The Invisibility of Black Girls in Mathematics

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Partnering with students to support them in becoming educated, productive, and responsible citizens is at the core of the Virginia Department of Education's mission, and I wonder how Black girls are experiencing this mission in their K-12 trajectories? The 2015 NAEP mathematics data for Virginia shows a 22- and 30-point difference between Black and White fourth- and eighth-graders respectively (National Center for Education Statistics). Although Board of Education President Billy K. Cannaday Jr. notes that the state board's top priority is to continue to work toward narrowing and ultimately closing the achievement gap between Black and White students, I wonder what Virginia plans to do for its Black girls in particular? The 2015-2016 Virginia State *Standards of Learning* (SOL) Assessment data shows the following pass rates for Black girls from third- through twelfth-grade (see Table 1).

So just what is the state of Black girls' experiences in mathematics in Virginia? It is difficult to answer this question in part because most states rarely disaggregate their assessment data at intersections of race and gender, but also because there is a limited focus on contextualized studies that examine Black girls and their mathematics education experiences. It is not just a Virginia problem; it is a national problem. Black girls' experiences in mathematics remain invisible and largely untheorized and this invisibility produces obscurity to most mathematics teachers; consequently, program and learning design efforts remain non-existent. Interventions that are put in place are usually single-axis and assume that either all girls or all African-American students have the same needs. Intersectional interventions can provide promise for Black girls and other racialized minorities. Such interventions would not only take into account Black girls' particular learning needs for persistence in mathematics (Joseph, Hailu, & Boston, 2017), they would also account for issues of power, oppression, and center social justice (Collins & Bilge, 2016).

Understanding Black girls' experiences in mathematics during their K-12 trajectories can shed light on their underrepresentation in higher education majors and careers that require mathematics degrees. For example, studies have shown that Black girls have higher mathematics career aspirations than their White and Latina female peers (Riegle-Crumb, Moore, & Ramos-Wada, 2011), yet, few make it to the doctoral level. Table 2 shows the number of mathematics doctorates awarded to American citizens over the last 10 years. What we notice is that over the last 10 years, White males earned roughly 75% of the mathematics doctorate degrees in comparison to all women. We also notice that in 2014, all women, with racialized women yielding eight percent, and Black women roughly one percent, earned 27% of the math doctorates.

Table 1. *2015-2016 Virginia State Standards of Learning (SOL) Assessment Pass Rate for Black Girls, 3rd – 12th*

	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
Black Girls	64.48%	73%	69.9%	74.15%	62.18%	71.60%	79.97%	72.32%	69.94%	67.03%

Source: Virginia SOL Assessment Build-A-Table (http://bi.virginia.gov/BuildATab/rdPage.aspx)

Table 2. *United States' Mathematical Sciences Doctorates: Females Compared to White Males 2005-2014*

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total (M/W)	540	583	645	671	788	863	849	852	912	948
Total Women	152	151	193	218	235	245	230	224	242	254
Black	9	5	5	11	16	9	9	10	6	9
Hispanic or Latino	6	11	4	5	12	8	9	11	6	7
Native American	0	0	1	0	1	0	0	0	1	1
White	101	102	132	161	154	168	155	163	170	179
Asian	NA	NA	NA	NA	NA	NA	38	22	34	32
Asian or Pacific Islander	26	20	29	24	27	39	NA	NA	NA	NA
Hawaiian/ Pacific Islander	NA	NA	NA	NA	NA	NA	0	0	0	0
Other	10	13	22	17	25	21	18	15	22	22
Two or More Races	NA	NA	NA	NA	NA	NA	1	4	3	4
Total Men	388	432	452	453	553	618	619	628	670	694

Source: *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2017 (table 7-7)*

These numbers can be explained by several factors; here, I discuss a few. We know from thirty years of research by Jeannie Oakes (1985, 1990a, 1990b) that mathematics tracking substantially limits African-American students' access to advanced mathematics courses. Mathematics tracking is the process of organizing students into mathematics courses that are based on their ability, and it has been an accepted practice in U.S. schools for nearly a century (Rubin, 2008).

Teachers' low expectations and overall assumptions about Black girls in society impede the opportunity for Black girls to learn in mathematics classrooms (Rist, 2000). Teachers hold low expectations of low-income Black girls in upper elementary classrooms who are perceived as having limited knowledge and bring social challenges to the learning environment (Pringle et al., 2012). Black girls' early confidence in and value of mathematics often fails to translate when it comes to interactions with their mathematics teachers. Battey and Levya (2013) found positive and negative effects on Black girls' mathematics achievement in terms of relational interactions with their teachers. There is also a deep-seeded historical and societal myth that Black girls and mathematics are incompatible (Gholson, 2016; Hottinger, 2016; Joseph, 2016). In addition to the damaging stereotypes that can lead to disidentification with the discipline of mathematics, Black girls often lack access to high quality, advanced mathematics and science courses in schools located in their communities (National Women's Law Center, 2014).

My own work examines how Black girls develop mathematics identities since we know that productive and robust mathematics identities contribute to longer-term persistence in mathematics (Boaler & Greeno, 2000; Joseph, Hailu, & Boston, 2017; McGee, 2015). Specifically, I aim to examine the roles race, class, gender and other socially constructed identities as well as interlocking systems of oppression play in shaping their mathematics identities. Understanding what factors contribute to robust mathematics identities for Black girls is important for the national discourse about underrepresentation of racialized minorities in STEM

broadly. Next, I share some findings from a pilot study that explored these ideas with undergraduate Black women in STEM majors at both Predominately White Institutions and Historically Black Colleges and Universities. I close the essay by invoking Virginia's unique history of Black excellence in STEM, as conceptualized in *Hidden Figures*. This is one way to center possibilities and build upon a legacy and tradition to transform Black girls' mathematics experiences and their overall lives in the educational system of Virginia.

High School Experiences in Mathematics Shape Higher Education Success

I recently conducted a pilot study that explored mathematics identity among undergraduate Black women STEM majors at different institution types. Seven Black women participated in a three-part study that included a one-on-one semi-structured interview, the creation of an annotated symbolic artifact of mathematics identity affirmation, and a focus group based on the movie *Hidden Figures*. In this article, I share just a couple of the things that I learned from these women in their conversations about *Hidden Figures*. We discussed what they noticed about the Black women and their roles as mathematicians, what our mathematics education system does right and wrong for Black girls, and what is needed to promote robust mathematics identities among Black girls. The two themes below were salient in their discussion and have implications for mathematics teachers.

Limited Access to High Quality Mathematics Instruction.

The young women articulated a position about the inequality of schools and the related mathematics instruction they received as a result of attending such schools. One participant stated:

> I talked to a [White] girl, she said they didn't have desks – they sat in a Socratic style. They sat around a table, and they were forced to think out – it wasn't just written tests, and that's how you have to think in order to succeed at these top institutions. It's more than a paper test. You have to be able to think outside the box, and if you haven't been thinking like that and they've been thinking like that since ninth grade, you're not gonna perform at the level.

This quote suggests that Black girls experience mathematics instruction that is more traditional and rarely have access to high quality mathematics teachers, specifically, the type of mathematics teachers that prepare students to be critical thinkers (Oakes, 1990a). Oftentimes the schools' best mathematics teachers are given choices of which courses to teach, and many of them choose to teach advanced mathematics courses and these courses can include a strikingly different pedagogy. These courses can be more student-centered and include more opportunities for critical thinking, rather than drill and kill and worksheets, which often can be seen in many of the lower-level courses (Oakes et al, 2004). We know that the quality of a teacher has been consistently identified as the most important school-based factor in student achievement (McCaffrey, Lockwood, Koretz, & Hamilton, 2003; Rowan, Correnti & Miller, 2002), and that teacher effects on student learning have been found to be cumulative and long-lasting (McCaffrey et al., 2003; Mendro, Jordan, Gomez, Anderson, Bembry, & Schools, 1998). Therefore, mathematics teachers can play a role in changing the type of instruction Black girls receive in their classrooms, as well as promoting Black girls' enrollment into advanced mathematics courses.

Low Expectations from Others.

Not being expected to accomplish greatness was another salient theme that I learned from the focus groups. One woman stated emphatically:

> We expect White people to succeed and we expect Black people to fail inherently.

A different young woman expressed her thoughts about low expectations when she responded:

> I think it's about expectations because they [White students]—when White kids whose families have—like they aren't the first in their family to go to college, wherever they go, it's expected of them to finish. If they come into engineering, it's not like, oh, you [Black girl] may change your major, and this and that. It's expected that they're [White students] gonna finish. Why is it that when Black kids go to college and they

> may be the first in their family, it's like, are you sure you gonna be able to do that [engineering]?

These findings suggest that Black girls perceive that their mathematics teachers and other school personnel do not believe they will succeed in STEM fields. Other studies have found that low-expectation teachers blame Black students, their families, and their communities for achieving at lower rates than Whites (Lynn et al., 2010; West-Olatunji et al., 2010). Some middle-school Black students struggle academically because of their perceptions of low teacher expectations and the teacher-student relationship (Ferguson, 2003; Noguera, 2003). Overall, low expectations can significantly decrease Black girls' chances to succeed academically. To counteract this, mathematics teachers need to be made aware of how their perceptions and beliefs impact Black girls' academic achievement. We need teachers who have already or can adopt a disposition of high expectations and unequivocal faith in their Black girls to succeed in learning rigorous mathematics. This can be challenging because as mathematics teachers, we have cultural scripts (Stigler & Heibert, 1998) about what represents success in mathematics, and when Black girls do not align with that script, we make assumptions that something is wrong with them, rather than our own teaching and more importantly, our system. Overall, these themes help us understand the viewpoints of some Black girls' experiences in mathematics and that our mathematics education system needs to change if we care about Black girls succeeding.

Black Girls Becoming Visible in Mathematics: The Affordances of Virginia's History of Black STEM Excellence

Virginia has a robust history of Black excellence in STEM as seen through the historical analysis in Shetterly's (2016) book, *Hidden Figures*. We now know that over 20 Black women worked as human computers or mathematicians at NASA and contributed to the United States' success in the space program. Shetterly recalled: "that so many of them were African-American, many of them my grandmothers' age, struck me as simply a part of the *natural order of things*. Growing up in Hampton, the face of science was brown like mine" (p.xiii). She continued, "I knew so many African-Americans working in science, math, and engineering that I thought that's just what Black folks did" (p. xiii). This history gives mathematics teachers a way to center and engage Black girls in mathematics in a meaningful way—helping Black girls understand the greatness from which they come and can draw upon.

Virginia is an epicenter of Historically Black Colleges and Universities focused on STEM and can serve as spaces to transform the mathematics teaching and learning experiences of Black girls. Below, I list a few recommendations about what mathematics teachers can do to disrupt Black girls' invisibility in the discipline:

a. Encourage all Black girls to take more mathematics, not less, pushing back against the tracking system. This is important because it can open up more opportunities for the pursuit of STEM degrees in college (Tyson et al., 2007). Ways mathematics teachers can do this is by working with school counselors to find "bubble" and high-achieving Black girls and strongly encourage them to take additional math (if they are not already doing so). It is more than just telling them to take more math, but it is about pulling in their families to discuss together the benefits of such actions as well as the future consequences for not doing so.
b. Invite Black women in STEM careers from local Virginia universities/industries to dialogue with Black girls in small groups. Many Black girls, such as those in my study, may not even know about or understand different STEM careers (i.e. engineers, actuaries, scientists, etc.). Finding other math teachers in your local school district and working together to locate these Black women professionals is one idea for getting at this recommendation. Mathematics and science teachers also might survey their Blacks girls to see if they have family members and/or friends who work as STEM professionals to come share their stories.
c. Teach Black girls mathematics through prob-

lem posing and discovery, rather than traditional procedures, allowing them to bring their full identities to the classroom. Completing worksheets usually does not stimulate students' minds for discovery and problem posing. My work with high school Black girls suggests that they value mathematics teachers who promote academic and social integration, while learning mathematics (Dunleavy et al.). What this might look like in a classroom is the teacher promoting Black girls to utilize personal, local, national, or global community contexts to pose problems that are meaningful to them. They should be able to produce problems that are open-ended, relevant, and co-created with others. This type of learning experience should be employed from day one of school and developed all throughout the year in order to see sustainability.

d. Partner with local HBCU STEM departments to create programming that provides opportunities for research and mentoring. This is important because it can increase interest in STEM fields and college going rates (Schneider et al., 2013), and graduate school aspirations (Odera et al., 2015). This can create multiple pathways through the pipeline.

These recommendations are not silver bullet answers, as this phenomenon is complex. Our nation must work to disrupt deficit narratives about Black girls and the associated myths about mathematics. Virginia mathematics teachers have a unique opportunity to be the "first" to lead this effort in a systemic way.

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