development courses at Central.

Findings

The analysis of interview data revealed how aspects of community cultural wealth (Yosso, 2005) were often called upon by Kayla, Patricia, and Shannon during their educational and professional experiences as both students and teachers of engineering. Community cultural wealth is conceptualized as "an array of knowledge, skills, abilities, and contact possessed and utilized by Communities of Color to survive and resist macro- and micro-forms of oppression" (p. 77). Thus, it became apparent the teachers utilized a variety of accumulated resources during their educational journeys within engineering, as well as calling upon these same resources in their current roles as teachers of engineering. In the next two sections, we specifically highlight how the deployment of *aspirational capital* was critical during the teachers' educational and professional experiences. Building upon Yosso's (2005) definition, this study conceptualized aspirational capital as the teachers' ability to maintain their hopes and dreams of becoming engineers throughout their education pathways, as well as their capacity to support the engineering aspirations of their students at Central.

Deploying Aspirational Capital During Teachers' Navigation of Their Educational Experiences

As Kayla, Patricia, and Shannon reflected on and spoke about their successful navigation of their engineering pathways, two primary themes emerged that called attention to the ability to persist in becoming successful engineering students. These included (a) the role of family in nurturing the development of dispositions that were essential for succeeding in hostile learning environments and (b) access to Black institutions and organizations that supported their aspirations for becoming engineers. Detailed teacher reflections on each of these themes are provided below.

The role of family in nurturing dispositions that were essential for navigating Central STEM
Kayla, Patricia, and Shannon each reflected on the challenges they, as Black girls in engineering, encountered as students in Central's engineering department and how their families were instrumental in cultivating the resiliency necessary for successfully navigating this context. Reflecting on the challenges of succeeding within engineering learning environments that were typically dominated by White male students, Kayla noted:
> *Excerpt 1.* Kayla's reflection on her engineering experiences at Central High School
> "The majority of the obstacles were cultural obstacles because I went to predominantly white schools throughout k-12 and then--that are not predominantly white schools now… when I got here [Central] in 9-12 [grades], I can say that it was male dominated and culturally different. So, it wasn't very many females around here when I went to school

here and I chose the engineering option and still, to this day [in] the engineering option, I teach far more males than I teach females in that option. So, it's always been a survival of the fittest kind of thing. You've gotta jump higher and run faster than the boys. So, that aspect was always kind of tough."

In this excerpt, Kayla problematized the context within Central's engineering department by describing a learning environment where success was determined by a *'survival of the fittest.'* As a learning environment that was not historically designed with Black girls in mind, engineering courses at Central were perceived as spaces where girls were required to metaphorically *'jump higher and run faster than the boys.'* Reflecting on her successful maneuvering through this space, Kayla acknowledged how dispositions instilled by her parents were instrumental in supporting her maintenance of dreams for becoming an engineer. Specifically, Kayla provided insights into the inspiration and high standards that her mother provided, despite her mother not finishing high school herself:

Excerpt 2. Kayla's description of her mother's high expectations
"They [parents] made it so that you were held to a certain standard. And it was, you are going to do this and you are going to do that… There was nothing about my mother that would've said she never finished high school, to me. So, these types of things. The standards that she set for us; finishing what we start, completing our responsibilities, those types of things are the things that let me know that it [achieving your goals] was a sacrifice. I was a student-athlete, but she didn't care about athlete anything if there was anything less than a B on my report card."

Kayla's reflections on the standards that her mother set for her (i.e., finishing what you start and completing her responsibilities) were interpreted as nurturing Kayla's cultural wealth of aspirational capital. Despite Kayla's mother not finishing high herself, she "maintained consistently high aspirations for her child's future" (Yosso, 2005, p. 78), and thus supporting Kayla's determination of succeeding within the context of Central's engineering department. Similar to Kayla's sentiments, Shannon also acknowledged her family's role in cultivating dispositions that she utilized in navigating Central's engineering courses. In response to questions regarding the nurturing of her engineering interests, Shannon responded:

Excerpt 3. Shannon's discussion of her familial contributions
"Something about a mindset instilled in me, especially my family; a growth mindset that failure will happen, you will make mistakes, and it's really the process that's important… And so, I knew that I was smart. I was told that I was smart. And so, I just had to believe that I could do it and be willing to accept some failures with that."

Notions of persistence and learning from failure have been identified as important epistemic practices within engineering education (Cunningham & Kelly, 2017; Lottero-Perdue & Parry, 2019). Shannon acknowledged this mindset of being smart was instrumental in her persistence within an educational setting that was predominantly White and male, and her "first experience with students who were on the same level and even more advanced." Adding to her previous response, Shannon also provided additional details into how her family supported her maintaining a focus on achieving her goal of becoming an engineer:

Excerpt 4. Shannon's additional insights into her familial supports

> "My mother, and actually my stepmother and mother, told me I was smart even when I made poor choices. And so, I believed that I came from a smart family, that we were all smart, and that's what we did. And so, with that, being a kid, my failures and my mistakes didn't disprove that, right? It was part of the process. And, so, as an educator, I try to instill that as well."

Similar to Bush's (2013) findings, we argue that both Kayla and Shannon's resiliency for maintaining their hopes for pursuing engineering were informed by the dispositions cultivated through familial support. Specifically, their family's high standards and expectations and intellectual affirmations were instrumental in building the aspirational capital necessary for successfully navigating the engineering context at Central. In addition, it is interesting to note that Kayla and Shannon both highlighted and recognized the support from female family members, i.e., mother and stepmother, in nurturing the dispositions for successfully maneuvering through these spaces.

Recognizing and calling upon the available capital in Black institutions and organizations

The teachers in this study also acknowledged that access to Black institutions and/or organizations were instrumental in supporting their hopes and dreams of becoming engineers. Specific examples of this access were the emotional, academic, and economic supports provided through historically Black colleges and universities (HBCUs) and organizations such as the National Society of Black Engineers (NSBE). For instance, Shannon reflected on her educational experiences while navigating spaces for learning engineering at a large, predominantly White institution (PWI) as she stated:

Excerpt 5. Shannon's reflection on the challenges faced at a PWI

> "I was not supported at State University. I mean, there were limited opportunities for you to actually work [internships and/or co-ops] in your career, right? Because it was a large research school. And, so, those [research opportunities] did not always go to students of color, and if they did, then it was students who did not look like me."

In this excerpt, Shannon highlighted the racialized and gendered challenges she faced while navigating the engineering program at State University. She initially acknowledged that students of color were often overlooked for important engineering internships and/or co-ops. Additionally, she described that when opportunities were made available to students of color, students that "looked like her," specifically Black women, were typically not selected. These kinds of challenges fostered a sense of isolation and the perception of having limited institutional support from the department. Despite these challenges, Shannon was able to recognize and draw upon the social network afforded within organizations such as the National Society of Black Engineers (NSBE). Discussing this network and the ways in which the organization supported her engineering journey, Shannon stated:

> *Excerpt 6.* Shannon's acknowledgement of the National Society of Black Engineers
> "To date, studying mechanical engineering was the hardest thing I've ever done at a predominantly white institution, where it was a very large school and I felt like a number, right. And, so, really it was NSBE. It was joining organizations that were geared towards Black excellence and identifying and helping to sort of create a cohort or group of

students that worked together was really instrumental in my success in obtaining that degree."

In this excerpt, and similar to findings from other studies (Watkins & Mensah, 2019), Shannon recognized the real and perceived challenges she faced as an engineering student at a PWI; however, she also acknowledged that access to Black organizations that were geared towards *Black excellence* were "instrumental in her success in obtaining that [mechanical engineering] degree.

      In contrast to Shannon's experiences at a PWI, Patricia reflected on the positive ways that attending an HBCU supported her goals for completing an undergraduate course of study in architecture. While discussing the perception that Central often pushed students to primarily consider engineering programs at PWIs, Patricia noted how resources at an HBCU were instrumental in the continued development of her aspirational capital:

Excerpt 7. Patricia's reflections on the affordances of attending an HBCU

"I feel some kind of way about that because all of my kids [students] are not going to get into State University. And even if they do, they're not going to have the money to afford State University. I went to DuBois University tuition free. I graduated with no student debt. And, so, I just feel as though, I don't know."

Here, Patricia is initially discussing how the leadership within Central's engineering department often pushes students towards State University, the state's flagship PWI, and her feelings that the local HBCUs should also be considered. Reflecting upon her experiences of having to attend a community college and then matriculating to DuBois University, Patricia explicitly acknowledged the financial support she received by attending DuBois. She specifically placed a high premium on graduating from this institution debt-free due to DuBois' financial support of her education.

Supporting Central Students' Development of Aspirational Capital
      In addition to exploring the teachers' deployment of aspirational capital while navigating their engineering pathways, this study also analyzed how the teachers viewed their current roles of teachers of engineering at Central. Specifically, we found that Kayla, Patricia, and Shannon often talked about the need to support their students' development of aspirational capital, especially within Central's academic environment that rarely acknowledged the assets and resources within Communities of Color. In various ways, each of the teachers situated their presence at Central as a counternarrative to what engineering was and who engineers could be. The next section illustrates how the teachers (a) sought to support students' engineering aspirations by acknowledging potential resources within Communities of Color and (b) viewed their own presence at Central as offering alternative notions on who engineers look like.

Recognizing resources in Communities of Color and supporting engineering aspirations
      Kayla, Patricia, and Shannon all felt that it was a necessity for their students to interact with practicing Black engineers, which was not a typical practice at Central. Speaking to how she supported her engineering students' aspirational capital by intentionally arranging for these interactions, Kayla stated:

Excerpt 8. Kayla's race conscious approach to supporting students' aspirational capital

"You have to get African American students interested in long-term outcomes. You have to get them interested in the things that they see. You know you're watching—I used to teach a programming class here too and I had a friend come in from Motorola. We went to Booker T. Washington [an HBCU in a neighboring state] together. He went to Daisy Bates [another HBCU] and got his Ph.D. from DuBois and then the whole time worked for Motorola. He just finished being in the Obama administration for some of the program and stuff like that. So, I bring him in to get him to talk. You gotta see people that look like you when you are doing some of this stuff."

Kayla noted that in order to support her students' aspirations of becoming engineers, she felt it was essential that students *"see people that look like them when they are doing some of this stuff."* Kayla felt that this counternarrative to Central's often utilized approaches of identifying speakers offered her students alternative conceptions of who could be an engineer. Patricia also offered her insights into Central's normalized practice of inviting speakers that didn't resemble the student body and the ways in which she attempted to counter this practice. Patricia stated:

Excerpt 9. Patricia discussing her role in presenting varied representations of engineers

"So, my goal this year, myself as a teacher, is to try to get people out there in the field to come [to her classroom]. So, for example I know a gentleman [Black male] who is working on his PhD in electro optics and microwave photonics. I had never heard of such a thing in my life. That's important because that might hit home with one of these young Black male students in a way that I can't reach them. So, I'm trying to make sure I can bring in people. We had a career day, which is great, but my class had a speaker that was an older white man in engineering. Probably somewhere pushing 70. Even though he had something to offer, I had kids sleeping because they didn't feel like he was offering something up for them. So, with that being said, that hit home for me because something needs to change because there are a lot of kids that have the math skills, they have the science skills, but they don't know where to go from there. So, I'm reaching out to all the people that I know in architecture and engineering and some other fields. So, they can have an opportunity to speak to and learn about their experience."

In this regard, Patricia contends that it is important to push against Central's typical practice of primarily inviting "old White men" to speak on engineering-related topics and to provide students with a more diversified conception of who engineers are. Patricia articulated how she looked to nurture her students' potential aspirations in engineering by calling upon her friends within the field to also come and speak to her students. Lastly, Patricia explicitly highlights the potential impact that this approach may have on her Black male students, however, Patricia made it clear throughout the study that she often considered alternative approaches for reaching all of her minoritized students.

Teachers situating their presence as an inspiration for the next generation of Black and/or female engineers

Teachers also conceptualized their role as engineering teachers at Central as an important element in offering students counternarratives of who could be engineers, thus supporting

students' aspirations for becoming the next generation of Black and/or female engineers. For instance, when discussing the importance of her role as a Black educator, Shannon stated:

Excerpt 10. Shannon's conceptions on being a Black educator in an urban school

"Yes, being a Black educator, engineering educator benefits my school, at an engineering school where students are Black like us. They identify themselves in me. And I'm able to relate to them. But, I think outside of the classroom, my students really want to know how did you do it [successfully navigated an engineering pathway], right? I went to Central, so I was right where you are. And so, it is possible, and you can do a bunch of things with it [an engineering degree]. I try to bring in my other students who graduated with me, who are doing other great things in the field, into the classroom to really let them see that this is possible and it's not too far-fetched."

Shannon viewed her presence as a Central engineering teacher as providing students with a counternarrative for their future possibilities in engineering and serving as an example of how they too could achieve success when navigating engineering pathways. In addition to providing disciplinary expertise in engineering, teachers' conceptions of their ability to provide these counter-examples of engineering and engineers emerged as the primary benefactor in teachers' roles at Central STEM Magnet.

Discussion

Bartolomé (1994) argued that in order to positively impact the educational experiences of minoritized students, educational institutions need to "respect and use students' realities, histories, and perspectives as integral parts of educational practice" (p. 173). In this study, we adhered to this humanizing approach in education research by respecting and affirming the "realities, histories, and perspectives" of three Black women who successfully navigated obstacles in their engineering pathways to become teachers of engineering. Kayla, Patricia, and Shannon used these realities, histories, and perspectives to inform the ways in which they contributed to a desettling of the historical and contemporary representations of engineers and engineering at Central. Informed by Cheryl Harris' (1995) construct of *settled expectations,* Bang, Warren, Rosebery, and Medin (2012) called for the development of a "desettling frame" (p. 315) that reimagines acceptable meanings and meaning-making practices in STEM education. The argument here is that the settled expectations, or "set of assumptions, privileges, and benefits that accompany the status of being white… that whites come to expect and rely on" in the many facets of daily life (Harris, 1995, p. 277), are deeply entrenched in engineering education and continued to shape the ways in which Central conceptualized the presentation of engineering to its predominantly Black student population. In the context of Central, developing a "desettling frame" entailed Kayla, Patricia, and Shannon grappling with the idea that their current students could have racialized and/or gendered experiences and thinking about these possibilities in "more complex and immersive ways" (Bang et al., 2012, p. 315). This complex and immersive approach for developing a desettling frame included Kayla, Patricia, and Shannon connecting their own experiences and knowledge of successfully navigating spaces of engineering learning with their students' current experiences in the same context. Through a lens of community cultural wealth, we illustrated how these teachers reimagined the ways in which students were provided access to conceptions of engineering.

Implications/Recommendations

Through this research, we argue for increased investments in research within engineering education that explores the "accumulated assets and resources in the histories and lives" (Yosso, 2005, p. 77) of Black women and girls. King and Pringle (2019) claim that these kinds of investments are essential in order to "paint a systemic portrait that portrays the STEM talents and proficiencies of Black women and girls" (p. 540). Thus, contrasting the implicit and explicit deficit frames that are often associated with this demographic, we highlighted the resources that three Black women utilized to successfully navigate racialized and gendered engineering pathways. The rich, intersectional experiences of being a Black person, a woman, and a doer of engineering informed the ways in which the teachers designed learning experiences that supported students who are experiencing engineering along racialized and/or gendered pathways. By privileging the contributions of African American women teachers, whose gendered experiences and perspectives have been historically silenced and marginalized (hooks, 1994), we posit that similar to efforts in education to increase the representation of Black male teachers (Bristol & Goings, 2019; Bryan & Ford, 2014; Lewis, 2013), efforts to increase the representation of Black women teachers within k-12 STEM spaces are needed. Historically, Black teachers have expressed a responsibility to educate Black students with an initiative to impact and improve quality of life, not only just for Black students, but all students (Adair, 1984; King, 1993). Simply, we must continue to engage in research that acknowledges the academic and professional experiences and contributions of Black women in STEM learning spaces and use these understandings to continue to reimagine what STEM learning spaces look like for young people along similar pathways.

By directly drawing attention to the *different lens and different approaches* taken up by three Black women engineering teachers, this study offers k-12 teachers new ways of situating the racialized and gendered experiences of their students within spaces of engineering learning. Specific strategies for countering colorblind conceptualizations of these experiences included (a) intentionally seeking engineering role models and speakers that resembled the demographic makeup of Central's student body, (b) promoting engineering opportunities at historically Black colleges and universities, and (c) reimagining engineering curricula in culturally responsive ways. Teachers need to first recognize and acknowledge students' experiences and purposefully envision race conscious approaches for supporting students' community cultural wealth for navigating engineering pathways.

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Appendix A. List of codes developed during the initial layer of open coding

Generated Codes	Example Discussion Topic(s) From Teacher Interview
Alumni Experiences	Attending the same school where they are currently teachers
Career Switch	Thoughts on changing professions; Discussion on reasons why teachers left previous careers
Childhood Influences	Discussions of "when I was a child…"
Contributions of Administration	School administration support for engineering department & students; School district's support for engineering education
Curriculum Design	Teachers agency in adjusting the current curriculum
Entering the Teaching Profession	Discussions about how participants were encouraged to become teachers; Discussion on professional education requirements for teaching
Family Influence	Women acknowledged specific women in their families
Holistic Approach to Teaching	Teachers discussing the importance of supporting students' college readiness and preparedness outside of just engineering class
Impact of Mentoring	How professional mentoring has (or not) affected their perceptions of teaching; How participants view the impact of their mentoring current students
Importance of Being a Black Educator	Discussions on participants' perceptions on the meanings of being a Black teacher and potential benefits to school & student
Importance of Education	Ways in which participants viewed education and the meanings of learning as students of engineering.
Meaning of Being a Teacher	Responses to the specific question, *"what does being a teacher mean to you?"*
Navigating STEM Pathways	Gender & racial aspects of teachers' experiences; Different support systems used while participants were students and currently as teachers (i.e., other teachers, NSBE)
Relationship Building	Discussions about relationships between teachers, students, and families
School Tracking	Accelerated college preparatory versus general college preparatory tracks; Students' abilities & tracking of students in particular programs; Perceptions of students within the school's different tracks
Training for K-12 Engineering Teachers	Or the lack of training; Previous engineers with no education training; What would it mean to teach engineering with proper training; What does teaching engineering in urban contexts look like; Professional development
Views on Teaching	People inside engineering look down at k-12 teachers of engineering; People in teaching profession look up to k-12 teachers of engineering

| Why Teachers Teach Where They Teach | Teaching engineering within urban contexts; Impacts of how participants interact with students; Discussion on how other teachers do not come from similar contexts as their students |

Appendix B. List of codes generated during the second cycle of coding

Generated Condensed Codes	List of original codes included in the condensed code
Becoming a Teacher	Career switch from engineering and/or architecture majors of careers
Education Beliefs & Philosophy	Importance of education; Family influences; Holistic approach to teaching students; Childhood influences
Navigating STEM Complexities	Navigating STEM pathways; Undergraduate college experiences
Perceptions of School Culture	School tracking; Why teachers elect to teach in urban contexts; Contributions of the district level & school level administrations
Teacher Retention Issues	Impact of mentoring; Entering & staying in the teaching profession; Training for k-12 engineering teachers
Views on Being a Black / Teacher	Views on teaching; Meaning of being a teacher; Curriculum designing; Importance of being a Black educator