

Mathematics Literacy, Identity Resilience, and Opportunity Sixty Years Since *Brown v.* *Board: Counternarratives of a Five- Generation Family*¹

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In this chapter, the authors use Black Feminist Thought (BFT) to examine the mathematics education and the educational attainment of African American females in a matrilineal line that spans five generations. A cross analysis of school experiences, from a maternal great-great-grandmother to her great-great-granddaughter, reveal a portrait of segregation, desegregation, and resegregation. The impact of these educational contexts on the mathematics literacy and mathematics identity of four African American women and the hope and promise of a young girl in the class of 2026 are also presented. From sharecropper schools in Mississippi to prestigious universities in the eastern United States, the challenges and successes of one family's struggle to obtain mathematics literacy and the American dream are discussed through the historical lens of Brown v. Board of Education. Using this historical context, the specific experiences of these five family members encourage a dialogue about a larger narrative—the mathematics attainment of all Black children.

KEYWORDS: Black Feminist Thought, counternarratives, mathematics identity, segregation

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The purpose of this qualitative study, which uses case study design, is to present and examine the mathematical experiences and educational attainment of five African American females. They represent five generations in one African American family whose roots began in rural Mississippi in the 1860s—nearly one hundred years before the Supreme Court ruled in *Brown v. Board of Education* (1954) that the racial segregation of schools is unconstitutional. While the experiences of the female members in this family are not meant to be generalized to all Black families, their struggle to obtain mathematics literacy can be used as a theme to understand the Black struggle for quality education pre- and post-*Brown v. Board of Education*.

This study begins with a great-great-grandmother (now deceased) born in Washington County, Mississippi, in the 1910s during the Black Nadir and ends with her six-year-old great-great-granddaughter, who began first grade in Delaware County, Pennsylvania, in the fall of 2014—sixty years post-*Brown v. Board of Education*. Descriptive content analysis of their mathematical experiences provides a sociohistorical (i.e., changes in society over time) account of five African American females' mathematics literacy and mathematics identity. Additionally, we describe the impact their mathematics education had on their career trajectories and everyday lives. These narratives are told through the historical lens of *Brown v. Board of Education*.

Review of the Literature

The bodies of literature that support this study are mathematics literacy, mathematics identity, and the intersection of race and gender in mathematics education. Terry (2011) described literacy broadly as not only the ability to read and write but also its importance for understanding literacy as the means to liberation and freedom. This view is grounded in Frankstein's (1990) notion of *critical mathematics literacy* and Gutstein's (2006) notion of *reading and writing the world* with mathematics.

Mathematics Literacy

Mathematics literacy is *using* mathematics as a cognitive enterprise to communicate mathematically with others (National Council of Teachers of Mathematics, 2000), engage in society as an informed citizen (Moses & Cobb, 2001), and position oneself as a *doer* of mathematics for empowerment (Leonard, 2009). Thus,

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mathematics literacy is racialized and situated “within the larger contexts of African American, political, socioeconomic, and educational struggle” (Martin, 2006, p. 197) and the struggle for civil rights (Moses & Cobb, 2001).

Mathematics Identity

We examine mathematics identity among these five multigenerational females. Martin (2006) defined mathematics identity as “the dispositions and deeply held beliefs that individuals develop, within their overall self-concept, about their ability to participate and perform effectively in mathematical contexts and to use mathematics to change the conditions of their lives” (p. 206). Martin (2000) suggested that students with a well-developed mathematics identity are successful *doers* of mathematics. Students with well-developed mathematical identities have the following characteristics: (a) believe in their ability to perform in mathematical contexts, (b) understand the instrumental importance of mathematics, (c) realize there are constraints and opportunities in mathematical contexts, and (d) exhibit motivation and engagement in strategies to obtain mathematics knowledge (Clark et al., 2009). The authors believe that individual and collective experiences should be studied and examined within the contexts of mathematics literacy, mathematics identity, and cultural practices as Black women. This study adds to the literature on Black feminism (Collins, 2009), Black resilience in mathematics (McGee, 2013), and Black self-determination (Dixson, 2011), offering a multi-generational analysis seldom seen in mathematics education research (Gholson, 2013).

The Intersection of Race and Gender

In this study, we not only examine the individual beliefs and mathematical understandings of five related but distinct females in a matrilineal line but also how their identities are interwoven and intersect with race and gender. Specifically, we show how their mathematics identities are shaped and influenced by their mathematics attainment and positioning in the family across different generations. Using the lens of *Brown v. Board of Education*, we present the counternarratives of five African American females, their struggle for mathematics literacy, and how it shaped or limited their access to higher education; science, technology, engineering, and mathematics (STEM) education; and STEM-related careers. This study stands in contrast to the literature base on African American mathematics education in general, which is often related to gap-gazing (Gutierrez, 2008; Lubienski, 2008) and cultural deficit theory (Martin, 2006; McGee & Pearman, 2014; Terry & Howard, 2013) rather than mathematics literacy, identity, resilience, and agency (Martin 2000, 2006; Walker, 2012, 2014). Yet, narratives about mathematics achievement and attainment among African American women and girls are sparse in the literature (Lim, 2008; Lubienski

& Bowen, 2000). In the small number of studies that compare mathematics achievement among male and female students, Lim (2008) claimed:

The majority of previous studies of gender issues in mathematics education have focused on the differences between boys' and girls' motivational constructs, performance levels, or learning styles while ignoring the dynamic socio-cultural context of their mathematics learning in and out of schools. (p. 308)

Thus, focusing on the intersection of race, gender, and mathematics attainment, this study adds to the research on both gender studies and mathematics education.

Theoretical Framework

The theoretical framework that undergirds this study is Black Feminist Thought (BFT), which Collins (2009) describes as an epistemology used to validate Black women's knowledge and experiences. The core themes of BFT are "work, family, sexual politics, motherhood, and political activism" within the U.S. context of racial and gender oppression (Collins, 2009, p. 269). The principles of this epistemology rely on two types of knowing that derive from Black women's experience—knowledge and wisdom (Collins, 2009). In this way, Black women from all walks of life participate in a type of knowledge that is based on collective experiences that emerge from similar forms of oppression. Domestic workers had to learn how to function in two worlds—one where they were responsible for rearing White children, while simultaneously being viewed as inferior, and the other where they raised their children to resist such definitions and to strive for something better. In the narratives to be described, a great-great-grandmother's school and work experiences in rural Mississippi and later in an urban city in Missouri shaped and informed the educational trajectory of her granddaughter in urban St. Louis during the 1960s and 1970s. Thus, mother wit is valued alongside institutional knowledge, providing voice and legitimacy to four generations of women.

Black Feminist Thought uses dialogue to assess knowledge claims, promoting an ethic of care that is characterized by "personal expressiveness, emotions, and empathy...central to the knowledge validation process" and the ethic of personal accountability (Collins, 2009, pp. 281–282). Black women validate each other's experiences through dialogue and storytelling that has roots in "African-based oral traditions and in African-American culture" (Collins, 2009, p. 279). BFT is used as a framework to discuss how mathematics literacy can be used to empower Black women to challenge oppression and the status quo.

We acknowledge that BFT as a framework has limitations. As a social theory, it lies at the intersection of "race, class, gender, sexuality, ethnicity, nation, and religion" and can only partially tell the entire story (Collins, 2009, p. 12). The hope of

Brown v. Board of Education sixty years ago was that the United States would turn the corner on race and racism to provide all students with equal access and educational opportunity. The *Brown v. Board of Education* decision took a first step to eradicate the *separate but equal* doctrine that perpetuated Jim Crow for a half-century and reversed Black advancements in politics and education acquired during Reconstruction (Patterson et al., 2008; Rucker & Jubilee, 2007). However, the voices of Black women and their educational experiences, particularly in mathematics, are often missing from the extant literature (Walker, 2014). Thus, BFT is a powerful analytical and theoretical tool to examine the ways in which seemingly neutral educational policies and practices reproduced gendered and racialized mathematics education in African American communities. These policies are evident in the counternarratives of a five-generation family. From a sharecropper school system in Mississippi with burgeoning class sizes and high dropout rates to a suburban school district, the females in this family experienced segregation, desegregation, or resegregation. Such educational contexts had and continue to have an impact on their mathematics education and educational attainment in general.

Research Questions

The research questions that guide this study on five African American females in a matrilineal line are as follows:

1. How do the counternarratives of a five-generation matrilineal line of African American females compare and contrast in terms of their mathematics literacy, mathematics identity, and resilience?
2. What role did mathematics literacy and social agency play in terms of educational opportunities and career paths?
3. How do their mathematics education and educational attainment illustrate a broader social and political context of race, class, and gender?

To answer these research questions, we engaged in descriptive content analysis of the counternarratives, document analysis of historical records and artifacts, and comparative analysis to find themes and patterns from multiple data sources.

Methodology

We used the counternarrative or counter-storytelling approach to examine the mathematics literacy, identity, and resilience of a five-generation matrilineal line. Solorzano and Yasso (2002) present three general forms of counter-storytelling: (a) personal stories or narratives told in first-person, (b) other people's stories or narratives told in third-person, and (c) composite stories or narratives constructed through various forms of data, historical records, or archives. In this paper, we employ all

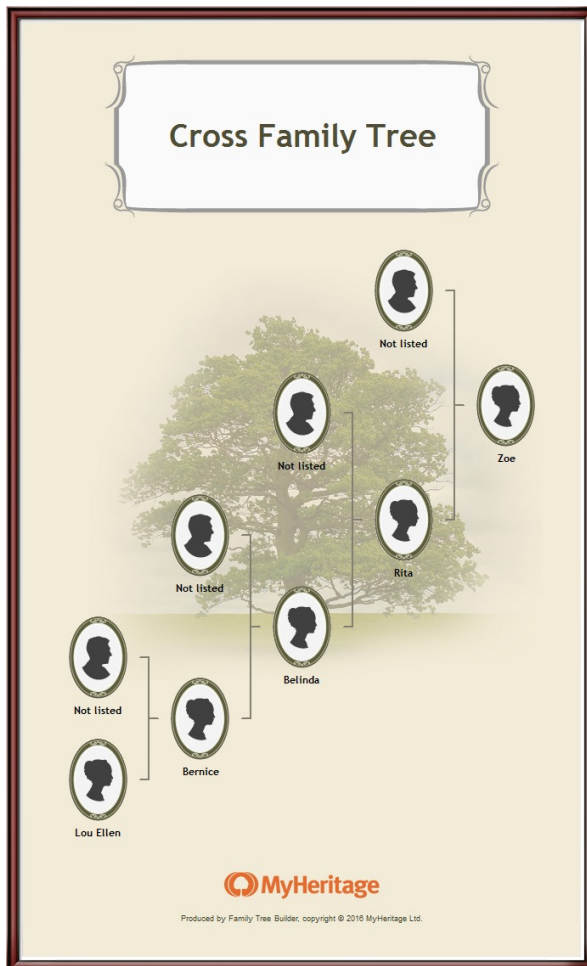


Figure 1. Cross Maternal Family Tree

three of the aforementioned methods of counter-storytelling to examine historical data, school records, and test data that span 70 years of schooling from the rural South to the urban East Coast. These sources also include data obtained from interviews and questionnaires as well as oral history (i.e., recollections and oral traditions told by elders to members of successive generations). Two authors of this paper are members of the five-generational family reported in this study. To ensure validity and reliability, an unrelated third-party analyzed the qualitative data to find emergent themes.

Data Analysis and Data Sources

While counternarratives are used to uncover the use of simple language and thick descriptions, we also examined anecdotal records and artifacts to understand the varied mathematical experiences of each family member by using descriptive content analysis (Neuen-

dorf, 2002). The data sources consist of artifacts and documents that span more than 70 years. These data include census records, report cards, SAT and GRE scores, interviews, and questionnaires collected at different time periods. Additionally, oral stories are used to describe the mathematical experiences and educational attainment of four adult women and one child who represent five generations in one family. These stories reveal details about these Black females' mathematical literacy, identity, resilience, and educational opportunity that can be used to tell a larger narrative about the education of African American children.

Participants and Settings

The participants in the study are members of the Cross family (all names are pseudonyms (see Figure 1 for family tree and birth order). Results of recent DNA testing revealed the ancestry of this family is 76–80% Yoruba (West African tribe near Nigeria) and 20–24% European. Tracing the maternal side of the family tree through census records, the authors found that seven generations of the Cross family resided in Oktibbeha County, Mississippi, beginning in 1860.

The Counternarratives

We present the individual counternarratives of five females in a matrilineal line to illuminate their early life, school experiences, mathematics literacy, mathematics identity, and resilience within historical and educational contexts. Each counternarrative is unique, exploring the individual and social agency that influenced each family member's life. The counternarratives begin with Lou Ellen, the great-great-grandmother. Living into her nineties, she had a strong influence on the family for nearly 75 years.

Lou Ellen's Story: "It was hard for me because I did not have the learning."

Early life. Lou Ellen was born in Washington County, the heart of the Mississippi Delta, during the 1910s. The family moved during her early childhood years, and she was reared in Oktibbeha County. Lou Ellen's responses to a questionnaire administered by her great-granddaughter, Rita, in 1997 as part of a college course reveal many nuances about her school and adult life.

I was born in Leland, Mississippi. I grew up in Starkville, Mississippi, on my grandmother's farm. I loved that farm very much. I have a cousin still on that farm now, but it much different. [My grandparents] had nine children—four boys and five girls. My grandparents owned their own land. . . raise the children and take care of the land. [My father] worked on a dairy farm; he helped to milk the cows. He got paid for working. We raised all our food. [Mother] did not work; she took care of the house and children. My mother died when I was ten years old. I lived with my oldest sister after she married.

Historical and educational contexts. Lou Ellen went to school in the 1920s. During this period, the agrarian South was dotted with farms and sharecroppers. However, teaching was a stable, high-status profession for Blacks during this period. Ladson-Billings (2005) noted there were about 66,000 Black teachers in the United States in 1910. Unable to teach in the North, many of these teachers taught in the South (Tillman, 2004).

School experiences. Lou Ellen often told stories of how she and her sisters had to walk 10 miles to school. The stories revealed the nature of the one-room schoolhouse where reading, spelling, and figuring were the lessons of the day. Given the demands of farm life in rural Mississippi, it was common for Black students to work on the farm instead of attending high school, which was not compulsory. Although Blacks represented 29% of all high school students, only 5% of Black children were enrolled in high school in the South during the 1910s (Anderson, 1988; Rucker & Jubilee, 2007).

I was not able to go to high school. My father could not send us to high school. It was three of us. He could not pay for us to go. . . . We did not have a lot of money but that was no problem. We had food and shelter, and we was [sic] happy then. . . .

Lou Ellen's statement implied the family could not afford for her to attend high school. If she was old enough to work in the fields or perform day work, the family needed her to bring in additional income. Although she did not complete high school, she had aspirations to further her education.

I wanted to go to college and learn a traid [sic] to work with older peoples [sic] and to help peoples [sic] that can't help themselves.

Mathematics literacy and mathematics identity. Although there were no copies of school records, Lou Ellen often told her family that she completed school as far as the eighth grade. While her literacy in mathematics was unknown, she read the Bible on a daily basis and was able to fix anything that was broken. She often said she was good at figuring, which was evident by her ability to manage and save money.

Life choices and career trajectory. As a young adult in the 1940s, Lou Ellen made a life-changing decision. She left her family in Mississippi and relocated to St. Louis, Missouri, during the Great Migration. There were relatives in St. Louis that helped her to get settled. She joined the African Methodist Episcopal Church, where she was a member for 65 years before her death in 2010.

I been without a job, without food, and [did not] know where I would get my next meal or get money for rent, but the Lord made a way for me to get a job. It was hard to get a job without training or education. It was hard for me because I did not have the learning. So I wint [sic] back to school. My first job was day work.

Lou Ellen lived and worked in St. Louis as a baker, cook, and dietician until she was 70 years old. Because of her self-determination to leave Mississippi and start a new life, Lou Ellen influenced her daughter, Bernice, to leave Mississippi as well. Thus, her decision to relocate led to opportunities that changed the career trajectories of both women. She shared her pride as a Black elder and offered advice to her progeny.

It is nice to be Black at any age. It does not [matter] what color you are. Age does not change anything. I am proud to be Black. I am proud [to] be what God intended for me to be. Glad I am Black.

Stay in school and get [some] learning. Do not smoke or drink. Don't let men take advantage [sic] of you. Don't let your relationships into fear [sic] with your education or with religion.

Bernice's Story: "I wanted to finish high school, but I needed a job."

Early life. Bernice was born in Oktibbeha County, Mississippi, in the late 1930s. She was the only child living in the household. She appeared to live an uncomplicated life with her mother and stepfather prior to matriculating in school. When she was seven years old, her life became complicated after her mother, Lou Ellen, left for St. Louis. Because Lou Ellen was uncertain that she could find a job right away, she left Bernice with an aunt in Mississippi who could provide a home and a nurturing environment.

Historical and educational contexts. There were two educational philosophies that were prevalent during the 1940s—classical (liberal arts) and industrial (technical) education influenced by Du Bois and Carver, respectively (Russell, 2014). During this period, many Black students learned applied mathematics, which allowed them to learn a vocational trade. However, other Black students, influenced by Du Bois' philosophy, studied algebra and plane geometry in high school (Russell, 2014). Interestingly, the high school mathematics curriculum in Oktibbeha County, Mississippi, was predominantly influenced by Du Bois since tenth-through twelfth-grade students took algebra, geometry, and trigonometry in high school.

School experiences. School records revealed that her mother, Lou Ellen, registered Bernice for school at the age of five. Education in the South often took place in segregated schoolhouses like the one shown in Figure 2. The photograph shows Bernice smiling as she stood among 50 members of the third-grade class at the Oktibbeha County Training School.



Figure 2. Schoolhouse in Oktibbeha County, Mississippi

Mathematics literacy and mathematics identity. Examination of report cards revealed that Bernice earned B grades in first-grade arithmetic and As and Bs in second grade. Her grades dropped to Cs in grades three through five. By sixth grade, her arithmetic grade slipped to a D. However, attendance records also showed 17 absences during her sixth-grade year. These absences no doubt had an impact on her performance. When asked about these absences, Bernice replied:

When I was old enough, I had to stay home to watch Auntie's younger children while she went to work. I also stayed with another Aunt sometimes who lived further away from the school. If the weather was bad, I couldn't go. My other aunt lived more than 10 miles from the school. I had to leave at 6 a.m. to walk to school to get there before 8:30 am.

Because of D grades in arithmetic and history, Bernice had to attend summer school to be promoted to the seventh grade. However, her grades in mathematics showed little improvement. When asked about her grades, Bernice stated:

Math gets harder as you go along, and you need someone to help you. Auntie had an eighth-grade education and a family of her own, and I didn't have anyone to help me with my homework.

In high school, Bernice was enrolled in a course that used a book called *Math at Work*. George Washington Carver and the current thinking of the day may have influenced such a text. While her behavior was good, and her grades in English and reading were passing, she reluctantly claimed, "I was not good in math." She earned a D grade in general math in ninth grade. In tenth grade, she was enrolled in algebra but later withdrew from the course (see Table 1). When queried about this, Bernice said:

In grade 10 you had algebra, geometry in grade 11, and trigonometry in grade 12. There was [sic] four years of math in high school. It was difficult for me because I did not understand the concepts. There were 40 or 50 students in my elementary classes. In high school, students came from the surrounding areas and there could be 90 in one class. Mom and Auntie dropped out of school to work on the farm. I was the first one to go to high school, but I dropped out in the tenth grade.

Table 1

Generational Mathematics Achievement: High School Courses and SAT Scores

Family Member	High School Type	8 th grade course	9 th grade course	10 th grade course	11 th grade course	12 th grade course	SAT* math score
Bernice	Oktibbeha County Training School, Starkville, MS Enrollment: NA Minority: 100%	General Math – D	Mathematics for Work – D	Algebra – W	Withdrawn	Withdrawn	NA
Belinda	Public High St. Louis, Missouri Enrollment: 2,500 Graduation Rate: 50% Minority 99%	General Math – A	Algebra I – A	NA	Geometry – W	Algebra II/Trig – A	510 (81 st percentile**)
Rita	Public High School Howard County, Maryland ***Enrollment: 1,155 Graduation Rate: 90% Minority: 66%	Pre-Algebra – B	Algebra I – A	Geometry/Trig – A	Algebra II Honors – A	Calculus, AP – A, Score 3	560**** (72 nd percentile)

*SAT scores scaled 200–800

**Percentile Rank is for all students only

***Enrollment, graduation, and minority data from 2012

****SAT recentered in 1995

Life choices and career trajectory. As an adult, Bernice did not lose sight of her desire to finish her high school education. She enrolled at a community college in St. Louis during the 1970s and completed studies to earn a GED and later an associate's degree. This self-determination opened the door of opportunity. Bernice was able to get a better job where she became a union worker at a local bakery chain. Her wages doubled, enabling her to become a homeowner and to move from working-class to lower-middle-class status. This decision impacted her life and the lives of her mother and children, who were able to enjoy the comforts of homeownership.

Belinda's Story: "I decided to go back to college."

Early years. Belinda was born in Missouri in the late 1950s. She was Bernice's older daughter and one of three siblings born in St. Louis. She responded to the same questionnaire, which was administered by her daughter, Rita, in 1997. Belinda's responses revealed details about her life and upbringing during the sixties and seventies.

I remember looking out the window of my neighborhood when I was four years old and liking what I saw. Streets were lined with brick apartments and bungalow houses dotted with trees, flowers, and green grass. My neighborhood consisted of corner stores and confectionaries owned by Blacks and Jews. There was a grocery store, library, and several clothing and shoe stores a few blocks away.

Historical and educational contexts. Two major events defined the 1950s—the U.S. Supreme Court decision on May 17, 1954, known as *Brown v. Board of Education*, and the launch of Sputnik by the Russians on October 4, 1957. As a result of Sputnik, children in the 1950s and 1960s were introduced to “new math” (Berry et al., 2013). A chapter on sets was common in every textbook as new math became synonymous with set theory (Berry et al., 2013; Raimi, 1995). Despite the millions of dollars spent to design the curriculum, the new math program was a failure (Raimi, 1995). Mathematics achievement scores dropped during this period, revealing students, in general, were worse off than they were before new math was introduced.

School experiences. De facto segregation existed in the St. Louis Public Schools when Belinda began matriculating in 1963, despite the passage of *Brown v. Board of Education* almost ten years earlier. Belinda attended a K–8 neighborhood school for nine years. The majority of her teachers were Black, and some lived in the community. Discipline was strict, and parents unequivocally supported the teachers.

My neighborhood [school] was all Black.... [My mother] was a hard worker. Her unhappiness inspired me to do better. I valued education as the key to success and worked hard in school. I valued family.

Mathematics literacy and mathematics identity. Belinda disliked mathematics in elementary school because teachers tended to focus on rote memorization and computation, if they taught mathematics at all. While she did not remember what mathematics curriculum was used, she recalled studying set theory (i.e., new math) in seventh and eighth grade using old books that were passed down from White schools. Belinda's eighth-grade teacher was an African American woman who liked teaching math. She spent a great deal of time teaching the class how to solve word problems, fractions, decimals, and percent. Working with rational numbers (i.e.,

fractions) was Belinda's earliest recollection of enjoying mathematics, and she realized that she was good at it.

The eighth-grade teacher recommended that Belinda take algebra in ninth grade at the local high school. To her surprise, she enjoyed solving quadratic equations and using the foil method to distribute binomials. Her grade in Algebra I was an A, reflecting the time and effort she put into the course. Unlike the schools in Mississippi in the 1950s, four years of mathematics were not mandatory in the St. Louis Public Schools in the 1970s. Therefore, Belinda appealed to the high school counselor to skip geometry and take Algebra II/Trig instead. Permission was granted, and she earned an A in Algebra II/Trig as well. In her senior year, Belinda's score on the SAT was higher than most students who attended her predominantly Black high school (see Table 1). Encouraged by her counselor, teachers, and college-bound peers, Belinda decided to attend college in New England.

My biggest challenge was staying focused on completing my education. I dropped out of college to get married. Family and belonging were important to me. Because I could type, I took jobs as an office clerk. It was hard to emerge from the domesticated role of being a clerical worker and mother. I decided to go back to college.

Life choices and career trajectory. Belinda's decision to return to college was one of self-determination. She enrolled in the teacher education program at a private urban university in the Midwest during the early 1980s. She graduated with a B+ average and a teaching credential in general science and began teaching science at a middle school in a nearby suburb. After relocating to Texas with her family, Belinda obtained a master's degree in mathematical sciences and taught middle grades mathematics for eight years. Ten years later, she obtained a Ph.D. in mathematics education in the late 1990s from a research university in the eastern United States. Belinda eventually became a tenured professor. Her life choices and career trajectory firmly planted the Cross women in the middle-class.

The Civil Rights movement gave me a militant attitude, but I believe I am tolerant of others. The women's movement gave me strength to break out of stereotypical jobs for women and to pursue mathematics education and ordained ministry.

Rita's Story: "I was accepted to an Ivy League university."

Early years. Rita, Belinda's older daughter, was born in the late 1970s on a military base in the South. Three years later, the family relocated back to Missouri after her father was honorably discharged. Rita started kindergarten at the age of four because she had a fall birthday. She was most often the youngest student in her class. Rita initially attended elementary school at a private Christian school in Missouri and later two public elementary schools in Texas when the family relocated. The racial

makeup of the private school in Missouri was predominantly White, whereas the public schools in Texas consisted mainly of African American and Latinx students. During her adolescent years in Texas, Rita attended a small, private, predominantly White Episcopalian school for seventh and eighth grade.

Historical and educational contexts. On the educational front, the National Commission on Excellence in Education presented a report entitled *A Nation at Risk: The Imperative for Educational Reform* (1983). During this time, U.S. students were compared with their international counterparts and found to be lagging, particularly in mathematics and science. In response to public criticism of the report, many states began requiring Algebra I as a graduation requirement. From 1982 to 1992, student enrollment in Algebra I and advanced mathematics courses increased dramatically: Algebra I from 65% to 89%, Algebra II from 35% to 62%, and calculus from 5% to 11% (Raizen et al., 1997).

Mathematics literacy and mathematics identity. In elementary school, Rita was part of the Talented and Gifted Program, where she enjoyed solving logic problems. She learned early on that she was good in mathematics and enjoyed word problems. Throughout high school, Rita was placed in Honors or Advanced Placement mathematics courses. Responding to a protocol in 2013 provided by her mother, Belinda, she shared her mathematics experiences:

In my math classes in high school, I was usually the only Black person in class. There was a 99 club where the students' average grades were 99 or higher for each report card, and there were at least 20–30 students in that club, if not more. I was a member of the 99 club as well.

In the middle of 11th grade, Rita moved to the East Coast to finish high school, as her mother was pursuing a Ph.D. The high school demographics were primarily mixed. African American and White students attended high school together as a result of a planned community that prided itself on developing neighborhoods to house both middle-class and affluent families. Rita remembered her Algebra II and calculus teacher was a mentor and role model.

He was very encouraging and advised me while applying to college. He was very excited when he found out I was accepted to an Ivy League university and encouraged me to attend that school over others.

After graduating from the Ivy League university, Rita was admitted to a master's degree program in allied health. Note the growth in quantitative reasoning on her GRE scores as shown in Table 2 compared to her SAT scores in Table 1. After obtaining the advanced degree, Rita began a career in allied health that has spanned 14 years. She credits her positive experience in mathematics as a factor in acquiring

higher education, obtaining a stable job in healthcare, and maintaining the middle-class lifestyle she enjoyed as a child.

Table 2

Generational Mathematics Achievement: College Mathematics Courses and GRE Scores

Family Member	College Information	College Statistics	College Mathematics Courses	GRE*** Scores
Bernice	St. Louis Community College St. Louis, Missouri Public Two-Year College	Gender: 66.8% F; 33.2% M Black: 45.7% Asian: 0.04% Hispanic: 0.02% White: 37.0% Other: 0.05% *Total Enrollment: 7,232	General Math – C	NA
Belinda	Boston University, Boston, Massachusetts Private St. Louis University, St. Louis, Missouri Private Jesuit	Gender: 57.6% F; 42.2%M Black: 8.3% Asian: 8.2% Hispanic: 0.04% White: 72.3% Two or more races: 0.04% **FT Undergraduate: 7,716	College/Algebra Trig – B Calculus – A Calculus II/Analytic Ge- ometry – B+ Trigonometry A	570 (53 rd percentile)
Rita	University of Pennsylvania Philadelphia, Pennsylvania Private Ivy League	Gender: 51.3% F; 48.7% M Black: 7.1% Native American: 0.3% Asian: 18.6% Hispanic: 8.1% White 46.2% Two or more races: 2.2% International: 10.9% **FT Undergraduate: 10,324	Calculus I – C- Calculus II – B Intro to Stats I – B+ Intro to Stats II – C+	660 (81 st percentile)

*STLCC data from 2007

**SLU & Penn data from 2011

***GRE scores scaled 200–800

Zoe's Story: "Every number plus zero is the same number."

Early years. Zoe was born in a research hospital in Pennsylvania in the late 2000s. She is Rita's only daughter. Zoe has one brother who is 18 months older than she. Prior to enrolling in a neighborhood public school, Zoe and her brother attended daycare less than a mile from their home. At the daycare, Zoe learned to recognize the alphabet, counting numbers, the calendar, shapes, and colors. She also enjoyed playing with dolls and playing house.

Historical and educational contexts. Notwithstanding, one of the most important legal cases in recent history was *Parents Involved in Community Schools v. Seattle Public School District* (Dixson, 2011). The crux of this case was deciding whether a school district could remedy racial segregation voluntarily. Race was considered, among several factors, to determine admission to highly demanding Seattle high schools. Parents filed a lawsuit, contending that admission based on race was unconstitutional (Dixson, 2011). The Supreme Court ruled in favor of the parents, stating that the way race was used to admit students was unconstitutional and violated the 14th Amendment. Some legal scholars saw this case as overturning *Brown v. Board of Education*, offering no remedy for school resegregation (Dixson, 2011) and leaving Black parents with few choices other than charter and neighborhood schools (Leonard et al., 2013; Morris, 2004).

School experiences. Zoe currently attends a public school in Pennsylvania, where she began kindergarten in the fall of 2013 with a great deal of exposure to technology. Her kindergarten teacher reported that Zoe knew how to count up to 40 and was an active listener in class. According to Child Trends, a research center based in Maryland, 4 million children (52% White; 23% Hispanic/Latino; 16% Black/African American; 5% Asian/Pacific Islander; 2% Multiple races; and 1% American Indian/Alaska Native) started kindergarten in the fall of 2013 as the class of 2026 (Samuels, 2013). This class has been described as happy, resilient, and eager to learn.

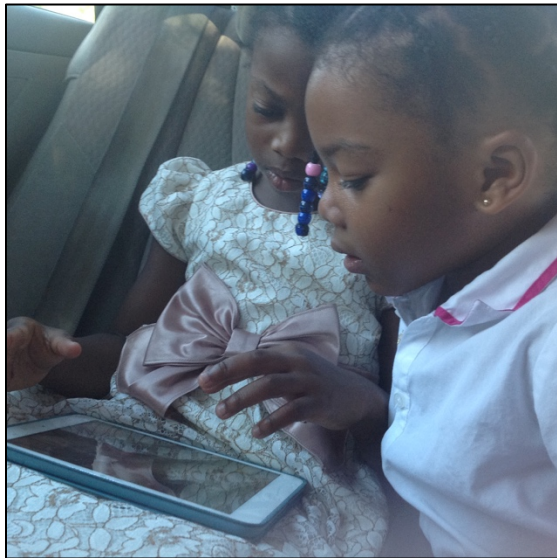


Figure 3. Zoe and friend using iPad mini

Mathematics literacy and mathematics identity. During kindergarten, Zoe enjoyed counting various objects, such as light displays, during the Christmas season as her mother drove the car. She often shouted out math problems, such as “ $2 + 2$ is 4 and $3 + 3$ is 6.” When her mother asked her how she knew, Zoe said, “*I already know that.*” She frequently played games on her mother’s iPhone and iPad (see Figure 3). Zoe also had a Leap Pad that she used to play math games. Her grandmother, who is a mathematics educator, heard her count backwards from twelve during the Christmas holidays: “12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1, 0.” Surprised to hear Zoe state the number zero, her grandmother wondered how deep Zoe’s mathematical understanding was at the age of five.

A few days later, while riding in the car, Zoe asked, “*What’s zero plus 3?*” Her older brother responded the answer was three. The next week Zoe asked the same question again. Her grandmother explained that any number plus zero was that number and drilled both children by asking: “*What’s $4 + 0$? $10 + 0$? $25 + 0$? $200 + 0$?*” They responded in unison: 4, 10, 25, and 200. Several days later, her grandmother asked, “*What’s $0 + 300$?*” Zoe responded 300. Then her grandmother asked, “*Why?*” Zoe responded, “*Zero plus 300 is 300 because 300 plus zero is that number.*” A few minutes later, she told her brother, “*Every number plus zero is the same number.*” Thus, not only was Zoe able to recognize zero as a number, but she was also able to generalize the *zero property of addition*, regardless of the order of the addends. As a kindergartener, Zoe’s brilliance in mathematics suggests that Black children are capable of learning much more mathematics and that their mathematics identity can be developed as young children (Leonard et al., 2013).

Zoe also modeled her teacher at home by posting grids on the wall and counting down to a reward: “*When we get to the number 17, we will have a dance party!*” Her mother encouraged math concepts by dividing hot dogs and pancakes into parts or cutting a pizza into slices. She often asked Zoe, “*Would you like your pizza cut into quarters or halves?*” After Zoe responded, her mother told her, “*You know math!*” In kindergarten, Zoe aspired to become either a teacher or a boss.

Data Analysis

The counternarratives describing the mathematics experiences of five generations of Cross females (Lou Ellen, Bernice, Belinda, Rita, and Zoe) in many ways reflect the 20th century history of school mathematics in the United States. As described earlier in this paper, many contemporary narratives of the history of mathematics education emphasize key historical landmarks, such as the Sputnik launch in 1957, the “new math” of the 1960s, and *A Nation at Risk* in 1983, as well as their impact on school curriculum, instruction, and assessment. However, these counternarratives also reveal a simultaneously occurring story: that of how one particular set of American citizens—Black Americans—were finally gaining legal access to rights as citizens. The *Brown v. Board of Education* decision in 1954 and the Civil Rights Movement of the 1960s, along with increased attention to standards and equity as described in *A Nation at Risk*, had profound implications for education generally and mathematics specifically. Thus, to consider the mathematical lives of these five African American females, and African Americans in general, without attending to the broader historical, educational, and social contexts would be ahistorical and incomplete. When comparing and contrasting the counternarratives, two themes emerge: *Mother Wit* and *Like a Boss*. We draw upon BFT as a theoretical framework to analyze these themes within a sociohistorical context (i.e., changes in society over time).

“Mother Wit”: The Drive for Education Within Constrained Opportunity

We see this broader historical context writ large in Lou Ellen and Bernice’s stories. The South, as others have described (Anderson, 1988; Morris & Monroe, 2009), holds an important place in education for African Americans. Here is where most African Americans were enslaved and, thus, barred from educational opportunity. Following the end of slavery, a sharecropping system was developed, which kept Blacks in poverty. The education provided for Blacks in Mississippi and other southern states during this period was minimal, inadequate, and relegated African Americans to second-class citizenship designed to maintain the status quo (Rucker & Jubilee, 2007). Despite significant obstacles to Black education in the South, Black parents valued education (Mizell, 2010). Moreover, Blacks supported community schools, which were largely built, maintained, and supported by all-Black communities (Anderson, 1988).

The quest for education was also at times hampered by the financial realities of living in the agrarian South. Children were needed for labor—on the farm or at home—and schooling was often interrupted. In the case of Lou Ellen, families simply could not forego the financial benefit of additional laborers working the farm. Thus, for this generation of young people, going to school would have decreased family income significantly.

Further, Lou Ellen and Bernice’s description of family life resonates with the broad and extended family networks of many African Americans in the South. For a variety of reasons, children lived not only with their parents but also with grandparents, aunts, uncles, or older siblings. At times, schooling was interrupted due to family obligations—Bernice was entreated to stay home and look after younger cousins because her aunt had to go to work. Demands of family and work also prevented Bernice from getting help with her math homework. The limited education of her elders adversely affected Bernice’s educational trajectory. As was discovered in a study of African American mathematicians who described cases of older generations of family members being born ‘too early’ to benefit from advances in civil rights (Walker, 2014), Lou Ellen’s desire to go to high school and college was thwarted by her circumstances. There is evidence that Lou Ellen exhibited talent (“able to fix anything that was broken”) that was unrealized within a traditional educational context, in part because she was Black and arguably because she was a woman.

In Black mathematicians’ descriptions of family members who exhibited mathematical talent but were undereducated, the men often worked at skilled and technical but menial labor. Women, however, were in most cases limited to the domestic sphere whether they worked in their homes or were domestics in the homes of others. Lou Ellen’s “cautionary tales” to her own descendants—about getting an education and not allowing relationships with men to interfere with education or progress in

life—are deeply centered in a Black feminist ideology of self-determination. The emphasis on acquiring education to support oneself, help extended family members, and not ‘fall,’ while prominent among African American women, did not have the same urgency among White women of a similar era (Giddings, 1984; Jones, 1985).

The tension between vocational and classical education in terms of what was “most appropriate” for African Americans was evident in Bernice’s experience—although classes like algebra, geometry, and trigonometry were offered to 10th through 12th graders, a high school course that Bernice took in the 9th grade used a book called *Math at Work*. Bernice felt her lack of progress in mathematics limited her opportunities for employment. Therefore, she exhorted her progeny to do better and learn more than she had. Although she had not benefitted from direct intervention on the part of her mother or aunt, she was determined to help her children go even further in school and to be successful. In the urbanized Midwest, there were varied opportunities for employment—better paying than the farm and domestic jobs of the South—and more opportunities for young people to be exposed to educational and social experiences. Bernice’s quest for education continued when she earned her GED and was able to secure better employment, benefitting not just herself, but her elders and descendants.

Like “A Boss”: Honoring and Redefining “Women’s Work” in Mathematics and Beyond

The self-determination ethic inspired the mathematical lives of Bernice’s descendants, Belinda and Rita. Belinda, who was born just after the *Brown v. Board of Education* decision, experienced mathematics at a time when educational opportunity was increasing for Blacks and the traditional curriculum in mathematics was changing. Unlike her mother, who took standard courses in arithmetic and algebra, Belinda recalled studying set theory in addition to traditional mathematics topics in her neighborhood school. For many schools in the South, the *Brown v. Board of Education* decision did not ensure speedy desegregation. Likewise, Belinda’s school had a predominantly Black teaching force, with teachers and their families living and working in the same community. She attended a progressive high school, where she was able to take advanced mathematics courses up to pre-calculus if she chose to do so. Belinda’s daughter, Rita, like many Black children of the 1970s and 1980s attending integrated schools, still found herself one of only a few Black students in advanced mathematics classes. The narrative about advanced mathematics classes “being the most segregated places in American society” (Stiff & Harvey, 1988, p. 190) is a familiar one to high-achieving mathematics students, educators, and researchers (Walker, 2006). Disturbingly, there is significant evidence that even when Black students are ‘qualified’ for these courses, they are shunted into lower-level courses

(Oakes, 1995), or they may self-select lower-level courses themselves to avoid the isolation they experience in advanced courses (Walker, 2006).

Like high-achieving students describing family members whose own experience in school was not indicative of their mathematics potential (Walker, 2006), Belinda saw her mother's life as a cautionary tale: working hard at unsatisfying labor because of limited education and lack of success in school. Knowing the narrative of her mother's interrupted education, she knew that she had to do well in school to avoid having similar experiences. Belinda advocated to take advanced mathematics courses and defined her path through the high school mathematics curriculum. She graduated from high school and attended college but interrupted her college education to get married. As Belinda described it, the pull of family life was strong. Nevertheless, she continued her education in mathematics and mathematics education, becoming a teacher and later a professor. Her daughter, Rita, attended an Ivy League university, and although she is not in a mathematics career, she described mathematics as being an important means to securing her university education and well-paying career. Rita's daughter, Zoe, is a beneficiary of her grandmother's mathematical expertise and her mother's encouragement of mathematics discussion and learning. In addition, she undoubtedly benefits from the ease of access to technology, which supports mathematics learning through games and apps. What Zoe sees in her mother and grandmother are women who are invested in and committed to her education and who have time to talk to her about math. Despite Zoe's elders, Bernice and Lou Ellen, not having this luxury of time to devote to their descendants' education, the lessons they imparted—directly and indirectly—about determining one's future are evident. That Zoe wants to “be a boss” is a testament to the sacrifices of her elders and her freedom to declare herself as such without censure.

Discussion

The multiple and interlocking layers of race, gender, and mathematics among these five generations of females are of interest from a historical perspective, to be sure, but also have significant implications for how we consider these constructs in current educational settings. Much of the literature on race and mathematics focuses on racialized hierarchies of performance with little attention to the role of gender and cultural contexts. Much of the literature on gender and mathematics omits discussion of race and focuses on (White) women's attitudes towards and performance in mathematics. However, more recent literature (e.g., Walker, 2001; Riegle-Crumb, 2006) and cross-sectional analyses of national datasets show that the picture is considerably more complex. For example, African American girls have very positive attitudes towards mathematics, higher than those of their White and Latina counterparts, and are as likely as White boys to persist in advanced mathematics classes in high school.

The societal meme that women are not good in mathematics or are not confident in mathematics largely does not apply to Black women.

Yet, given the counternarratives of these five females, mathematics has multiple meanings. Despite their interest in school, educational opportunity for Lou Ellen and Bernice was limited, and their mathematical trajectories were cut short. We hear about math enjoyment from Belinda and Zoe, while Rita sees it as more of a driver to facilitate access to college and career. For Belinda, who saw the struggles of her mother, and undoubtedly heard the stories from her grandmother, school was a way to ensure social mobility and success, as it was for many African Americans in the United States. However, without the TRIO programs instituted by the Johnson administration, educational attainment and economic success may have been limited during the 1970s.

Further, in a time of significant economic stress, it is important to consider that some of the same choices that Lou Ellen and Bernice had to make are those that resonate with young women of color today. Given that girls are still more likely than their brothers to be called upon to provide domestic care for elderly relatives and younger siblings, the impact of these experiences on their schooling might be considerable. How do we ensure that close familial ties and a desire to support their families do not conflict with girls' mathematics success?

Finally, and rather disturbingly, there is substantial evidence that opportunities to learn mathematics are more limited in rural educational settings. Various reform movements in mathematics and school organization may not necessarily be aligned—as one example, course offerings in small high schools (a popular school organization reform) in mathematics are often limited. Despite their best efforts to stay in school and commit to their education, a ceiling effect in terms of coursework can affect Black girls' college and career chances.

While the last century has brought great progress, in many ways, these cautionary tales abound. The mathematical experiences of five generations of Black females show the strides Blacks have made in education and professional settings. However, there is still much to be done to ensure that children of color have the opportunities to determine their paths.

Conclusions

This study examined the mathematical experiences and educational attainment of five African American females in a matrilineal line that spanned five generations. Their mathematics literacy and mathematics identity developed differently due to various educational opportunities based on sociohistorical contexts. The elder women, who grew up prior to *Brown v. Board of Education*, had family responsibilities that hindered their educational attainment. Nevertheless, the elders seized

opportunities to advance their education by enrolling in training programs or returning to college. They also encouraged the women in younger generations to stay in school and avoid the distractions that might derail their education. While effort, resilience, and perseverance were important factors in actualizing successful careers, school segregation and integration had an impact on Belinda and Rita's academic preparation, respectively. Segregation is hegemonic and disadvantages students of color. Yet, caring teachers pushed African American students and influenced students like Belinda to succeed. In contrast, attending integrated schools provided Rita with broader opportunities to learn than her mother, grandmother, and great-grandmother. Nevertheless, being the only African American in advanced mathematics courses was intimidating and isolating for Rita. Yet, these experiences prepared her to succeed at an Ivy League institution, whereas her mother dropped out but later returned to college.

The counternarrative of this family is not complete because the educational journey continues for young Zoe. At the present time, Zoe attends a predominantly African American school in a suburban school district near a large urban city. Her future is dependent upon the strength of family support and learning opportunities provided by the school district or her mother's ability to relocate to a better district in the future. While the success of previous generations of women provides no guarantee, the family legacy of educational attainment is a strong predictor of Zoe's future success. What remains to be seen is whether the nation turns the corner in the 21st century to deeply invest in the mathematics education of African American females.

Recommendations

This study reveals the challenges that African American females face in mathematics classrooms in public school systems in the United States. The literature reveals they are underserved when it comes to opportunities to learn advanced mathematics (Leonard, 2009; Walker, 2012, 2014). Low enrollment in advanced courses, lack of rigorous coursework, poor perceptions of ability, and feelings of isolation hinder the success of African American women and girls in mathematics. Given that most careers require more mathematical knowledge than in the past, three recommendations emerge from this study. The recommendations are to (a) continue to advance efforts to remedy segregation in public schools (Dixson, 2011), (b) broaden opportunities for African American girls to take advanced mathematics and science courses, and (c) support longitudinal studies on the STEM education of African American girls.

While we acknowledge educational progress for African American children since the passage of *Brown v. Board of Education*, evidence suggests that public schools remain highly segregated along racial and economic lines (Berry et al., 2013;

Dixson, 2011; Leonard et al., 2013). As evident in this study, middle-class, African American families often live in large urban cities or first-tier suburbs where schools serve predominantly Black and Brown children. African Americans continue to be underserved by receiving a different kind of mathematics education than their White counterparts (Berry et al., 2013; Martin, 2006). Until academic success cannot be correlated with one's zip code, the intent of *Brown v. Board of Education* remains unrealized.

Broadening opportunities for African American children in general and African American girls in particular requires broader access and creative innovation. To promote student success in STEM, some schools and districts are implementing cutting-edge programs like robotics and game design as early as third grade in afterschool clubs (Leonard et al., 2016; Repenning et al., 2010). However, encouraging girls to participate in these activities during afterschool clubs has been challenging (Leonard et al., 2016). What has been successful in some school districts is offering robotics and game design classes during the regular school day. In these settings, female and minority students have reported high self-efficacy on video gaming and use of computers when a combination of robotics and game design is offered (Leonard et al., 2016).

Connecting robotics and game design to problem solving and mathematics may help to increase the need for learning advanced mathematics, particular among young African American women and girls who are growing up in a gaming culture. For students like Zoe, who are intrigued with iPads and tablets, opportunities to learn mathematics and computational thinking through robotics and game design hold promise. Computation thinking is a problem-solving process that promotes algorithmic thinking (Wing, 2006). In fall 2015, Zoe's grandmother, Belinda, facilitated a study on computational thinking in Zoe's school district. This study will unpack teacher learning and facilitation of robotics and game design as well as student learning in STEM and development of 21st Century skills (see Newton et al., 2020). The impact on African American students and girls in these schools has yet to be realized.

Finally, we recommend conducting longitudinal studies to examine the relationship between African American girls' exposure to innovative STEM curriculum and role models and their persistence in advanced mathematics courses and academic success. Such studies are needed to understand issues related to recruiting and retaining African American women as STEM majors and professionals. From Euphemia Lofton Haynes (first African American woman to receive a Ph.D. in mathematics in 1943) to Tasha Inniss, Sherry Scott, and Kimberly Weems (first three African American women to earn the Ph.D. in mathematics from the same institution in 2000), the counternarratives of African American women continue to challenge the notion that mathematics is a White male endeavor. It is our hope that young girls like Zoe will benefit from their history and pursue careers in mathematics.

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