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Protective Factors that Yield Empowerment for Black Girls' Mathematical Brilliance

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ABSTRACT Black girls are marginalized and often experience barriers to accessing advanced mathematics, which affects their socialization and identity. Little is known about the experiences of Black girls who have gained access to advanced mathematics programs. The participants in this study were 11 middle school Black females enrolled in advanced mathematics, a course with a curriculum at a higher grade level and a faster pace compared to their same-age peers. Using a qualitative methodology, we use collective memory writings, individual and focus group interviews, and the researcher's journal data to examine how girls' perceptions of societal messages work to impact and empower Black girls enrolled in advanced mathematics coursework and extend current research on this topic. We conclude that Black girls have various protective factors-innate characteristics that yield positive outcomes, influencing their self-efficacy. The themes uncovered as a result were that Black girls are motivated by engaging in valuable mathematics that is meaningful to them; their perceived mathematical identity represents a protective factor. This research study illuminates that Black girls are brilliant, but only those with prominent protective factors are often recognized in educational institutions for their merit.

KEYWORDS *Black, girls, advanced, mathematics, identity, protective factors*

Introduction

This study aimed to seek a deeper understanding of how messages, relationships, and real-life experiences contribute to the empowerment, self-consciousness, and self-efficacy of middle school Black girls who participated in advanced mathematics coursework. This study examined how micro-messages are delivered intentionally through society and impact students' academic trajectories. Micro-messages are small and semi-conscious messages that become apparent in daily interactions, conversations, and instruction. Delivered when interacting with others, micro-messages are presented in five forms that include facial expression, tone of voice, hand gestures, choice of words, and eye contact; these messages can exude either a negative or positive connotation and shape every relationship, allowing educators

to either damage student relationships or forge better ones (Young, 2016b). Brilliance is used as an anchor to illuminate resiliency among Black girls as they endure and overcome obstacles along their educational journey. Martin (2018) argues that we initially begin asserting that Black children are brilliant, not as a conjecture but as a self-evident starting point, logical statement, and axiomatic truth. Resilience refers to coping and returning from all challenges (Tugade & Fredrickson, 2004).

The challenges and struggles often encountered by Black females as learners and doers of mathematics have taken on many descriptive terms in education. Explicitly referring to the mathematical challenges experienced by Black female students, one must consider the marginalization due to the intersections of gender and race (Evans-Winters & Esposito, 2010; Young, 2016; Young et al., 2017). Consider coupling this marginalization

with other transitional factors middle school students confront in adolescence. The multifaceted experiences of racism and sexism of being Black and female in the mathematical sciences have been described as “double-blind,” “double disadvantage,” “double and multiple jeopardies,” and “gendernoir” (O’Brien et al., 2015; Young et al., 2017; Hotchkins, 2017).

Students are equipped with protective factors that are linked to their identities. Protective factors for adolescents are the feelings of belonging or being connected to a school and are advantageous when students have positive and successful interactions with peers and teachers (Catalano et al., 2004). These factors include academic, emotional, and mental support and connecting with peers as friends. These protective factors are essential to the child’s well-being and academic trajectory during adolescence (Center for the Study of Social Policy, 2023). Protective factors are the mechanisms that allow people to be resilient despite adverse circumstances in their lives. These constructs, considered attributes, are shaped by their experiences in educational settings and the greater community in which they live. Direct or subtle messages in learning communities can either work to build students up as confident learners or tear them down, contributing to feelings of despair and discouragement related to mathematics.

The brilliance and resilience of Black girls in this study are examined through the lens of their protective factors. Protective factors, both internal and external, work as the strengths of individuals and their communities that mitigate risks and are characterized to contribute to healthy and positive development (Center for The Study of Social Policy, 2023). We often see them as attributes that help students navigate difficult situations successfully. “The protective factor model suggests that promotive assets or resources modify the relationship between a risk and promotive factors and outcomes” (Zimmerman, 2013, p. 382). This research examines barriers that impact Black girls along their educational journey. We desire to amplify Black girls’ voices to share how they overcame obstacles and persist with superior achievement and consistent success.

Literature review

McGee and Pearman (2014) examine protective factors in two categories. The internal factors are associated with intrinsic motivation, strategic agency, and drive; external influences mediate internal drive. External factors refer to a more resource-oriented outcome. These external factors include support of solid family

socialization, community support of education, and early at-home mathematical development. This study focused on Black girls in an advanced math program to identify the protective factors that supported their academic success. This success extends from their home environments and contributes to their mathematical performance.

Berry (2008) investigated the protective factors for middle school Black males. He identified five themes that support Black middle school male students’ achievement in mathematics: (a) successful early educational experiences in elementary school that worked to circumvent potential problems common among Black boys, (b) identification of academically gifted abilities by the school staff with advocacy efforts from their parents, (c) active support systems, (d) self-identification as a good mathematics learner, and (e) identities associated with other non-academic activities. With these supports, he argued, African American middle school males are more likely to succeed in navigating urban education systems.

On the other hand, black girls’ challenges in mathematics education have multiple layers, more so than Black boys, offering a lens into their reality of oppressive sexism and racism. The literature suggests emerging themes of unpacking stereotype threat and addressing bias and subtle messages, such as micro-messages, that accompany high levels of learning.

Stereotype Threat

Steele (1997) mentions that schooling experiences for Black and white children appear to be the same in curriculum and instruction. However, it encourages us to consider how these two racial student groups may still experience the classroom so differently that Black children’s schooling experience impacts their achievement significantly. Social-psychological threats exist in classrooms that negatively judge groups of students and cause unjust treatment to them. These “threats in the air” are stereotypical and exist as situational threats that work to impact group members negatively. In the school environment, groups can fear being diminished by the stereotypes imposed on them, causing a self-threatening disposition that hampers their achievement.

Steele shares that stereotype threat is a situational pressure that affects a sub-portion of the stereotyped group. He finds that in schools, this threat often affects the more confident students in each subgroup, making stereotype threat more opposing to students who are high achievers or performers compared to others. Stereotype threat affects intellectual performance, especially

among women. His studies examine mathematics and suggest women experience society-disseminated stereotype threats associated with their mathematics ability in mathematics-performance environments. This stereotype confirming implication threatens their belongingness and acceptance in mathematics spaces. Although men could be equally threatened, women carry additional pressure given the historical stereotype confirmations in our society related to women's roles and their capabilities or the lack thereof related to their abilities in science, technology, engineering, and mathematics.

McGee and Martin (2011) define stereotype threat as a "type of confirmation bias in which the threat of being viewed through the lens of a negative stereotype suppresses academic performance among Black students at all academic levels" (p. 1348). McGee and Martin (2011) used the personal narratives of 23 high-achieving Black college students to provide insight and detail into the outcomes of stereotyping. The narratives provided feedback on Black peoples' innate ability to perform at high levels in mathematics. Further, McGee and Martin (2011) remind us that students recognize that stereotypes exist in schools and classroom contexts. The participants in this study felt a need to justify that they were not constantly mathematically inferior. Although stereotypes significantly impact the students who experience them, it is essential to realize that in this study, the participants' constant exposure to negative cultural views of Black learners' ability in mathematics contributed to a pattern of resilience that worked to assist them in being powerful beyond belief amid discouraging messages of inequity. Over time, the participants managed stereotypes by incorporating their complex protective tactics and unique identities, which helped them deal with the burden of functioning in a radically stressful and frequently emotionally debilitating environment. This study revealed that the participants were vigilant to verify these stereotypes as wrong, served as role models and mentors to their Black peers and family members, and always felt pressure to be competent in their studies.

Bias and Subtle Messages

According to Covington Clarkson and Contreras Gullickson (2020), Black girl magic in the media is ubiquitous, establishing a positive narrative for Black women with a history of curriculum, societal, and career marginalization. They encourage us to initially work to understand Black females' challenges to examine how they break through barriers. This qualitative study revealed themes of confidence, notions of connection,

competence, culture, community, and communication. Findings suggest that Black girls want to be included in rich and rigorous mathematics learning, and when they receive high expectations, they work toward them. The participants sought opportunities to communicate about challenging mathematics and desired to be acknowledged with micro-affirmations for their success. This study sought to establish sources of "agency and validation for students of color" (Covington Clarkson & Contreras Gullickson, 2020, p. 65) while opposing white normed constructs. Encouraging and mentorship support Black girls while navigating the racial and social issues in mathematical spaces.

Research Questions

This study centered on seventh and eighth-grade middle school Black girls aged 11-13, enrolled in advanced mathematics, Algebra I, a high school mathematics course designed for ninth-grade students. The following questions guide this study:

- 1) How do intrinsic and extrinsic factors affect Black middle school girls' performance in advanced mathematics classes?
- 2) How do societal messages about Black girls' and their mathematics abilities impact them, and how do they combat damaging stereotype threats?

Methodology

This study was conducted at Katherine Johnson Middle School – KJMS (pseudonym), located in the southern region of the United States. We chose this site to conduct this study since it was the most significant urban middle school in the state where the lead researcher resided and enrolled the highest number of students. We wanted to attract as many diverse potential participants as possible. The sixth to eighth-grade population at the research site was approximately 1,764 middle school students, with 930 students enrolled in seventh to eighth grades. Among the population, 150 students were enrolled in Algebra I, the most advanced course available. Of the 150 students enrolled, 23 students self-identified as Black and female.

Participants

Black girls enrolled in Algebra I as middle school students were the most suitable for this research study because they met the following criteria: 1) mathematical advanced placement, 2) race identity as Black, and 3) gender designation as female. The mathematics placement criteria required students to be slated for

or enrolled in Algebra I before or during their eighth-grade school year.

Among the 23 students eligible for the study, 11 agreed and provided appropriate permissions to engage in this study. All eligible and willing students were invited to participate. The 11 participants (denoted by pseudonyms) were Alexandria, who was in seventh-grade and considered twice accelerated in mathematics since she was a seventh-grade student taking a ninth-grade mathematics course; musically talented Allison; Aaliyah, who has a passion for social action related to race and gender; Amari, who uses technology to assist her in learning when it becomes difficult; Elizabeth, an energetic seventh-grade student who enjoys engaging in art and music; Kayla, an inter-district student who travels from a nearby city to attend school and intrinsically motivated, introverted, and reserved; May, who is academically competitive with her friends; McKenzie, a confident student and avid reader; and Penelope, Trinity, and Zoe all student-athletes who also engage in several school activities as leaders.

Data Sources

This research study took place during the Fall 2019 semester. As a qualitative study, four types of data collection mechanisms were employed: 1) individual interviews, 2) focus-group interviews, 3) collective memory writing, and 4) the researcher's journal.

Interviews

Interviews were designed to foster interactivity between the researcher and participants. Each participant engaged in individual and focus group interviews in October 2019. Thus, they yielded data that elicited in-depth descriptions, context-rich personal accounts, and perceptions of their educational and, specifically, mathematical experiences. The focus group interviews were employed to engage the research participants in different collaborative interview questions. The open dialogue centered on the participants' experiences and parallels among the participants' lived realities. The semi-structured individual interview encouraged rich and detailed data concerning how they perceived mathematical experiences from elementary to middle school, ranging between twenty-five and forty minutes. The two focus groups comprised approximately half the participants and engaged in different collaborative questions centered on the parallels in their lived experiences. The individual and focus group interviews took place on the school's campus in a welcoming location familiar to all participants, which gave them privacy

from students not participating and an opportunity to participate honestly without restrictions.

Collective Memory Work

Written memories through collective memory work (Haug, 1999), a feminist research methodology, was employed non-traditionally. Collective memory work, implemented through journaling, gives participants a solidarity voice that is unfiltered, uniquely their own, and without constraint that speaks to their individual histories and allows their written expression to speak accurately to their mathematical experiences. Parents and participants were introduced to the collective memory work procedure during the informal meeting, and it was reinforced as assent and consent forms. The collective memory work in this study was presented as writing response prompts on a Google form with an opportunity to respond on a desktop computer. The participants engaged in this process twice, once after their interview and another after the focus group opportunity.

Researcher's Journal

The primary researcher kept a record of changing thoughts, new ideas and connections, and details related to the literature and its connection to this study. The researcher's journal also included participants' non-verbal expressions relevant to the study. These reflective and reflexive accounts were also derived from occurrences outside of the research agenda and timeframe in their natural environments as they occurred.

Data collection and procedure

The interviews for this study were audio-recorded to provide an accurate, verbatim account of the participants' ideas. As a benefit to the researcher, the artifacts allowed for the researcher's word-to-word dictation and transcription. These data collections were stored in the researcher's locked personal computer and journal. Data collection and a thematic analysis were systematically done to determine themes and patterns from the collected data using an inductive approach to coding.

Role of the Researcher

As an educational advocate within the KJMS community, the lead researcher has explicitly worked with students through supplemental programming adjacent to middle schools in a non-profit organization within the community. This organization works with Black girls in the community after school and during the summer but is not connected directly with the school. For six years of this study, the lead researcher has focused on

the educational empowerment of Black girls in science, technology, engineering, and mathematics. This role has enabled her to build relationships with the stakeholders in the community. This opportunity provides an advantage in this research, given that the participants had already acquired trust with the lead researcher. This connectedness strengthened a partnership that became advantageous for the research agenda since the lead researcher is familiar with the community and a few parents of prospective participants who were ideal for this study since they met the requirements to engage.

Results

The participants in this research study shared aspects of their experiences and focused on accountable relationships with their parents, coaches, and school personnel. These accountability relationships ensured the participants that their achievement in the classroom was expected and supported in their homes, non-academic spaces such as community centers or churches, and on the basketball court. The prevalent themes that arose were motivation from the engagement in activities involving enjoyable mathematics that they found valuable in their real world, examining the mathematics perceptions held by society about them, and their own perceived mathematics identity.

Valuable Mathematics Outside of School

The participants in this study shared how they used mathematics outside of the classroom. Shopping with parents was mentioned by more than half of the participants in response to how they use mathematics outside of school. Zoe and Trinity also shared how they use mathematics as student-athletes. Zoe reflected on conversations with her basketball coach. It usually takes others an extremely long time to complete the statistical sport record books, but her coach noticed she finished the task in a fraction of the time and told her, "Hello! You are good at math." These statistical record books use data from sporting practices or events to collect and track results from championships, tournaments, and player record holders' performances. Trinity wrote about the same coach but in a different context: "Our coach limits how many turnovers we have and tells us not to go over a certain number, which brings us (to) inequalities."

McKenzie, who conducts scientific experiments, mentioned, "My dad likes to look up different chemical reactions that would happen with certain household objects. And then we make the experiments and just have fun doing that." McKenzie uses mathematics to

measure appropriate chemical reactants to ensure safe and successful experiments. Other participants connected their mathematics experiences to the arts. Allison and Elizabeth reflected on how musical note lengths have particular purposes; for example, the slow and soft notes in songs "really bring emotion to people," mentioned Allison. Participants also mentioned using mathematics when cooking, playing games, or keeping scores for quiz bowl competitions.

Valuable Mathematics Inside of School

Many participants identified their elementary experiences as their starting point for becoming advanced in mathematics through enrichment opportunities. Aaliyah realized that her engagement of advanced academic skills in enrichment programs at the elementary level allowed her to "escape class to work on a project or do something fun." In gifted and talented and mathematics enrichment activities, Aaliyah engaged in learning that extended the regular classroom curricula. "My Math Olympiad™ teacher already taught us algebra concepts like variables, math formulas, and more. We also played math games to help us understand the concepts. These things helped; on the test, I was already ahead." Engagement and valuable mathematics activities such as the stock market game, mathematics Olympiads, and gifted and talented mathematics activities prepared them to excel in mathematics now and in the future, representing each participant's desire.

Perceptions and Self-Perceptions of their Mathematics Identity

The girls in this study were asked, "How do you view yourself in mathematics?" They viewed themselves as "brilliant mathematicians." However, they believed that perception differs in society. Trinity recognized that some people believe Black girls cannot do high-level mathematics "because we didn't have the same education they did at some point. So [they think] we will be behind." She reiterated, "They always had a low, you know, way of looking at Black people."

Aaliyah elaborated,

It mostly originated with White people, but then, you know, Black people started to think it themselves; I guess we're seen as lower level, as a downgrade. They think because some people are poor, and I guess when you live in those areas, you act differently, so they don't expect you to do higher math.

This sentiment was reinforced by Allison, who shared: Since many people are in the minority group, people expect lower than us. They don't have

high expectations for us because we're minorities in American society. It's because there are stereotypes. They expect you to act a certain way for being a certain color.

These brilliant mathematicians identified several advocates in their network. Allison reflected on the mathematical mindset her mother encourages her to have that will lead to desirable thoughts to do mathematics.

Elizabeth's older brothers made mathematics fun for her. She elaborated:

[My brothers] said if I were smart enough to be in the advanced class, I would understand the work. If I can't understand it, I'm smart enough to go ask the teacher or an adult to help me with it. I think it's their personalities that helped me with math because they're both really good at math. So, with them being really good in math and also being hyper and energetic and weird and quirky, all those things tied up into one, with math, it brings this new environment for me just to learn it at home.

Zoe shared how her dad showed up for her and her mathematical development even while living on another continent due to his military duties. As a protective factor and a source of accountability, Zoe understood that her academic performance was not an accomplishment of her own; it was one that she shared with her family.

The brilliant mathematicians in this research study used their quotes as sources of motivation. Some words they choose to motivate themselves and their peers despite societal perceptions include: "Don't doubt how good you are in math. Because when you doubt [yourself], you believe you can't do advanced things and won't try." Amari echoed this sentiment: "Push past what you think your limitations are; if you go beyond what you think you can do, you might discover that you are good at advanced math." Aaliyah said, "Try it, and then be willing to do it." Alexandria suggests, "If you say you cannot do it, you will not. And if you say you can, you will."

Discussion

This research study investigated the protective factors that led to the empowerment, self-consciousness, and self-efficacy of mathematically advanced Black girls in middle school. With a critical lens on the protective factors, this study sought to find motivators associated with their affiliations and accountability relationships that contributed to their heightened mathematics success.

The key findings referenced the value of mathematics in and out of the classroom for the participants and served as a motivator for them to push forward. Black girls in this study were eager to learn mathematics in meaningful ways that contributed to their curiosity in the real world. They sought opportunities to do science experiments involving mathematics and opportunities to escape the regular classroom to engage in fun enrichment and gifted and talented spaces that allowed for exploration of the content in exciting spaces of learning. Their self-perceptions as mathematics students differed from their perception of societal views of Black girls as lower-level individuals with little or no mathematics competencies. Given these stereotypes, they found it necessary to demonstrate their worth while rejecting the opinions of others. Their protective factors worked as accountable validation systems at the school, community, and home levels, with the family offering the most support. Despite societal views of their intellectual ability, the participants persisted in achieving at the highest level. Fathers, mothers, and brothers (in that order) held the most accountability value to the participants in this research study. People of accountability helped to cultivate their brilliance as mathematicians. Other supports, such as accountability partners, were mentioned and the participants mentioned athletic coaches, teachers, peers, and tutors were members.

Limitations

Black girls from one school within a single school district participated in this research study, thus limiting the focus to a single community. The collective memory instrumentation, which required the students to reflect and narrate their past experiences, was the most challenging activity for the participants. This challenge of completing both writing prompts may be age-related or effort-based. The quality of the writing was superior for the ten participants who did engage in the memory writing activity. Most participants completed one of the two writing prompts. One participant was checked out of school for a family emergency and did not have an opportunity to engage fully with either collective memory writing prompts.

Study in Context

The findings examine the implicit biases in our society and how the brilliant Black girls in this research openly acknowledge the presence of racism, sexism, and stereotype threats in our country. Achievement gap narratives in education are supported by policy reports that label Black students as mathematically illiterate

(Martin, 2009; National Research Council, 1989). Many of the participants in this research study know that society sees them as “lower level” or incompetent in doing high-level mathematics, which supports the literature that Black students, especially those who face multiple jeopardies due to the intersections of race and gender experience discouraging educational and societal narratives (Evans-Winters & Esposito, 2010; Tang, 1997; Young, 2016; Young et al., 2017; Hotchkins, 2017). Meso-affiliated resources, those linked to the student’s identity and shaped by their community and neighborhoods (Martin, 2012), can push Black girls forward toward success and combat these narratives so they may push past them toward success.

The participants in this study shed light on the empowerment and resilience of Black girls enrolled in advanced mathematics as they reflect on the valuable ways, they use mathematics. This research study mirrors the claims aspects of McGee and Martin’s research in illuminating Black girls’ success in mathematics.

McGee and Martin (2011) concluded that “racial stereotypes are powerful, but not deterministic” (p. 1380). These messages speak volumes about the empowerment the participants in this study maintain while encouraging others. Using their quotes, many reflected positively with encouragement, suggesting that if you push past your limits, you can achieve, and if you say you can do something, you will accomplish the goal.

Implications

Our findings suggest that all students are vulnerable, and protective factors can propel them forward. Students with more protective factors are better supported in the educational system to engage in higher-level learning. Engagement in extracurricular activities allowed the brilliant mathematicians in this study to explore mathematics in relevant ways. Due to this value, the participants could grapple with mathematics through practical means. These relationships are valuable for Black girls and add a sense of accountability to their mathematics learning.

Examining the compounded effects of stereotypical messages presents an opportunity to engage in dialogue centered on this phenomenon of placing Black girls in a limited mathematical box that is not true to their identity or abilities. Ultimately, there is value added when educators, policymakers, and stakeholders creatively produce opportunities and examine bias by unpacking Black children’s resilience, agency, and tenacity to communicate their brilliance as normative and not as

societal outliers. Black children are less likely to be identified as gifted or to participate in advanced placement courses due to internal school policies that act as barriers that limit them (Anderson, 2020). Programs such as Black Girls Code®, GIRLS WHO CODE, GIRLS-wSTEAM®, Black Girl MathGic™, and MathCounts® may help spark these students’ interests in mathematics and create new, innovative, fun, challenging, and engaging programming to enhance the education of brilliant Black girls.

Conclusion

Experiences during elementary school equip our students with a mindset for mathematics. Although this research is focused on participants at the middle school level, it emerges at the intersection of early and intermediate elementary levels, a time when they begin cultivating a solid mathematics identity. Black girls are brilliant mathematicians and seek opportunities to enjoy mathematics in the real world. Narratives focused on how students use mathematics in valuable ways became a significant theme uncovered in this study. Each participant in this study was engaged in mathematics outside of school and found those experiences to be the most memorable and valuable.

The counter-narratives of stereotypical messages must be pushed forward, illuminated, and shared widely. Enrichment activities like Gifted and Talented programs and the Stock Market Game, taken from the participants’ perceptions, helped prepare the theme for advanced mathematics curricula. Communities that advocate for Black children must push the agenda to unlock the chains of confinement to provide access to challenging curriculums, including those of advanced mathematics, to Black girls.

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