SEEK AND YOU SHALL FIND: BUILDING STEM EDUCATION AND CAREER PATHWAYS FOR GIFTED BLACK GIRLS

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Is it possible that the square root of impossible is me?

—Journey (Jingle Jangle, 2020)

Historical and fictional films in the past 5 years have given Black girls and women glimpses of themselves and have opened a pool of inquiries about career opportunities. These on-screen depictions have helped remove misconceptions about the homogeneous archetypes of who can engage in STEM. These media representations of Black women in STEM appear in biographical films such as Hidden Figures, Melfi (2016), which illuminates the brilliance of young engineer and mathematician's journey, also in the film Jingle Jangle, Talbert (2020), the early exploration of STEM with Doc McStuffins, and lastly, through scientist Shuri's genius in Black Panther (Coogler, 2018, 1:20:15). These films have shown Black girls and women exploring and thriving in STEM pathways and careers. As the authors of this text, Tia Dolet and I use these modalities of critical media as an example because representation and positionality are key to unlocking opportunities for the brilliance and talent potential of gifted Black girls and women (GBGW). Representation is a key component, but educators have to move beyond representation to action-oriented initiatives to engage girls (Pringle, 2020). This also leads the authors to critically examine the ways in which educators position STEM education and career pathways for gifted/high-ability Black girls and women.

The research and literature about the experiences of gifted Black girls and women are scant but a critical need (Anderson, 2020). Even more so, explorations about the talent identification and development of Black girls in STEM are needed for K–12, postsecondary, and advanced degrees. This article aims to explore our positions as formally identified gifted Black girls exploring STEM education and ways our occupations have rendered us opportunities to identify and develop the gifts and talents of Black girls and women in integrated STEM spaces. We aim to provide strategies and approaches that have benefitted us as formerly identified gifted Black girls and women, as well as insights about our own educational trajectories and engagement with STEM (K–12) as educators and community activists. We utilize Critical Race Feminism Theory to frame the work and provide a scope and sequence to pathways of development for young Black girls and women in STEM through university-school-community partnerships.

REVIEW OF RELATED LITERATURE

UNDERREPRESENTATION OF GBGW IN GIFTED AND ADVANCED K-12 STEM EDUCATION

Historically, there has been an underrepresentation of Black students in gifted education programs (Ford et al., 2000; Grissom & Redding, 2016; Jenkins, 1936). To help close this gap, local, state, and national policies and initiatives have attempted to make gifted education programs more accessible, including by providing more culturally competent identification screening (Ford & Grantham, 2003; Ford et al., 2016; Naglieri & Ford, 2003). Unfortunately, Black girls are still underidentified for gifted services (Evans-Winters, 2014). During the 2015–2016 academic year, roughly 50% of identified gifted students were girls. However, Black girls were only 9.4% of girls in gifted education classes in comparison to White girls who made up 57.8% of the identified gifted female population (U.S. Department of Education [USDOE], 2018). Due to this vast underrepresentation, much is unknown about the narratives of Black girls in gifted education (Anderson & Martin, 2018).

For GBGW, there have been additional opportunity gaps in terms of access and equity to rigorous STEM classes. Schools with high Black and Latinx student populations have less access to Algebra I, Geometry, Algebra II, advanced mathematics, calculus, biology, chemistry, and physics (Civil Rights Data Collection, 2018). It is critical to note that Algebra I is considered the gateway course for upper-level STEM subjects. A recent data story released by the U.S. Department of Education (2018) called the lack of an early Algebra I foundation the "leak in the STEM pipeline" for many U.S. students. The report highlighted the critical need for students to take algebra early (eighth grade); however, only 41% of public schools offer Algebra I in the eighth grade (USDOE, 2018). Additionally, for eighth graders who had access to Algebra I, only 25% of them took the course (CRDC, 2018; USDOE, 2018). Of that 25%, Black students accounted for only 12% of the Algebra I eighth-grade enrollment (USDOE, 2018). Most likely the result of unequal access to STEM education, the National Assessment of Educational Progress (NAEP, 2015) showed that only 16% of Black girls were proficient in math by eighth grade.

Regardless of proficiency rates, at the high school level, Black girls are still engaged and interested in STEM subjects while navigating the limited access to this content (Hanson & Palmer-Johnson, 2000; Mau et al., 1995). At this critical turning point, they must decide if their passion for STEM could later translate into a career. Collins's (2018) Black student STEM identities (BSSI) model explores Black girls' motivators for pursuing upper-level STEM courses during their high school years and what pathways would place them on track to enter a STEM undergraduate major. The model predicts Black girls' questioning of their belonging in STEM spaces, their probing of whether they could succeed, and their analysis of how they would have to assimilate—and their willingness to do so—in order to be successful (Collins 2018; Collins et al., 2020). Nonetheless, an examination of roughly 20 years of research on Black women and girls in mathematics education showed that those who persisted through the STEM pipeline were nurtured in developing a positive math identity through classroom environments designed for them to excel in STEM (Joseph et al., 2017). In mathematics classrooms, Black girls are often intellectually invisible and are aware of this marginalization in STEM education settings (Gholson & Wilkes, 2017; Harper & Anderson, 2020; Jones, 2003; Joseph et al., 2017). Researchers and practitioners have found that Black girls are collaborative learners

whose complex learning experiences benefit from positive social interactions and supportive learning environments (Joseph et al., 2017; Tuitt, 2003; West-Olatunji et al., 2007). In a synthesis further examining Black girls' learning experiences in STEM education, Ireland et al. (2018) highlighted the nuanced socioemotional needs that must be met in order for Black girls to thrive in these spaces.

UNDERREPRESENTATION OF BLACK WOMEN IN STEM IN HIGHER EDUCATION AND CAREERS

A study conducted by the American Psychological Association (APA) found that Black women were actually more likely than White women to express wanting to enter a STEM major in college but are less likely to earn a degree in a STEM field (O'Brien et al., 2015). In an APA (2014) press release for the study, the lead researcher stated: "If Black women start out in college more interested in STEM than White women, but are less likely to complete college with a STEM degree, this suggests that Black women may face unique barriers, such as race-based stereotypes" (para. 9). When Black women's interest in pursuing a STEM field/career is met with systemic and structural obstacles, the result is their vast underrepresentation in STEM undergraduate majors and careers (Joseph, 2020). The National Science Foundation (NSF, 2017) found that of the STEM bachelor's degrees earned in the U.S., Black women accounted for 4.23% of degrees in the biological sciences, 2.6% in computer sciences, 2.83% in the physical sciences, and only 0.99% in engineering. When comparing the STEM degree attainment of Black women in STEM fields between 1995 through 2014, NSF (2017) also revealed a steady decline of their degrees conferred in math and statistics, physical sciences, and engineering. At the doctoral level, 42,227 PhDs in STEM were awarded in 2018 of which Black women accounted for merely 2% (856) of the doctorate degrees earned (NSF, 2020).

This causes us to question: What forces/factors could be driving this underrepresentation? A study examining undergraduate student trends of persistence within different majors found that Black students with STEM majors were least likely to persist toward a degree in a STEM field and more likely to switch majors or leave college altogether (Riegle-Crumb et al., 2019). These findings suggest that many Black undergraduate STEM majors lacked the institutional support needed to complete their degrees. Accompanying this discovery, another study emphasized university academic cultures that "provided few formal support structures to ameliorate barriers encountered by African American STEM as they progressed through their program of study" (Lancaster & Xu, 2017, p. 184). Participants, all Black STEM majors, described hostile learning environments, difficulty building relationships with STEM faculty members, large and intermittent class offerings, challenges with academic advising, and a lack of mentoring and other peer support (Lancaster & Xu, 2017). Even at the doctoral level, Black women in STEM still struggle to find their place in their field. A study of people who earned a PhD in a STEM subject showed that Black people and women were most likely to leave the field (Turk-Bicakci & Berger, 2014). At this intersection, the retention rates for Black women in scientific research and development are in peril.

Reflective of the barriers Black women and girls face in STEM education, their underrepresentation is echoed in the workplace. It is estimated that men make up 74.9% of the STEM workforce (U.S. Census Bureau, 2017). White men are the majority of the workforce

(53.8 %), while Black women hold just 2.2% of all STEM occupations (U.S. Census Bureau, 2017). Additionally, only 5% of STEM managerial jobs are held by Black men and women (NSF, 2017). Gendered stereotypes about STEM leadership and various STEM professions also contribute to men's overwhelming dominance in the computer science field (Beyer, 2014; Funk & Parker, 2018). Although decades of data have shown no consistent gendered math achievement gap in upper elementary and middle school years, in the school districts where boys outperformed girls in mathematics—notably all affluent, majority White school districts—there were also gender employment and income gaps present (National Science Foundation 2020; Reardon et al., 2018). This implies a trend of preparing boys (especially White boys) from upper-class households for top-paying STEM jobs and leadership roles. For Black girls especially, these types of educational barriers can have economic consequences. Black women in STEM careers earn 87% of their White female colleagues' salaries and only 62% of the salaries of their White male colleagues (Funk & Parker, 2018).

OUT-OF-SCHOOL STEM PIPELINE SUPPORT

Although formalized educational spaces present obstacles for GBGW engagement in STEM, out-of-school time (OST) programs have made impressions for supporting minoritized student populations throughout the K–career STEM pipeline (Anderson, 2020; Anderson & Coleman-King, 2020; King & Pringle, 2019). A meta-analysis of research on OST STEM programs showed their positive effect on students' interest in STEM and contribution to their academic success in mathematics (Young et al., 2017). OST STEM programs also give students access to resources that may not have been afforded to them otherwise, like materials for science experiments, the expertise of program facilitators, and STEM education settings that extend beyond the classroom (Barron et al., 2012). An evaluation of OST programs specifically designed to engage girls in STEM education found that participants' engagement in supplemental STEM activities resulted in improved confidence using math skills, increased plans to enroll in undergraduate STEM majors, improved classroom behavior, improved problem-solving skills, increased confidence in using computers, and decreased beliefs in gender stereotypes (Chun & Harris, 2011). King and Pringle (2019) centered the voices of Black girls who participated in I AM STEM, a program they referred to as a community-based informal STEM program. One of the themes that emerged from this research emphasized how programming that was intentional about the race, gender, and socioeconomic status of the participants recruited resulted in Black girls becoming self-agents in determining their future engagement in STEM activities. During the school year, participants were engaged in science-based field trips in their communities. As a result, many chose to participate in summer and spring break STEM programs at these sites (King & Pringle, 2019).

At the secondary and higher education level, summer bridge programs can provide minoritized students with additional support in STEM education and nurture the growth of their STEM identity. As defined by the U.S. Department of Education, summer bridge programs happen during the bridge period between high school and college "designed to ease the transition to college and support postsecondary success by providing students with the academic skills and social resources needed to succeed in a college environment" (Institute of Education Sciences [IES], 2016, para. 1). Studies and evaluation reports have found that for decades, summer bridge programs have been influential in improving the persistence, retention rates, and academic performance of underrepresented student

populations (Ackermann, 1991; Garcia, 1991; Walpole et al., 2008). As verified by the What Works Clearinghouse, bridge programs also have a positive effect on participants' undergraduate degree attainment (Murphy et al., 2010). College bridge programs can be exceptionally beneficial for first-generation students and/or students of color entering STEM majors. Summer bridge programs have been shown to help participants' retention rates in their STEM programs, facilitate ongoing support and campus/academic resources, create opportunities for networking within the field, and provide a sense of familiar belonging (Maton & Hrabowski, 2004; Tomasko et al., 2016).

For more than 30 years, the University of Maryland Baltimore County (UMBC, n.d.) has accepted cohorts of diverse students for its Meyerhoff Scholars Program (MSP) with the intention of diversifying the STEM field. The program is built on a culture of ongoing support throughout the participants' undergraduate career, and it begins with a summer bridge program before their freshman year. The bridge program was found to be essential for creating a community foundation and campus network for MSP students (Stolle Mc-Allister, 2010, 2011). Black students in the program were found to be twice as likely to earn a STEM bachelor's degree and 5 times as likely to pursue a PhD than Black UMBC STEM majors who were not Meyerhoff Scholars (Maton et al., 2000, 2009).

MENTORING FOR BLACK GIRLS AND WOMEN IN STEM

As we prime pathways for STEM careers and development, schools, educators, and families must actively center the needs, characteristics, and challenges of Black girls. Their underexplored lack of access to gifted, Advanced Placement/honors, and STEM programming—more than any other minoritized group (Anderson, 2020)—places them at a vast academic disadvantage, particularly in the realm of STEM education. Their experiences have been both hypervisible and hyperinvisible, which calls for intentional and extensive mentoring among other structural interventions. Rodriguez Amaya et al. (2018) called for the critical need of faculty mentoring for minoritized women in undergraduate programs as a means of guiding student learning and self-identity. Joseph and Cobb (2019) argued for early intervention and exposure to science and mathematics to support STEM engagement and persistence. With these early explorations and mentorship, gifted Black girls are better prepared to engage and achieve in advanced STEM coursework and programming. Mentorship, when coupled with anchors to foster STEM identity development, will assist with positioning gifted Black girls to mirror and demonstrate ideas, values, strategies, and actions that promote STEM career development (Collins et al., 2020).

METHODS

As educators, families, and community stakeholders work to meet the needs of high-ability/gifted Black girls, they are contending with the ways these students are being seen across educational learning spaces. At present, Black girls and women have been largely invisible in gifted education research and engagement, and in larger educational contexts, much of discourse has been around disparate discipline and treatment in classrooms. In addition to how Black girls and women are being perceived, educators must reframe their existing knowledge of how they understand the impact of race, gender, class, and place have on STEM career path development. Gifted education programs and facilitators must disrupt existing structures and perspectives in gifted programming and services

because they do not accurately capture or portray the brilliance of Black girls and women (Anderson, 2020). As educators interrupt and reimagine how gifted and talented programming and services recognize talent in formal spaces, they can also look at the potential of out-of-school learning contexts.

Using qualitative methods to explore our narratives, we used duoethnography to share our ethnographic accounts, detailing our experiences through paired and individual voice and prose. According to Sawyer and Norris (2015, duoethnography is a collaborative research methodology in which two or more researchers engage in a dialogue on their disparate histories in a given phenomenon. We frame and position our intersectional experiences of knowing, learning, and doing in OST STEM opportunities as gifted Black women at the center of this work (Dillard, 2012; Evans-Winters, 2019). As we co-constructed our duoethnographical renderings, we identified similar themes across K–12 gifted education experiences, enrichment programming, and pipeline development. To demonstrate this, we have included our narratives to showcase our authentic lived experiences as gifted-identified Black girls and now as educators.

THEORETICAL FRAMEWORK

In order to both frame and understand our unique and nuanced experiences at the intersections of race, class, gender, ability, and other identities, we use Critical Race Feminism Theory (CRFT) to guide our duoethonographies. Critical Race Feminism Theory is an extension of Critical Race Theory but has its distinctions, particularly as it provides an unapologetic examination of the broad experiences of women of color (Wing, 1997). Several scholars utilize CRFT to analyze and explore the experiences of Black girls and do so without conflating or comparing the needs of Black boys in educational settings (Evans-Winters & Esposito, 2010). CRFT focuses on the lives of those who face multiple discrimination on the basis of race, gender, and class, and reveals how these factors interact within a system of White male patriarchy and racist oppression (Wing, 1997).

CRFT as a multidisciplinary approach emphasizes both theory and practice, where discourses and policies around issues for women of color are supplemented with praxis by acting on micro and macro levels to deconstruct, and then counteract, oppression of Black women and girls. In this paper, race, class, ability, and gender are social phenomena within larger socio-historical and political structures, particularly focusing on outside-of-school STEM experiences. This research answers a call "to alleviate the knowledge desert that exists around the lives and experiences of Black girls" in out-school-school programming and STEM (Crenshaw & Allen, 2014, p. 6) by exploring the multiple identities and experiences of Black girls and surfacing (from their perspectives) the complex intersections of race, gender, and STEM spaces. We use our voices to share our experiences with out-of-school gifted programming to provide critical insights to STEM career pathways and development.

BUILDING THE STEM PIPELINE: OUR VOICES, OUR EXPERIENCES

BA'S OUT-OF-SCHOOL-TIME OPPORTUNITY: SUMMER ENRICHMENT CAMP

In my seventh-grade homeroom, my teacher made the announcement regarding a program Baylor University would offer in the summer camp for gifted students. This was a grant-based project for gifted students from low-income backgrounds in the district. Project Promise students received full scholarships to attend University for Young People, a summer enrichment program. The program is modeled after engaging classroom experiences enriched with problem-based instruction, cohort groups, mentors, and a full campus experience. This was my first experience in an out-of-school program and summer camp, and I did not know what to expect. This was also my initial exposure to a college campus, despite it being near my home. To a future first-generation college student, the academic and social atmosphere was a new experience that served to inform my knowledge base about college in general but also shifted my perspective about collegiate access.

This type of enrichment was a move from the monotonous and scripted learning that occurred at my Title I middle school. From the robust courses offered, I chose French, engineering, leadership, creative writing, and geology, and a new awakening and engagement with learning transpired. To my surprise, the geology class struck a renewed sense of curiosity for me, and the engineering class activated my creative problem-solving skills. At this camp, learning new things that aligned with my interests, core tenets of programming, sharpened my skills and knowledge and made learning meaningful for me. This type of learning was not centered on memorization, but divergent thinking, which sparked a sense of freedom for me. In addition, I did not feel singled out for my abilities by my same-aged peers; we were able to create synergistic experiences based on our interests. The exposure to the university and newfound awareness of navigating my strengths, talents, and challenges with critical thinking offered moments of insight on how I identified as a gifted and talented learner.

This summer enrichment program helped me not only explore new content-specific interests and my leadership potential, but also think critically. From this initial experience, I began to read the world in different ways and approached school engagement beyond grades. This out-of-school environment allowed me to take risks, evaluate, develop, and create. Not only did this camp shape my interests and how I viewed myself as a scholar, but it also began to shape how my mother viewed gifted education and pathways to deepen and enrich my learning experiences. From the three summers at this educational camp, an engagement and skillset in science and technology was developed. I later applied for the Academy of Information Technology in high school and devised how I engaged with this subject matter. An educational trajectory was forged in addition to the network connections that were made with university personnel that would benefit me later as I became an undergraduate student at Baylor University.

Unknowingly, it was during this time that my scholar identity around the experiences of Black girls in university-school-community partnerships activated. Having this experience provided me with the resources and exposure to an institution of higher education, rigorous academic content that included STEM development and engagement, a gifted peer community and network, and opportunities to identify my talent and creative potential.

Similar to the presuppositions of Collins's (2018) Black Student STEM Identity (BSSI) Model, this opportunity provided a pathway to identify and engage STEM talent development outlets that

I later used in my teaching as an elementary educator. However, my initial interest to engage in OST STEM did not translate to the general classroom setting. The lack of pipelines and pathways to participate in STEM activities limited the scope to extend my schema, particularly in science. Therefore, without these anchors, my reflective identity and competence to engage in STEM were not fostered (Collins, 2018). It was not until my appointment as a professor did I realize that I did have a STEM identity and reflected on the opportunities missed for me to both value and engage in STEM disciplines.

TD'S NARRATIVE: EXPLORING LEARNING PREFERENCES AND A COHORT MODEL FOR STEM EDUCATION FOR MINORITY STUDENTS

Upon receiving my acceptance for American University, I was told I also had to attend the Summer Transition Enrichment Program (STEP) bridge program. Minoritized students were identified for this program based on a variety of markers about our graduating high school, first-generation status, grades, and standardized test scores. Although the program was mandatory for admission and many of us did not want to be there at first, it ended up being a great opportunity to get the support we needed to get acclimated to the university. One of the best parts about this program was its emphasis on math education. Even though we all did not have STEM majors, the university's general education program required us to take nine credits of math and science courses. During STEP we were able to complete our math credits in a collaborative environment that gave us the extra support we needed. Having the opportunity to also live on campus, our cohort was able to learn and study in a community environment. Within our living and learning community, we were able to lean on each other for support in subjects that most of us had struggled with in high school mostly because our high schools did not offer opportunities for upper-level STEM education. Our resident assistants and program director were also great supports as well. They connected to resources on campus that supported our success in our foundational STEM classes. Without this model, I would have struggled to pass these classes on my own. I was able to reconnect with statistics, as I was now in a non-hostile environment that did not penalize my inquisitiveness and gave me the time I needed to understand key concepts. Although my undergraduate degree is in the arts, this experience gave me the confidence to pursue quantitative later during my master's and PhD programs.

PIPELINE STUDENT SUCCESS COACHING IN UNDERGRADUATE STEM EDUCATION

I (TD) served as a Student Success Coach for the Achieving Collegiate Excellence and Success (ACES) program, a partnership in Montgomery County, MD, between Montgomery County Public Schools, Montgomery Colleges, and the Universities at Shady Grove (USG). I was the coach once students entered the junior and senior years at 4-year undergraduate programs at USG. Most majors on the USG campus are STEM-focused, as they were designed to train a local workforce for high-demand STEM careers in the county. Through this mentoring structure, students were able to receive one-on-one success coaching that provided them a space to set goals (personal, professional, and academic), explore career options in their chosen field, discuss graduate school opinions, and plan for their post-undergraduate lives. Additionally, the program required them to meet semesterly with other academic and career support services. As their coach, I noticed that my most students did benefit

from personalized coaching sessions that allowed them to connect their course content with possible careers in the STEM industry. I believe this model of ongoing support was successful because it led them to not only securing internships and later full-time jobs in their fields, but also asking if their classmates could meet with me to help them plan as well. Referrals are the best sign that something is working! Their peers, mostly minority and/or first-generation students as well, had not been receiving the career counseling needed from their department to help them continue on the STEM pipeline.

With these experiences, I was able to actualize pathways possible for gifted Black girls to experience mentorship, preparation, and engagement in STEM. It was through these OST STEM experiences that I realized how pertinent mentorship and STEM cultural relevance was necessary for Black girls (Collins et al., 2020). Using this critical knowledge of career pipelines and pathways, I now utilize this knowledge to inform the types of data analysis and programming I develop and design for students in urban schools, particularly Black girls.

SUGGESTIONS FOR TEACHERS, FAMILIES, AND COMMUNITY STAKEHOLDERS

We use our narratives to provide framing for educational stakeholders looking to shift perspectives and opportunities for high-ability/gifted Black girls. In order to frame this shift about perspective, talent development, and identification, we must consider these stories that move GBGW from the margins. We positioned our narratives as former students in these programs in addition to how we can engage in OST as facilitators. We utilized an intersectional lens (Crenshaw, 1991) to unpack our experiences with race, gender, class, and ability because all of the identities matter in the ways our girls engage, build capacity, and showcase their brilliance. When we say intersectional, we nuance their experiences based on race, class, gender, ability, place, language, and other identities that disrupt the idea that Black girls are monolithic.

As stakeholders engage in intersectional conversations about career pathways and OST engagements in STEM, we advise them to consider points of access for GBGW. What programs, courses, people, and other resources are available to identify and develop the STEM talents of GBGW? What are your attitudes or dispositions around the needs, engagements, and perceived interactions of GBGW? Do you believe this population has a right to these services? Do you consider this group as you are planning for STEM or other opportunities? What do you know about this population and their needs, and how can you learn more information? Seek out resources on Black Feminism and other educational sectors, such as math education. Lastly, how are you considering the interests of GBGW? We encourage stakeholders to ask GBGW about their interests and then consider the ways to bridge some of these interests with STEM opportunities and content. If a young woman is interested in makeup or skincare, what chemistry or math activities could you incorporate into my OST enrichment or conversations? If she is interested in coding, who do you know who codes or what organizations can you connect her to? As suggested by Tia, consider the bridge programs that may be available for these students. As you consider action-oriented steps to establish and sustain STEM pathways for high-ability and gifted Black women and girls, create a multi-year action plan to create relationships with organizations, understand what may be working within your program, and draft

goal setting methods that support successful completion of set goals such as the SMART Goal Method, Specific Measurable Achievable Relevant Time-bound (SMART), equitable goals for your students.

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