In Search for Pleasurable Experiences for Black Girls and Women in Engineering and Computing

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Introduction:

"Such a system reduces work to a travesty of necessities, a duty by which we earn bread or oblivion for ourselves and those we love. But this is tantamount to blinding a painter and then telling her to improve her work, and to enjoy the act of painting. It is not only next to. impossible, it is profoundly cruel."

-Audre Lorde.

Not only are the share of engineering degrees conferred for Black women decreasing, but Black women are also leaving engineering fields altogether [24,1]. One can infer that this exodus is happening because Black women are acting in the Spirit of Lorde's call for Black women to find pleasure in the work that they do. In this literature-based argument, I explore how these unpleasant experiences are spun from anti-Black girl and woman sentiment in the U.S and in engineering and computing histories. I present the following guiding research question: *In what ways can Black girls and women make revisions in engineering and computing that will center Black Feminist Critical Thought in how one teaches, learns, and practices engineering and computing*?

Positionality #1

Hard work, grit, and determination have been knit into the fabric of my existence. Because of this rich history that has been instilled in me exemplifying my identity, I am a quick thinker, goal-driven, and community-oriented. In addition, I am an analytical person who always keeps the social factors in mind with whatever I do because of the sacrifices of my people. Traditionally, Baltimore is a segregated and blue-collar city. I would not have been exposed to the STEM opportunities that I have gained had it not been for my parents' generation creating Black suburbia and advancing the school systems in Baltimore County for my generation. My parents' generation saw a vision for their offspring to be better than past elders and ancestors were able to. With respect and honor being the center of my morale, I took advantage of the advanced learning opportunities. Being able to be exposed to a higher-level STEM learning at the K-12 level in majority Black public schools in the suburbs was an integral part of shaping my academic life. I was able to gain a level of confidence in my ability to learn material that's presently shielded from many Black students (i.e. performing arts, Black history in all higher-level contexts, college-level STEM classes, enlightening field trips to historic landmarks on the east coast, new languages, and cultures).

I went on to continue my academic interests (while still choosing to live within Black spaces) as I moved down south to study at the number one public Historically Black University, North Carolina A&T State University. Undergraduate years unlocked a new coming-of-age experience as I was able to grow holistically as a leader, scholar, and community servant. I was able to see upfront the non-monolithic nature in the Black community. I discovered in my undergraduate studies that, although Black people have similarities throughout life and historical events, we are diverse within the diaspora. Additionally, I learned and experienced how racism has caused even more internal disturbance within us as we have adopted harmful tactics against one another within the Black community.

During my time being involved on campus as a student leader and community servant, I was shown that southern-mannered, thinner, less spoken, daintier, fairer skin, with looser curl pattern Black women were most favored amongst my peers. This fully awakened the Black feminist/womanist that I am now. Though on my resume I am a STEM professional that attended high ranking STEM institutions where I excelled academically, in both Black and white spaces my eclectic, Pro-Black woman presence alone causes a disturbance.

To mitigate challenges, I stay rooted in my enriched legacy and my lived experiences. During my first engineering position, I was able to have a level of transformative introspection that allowed me to understand my background, my experiences, my personal, and STEM identity in ways that I can create a fulfilling livelihood that is value added to my community. However, while having gratitude for my background, community, and spaces I have been able to inhibit, I still found it purposeful to be critical of those spaces. For example, the experiences I have had with being in so-called accelerated STEM courses in K-12 were still rooted in neoliberal diversity quotas and taking advantage of Black children's advanced intellectualism in ways to prepare them for colonized corporations (with the condition of graduating from an accredited university). Also, I faced the harsh reality that the Black community took in too many white, hetero-patriarchal norms that do not help liberate all Black people. Safe spaces are very limited for those who are not heterosexual, male, and christian.

I seek solace in pouring mentally, emotionally, and financially into Black and Brown spaces, businesses, nonprofits, funds, and miscellaneous organizations. I continue to remind myself of my mission and remember my purpose. These traumatic experiences forced me to find purpose in the pain. I do not want other Black women or any oppressed people to have to face the disturbing things that I have in the STEM industry. During my fellowship commitment, I have self-educated myself on the Black Feminist Technoscience theorems and positionality. Essentially, this thought process poses the question of what would the STEM fields look like if it could be executed from the lens of a Black feminist? Black Feminism is all about creating a society for "the least of them". I want to have this at the core of my scholarly works and interests in engineering education. My scholarly interest surrounds environmental practices, engineering education, Black studies, and women's and gender studies.

Positionality #2

As a Black female graduate of an HBCU who participated in a National Science Foundation funded STEM program (HBCU-UP), I can speak first-hand to the impact that experience has had on my career and life. As a first-generation college student who left high school with a 2.9 GPA from a low-SES family, the odds were stacked against me out the gate. However, my undergraduate institution, like most HBCUs with STEM academic offerings, created a culture and sense of belonging that confirmed for me that the past was the past and my future was what I wanted it to be. More importantly, the care, support, and mentoring I received while in undergrad prepared me for the challenging experiences I would face during my professional career. This included being left out of conversations and key decisions within my male-dominated teams, fighting for clearly deserving pay increases or promotions due to ageism, and being called racist or sexist while encouraging fellow minority and/or female employees to demand what they deserve, just as I had been doing for myself. Looking back, the holistic process of my

undergraduate experience prepared me for those obstacles and served as a constant reminder that my duty here on earth is to use my story to help the next generation of people who will face similar challenges. My foundation of pleasurable experiences not only provided a path towards completing my undergraduate degree, with honors, it also prepared me for the next three graduate-level degrees I would receive including a Ph.D. from one of the top engineering schools in the country. Contrary to my non-pleasurable experiences, the positive moments included having managers of various racial/ethnic backgrounds and genders who did support and sent words of encouragement years after learning about those organizations. Also, using those experiences as a pathway of discovering what I really desired in life and how I would spend my time moving forward. Both the non-pleasurable and pleasurable experiences opened my eyes in many ways that have brought me to my current place in life. At this point in my career, I believe that it is my call to service to use research as a pathway for changes in policy and practice that will drive true change within diversity, equity, and inclusion for Black people within STEM education.

2) Addressing Anti-Black Girlhood in Formal Learning Spaces and in Broader Communities

Black girls lose their innocence in the eyes of society much earlier than other girls which trace back to when Black captives were separated by gender and age. Black girls were put on the same slave ships alongside Black women which subjected them to sexual violence, a "breaking-in", hyper-surveillance/policing, and the pressure to perform domestic responsibilities at the same rate as their women elders [Cornelius, 2021, personal communication; 2; 3]. These same issues have presented themselves in the modern era as Black girls do not have safe spaces to learn and grow inside the communities, classrooms, or outside their racial/ethnic communities [4]. Ma'Khia Bryant is a perfect example of an untimely death of a Black girl who didn't have the protection to live a vibrant life that every American is stated to be afforded per the constitution. Bryant faced alienation, lack of safe spaces within her own community, and violence from the white supremacist police force [5].

Margolis et all. (2003) makes the statement that "African American girls hold on to their self-esteem but become more pessimistic about both their teachers and schoolwork than other girls" [19]. To provide further context on why this may hold true, I reflect on Bryant's casualty. As one who can easily orient herself in Bryant's position, I often ask myself and other professionals/scholars where are the safe spaces for Black girls? Harris (2021) invited me in a conversation about anti-Black girlhood even in perceived "safe", high achieving, formal learning institutions.

Here is a synopsis of our conversation:
Me: Though I am grateful that we were one of the Black girls that "made it", I realize that there was harm even in "making it". When I am on Twitter and doing one of my reflective tweets on a fiction read or an engineering education article, I have a lightbulb moment that a lot of teachers really didn't understand Black girls like us who have complex backgrounds and identities, but only wanted to pay attention to the parts of us that they deemed worthy to give attention to. Like the whole concept of gifted and talented is problematic to me because they are your best friends when you are performing well on AP tests, but the minute other parts of me show up in that

space, it is frowned upon and deemed unacceptable. When I got into that fight with ole girl and I was suspended for the week, all they were concerned about was that I missed classwork and after-school study groups, so I can do well on the AP exams. Even the so-called professor I was "close" to didn't bother asking me why it was that situation or how was my mental health. And it was a heavy situation, too-- very similar to what Ma'Khia dealt with.

Harris: Exactly. But it's one of those things where they are so far in their worlds that they can't comprehend all the problems and pressures that Black adolescent girls face, even those that so-call "do well in school". We are much more than robots. At that age, we are becoming. Personally, I do not appreciate how there is this extreme push for us to be perfect STEM students that graduate, get into, and graduate with a STEM degree from a well-known university to give the school success stories. Then, they only want the "perfect" students that didn't have any blemishes in their sight to come back to the students and sell fairytales. And there's a specific type of Black woman that they want to influence the younger generation, and it isn't people like you and me. Though we beat the statistics and have the credentials, our stories and advice are a too "raw, loud, angry Black woman". Also, the over-push for STEM really made me neglect other skill sets that I had hoped could've been nourished.

3) Engineering and Computing As Inherently Anti-Black woman

Educators across engineering and computing make compelling historical arguments that display implications for anti-Black womanhood in the STEM and computing worlds. Comprehensively, scholarly works give an understanding of racialized and gendered inhibitors from primordial Euro-American science and engineering politics to anti-Blackness within education inequities, particularly against HBCUs [24;16]. Though these scholars do not explicitly focus on anti-Black womanhood when discussing the white, male, and straight socio-cultural-political contexts of STEM and computing spaces, I will provide follow-up commentary that unambiguously names anti-Black womanhood to give a grounded understanding of this subject. The hope is for this section to contextualize the need for more Black women histories of STEM and computing that do not only situate around white women counterpart's struggles, but also Black peoples' overarching STEM and computing journeys from the formation of Black organizations like the National Society of Black Engineers (NSBE) or being tokenized barrier breakers in a capitalistic engineering and computing system.

3a) History of Engineering and Engineering Cultures

When considering Black women's engineering histories, one must constantly ask where a Black woman (especially with multiple, oppressed identities) would be oriented on the hierarchy at any point. The socio-political origins of engineering deeply oppose any pro-Black womanhood ideals as the field was created, purposely, for the economic success of white, middle-class, heterosexual men [22]. While Black women were recently Emancipated from chattel labor, engineering grew from tradesmen culture often called "shop culture" where white men were trained in engineering colleges to learn hands-on techniques to solve practical problems [25]. This is what Secules (2017) describes as a replacement of free labor from Black people and "… the quintessential productive force behind the industrial revolution. A modern invention, a capitalistic invention." [25, Page 3]. During this time, American politicians and white educators questioned what type of

education would be appropriate for newly freed Black people. As Slaton (2004) notes, any inclusivity of Black people in technical occupations or education was in direct response to how it would benefit the U.S.'s global competitiveness and economy.

In response, HBCUs were created and led by "white architects of black education" that educated Black youth on skills that would support a growing industrialized economy but kept Blacks in the lowest socio-economic positions [26]. These types of inadequate and inequitable practices can be dated back to the initial advancement of ABET-accredited engineering schools which grew from 125 in 1940 to 234 by 1976 but included very few HBCUs. For example, by 1963, only 6 HBCUs had established engineering programs, however, Howard University was the only institution with established national accreditation [27; 21]. Ransom (2015) notes that these discrepancies can be attributed to findings linked to funding gaps between white and black colleges between both state and federal funding allocations.

Secules (2017) mentions that a few Black men were able to take advantage of the post-Emancipation industrialization boom, especially those who were able to graduate from land-grant institutions (i.e., HBCUs, for example) or northern universities. For the purpose of situating anti-Black womanhood in the early engineering and education spaces, it must be noted that many of these prominent Black men presumed the same conservative politics as they became a spokesman for Black communities. For example, one of the main leaders whose voice on Black education post-slavery prevailed, Booker T. Washington, denied Black agricultural colleges to teach classical subjects and stressed a pedagogy that would keep Black women in domestic and subservient positions [26]. Though having elitist undertones, W.E.B Du Bois championed Black women's education as he stated, "The future woman must have a life of work and economic independence. She must have the right of motherhood at her own discretion" (Du Bois, n.d.). Though a challenge to conservative industrialization culture, Black women found ways in informal learning spaces where they could be inventors or scientists. In one instance, Black women used their ecological epistemologies in gardening to reclaim the notion of what is meant to practice environmental engineering [15].

Moving toward the WWII era, the ways in which engineering was taught changed from a practical, hands-on approach to engineering science. Seely (1999) notes that engineering teaching methods were coincided to meet the needs of the military that included the utilization of computers, electronics, nuclear bombs, and other emasculated weapons of destruction as engineering scientists were more equipped to execute these projects. Black women did not have the opportunity to be trained in formalized engineering science pedagogy as white leaders and Black conservatives of Black colleges, did not support the "scientization" of agricultural research and teaching [26]. Along with this transformation in engineering practices, engineering became even more anti-Black women as a masculinized and militarized meritocracy was established through "weeding" students out with unnecessary academic endurance and rigor [22].

Furthermore, one can conclude that even daily technology and artifacts were centered far from the needs or social politics of oppressed peoples and "enhance the power, authority, and privilege of some over others" [28, Page 6]. For example, bridges were made low so that buses that carried Black people couldn't bring them to areas intentionally reserved for white, middle, and upper-class people, military weapons of mass destruction typically used on other Black and Brown

peoples across the diasporas, and molding machines that more than likely, low-waged Black trades workers probably had to use [28]. Winner (2018) suggests that technology and artifacts can be redesigned and rebuilt to be more suitable for minoritized people. In the spirit of revisioning engineering, engineering education, and technological artifacts from the exclusionary and discriminatory engineering histories against Black women, "Americans must eradicate all traces of racial injustice, including minority underrepresentation in science and engineering arenas, for moral rather than strictly practical reasons" [26].

3b) Feminism in Engineering and Computing

Sterling (1990) suggests that, in the 1800s, sex and race became tools of oppression to define social worth. It is presumed that, during this time, Euro-American women's and African nations' achievements became erased during patriarchal control and colonization. In response to this, Sterling (1990) provides the following questions: "What scientific accomplishments in African nations were destroyed by colonial expansion? How did the extraction of goods from non-European nations affect the growth and construction of science as an arena of knowledge supposedly immune to the daily struggles of the world?" and "why are there so few women scientists that we know about?" [13, pg. 2]. Sterling also presents an image from Cesar Ripa's 1618 Iconologia of a Euro-American woman representing feminist science. Bix (2004) furthers the timeline to 19th-century women's histories in engineering and engineering education. She makes note that, initially, few women were able to attend and withstand hostile engineering programs and workspaces. These women were known as outliers who performed work outside their gender customs. Not until WWII were women recruited from industrial companies to do engineering work because of the shortage. When returned from war, men were not accustomed to working alongside women in engineering spaces and caused resistance. This resistance called for women to create support groups such as SWE in 1946. Women of these organizations organized for women to have equality to men at institutions and workspaces. These women organizations used second-wave feminist principles to attract and train women to be "good engineers". Sterling (1990) and Bix (2004) give contexts of how white women were disenfranchised in early and modern eras; however, one still wonders what are some pre-slavery, Black feminist science imagery? Who is acknowledged as the mother of Black science and invention aside from industrialized and colonized engineering contexts? What are the Black women's science and engineering histories that pre-date the late 20th and now 21st century? Why do we not know about them separate from Black men's achievements in US history? Black feminist engineering histories highlight Black women inventors such as Mary Kenner who made the first menstrual pad (or sanitary belt) or accredit Madame CJ Walker as one who informally practiced chemical engineering with her successful hair care manufacturing business. For example, Dr. Arlene Hambrick's (1993) dissertation, *"Biographies of Black female scientists and inventors: an interdisciplinary middle school curriculum guide: what shall I tell my children who are black?"*, is a masterpiece that fully analyzes the intersectional life experiences of the four mildly-known Black women (Miriam Benjamin, Sarah Boon, Marjorie Steward Joyner, Mary Beatrice Kenner, and Mildred Austin Davidson) who were the few Black women accredited with the title of "inventor" from the end of civil war era into the industrial age; and the need for biographies such as these to be integrated into science and math curriculum so Black children can know that Black women have always contributed to technology. These stories go untold as if Black women never existed in technological advancement domains because of the inequities Black people faced with

their lives de-humanized as second-class citizens and women's work only being attributed to domestic labor [10]. These women had to navigate womanhood, motherhood and simply surviving the harsh conditions of being the first generation removed from slavery while fighting systematic injustices during the patent process.

It is sobering that there is much we do not know about Black women's engineering or computing histories with even more limited knowledge of them as scientists or inventors. Nonetheless, there is another scholarship that allows us to explore non-conventional pathways of Black women as knowledge holders in engineering, technology, and science through Afrofuturism, Black feminist technology studies, and Black feminist womanist spiritual practices [6; 7; 8]. Because Black women are familiar with being "appropriated, exploited, misconstrued, and ultimately dismiss" [8] within traditional engineering and computing spaces, *"Black feminists and womanists offer a methodological stance that is dialogic or conversational in approach, that views the relationship between researcher and research subject as collaborative and equal, that incorporates activism into the scientific method, and that does not discount the importance of spiritual as well as material (including concrete, every day) scientific concerns"* [9].

4) Centering Black Feminist Epistemology and Pedagogy in Engineering and Computing

Influenced by the anti-Blackness theoretical framework, one questions what it means to learn and practice engineering in a way that centers Black critical thought. A group discussion with Dr. Holly Jr. from his publishing *"Disentangling engineering education research's anti-Blackness",* Dr. Holly Jr. enlightened a community of first-year engineering and computing doctoral students that there is a difference between being a Black engineer and one who does Black engineering work that is culturally responsive to the Black community and engages in research and practice from a pro-Black epistemology [17]. For example, Addae et all. (2014) discuss the importance of cultivating Black technology entrepreneurship programs through HBCU engineering programs as a way for Black engineers to foster their own engineering/tech startups that could increase more Black innovation, filling gaps of unemployment in Black communities, and using Black tech experts to help solve other crisis linked to systematic oppression. One finds it imperative to further this concept of doing pro-Black engineering and engineering education research and practice and add on principles from Black feminists outside of engineering and computing to explore pro-Black women engineering ventures in teaching, research, and practice. In *A Black Feminist Pedagogy*, Omodale (1987) gives context on how Medgar Edgars College students created a sit-in move to raise concerns to integrate academic coursework that emphasized the research, development, and studies that are relevant to poor and working-class Black women. One can hope that this methodology could be integrated in engineering and computing to shift from Black women working as engineers and computing sciences in white male-missioned organizations to Black women engineers practicing engineering in ways that benefit Black women and their communities.

Much work about Black women in STEM education focuses on Black women in the context where they are used as diverse subjects to improve the workforce or victims within the history of innovation and technology. For example, Anarcha Westcott has been used as the Black woman who helped advance modern gynecology. However, she never consented to be a test subject. As an enslaved woman, Anarcha never consented to the abuse she faced for "the father of

gynecology" to make advancements in the health science fields for non-Black women patients. Omodale (1987) calls for Black Feminist Pedagogy to be used in a way that "offers the student, instructor, and institution a methodology for promoting equality and multiple visions and perspectives that parallel Black women's attempts to be and become recognized as human beings and citizens rather than as objects and victims" [20]. Hall (2017), a Black woman computer scientist, admits that she switched to humanity-type subjects for her doctoral program because it was difficult to critique and center Black feminist thought in the ways that Omodale (1987) described in her technical courses. In *Technology in a Black Feminist World*, Hall (2017) revisions how the use of technology is taught and practiced in a way where everyone "is free to learn, to explore, and to innovate" and Black women can "develop and code our own community's technologies" [20, page 2]. Winner (2018) suggests that technology and artifacts can be redesigned and rebuilt to be more suitable for minoritized people. This prompts one to think about what it would mean for engineering and computing to be redesigned and rebuilt in a way that uplifts Black women and the communities they care for, as well as values Black women's thoughts on engineering design. Linsey (2021) provides an example of how culturally responsive education can be made for Black girls via informal maker spaces. The girls were able to have access to cutting-edge digital fabrication technology where they could create artifacts culturally relevant to them, a safe space to learn about Black women's STEM histories and mentorship that stimulated positive STEM identity development and self-reflectivity [18]. When merging the scholarship in the section, one wonders how engineering and computing practitioners and educators can utilize Black Feminist Pedagogy in formal education and workspaces. Black girls and women should not only have to be confined to only utilizing pro-Black girl and woman positionality in non-formal STEM education spaces when most of our time in STEM is spent in formal school and work settings.

5) Conclusion and Contribution

In closing, to understand the lack of pleasurable experiences Black girls and women face in engineering and computing, one must look at anti-Black girl and womanhood experiences in their personal lives, in educational settings, and in the workplace. It is essential to critique the history and present-day examples of anti-Black girls and womanhood to move in a more positive direction for generations to come. As scholars, who have been centered in anti-Black girls and women in engineering education and workspaces, we are constantly wondering where the safe spaces for Black girls and women in engineering and computing are. Influenced by those who have developed pro-Black women epistemologies, our hope is to add Black feminist epistemology to how engineering is taught, learned, and practiced fostering pleasurable experiences for Black girls and women in this field.

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